ROAD PRICING
BY TRADABLE SLOTS

To use road pricing simply as a new tax is to waste an opportunity for greater transport efficiency and higher economic growth.

This paper proposes a road use market that will curb congestion, bring order to city streets and transform the experience of motoring.

CONTENTS

Economists since Adam Smith[1] have studied roads, but not always in ways that have much modern relevance. The question of public or private road ownership is moot when most are state-owned, and philosophical analyses about the "fair" price of road use have been superseded by the need to combat road congestion.

A modern argument for road charges, "negative externalities", is hardly more useful. Although road travel imposes costs on more people than the travellers, the extra cost must be measurable if it is to be used to set road charges.

A frequently cited externality is climatic, but the costs of global warming are unknown so the price for carbon dioxide produced by cars cannot be inferred, especially when most CO_2 is not priced.

Certainly some price would be better than none. When road space is limited, giving it away leads to congestion, where users pay in time spent waiting and fuel consumed going nowhere. Apart from the inconvenience, road congestion is a burden on productivity.

A well-designed system for pricing roads will save costs and will raise economic growth. For it to have these effects, however, road users must be charged in a way that gives them the incentive and ability to reduce what they pay. Otherwise, it's closer to a tax than a price. Even if the worthy aim is to raise revenue for road construction, it's still a tax.[i]

[i] This distinction between taxes and prices is idealised. Road use fees can be avoided by not using the road so, no matter how inflexible, they could be called

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A price rations a scarce resource, partly by discouraging some users. But if the price is too high it will inhibit economic activity rather than stimulating it, and waste the investment in roads. The systematic way to set the right price is to establish a market in road use permits.

Because this paper focuses on the practical implementation, it is economics-light. Details have been shifted to footnotes, and relevant economists are quoted in endnotes on page 14. More theories on roads are presented in Robin Lindsey's excellent Intellectual History of Road Pricing.[2]

EXISTING CHARGING SYSTEMS

Current electronic road pricing systems are an improvement on the toll booths of the past but are still not good. Gantries that monitor vehicles passing below encourage drivers to use side roads. Sensors that penalize drivers who enter city centres encourage them to go around, which is indeed an aim of congestion charges.

However, the danger in incomplete road charging is that, while some costs are reduced, others increase. This will happen if drivers make far longer journeys to avoid the charges. The problem worsens as the area covered by the congestion charge grows.[ii]

The grail of road pricing is to monitor all roads and all vehicles. Currently the Global Navigation Satellite System is the cheapest way of measuring the distance driven, the route taken and the time of the journey. Every car, bus, van and truck can be tracked from the sky.

Privacy is one of the first issues that this raises (see Anonymity p.6) but there is another serious concern. Road pricing may become a revenue device. In that case, the more it succeeds in curbing unnecessary trips and promoting off-peak travel, the less money road use charges will collect and the higher they will be hiked.

This is not alarmism. Today, Europe's main way of charging for road use is to tax motor fuel. In EU countries, the average duty and tax on petrol is more than a third of its final price and the charges on diesel are almost as much. Electricity pays VAT only, and often at a special low rate. There is no way to set different prices on electricity according to how it is used.

When electricity becomes a viable alternative to liquid fuels for driving long distances, the switch to electric cars will leave a hole in national budgets. This will motivate governments far more powerfully to charge for road use than congestion does.

RING-FENCING REVENUE

There is natural resistance to a tax on mobility, but the association of the car with freedom does not mean that its use should be free. The more important issue is to prevent road use charges, once they are introduced, from creeping steadily upwards regardless of the demand for roads.

One way is to earmark the money for building roads or other transport infrastructure. There may be some logic in this, if high revenue is the result of congestion caused by

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prices. But an ideal tax is one that generates reliable revenue because it has little effect on demand, which is not the declared aim of road congestion charging.

[ii] I am indebted to Robin Lindsey of the University of Alberta for the observation, among many others, that the cost of traffic diversion does not increase indefinitely because few people will have an alternative to passing through a very large area.

inadequate transport arteries. But ring-fencing the revenue is a political non-starter.

Every new government weighs all forms of public spending. Sometimes a new motorway or railway will have priority over a hospital or battalion, but sometimes not. To ask for a promise binding on future governments is to invite disappointment.[3]

A better way of controlling road charges is to apply five rules. If the system of collection is inclusive, transparent, adaptive, predictive and responsive, the Road Authority (RA) is pursuing road efficiency. These rules create a market and will control congestion, with fewer disadvantages, than any system of partial tolls.

RULE #1 INCLUSIVE

The first rule is that the system should be inclusive, meaning that the RA applies user charges to every usable road within a chosen area, and to all vehicles on them. As noted earlier, if charges are applied only to the main highways traffic will be shifted onto unsuitable roads and drivers will make wasteful detours.

The demand that everyone should pay is also a matter of practicality. The RA can charge different types of vehicle differently, but if it exempts certain people or occupations – doctors, the disabled, police, taxi drivers, members of parliament, etc. – it will undermine the very principle for charging for road use.

Pricing roads is no less compatible with public welfare than pricing bread. When road prices create an unfair burden, the hardship can be alleviated with money grants. Cash allowances are more empowering than coupons or free passes because the recipients have the option of not using the money for bread or motoring.

#2 TRANSPARENT, NOT PERSISTENT

The RA's charges must be transparent, clearly calculated and stated in advance. They can depend on when the journey starts but not on how long it lasts (except in car-exclusion areas: see Traffic law enforcement, p.11). For road pricing to have the maximum effect, the driver must know the exact cost before setting out.

It would obviously be nice if the price of a given trip did not fluctuate wildly. Where we live – and therefore how far we travel to work, school or the shops – cannot be changed quickly. However, volatility can be controlled in other ways. If prices suddenly shoot up, they will be responding to an unexpected event. A system that is designed to ignore unusual conditions loses some of its benefits.

ROAD PRICING BY FUEL SAVINGS

For a mid-size European car, roughly calculated, wildly oversimplified

Consumption of unleaded 95:
6.5 litres per hundred kilometres
(5L/100km on motorways)

Fuel costs at €1.55/L:
€ 0.10 /km (€ 0.07 /km)

Approximate electric car power costs:
€ 0.02 /km

Car prices by engine type:
Electricity: petrol 2:1

Charge for road use by electric car:
€ 4.00 / 100km

Table 1: Fuel-based pricing calculation

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#3 ADAPTIVE

The RA should encourage off-peak travel on uncongested roads, by charging more to drive on busy roads. Slot prices should be adjusted to keep the number of users, at any given time, from exceeding the road's target flow rate. As the road starts to fill up, the price will rise. [iii]

Regardless of how tempting the subject is for political pledges, the ratio of peak to off-peak charges cannot be capped because it cannot be known. Only the market will show what extra charges are needed to flatten peaks.

The RA will set higher prices for travel at times when historical data shows congestion is likely, such as on the eve of public holidays. However, it cannot know exactly what price is required because, as the travel date approaches, road users will adjust their plans. The price will be fine-tuned by the market, which will also adapt to events not known long in advance.

Road pricing rules

1. *Inclusive*
2. *Transparent*
3. *Adaptive*
4. *Predictive*
5. *Responsive*

#4 PREDICTIVE

Uncertainty about road prices will be offset by the predictive rule. Delivery businesses and commuters are two of the groups that need to know their transport costs many weeks and months ahead. The system must allow them to book road slots. This will also benefit the RA by predicting road use far into the future.

When road slots are booked, only the RA's booking fees will be payable. In an electronic era, these transaction costs will be low. The road price itself becomes payable when the journey begins, unless the holder sells the slot back to the RA before then. [iv] The practical accounting mechanism is dealt with later, on page 7.

This does not mean that roads must be booked. Drivers will still be able to set out on the spur of the moment and drive according to impulse. They will pay no booking fees but just the current price, which will depend on how close the roads used are to their target flow rate. [v]

Businesses serving spontaneous demand for transport will be unable to book road slots far in advance. They will pass the costs directly to their customers.

Take taxis. Instead of running a meter and telling the passenger the price at the end of the ride with all its delays, the taxi driver will book the route when the passenger boards and state the price in advance. At peak times,

[iii] The target flow rate can be apportioned between vehicle types so that, for example, when the quota for cars is filling up and the price high, the quota for buses is still largely unused and the price is still low. In the same way, pricing could be used to discourage heavy goods deliveries when the roads are full of private motorists beginning their holidays.

[iv] Private road users could be exempted from paying for bookings wasted because of force majeure. If this promotes acceptance of the system, it might reduce enforcement costs, but refunds on demand, or after sufficient complaining, can only damage the system's legitimacy. Refunds will also raise transaction costs and harm market efficiency. These are arguments for keeping the RA at arm's length from government.

[v] In the language of the securities market, impulse drivers pay spot market prices and the various advance prices are the futures market. Prices charged by the RA are its ask prices and the sum the RA pays to buy back bookings are its bid prices.

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the driver may offer alternatives, fast and expensive, or circuitous but cheaper.

THE SLOT MACHINE

No one should be forced to keep road slots booked but no longer wanted, perhaps because they have gone out of business or changed jobs, or perhaps because the slot has become very valuable. Drivers must be able to sell unwanted slots back to the RA.

The RA's buy-back price will be the same as its current selling price but without the booking fee. The selling price will depend on the current state of demand for the road segment in question, so it may be more or less than the price at which the driver booked.

In short, there will be a road slot market. Opponents may brand it a "charter for speculators", but it is the same as the markets for houses and cars, where people buy not merely what they want and need, but also what will hold its value. The road use market will be at its most efficient when every slot owner is a potential seller.

Sometimes the RA will not be buying back a whole journey but just part of it. Obviously long slots are divisible into a number of smaller ones, the practical limit being set by natural geography and road locations. This complexity can be hidden from users by an interface that allows them to exchange the slot "A to D via B" for the slot "A to D via C", and to receive an account credit if some of this journey now takes place on less congested roads.

Another menu option could allow the journey to be shifted to a different time or date. Again, this could result in an account credit. Or the user could ask the system to display alternative routes or departure times that would produce an account credit. In all these ways, the RA would nudge drivers towards less congested roads and travel times.

ROAD TO RICHES?

The congested state of roads in Western Europe makes it natural to assume that slot bookings will be a one-way street to wealth, because slots seem certain to become inexorably more valuable as the travel date approaches. This is not so. If an early booking price is too low and starts to rise, some holders will sell their slots back to the RA. The road will then be farther from its target flow rate, easing the upward pressure on prices.[vi]

Those who hang on to unneeded slots take the risk that others will sell out first and the price will drop. With a pricing curve like the one shown in Figure 3 (p.10), the price will rise very steeply as the road approaches capacity, but correspondingly can fall very steeply as early bookers sell out.

Unless some slot holders are extremely large in proportion to the market, speculators will mostly be playing against each other.[vii] For normal road users, the safest strategy will be to buy only the slots needed but to be ready to sell a slot back as soon as it becomes more valuable than the benefit of the journey planned.

At least initially, while the system is unfamiliar, sales of slots from one person to another should probably be forbidden. The RA

[vi] The steepness of any price rise will depend on the elasticity of demand for slots and the elasticity of supply of slots sold back to the RA. Demand may be rather inelastic (see pricing structure, p.11). The shape of the supply curve is harder to predict.

[vii] Competition law must be examined to make sure that it applies to concentrations of slot purchasing power and collusion between commercial slot buyers.

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will operate the only legal road slot market. For companies, however, slot bookings will be an asset and any attempt to outlaw business-to-business transfers would be fairly easy to circumvent. Better not to try.

#5 RESPONSIVE

All travel is subject to abrupt events, from accidents to storms to demand spikes. Thus, the fifth rule is that the RA must be responsive. When a road suddenly exceeds capacity, the RA must offer compensation to those willing to interrupt or reroute journeys already begun.

Some drivers will not want to hear about opportunities to avoid congestion and save money. It need not be compulsory but, after the concept becomes familiar, only a few will ignore it.

TECHNOLOGY

There are two kinds of device needed, one for the car and one for the RA. In the car is a mobile-enabled GPS tracking unit: let's call it a routebox. This will be fixed to the vehicle or held by one of its users but programmed with the vehicle's licence number for the duration of the journey. Each routebox needs an account with the RA.

In regions where GPS coverage is poor, the vehicle may need an antenna to get a strong signal. And where weather conditions can make it hard for cameras to recognize licence plates, the vehicle may have to be fitted with a transponder to emit the plate number. No other vehicle modifications will be necessary.

The RA will require more complex devices to ensure that every vehicle on a use-controlled road contains an operating routebox. The same devices will collect real-time data on road congestion, which will be unpredictable because of drivers without bookings (Impulse & Planned modes, p.7).

The routebox will use the Global Positioning System to determine where the vehicle is. It will regularly transmit this location and the vehicle's licence number via a cellular network to the Road Authority. The RA will need to make special arrangements, perhaps GSM localisation, for road tunnels and urban canyons, but the overall cost of the devices required will still be low.

It will be illegal to drive a vehicle that is not reporting its correct position to the RA. This will involve police work although the RA's monitoring devices can help to identify offenders. But the system can reduce the overall amount of policing required on the roads, because of its applications in enforcing traffic law (p.11).

PRIVACY

The aim is to ration road use, not to create a new tool for monitoring people's movements. There must be legal safeguards for the privacy of data generated.

The system will contain an inbuilt privacy feature. Bookings will be specific to the routebox in question, not to any particular vehicle (although they may be for a certain type of vehicle, such as a car, light van, goods vehicle or bus).

The vehicle license number needn't be typed in until the journey begins. This solves the problem that would otherwise arise when account holders buy a new car. It also allows the vehicle to be changed during the journey.

Most routeboxes will probably be registered to individuals or companies but the system doesn't require them to be. People

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who require strong privacy safeguards can have anonymous routeboxes.

PAYMENTS

Although only the booking fee is payable when a road slot is booked, and the price quoted is not payable until the journey begins (page 4), limits must be imposed on speculative bookings. People should not be deterred from advance slot purchases, but they must have funds available.

This is particularly true for anonymous routeboxes. Otherwise, an owner who could not afford a booked slot nor sell it back at a profit would be able to avoid taking the loss by leaving the slot unused and discarding the account. Holders of registered routeboxes must also be discouraged from running up excessive debts.

It would impose a heavy burden on motorists and the road transport industry if road use fees had to be deposited with the RA when the slot was booked. This would still be unacceptable even if the RA paid a good rate of interest.

The solution is to use commercial banks. Routebox accounts should be held at banks that will guarantee payment. The bank would be responsible for ensuring that the account holder had the funds to pay for the slots booked, or at least assets that could be liquidated to do so. Interbank competition would hold account management fees low.

Drivers who wish to avoid banks can be allowed to open accounts directly with the RA. These accounts would offer ultimate anonymity, because they would be topped up in the same way as prepaid mobile phones.

Drivers with only an RA account (i.e. no bank guarantee) will have to keep the account in enough credit to pay for all their road slot bookings. RA accounts will obviously be appropriate for occasional impulse-mode drivers and for foreign visitors (see International Aspects, page 9).

The RA can pay interest on funds deposited in the account, but it cannot consider the current resale value of bookings when calculating the balance. As market conditions change, so will this balance. It does not represent a guarantee of future liquidity.

IMPULSE AND PLANNED MODES

At its simplest, the routebox will display the rate per minute that the present road journey is costing. An application in a GPS-enabled smartphone can do this. If the journey has not been booked, the RA deducts the current road use charges from the account as the vehicle travels forward.

In this impulse mode, without a road slot booking, the driving experience will be little different from today. Probably most people will continue to make short trips on impulse. However, if they live in congested areas, they would be wise to check which local roads have high current user charges.

More sophisticated routeboxes, based on a laptop or a tablet computer, will be able to operate in planned mode. The driver will input the starting and finishing point and the desired departure or arrival time. The RA then calculates alternative routes, departure times and the road use charges for each.

When the driver accepts a route, the routebox reserves the road slots required. On the road, it guides the driver, gives information about delays and sometimes offers credits for accepting a route change.

IN THE BAND

Any road allocation system that outlawed free choice would be unacceptable. Freedom

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of the road is already hedged with a thousand restrictions but to be forced to follow computer instructions would be new tyranny. There is no rationale for it. In intercity travel at least, the RA must allow sudden deviations from the route booked.

If the driver wants a restaurant, filling station or other facilities, or dislikes the current route for any reason, he/she must be allowed to turn off it at will. The booked route is not a line but a band within which the driver can move, using side roads, at no extra charge. The width of the band will vary according to geography and the capacity of roads in nearby areas.

Unfortunately, frequently interrupted journeys may shift the vehicle into a later, congested road slot that has not been booked. This could also happen if a delivery vehicle is delayed by loading and unloading, or if the driver simply chooses to drive well below the permitted speed.

It remains to be seen whether this is a significant traffic planning problem. In one sense, the driver is already paying a penalty in terms of time wasted. However it is possible that, when the absence of congestion improves the experience of driving and eliminates the need to make up for time lost, top driving speeds will fall. If it turns out to be so, the booking system may have to request target speeds.

The opportunity for concatenating disparate intermittent trips is a loophole that can be closed by suspending journeys that pause for long periods. The periods need not be fixed; the RA can calculate whether delays are resulting in travel on more congested road segments, and the routebox can issue a warning accordingly.

If the warning is ignored the journey will be suspended automatically. Thus the system will also provide a cut-out for journeys that are terminated by unforeseen circumstances like accidents. See also Accidents, breakdowns, p.12.

Similarly, drivers can be warned if they are straying beyond the band that they have booked and given the opportunity of booking a revised route or continuing in impulse mode. In either case, the RA would buy back the unused journey segments.

SYSTEM OPERATOR

The RA won't have to operate its own navigation system. It can request bids from providers of existing navigation applications. A sample interface shown in Figure 1, displaying the route and the band, is loosely based on Google Maps.

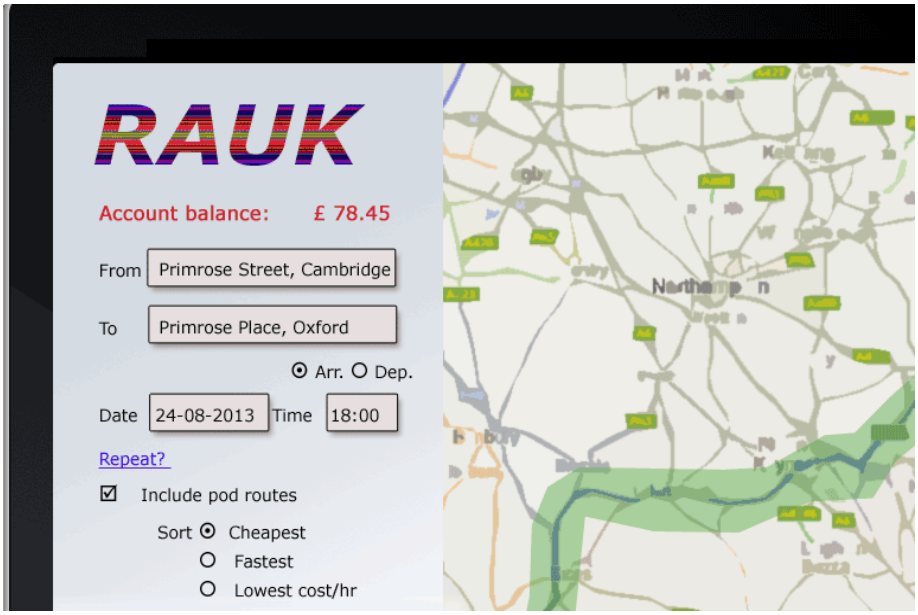

Figure 1: Sample routebox interface

The costs of the navigation app provider can be offset by revenue from location-aware advertisements, if the user chooses to receive these on his routebox. Restaurants, hotels and nearby filling and charging stations are potential advertisers. Data mining offers other opportunities

It has been assumed so far that the Road Authority is a public body so there is no reason for a value-added or sales tax to be imposed on top of the road use price. If the RA is a private organization, a tax could be incorporated in the road use charge. However, it won't affect the price to users, which is set by the target level of road use. The RA will just get less of the take.

INTERNATIONAL ASPECTS

The scheme proposed in this paper can be easily adapted to conform to the specifications for a European Electronic Toll Service.[4] However, the underlying European Union Directive 2004/52/EC is concerned with the standardisation of tolling technology and mechanisms for toll collection. It will need to be updated to ensure European interoperability if flexible market-based pricing systems are adopted.

Advance transnational agreement would be required if an EU country wanted to replace excise duty on motor fuels with road pricing. By decision of the European Council ten years ago, there is a minimum level of tax on motor fuels in the EU. Eliminating this tax would certainly encourage public acceptance of road use charges. On the other hand, leaving the tax in place would promote the transition to electrically powered vehicles.

There are very few other barriers to the early implementation of RA systems. Foreign vehicles arriving at the border can be loaned a routebox for the duration of their stay, with an RA account. The visitor will start by topping up the account with prepaid credit.

WINNERS AND LOSERS

Like any system of fees, road pricing will hurt some users more than others.[5] The sharpest divide is between business and individuals. Companies can deduct their expenses from taxable income, whereas private persons usually cannot. The distribution of real road pricing costs will be most unequal in countries with high corporation and income tax rates.

The salesman on business is more likely than the shopper to be able to afford to set out for a busy district during rush hour. If the

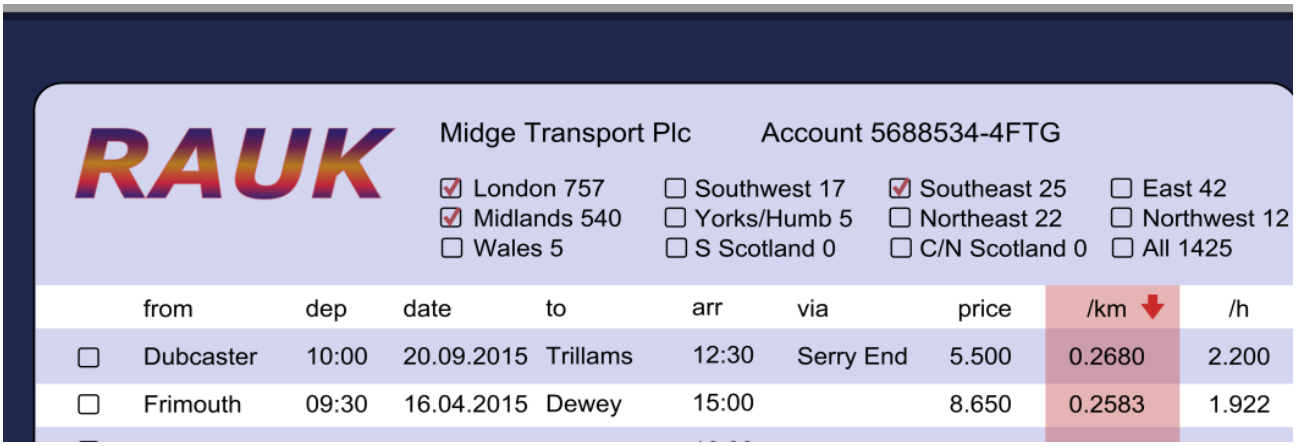

Figure 2: Account management interface

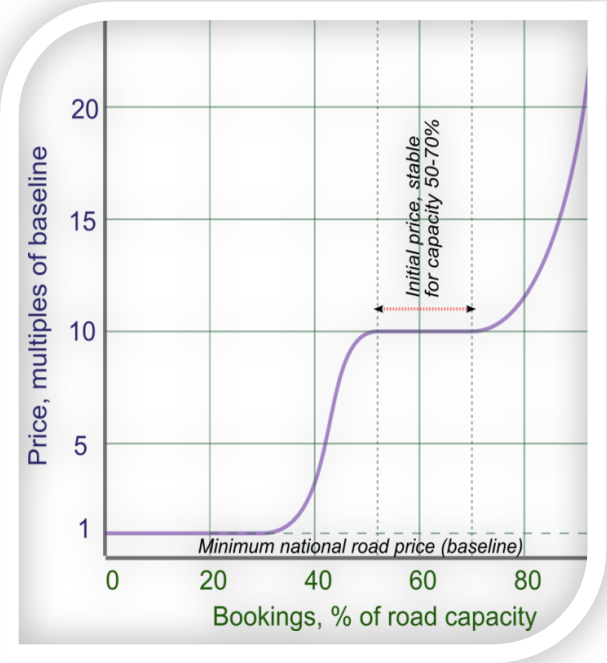

Figure 3: Notional pricing curve for busy road

salesman's trip is for his employer, this may be justifiable. It becomes inequitable when the salesman is actually just going shopping.

In many countries of high personal taxation, employees and employers collude over no-questions-asked expenses. Unlimited taxi receipts are reimbursed, employees' mobile phone bills go direct to the employer, etc. Although tacitly accepted by taxation authorities, this weakens the employee's incentive to choose the cheaper option.

In a road use market, the disincentive would be disastrous. The reason that road charges rise is to discourage road use. If they don't discourage it, because someone else is paying, they will keep on rising.

Pretty soon, the unemployed and others without generous fringe benefits would be driven off the roads entirely. Well before then, of course, the whole exercise will have been written off as a "market failure", though it will have been a political failure.

Any attempt to shield drivers from road use prices would be counterproductive. The costs to private individuals must not be tax deductible and the deductibility of road charges in corporate taxation must be tightly controlled.

DAY ONE

The system will have to be introduced in two stages. First it will be announced that road pricing will begin in a certain region at a future date, perhaps a year hence. Too long a transition would be counterproductive, yielding first no response and then, as the deadline loomed, demands for its extension.

The RA will start accepting bookings immediately for journeys that will be made after road pricing has begun. For this, it needs to estimate demand. Today the cost of peak period travel is paid mainly in terms of time wasted in traffic. It is hard to know where the price will settle when it is paid in money.[6]

The road booking system will gradually generate data about how strongly the price of road slots affects the demand for them and the supply of slots sold back. But even that relationship will evolve over time, as businesses and personal driving habits respond to road pricing. Other transport systems and the whole range of prices affected by transport costs will change.

If a formula existed for calculating exactly what the right price is, we would not need a road slot market at all. The problem on Day One is that not even market participants will have much idea of the right price.[viii]

This points to a need for extensive surveys and studies in advance. It will be a difficult task because, in countries suffering severe

[viii] An open, ascending price auction does not appear to be viable, because of the great range of slots available. The allocation mechanism must not only be fair but also accessible to ordinary people.

congestion, the price that people would feel happy about paying will be below the price that is effective in eliminating congestion.

PRICING STRUCTURE

The RA will first decide the baseline, meaning the minimum price payable for road use (e.g. Table 1, p.3). It will then decide a number of multiples of this price for certain roads at certain times, depending on historic demand. These will set the prices which it initially charges for advance bookings.

Its aim will be to set a price which is as likely to fall as to rise. When the road reaches a certain proportion of capacity, say 70%, the price will rise. The closer it gets to 100%, the more steeply it will rise, curbing demand and stimulating sale of slots already purchased.

But if, at a certain number of months from travel date, the road is below a certain proportion of theoretical capacity, say 50%, the price will be reduced towards the baseline. Figure 3 shows a notional pricing curve for a busy road, where the initial price is set at 10 times baseline.

A multiple of ten may seem a lot but, in countries of great road congestion, the price required to choke off excess demand on busy roads will be high. Because road prices are expressed per distance, a high price will be needed to discourage short urban trips. And over longer distances, a priced road contains the promise of a journey unimpeded by traffic jams, which is worth paying for.

The formulae used to calculate the price must be public. So must all booking data. A corps of experts, analysts and brokers will inevitably form, but the road slot market can remain accessible to the ordinary motorist via news reporting and commentary, in the same way as the housing market is.

TRAFFIC LAW ENFORCEMENT

So far, the system of road pricing has been described as it applies to high-flow and intercity roads. It can fulfil different functions in urban areas. On highways, the target flow rate will often be the speed limit, but it can be set individually for each road.

The equipment for road pricing is capable of replacing many other road monitoring devices and systems. It also offers considerable savings in police manpower.

Pedestrian zones

Europe has mixed experiences with creating shopping streets or waterfront promenades by banning vehicles from them. Enforcing the ban requires continuous policing, and exemptions have to be made for maintenance, deliveries and special needs.

The tangle of official and unofficial rules for vehicle exclusion can be swept away by road pricing. In this case, the price would not be determined by a target flow rate, but set at a fixed, very high rate for use per minute.[ix]

Low-flow streets

Beyond pedestrian areas, inner city streets can be assigned low flow rates. These rates can vary throughout the day, for example to shift essential traffic to the early morning or late evening.

Instead of polarised vehicle rules – absolutely forbidden or entirely allowed – road pricing can pedestrianize city centres without an army of inspectors.

[ix] A very low designated flow rate might achieve the same result but the market would be so thin that the price would be volatile. Moreover, charging by time will control waiting and parking in the pedestrian area, as well as access to it.

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Bus and taxi lanes

Roads reserved for buses can be enforced by high user prices. Some may see this as turning bus lanes into Bentley lanes, but the present system of fines is hardly different. If only some offenders are apprehended and only after a while, there is a benefit from breaking the rules if you can afford it.

Indeed, even the poor will sometimes happily pay a premium for a fast route when the cost of arriving late is greater, such as when hurrying to catch a plane.

Where road pricing eliminates congestion, the benefit of using a bus lane will be reduced. However, many cities will continue to dedicate some roads to public transport. High prices for non-authorised use are an alternative to police work.

They also resolve the vexed question of whether taxis should be allowed to use roads reserved for public transport. Yes, if the passenger is prepared to pay a substantial extra charge. (See taxi operations on p.4, too.)

Speed limits

A system that continuously monitors vehicle positions could track speeds far better than road cameras, although speeding would remain a punishable offence rather than becoming a chargeable option.

Speed monitoring would be valuable in the pedestrian zones mentioned earlier in this section. Unless extremely low speed limits are enforced, the high price per minute of road use will encourage fast driving.

Waiting fines, parking fees

Speed monitoring in urban areas can be used to enforce stopping and waiting restrictions, which will still be necessary in a congestion-free world. It will be easy to distinguish between a flow of vehicles interrupted by a traffic light, and a single rogue. The system will impose the restrictions continuously, not just when a traffic officer is present.

Routebox accounts might even be used for paying standard parking fees, if the RA is allowed to collect monies on behalf of other organisations. The charge in pedestrian zones would extend to time parked in any case.

Accidents, breakdowns

Road vehicles do not always work as expected. The routebox interface must contain an easily accessed stop button, for drivers who find themselves suddenly immobilized in a place where they would be subject to waiting fines or parking fees.

To avoid misuse, there must be a charge for using the stop button but it can also perform the valuable service of summoning emergency assistance. The same function would be useful beyond urban areas; see In the Band, p.7.

IMPLICATIONS

Tradable road slots is a new idea. In the past 2-3 years there has been some analysis of how a market for driving rights would work[7] but ICT advances have taken the potential of Road Authorities to a new level. Returning to the supermarket analogy, charging for the right to go shopping is inferior to pricing the goods, and the best result will come from pricing everything on the shelves rather than just popular items.

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In the months since this paper was first published, it has been acclaimed as the blueprint for transport efficiency and derided as the recipe for political suicide. A British political commentator applied the *Daily Mail Test* and concluded that the scheme is utterly unworkable.[x]

The dilemma is that road pricing will cause great dislocation in countries like Britain that suffer severe, widespread congestion. Hence the search for a fix that will leave individual prerogatives unchanged while somehow modifying the aggregate outcome. Things may not be bad enough yet for a solution.

Paradoxically, countries like Finland that suffer only intermittent, slight, local congestion are able to consider road pricing dispassionately. Because they don't really need it, it will cause little social disruption.

CONCLUSIONS

The paradox points to the answer. The system should be developed where it is not yet urgently required. The data obtained on how road bookings respond to price changes can then be used to design complex models for congested national road networks.[xi]

The impetus to this development path should come from commercial road users, whose interests will otherwise be forgotten in the effort to gain public acceptance for road use charges. Whatever the attitude of private individuals towards the trade-off between price certainty and travel time,[xii] pricing transparency and predictability are vital for business.

Commercial road users can be the force that makes a market-based road pricing system work. Although cars account for four times as many vehicle miles on European roads as light vans, goods vehicles and buses, many of the cars are travelling in the service of employers.

Companies have the resources to manage road slot portfolios like other assets, changing routes and times to improve their profitability (Figure 2, p.9). And by selling back bookings that, in response to high road demand, have become more valuable than their yield, they will increase market responsiveness.

Unless road pricing is market-based, it will be used by governments for revenue or as a way to make transport systems "fair". In effect, "fairness" will often mean creating a comparative advantage for rail without any improvements in the railways.

For some road transport companies this spells bankruptcy. For all transport users it adds up to more costs and less competitiveness. Business needs to climb into the driving seat before that happens.

Pat Humphreys

[x] "How would the Daily Mail see this scheme? There is not the slightest chance of it passing that criterion. You brush off the equation of cars with freedom but, right or wrong, this is a monstrous granite conviction, politically immovable."

[xi] Road price elasticity will probably vary from country to country according to the level of income, the density of the high-flow road network and the availability of alternative transport modes. There may also be a "national character" involved.

[xii] Some high occupancy/toll lanes in the US employ frequently changing rates yet still have "approval ratings" well above 50 percent among the private motorists that use them.

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ENDNOTES

[1] "The expence of maintaining good roads and communications is, no doubt, beneficial to the whole society, and may, therefore, without any injustice. be defrayed by the general contribution of the whole society. This expence, however, is most immediately and directly beneficial to those who travel or carry goods from one place to another, and to those who consume such goods. The turnpike tolls in England, and the duties called peages in other countries, lay it altogether upon those two different sets of people, and thereby discharge the general revenue of the society from a very considerable burden."
Smith, Adam. 1776. An Inquiry into the Nature and Causes of the Wealth of Nations.

[2] "My search of the economic literature did not find a soul who favours traffic jams... Beyond that primary insight, however, there is much disagreement… over how to set tolls, how to cover common costs, what to do with any excess revenues, whether and how "losers" from tolling previously free roads should be compensated, and whether to privatize highways. These disagreements fill a lot of pages, while the main point of agreement is largely taken for granted."
Lindsey, Robin. 2006. "Do Economists Reach A Conclusion on Road Pricing?" Econ Journal Watch, Volume 3, Number 26.

[3] "(T)olls are looked upon, not as a means of financing road construction, but as a means of bringing about the best utilization of the highway network. This is in keeping with the growing acceptance among modern economists of the proposition that best use of facilities requires methods of pricing the services of these facilities that reflect the incremental cost attributable to each service demanded by an individual user. Because of the non-linearity in the relation between amount of use and cost, such pricing does not necessarily produce revenues equal to the total cost of operating and financing the facility."
Beckmann, Martin, C. Bartlett McGuire and Christopher B. Winsten. 1956. Studies in the Economics of Transportation. New Haven, CT: Yale University Press.

[4] "European electronic road toll systems introduced at local and national levels from the early 1990s onwards were, and generally still are, non-interoperable… The European Electronic Toll Service (EETS) will ensure interoperability of tolling services on the entire European Union road network. EETS will enable road users to easily pay tolls throughout the whole EU with only one subscription contract with one service provider and a single on-board unit."
Kallas, Siim. 2011. The European Electronic Toll Service (EETS). Directorate- General for Mobility and Transport.

[5] "Congestion pricing cannot be sold as a policy that harms no one, nor even as a policy that helps everyone. It needs to be positioned as a policy that will help some particular group a lot. We believe that constituency can and should be the cities that host freeways."
King, D.A., M. Manville and D.C. Shoup. 2007. "Political calculus of congestion pricing", Transport Policy 14(2), 103-180.

[6] "Road pricing is a simple concept that extends the common practice that is virtually ubiquitous in every other sector of a market economy whereby prices are used to reflect scarcity, and to allocate resources to those that can best use them. In most places road space, even in such supposedly market orientated societies as the U.S. is in actuality allocated in a manner more akin to the general practices employed in pre-1989 communist Russia, namely by waiting in queues and lines."
Button, Kenneth J. 2004**.** The Rationale for Road Pricing. In Road Pricing: Theory and Evidence, Research in Transportation Economics 9, ed. Georgina Santos.

[7] **Verhoef, E., Nijkamp, P. & Rietveld, P.** 1997. "Tradable permits: their potential in the regulation of road transport externalities", Environment and Planning B 24(4).
Wang, X.L., H. Yang, D.L. Zhu and C.M. Li. 2012. "Tradable travel credits for congestion management with heterogeneous users", Transportation Research Part E 48(2).
Nie, M. and Y. Yin. 2013. "Managing rush hour travel choices with tradable credit scheme", Transportation Research Part B 50(1).

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