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Transport policy for a post-Covid UK

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Keywords Transport policy**,** fuel taxes, road pricing, road investment

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Transport policy for a post-Covid UK

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Abstract

Transport policy needs reform. Future Government investment and fiscal policy needs re-orienting to stimulate the economy after the Covid-19 lock-down. Prices used in project appraisal must include all external effects, committing to proper social cost-benefit analysis. In consequence, fuel duty rates need to be more than doubled as a prelude to proper road pricing. Transport investment needs to be increased even with proper road pricing and more allocated to walking and cycling, guided by benefit-cost ratios, following Eddington's recommendations. The paper gives five reasons for raising fuel duty rates, more on diesel than petrol, and estimates the desired levels.

1 Introduction

The UK Government is now contemplating its exit strategy from the period of lock-down, when the economy will need to be stimulated to return to growth and something approaching full employment. In March, the Chancellor caught the headlines with claims to "get Britain building" by investing in roads and broadband internet.[2] The then Opposition leader criticised the Chancellor for planning to build more roads that would harm the environment further. Within a month lawyers acting for Transport Action Network sent a Pre Action Protocol Letter for Judicial Review to the Secretary of State for Transport opposing the Government's strategic plan to spend £27.4 billion towards investing in the Strategic Roads Network on the grounds, amongst others that "the Secretary of State must have regard, in particular, to the effect of the Strategy on the environment (underline added)."[3]

This paper will argue that transport strategy has needed a change for some time, but has faced considerable opposition to that change. Fortunately, there is now growing consensus that future Government investment and fiscal policy will need substantial re-orienting to stimulate the economy after the Covid-19 lock-down in a sustainable and equitable way. There are two key messages for that change in direction. First, the prices used in appraisal of projects and policies need to include all external effects, both good and bad. That should also be associated with a commitment to proper investment appraisal, or social cost-benefit analysis, as set out in the Government's Appraisal Manuals (*The Green Book*, HMT, 2018) and refined for transport appraisal. Second, as part of getting prices right, fuel duty rates need to be considerably increased as a prelude to proper road pricing. These messages echo those forcefully made by Sir Rod Eddington (2006):[4]

- My first recommendation to Government is…to improve the capacity and the performance of the existing transport network. Incremental improvements will not be sufficient. New

[1] I am indebted to Georgina Santos for swift and helpful comments, although I take responsibility for any misinterpretations.
[2] E.g. on the BBC at https://www.bbc.co.uk/news/business-51837206
[3] https://transportactionnetwork.org.uk/wp-content/uploads/2020/04/PAP-Letter-LD-to-DFT-09-04-2020-FINAL-cleaned.pdf
[4] Quotations from the Eddington Report are taken from Butcher (2010).

capacity will be needed ... I have no doubt that the right policies in the right places can make a significant contribution to UK productivity and competitiveness to the benefit of all…

- My second recommendation to Government is therefore to target future growth-focused investment…in the end - road pricing is an economic no-brainer. However, a sensible road pricing regime will still require additional road build - Government will need to strike the right balance.
- My third recommendation to Government is therefore to deploy a sophisticated policy mix of pricing, better use, and investment.

Transport prices must fully reflect environmental externalities, and transport planning must take account of likely carbon prices. …The Government needed to 'get the prices right' across all modes – especially congestion pricing on the roads and environmental pricing across all modes.

2 Road investment and taxation

The Chancellor' March emphasis on roads was partly counterbalanced by the greener February *Cycling and Walking Investment Strategy Report to Parliament.*[5] This reported on the 2017 statutory *Cycling and Walking Investment Strategy*. From 2016/17 to 2018/19 £1.2 billion was invested in cycling and walking infrastructure and other active travel projects. A further £1.2 billion is projected in 2019/20 and 2020/21 (£600m./yr.). This doubled the 2017 ambitions and increases spending in England, outside London, from £3.50 per head to over £10 per head.[6] This compares with £10.2 bn. spent on UK roads in 2018/19 (Table TSGB1303), and is 6% of that (annual) total, somewhat less than the share of distance walked or cycled in private transport (at 6.7%, in Table NTS0303).[7] Government accepts that the benefit-cost ratio of cycle investment is 13:1, which would be increased if some of the unquantified health benefits are included.[8] This rather rare reference to a benefit-cost ratio underlines the importance of making transport (and other) investment decisions of a fully social (i.e. with all impacts priced) cost-benefit appraisal, as Eddington noted above.

Given the rapid increase in public borrowing, tax increases at some stage are inevitable, while the net-zero 2050 legislated carbon target makes it imperative that investment is green. Both suggest an increase in road fuel tax, whose rate has been falling in real terms. As the public is currently wary of public transport and prefers therefore to use private vehicles, and as oil prices, and with it, petrol and diesel prices have fallen, now is a good time to raise the fuel excise duty. This would help offset the move away from public transport, encourage other forms of zero and low-carbon transport (walking, cycling, and electric vehicles), and help mitigate growing congestion. Part of that tax increase can be additionally defended by the need for carbon prices to increase (as they have already for fuels for generating electricity). Carbon pricing should take the form of carbon taxes as far as

[5] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/863723/cycling-and-walking-investment-strategy-report-to-parliament.pdf

[6] Compares average spend per head over SR15 period against SR10 period.

[7] All such tables can be found on the Department of Transport website, e.g. https://www.gov.uk/government/statistical-data-sets/tsgb03 .

[8] *Walking and cycling – the economic benefits* at http://content.tfl.gov.uk/walking-cycling-economic-benefits-summary-pack.pdf and Department for Transport (2015) which gives estimates based on a partial list of benefits.

possible (as they do in the electricity sector), ideally with Border Tax Adjustments to protect trade-exposed sectors. Leaving the European Union will require a rethink of carbon pricing.

This raises the issue of the reform of energy taxation more generally (Newbery, 2005b). At present, fuel and power for domestic use (including coal!), and electricity and gas for all use, bear VAT at 5% rather than the standard rate of 20%, and are thus relatively subsidized by just under 15%. Electricity bears a high carbon price (the EU Allowance price or its replacement, and the Carbon Price Support) while gas bears no carbon price unless used in a plant covered by the EU Emissions Trading System. Electricity also bears a number of other levies to pay for various environmental and efficiency purposes, while gas bears none. As an elementary proposition in public economics, all fuels should bear corrective taxes for damaging externalities (notably greenhouse gases), and all should be subject to the same standard rate of VAT (Deaton and Stern, 1986), which has the merit of falling on final consumers without distorting production.

The second strand of transport policy is decarbonising the fuel, which for cars means moving to battery electric vehicles (BEVs). The Government had already committed to spend £500 million on charging hubs for BEVs in its 2020 Budget,[9] and under the current system of road taxation, BEV's are heavily subsidized as they do not pay the fuel excise duty and hence do not contribute to the cost of the road network. At some stage if the switch from internal combustion vehicles to BEVs is successful, that lost tax revenue will need to be replaced, and the logical, at least partial, solution, is to replace it with road pricing, often termed congestion charging. Fuel duty would be reduced to levels justified by carbon prices and charges for other externalities (other air pollutants, such as NOx, particulates, etc.), and the residual cost of the road network (see below), with the rest collected through road pricing.

The third issue to address is that of the volume and type of road investment. The next *National Infrastructure Plan* will not be published until later this year, so all we have to go on is the *National Infrastructure Delivery Plan 2016 to 2021*.[10] That shows the cumulative allocation to transport (all sectors) at about 30% of the total of all infrastructure, both in the past and in the post-2020 pipeline (£68 billion out of £225 billion post-2020). However, 88% of the post-2020 transport pipeline is for rail, and only 0.3 of 1% for roads (and that is less than 0.1 of 1% of total infrastructure spending in the post-2020 pipeline). Perhaps this just reflects how out-of-date are the projections. If we look at the cumulative averages from 2018/19 to 2020/21 the share of road investment in transport investment rises to 15% and for rail falls to 53% (4% and 15% of total infrastructure investment over that period). It is therefore difficult to see how this is in any way excessive, and clearly at variance with the Eddington recommendations listed above. The next sections document the evidence in detail.

3 Road expenditure and taxation

The total revenue (in real 2018 prices) collected from all road users and total public expenditure on roads in shown in figure 1. Revenue comes from road fuel excise duty (shown excluding VAT) and vehicle excise duty (VED), which greatly exceeds the amount of

[9] https://www.gov.uk/government/publications/budget-2020-documents/budget-2020#executive-summary

[10] The latest update is at https://www.gov.uk/government/publications/national-infrastructure-delivery-plan-2016-to-2021

investment and maintenance expenditure on roads (central and local government, also shown in real terms). What is striking is that total maintenance expenditure has fallen by more than 50% from 2010/11, although capital expenditure has remained fairly constant. Total (investment and maintenance) expenditure per vehicle km travelled (VKT) has fallen by 25% from 2010/11 while total revenue per VKT has fallen by 19%. Looking back rather further, Figure 3 below shows that the number of lane-km of road completed each year has fallen considerably since 2000.

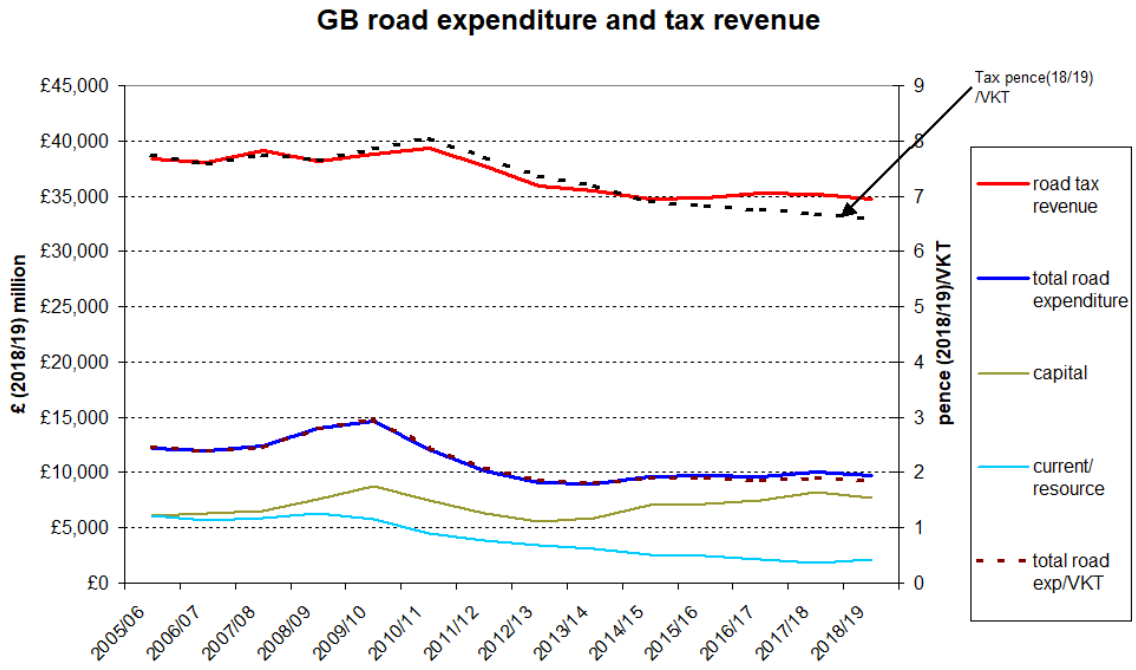

Figure 1 Road tax revenue and road expenditure
Source: *Transport Statistics for Great Britain* (Tsgb1302), deflated by CPI

Investment and maintenance expenditure is only part of the cost of the road network, as the network itself has considerable value as an asset. If its costs were to be calculated as for other network utilities, then the total would be operating costs (opex, mostly maintenance) and then the interest on the Regulatory Asset Base (RAB).[11] The 2020 Ofgem determination of the Weighted Average Cost of Capital (WACC) for electricity transmission assets is 2.47% (real, CPIH) based on 55% gearing with a cost of debt of 1.47% (real).[12] The road network is publicly owned with little asset risk compared to a privately owned grid, so arguably 2% is a more appropriate WACC. If the road network were valued at £300 bn. at 2018 prices,[13] the RAB*WACC would be £6 bn. at 2% or £7.5bn at 2.47% (compared to investment of £7.9 bn. in 2018/19).

Part of the reason for the fall in revenue/km might be improved fuel efficiency, and for that reason it is necessary to look at fuel tax per litre and also the pre-tax price of fuels. Both are shown in figure 2, together with VAT-included pump prices. Notice that diesel duty

[11] Normally depreciation would also be included but as roads are assumed to last forever with suitable maintenance that is already covered by opex.
[12] See https://www.ofgem.gov.uk/system/files/docs/2020/07/draft_determinations_-_finance.pdf
[13] Uprating the 1998 estimate in Newbery (2005), and allowing for 2% growth in lane-km since then.

was higher than petrol between 1998 and 2007[14] – justified by the higher pollution caused by diesel than petrol, as recently highlighted by the "dieselgate" scandal. The real duty per litre has fallen by 17% since 2010 and the pre-tax petrol price has fallen by 38% since then, leading to a fall in the pump price of petrol of 24% (20% for diesel).

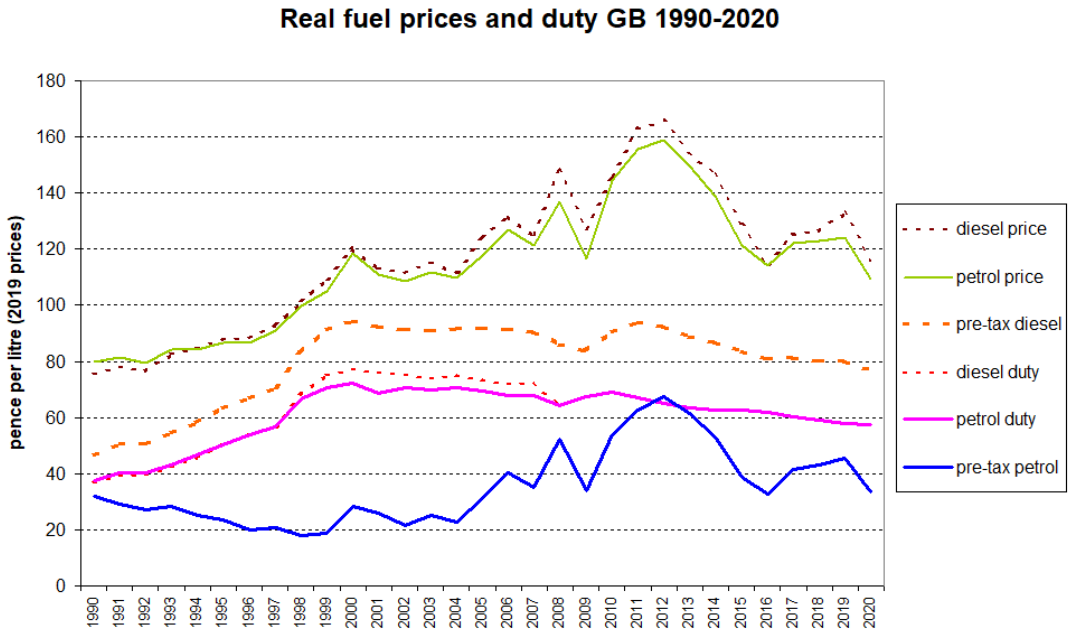

Figure 2 Road excise duty rates and road fuel prices pre and post-tax in 2019 prices
Source: DfT Statistics (Table ENV0105 /TSGB0305) deflated by CPI)

4 Congestion

Over the period since 1993 the length of all major roads has grown on average by 0.1 of 1% per year, while unclassified roads have grown by 0.5 of 1% per year, presumably to serve the growing number of new housing developments. Looking back 20 years, Figure 3 shows that the number of lane-km (km, not thousands of km, and lanes, likely to be 6 for a motorway) of road completed in England each year has fallen considerably since 1998/9.

At just over 100 lane km completed this is less than 0.02 of 1% of the total number of lane-km in England (i.e. at this rate it would take 61 years to add 1%).[15] Over the period from 1993 VKT on all major roads has grown by 35% and on motorways by 62%. Adjusting for increases in road length, figure 4 shows the growth in traffic (measured by VKT/kmyr) on motorways (41%) and 'A' roads (22%) or 31% on all major roads. This increase in traffic can be expected to lead to more congestion, but there is limited national data available to test this. Figure 3 shows the number of billions of hours cumulatively attributed to delays[16] on major 'A' roads averaged over the day both as index numbers to align with traffic and as absolute values that are shown on the right hand axis. Note that neither axis starts at the origin. The

[14] According to TSGB0305, but according the Government the two rates have been equal since 2001 – see https://www.gov.uk/government/statistical-data-sets/oil-and-petroleum-products-weekly-statistics
[15] If lane-km completed applies to major roads only (the statistics come from Highways England) then the rate of completion is 0.08 of 1% of all major lane-km, and it would take 12 years to add 1%.
[16] See next footnote (and to figure) for measurement details.

relationship between VKT and delays on 'A' roads is clearly complex, and the lack of consistent time series data makes this harder to study.

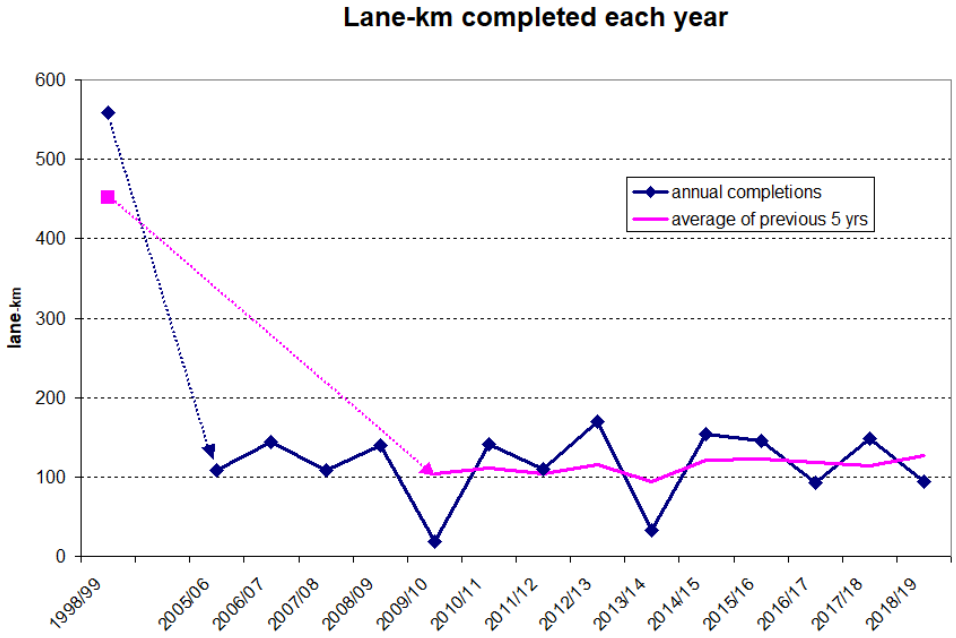

Figure 3 Lane-km completed annually in England
Source DfT Statistics (RDE0104 (TSGB0720))

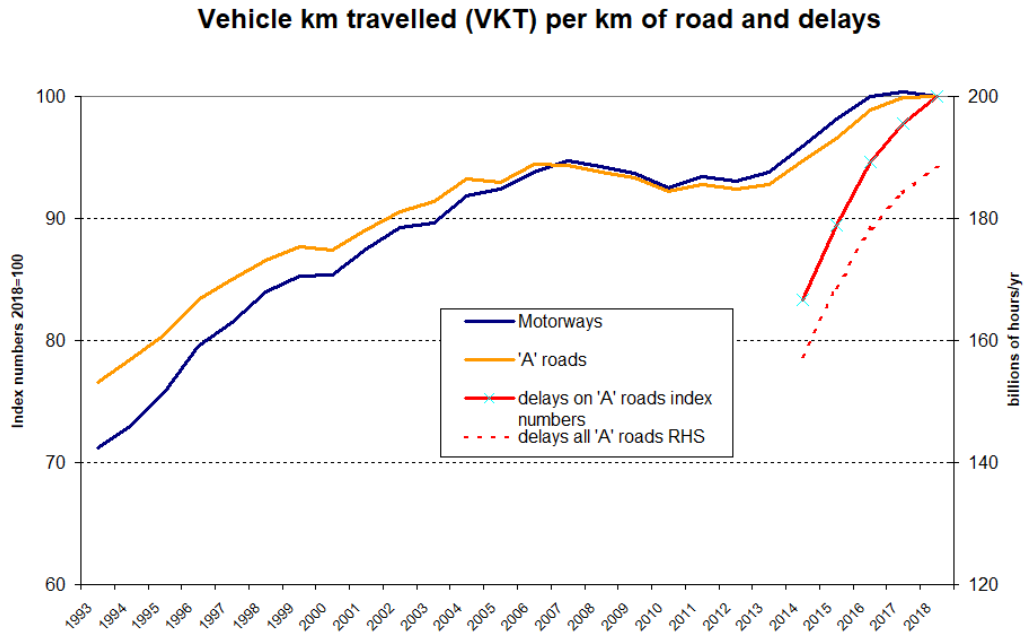

Figure 4 Traffic on motorways and 'A' roads, 1993-2018 and delays on 'A' roads 2014-19[17]
Source: *Transport Statistics for Great Britain*

[17] Delay is calculated by subtracting derived 'free flow' travel times from observed travel times for individual road sections. Free flow travel times are calculated using the 85th percentile speed observation for each individual road sections. These are 'capped' at national speed limits. The methodology for measuring congestion changed in 2014 and so comparable earlier data are not available.

5 The case for raising fuel duty

The efficient way of charging road users would be a Pigouvian tax that internalised all transport externalities – pollution (air, water, noise), accidents and congestion (Newbery, 1988, 1990, 2005a; Newbery and Santos, 1999; Santos, 2017). Climate change caused by CO_2 is simple to tax as it is directly proportional to fuel used, but all others depend on time and place, and are only imperfectly correlated with fuel use. Accident damage increases with the weight of the vehicle - Malczyk et al. (2012) show that in collisions between SUVs and normal cars, 3-4 times as many occupants of cars are likely to be seriously injured or killed than those in the SUVs. That suggests, crudely, that a Vehicle Excise Duty proportional to weight (or some power of weight) might offset the temptation to choose heavier cars to better protect the occupants rather than victims, while fuel duties capture both distance related and to some extent weight-related accident risk.

Santos (2017) quantifies the costs of these externalities on the assumption that they can only be imperfectly charged through fuel duties, updating earlier estimates by Newbery (2005) and Van Essen et al. (2011). Based on 2008 levels of traffic and at 2010 prices, for the UK the marginal externality costs are €ct 11.5/VKT for gasoline and €ct 12.25/VKT for diesel cars, or, more usefully, €1.68/l for gasoline and €2.15/l for diesel (Santos, 2017, Table 8). At 2018 prices the marginal external costs would be £1.70/l for gasoline and £2.18/l for diesel. However, in order to derive the corrective tax, these costs were further adjusted by Santos (following Parry, 2009) to allow for the reduction in fuel consumption that comes from a reduction in distance driven. The formula for the fuel tax is

$$t = \tau + f\beta\,(E^P + E^C + E^A + E^N)$$

where t is the excise tax on fuel, τ is the social cost of the carbon content per litre, f is fuel efficiency, β is the proportion of the reduction in fuel consumption that comes from a reduction in distance driven, E^P is the air pollution externality, E^C is the congestion externality, E^A is the accident externality, and E^N is the noise externality. Parry (2009) estimates β for cars at 0.5. Uprating these data from Santos[18] to 2018 prices (but still based on 2008 traffic levels) the corrective taxes are 90p/l for petrol and 124.5p/l for diesel, compared to the current rate of £0.58/l for both. Since 2008, congestion has increased, and even if air pollution (other than CO_2) has decreased with the increasing stringency of vehicle standards, as congestion was 68% of gasoline cost and 64% of diesel cost, the overall impact is likely to be an increase in cost and hence in the justified road fuel duty rates.

If the petrol duty rates were raised to bring the pre-VAT petrol pump price back to its 2012 real level, the rate in 2020 would be raised by 41.2p/l to a new total duty rate of 99.2p/l, which would be above the required Pigouvian tax level of 90p/l. Moving to the correct petrol tax in one step would therefore seem straightforward.

It would be good to establish the principle that diesel should bear a higher corrective tax for the extra pollution if causes, not least because for each litre, diesel vehicles drive further and do more damage. Uprating Newbery (2005a) suggests an extra 6.5p/l but the more

[18] Personal communication using Santos' uprating. Taking the original data from Santos (2017, Table 8) and the 2010 £/€ rate and then uprating by the CPI gives 89p/l (petrol) and 113.5p/l (diesel).

careful and recent estimate from Santos (2017, Table 8) suggests an addition to the petrol tax of 16.1p/l. If this were added to the now correct petrol duty of 90p/l the new diesel duty would be 106.1p/l, still 18.4p/l below the required rate (diesel vehicles travel further per litre and hence cause more congestion per litre).

In principle, the efficient way to charge for congestion is for traffic related road pricing (perhaps approximated by locally specific time-of-day charges as in the London Congestion Charge). Road pricing gas been long advocated by economists, and actively since the 1960s, most notably by Walters (1961) and Vickrey (1963). It was a policy recommendation of the Smeed Report commissioned by the UK government between 1962 and 1964 (Smeed, 1964). On 10 October 2019[19] a Parliamentary Press Release announced "The Transport Committee wants to start a national debate about road pricing – something that has been lacking for more than a decade since the then Labour Government's road pricing plans were abandoned. This is in advance of an inquiry to be formally announced in early 2020, when the Committee will invite views from across the country from drivers and non-drivers alike about the future of road-based transport." Understandably, with the pandemic, this has been postponed, but will soon have to be addressed.

The case for urban (and possibly on the strategic network) road pricing is strong, but the implementation costs are not inconsiderable, as demonstrated by the high installation and running cost of the London Congestion Charge (Santos, 2008). These costs will doubtless fall with the falling cost of smart cards and readers, electronic number plate recognition and wider scale roll-out, and will become increasingly necessary to replace lost revenue as a larger fraction of Electric Vehicles replace Internal Combustion vehicles. The cost argues for limiting their use to congested areas, where typically a small fraction of the road length accounts for an overwhelming share of congestion costs.

This would allow road fuel duty to be lowered to the level that covers the cost of using the relatively uncongested network, together with those pollution and accident costs that are reasonably well approximated by distance driven. Newbery (1994) sets out the case for treating the highway system as a regulated public utility like the wires and pipes of electricity, gas and water utilities. Fuel taxes could then be set to cover the interest on the highway asset value, together with maintenance expenditure. The rough estimates given above suggest that if maintenance expenditure is raised only to its 2006/7 real level of £5.25bn., the total cost under RAB pricing might be £11.25bn., comparable to total road expenditure (currently £10.2 bn.). Spread over total VKT this would average 2.3p/VKT or 33p/l for petrol and 39.6p/l for diesel.[20] To this would be added the non-congestion externality costs of 31.1p/l (petrol) or 47.2p/l (diesel) to give a total duty of 64.1p/l (petrol) and 86.8p/l(diesel). A possible superior solution would be to base these additional externality costs on the most recent vehicle standards, and recover the excess from older more polluting vehicles through higher VED, encouraging a switch to lower polluting vehicles (and electric vehicles in particular).

[19] At https://www.parliament.uk/business/committees/committees-a-z/commons-select/transport-committee/news-parliament-2017/national-road-pricing-17-19/

[20] This does not correct for the decreased distance driven as a result of the higher fuel taxes, which would increase the cost per litre if the aim were to recover the total road costs.

6 Five reasons for raising fuel excise duty

Until road pricing can be introduced, however, there is a strong case for raising the road fuel duty, for five reasons. The first is that it is currently well below the Pigouvian tax that would internalise the externality cost of private cars, as noted above (goods vehicles need to pay additional amounts via higher Vehicle Excise Duty).[21] The estimates above suggest raising fuel duty for this reason alone by a factor of 1.55 and diesel by a factor of 2.15, as they have declined in real terms. As noted above, the real duty per litre has fallen by 17% since 2010. In any case given higher pollution costs diesel should attract a higher duty than petrol, while the increased km/l offered by diesel is an additional reason for a higher tax per litre to give the same tax per km travelled.

The second reason is that pre-tax fuel prices have fallen over time, and recently dramatically with the fall in demand caused by the pandemic. The pre-tax petrol price has fallen by 38% since 2010, leading to a fall in the pump price of petrol of 24%. The best time to raise taxes is when the pre-tax prices have fallen, so the rise in the pump price compared to the past will not seem so high. The calculations above show that the rates could immediately be raised to 99.2p/l for petrol, higher than needed to internalise the various externalities. An increase to the correct 90p/l would therefor seem reasonable, taking advantage of the fall in fuel prices to restore the petrol pump price to somewhat less than its recent real level. Now that the higher pollution caused by diesel is widely recognised, it might at the same time be possible to impose a differential extra tax of between 16.1p/l (for pollution costs alone) or 34.5p/l to bring diesel duty up to the corrective level of 124.5p/l.

The third reason is that the Budget will need extra tax revenue, soon in very substantial amounts to pay down the high deficits of supporting the economy during the pandemic. Better to tax in ways that brings prices closer to their efficient level than increase taxes on already taxed goods, and in a green future taxes on fossil fuels have an obvious political attraction.

The fourth reason is that the population is wary of exposure to Covid-19 on public transport and prefers the self-isolation of private transport, and this should not be further encouraged. There is an incidental benefit of congestion charging (of which higher fuel taxes are an imperfect substitute) in that the economics of public transport have considerable economies of scale – increasing ridership with a fixed public transport budget can allow a more frequent service that in turn makes the service more attractive, while removing cars from the road improves reliability, again increasing attraction (Small, 2005). The same goes for encouraging bike use which again, by lowering traffic makes bike use safer, raising its appeal and inducing more motorists to switch mode.[22]

The fifth reason is that it should facilitate the move to road pricing, as this could be pre-announced with a future reduction in road fuel duty, as part of gaining public support for road pricing (at present many consider that road pricing would be an addition to existing

[21] Goods vehicles pay 4.5 times as much on average as private and light goods vehicles (Table TSGB1311 (RDE0103))

[22] http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=ENV/WKP(2019)2&docLanguage=En

perceived to be high fuel taxes). In the transition period it might be possible to persuade motorists to support road pricing as they would be given a rebate of say 60% of their fuel tax of up to 120% of their congestion charge. This might be done with a vehicle-specific smart card to record the purchases of fuel and hence duty paid (the remainder would be the duty to cover non-congestion road costs).[23]

7 Conclusion

The pandemic has lowered fossil fuel costs, giving a perfect opportunity to raise road fuel duty. Fuel duty has fallen in real terms over the last decade while the number of vehicles travelling over each km of road has considerably risen. Just restoring real pump prices would allow duty rates to rise by £1/l, and there is a case for restoring the higher tax on diesel even without road pricing to account for the higher pollution it causes. Covid-19 has reduced demand for public transport and hence raised demand for self-isolation in private cars, while encouraging a shift to public transport generates multiplier effects by improving their economics, hence their frequency and hence their attractiveness. The same effect applies to encouraging more walking and cycling, which become more attractive as vehicle traffic falls.

Road taxes are an imperfect way of charging for congestion, but until that can be rolled out more widely, current fuel duty rates are fall below those justified by current levels of congestion. Raising fuel taxes with the promise of a reduction once road pricing is rolled out would pave the way for that policy. Finally, the budget will need to find extra revenue sources to pay down the high cost of managing the pandemic, and corrective, rather than distortive, taxes are clearly preferable.

Much has been made (mostly by the Government) of their claimed ambitious plans for more road building. To date these are underwhelming, while the arguments that Eddington made in his 2006 Report are even more the case now – "to improve the capacity and the performance of the existing transport network. Incremental improvements will not be sufficient. … road pricing is an economic no-brainer. However, a sensible road pricing regime will still require additional road build. … My third recommendation to Government is therefore to deploy a sophisticated policy mix of pricing, better use, and investment. … Transport prices must fully reflect environmental externalities, and transport planning must take account of likely carbon prices."

The main addition to make to that is to redress the underinvestment in walking and cycling. That would naturally happen if infrastructure investment were guided by a proper *social* cost benefit analysis, where cycling appears to have benefit cost ratios of 13:1, higher than the already high (4+) values cited in the Eddington Report for good road schemes of all sizes, and putting the very low value of HS2 quite to shame.

[23] The choice of percentages would need more careful calculations than this illustration.

References

Butcher, L. 2010. *Eddington Transport Study*, House of Commons Library SN/BT/4208

Deaton, A. and N.H. Stern, 1986. Optimally Uniform Commodity Taxes, Taste Differences and Lump-Sum Grants, *Economics Letters*, 20, 263-266.

Department for Transport, 2015. *Investing in Cycling and Walking: The Economic Case for Action*, Department for Transport

Eddington, R., 2006. *The Eddington Transport Study. Main Report: Transport's Role in Sustaining the UK's Productivity and Competitiveness*,

HMT, 2018. *The Green Book: Central Government Guidance on Appraisal and Evaluation*, latest version at https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-governent

Lindsey, R., 2006. Do Economists Reach a Conclusion on Road Pricing? The Intellectual History of an Idea, *Econ Journal Watch,* 3(2), 92-397 at file:///C:/Users/dmgn/AppData/Local/Temp/2006-05-lindsey-reach_concl.pdf

Malczyk, A., G. Müller, T. Gehlert, 2012. The Increasing Role of SUVs in Crash Involvement in Germany, IRCOBI Conference 2012, at http://www.ircobi.org/wordpress/downloads/irc12/pdf_files/17.pdf

Newbery, D.M., 1988. 'Road User Charges in Britain', *Economic Journal* (Conference), 161-176.

Newbery, D.M., 1990. 'Pricing and Congestion: Economic Principles Relevant to Pricing Roads', *Oxford Review of Economic Policy'*, Vol 6 (2), 22-38.

Newbery, D.M., 1994. 'The Case for a Public Road Authority', *Journal of Transport Economics and Policy*, **XXVIII** (3), September, 325-54

Newbery, D.M., 2005a. 'Road User and Congestion Charges' ch. 7 pp 193-229 in S. Cnossen (ed.) *Theory and Practice of Excise Taxation* Oxford: OUP.

Newbery, D.M., 2005b. 'Why tax energy? Towards a more rational policy', *Energy Journal*, **26** (3), 1-39 http://www.jstor.org/stable/41319496

Newbery, D.M. and G. Santos, 1999. 'Road Taxes, Road User Charges and Earmarking', *Fiscal Studies*, **20**(2), 103-32

Parry, I.W.H., 2009. How Much Should Highway Fuels Be Taxed?, RFF DP 09-52, Resources for the Future, Washington D.C. http://www.rff.org/RFF/Documents/RFF-DP-09-52.pdf

Parry, I.W.H., Small, K.A., 2005. Does Britain or the United States have the right gasoline tax? *Am. Econ. Rev*. 95 (4), 1276–1289.

Santos, G., 2017. Road fuel taxes in Europe: Do they internalize road transport externalities? *Transport Policy* 53, 120–134

Santos, G., 2008. London Congestion Charging, *Brookings-Wharton Papers on Urban Affairs,* 177-234

Small, K.A., 2005. Road Pricing and Public Transit: Unnoticed Lessons from London, *Access*, No. 26, available at http://www.socsci.uci.edu/~ksmall/Transit%20-%20Access.pdf

Smeed, R.J., 1964. *Road Pricing: The Economic and Technical Possibilities*, HMSO at https://archive.org/details/op1265810-1001

Van Essen, H., Schroten, A., Otten, M., Sutter, D., Schreyer, C., Zandonella, R., Maibach, M., Doll, C., 2011. External Costs of Transport in Europe, Update Study for 2008, Report for CE Delft, commissioned by International Union of Railways (UIC). file:///C:/Users/dmgn/AppData/Local/Temp/CE_Delft_4215_External_Costs_of_Transport_in_Europe_def-1.pdf

Vickrey, W. S. 1963. Pricing in Urban and Suburban Transport. *American Economic Review* 53: 452-465.

Walters, Alan A. 1961. The Theory and Measurement of Private and Social Cost of Highway Congestion. *Econometrica* 29: 676-699.