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ROYAL COMMISSION *REPORT ON TRANSPORT AND THE ENVIRONMENT* – ECONOMIC EFFECTS OF RECOMMENDATIONS

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I. INTRODUCTION

The core of the argument, summarised in 14·4 of the Royal Commission on Environmental Pollution's *Report on Transport and the Environment* (hereafter the *Report*), is that the forecast doubling of road traffic by 2025 'would be unacceptable in terms of emissions, noise, resource depletion, declining physical fitness and disruption of community life.... It justifies placing significant constraints on the future evolution of the transport system'. The economic case for intervening in the transport sector must be that 'transport involves large costs, some incurred directly or indirectly by users, and some as a result of its environmental effects. Hitherto, most of the latter costs have fallen on the community rather than on the users or the builders of the transport system. Seriously misleading price signals have resulted, leading to decisions in all areas of transport which have harmed the community'. (*Report*, 14·5).

To an economist, then, the problem is one of market failure – the markets are failing to allocate resources efficiently because users face misleading price signals. If these were corrected to reflect external costs, or externalities, and if transport users responded efficiently to the corrected price signals, the result should be an efficient use of transport instead of the present and projected unsatisfactory outcome. This view suggests that the problem is how best to move to a situation in which the marginal social benefit of transport is equated to the marginal social cost, including all the cost currently borne by the rest of the community and the environment. How far can this be achieved by market means, using corrective taxes and proper charges for road use, and how much reliance will need to be placed on non-market controls over the supply of and access to road space?

These external costs can be usefully divided into three categories. The first are those primarily experienced by other concurrent road users, but not taken into account by road users in deciding their level of activity. These include congestion and accidents to other road users.[1] The second group includes environmental effects which harm current and/or future people. This group

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[1] Road damage can be charged for, or dealt with by restrictions on axle loads and configurations, and is discussed in the *Report* in the context of larger lorries at 10·56–60. See also Newbery (1988*b*).

includes air pollutants (especially particulates, nitrogen oxides, and other substances listed in Appendix A of the *Report*), most of which have an almost immediate impact on the health of individuals and acidification of the environment,[2] noise, with an instant impact, and CO_2 (carbon dioxide), whose stock increase will lead to global warming and future damage. The third and last group concerns the interactions between transport investment, transport demand and land use. It is one of the major achievements of the Royal Commission that it highlights this poorly understood but potentially crucial market failure.

How important are these three sources of market failure, and how far does the *Report* reflect their relative importance and identify appropriate corrective responses? Will the economic effects of its recommendations lead to an improvement in resource allocation, or may they make matters worse? These economic issues are discussed in the *Report* in chapter 7, which is, however, flawed in ignoring the main congestion externality. Table 1 above rectifies this

Table 1

UK Transport Externalities, 1993

Road taxes £bn		16·4			
(of which fuel tax) £bn		(12·7)			
Road costs @ 8% interest[a] £bn		10·9			
		A	*B*	*C*	*D*
		£ bn	£ bn	*A* as %	*B* as %
Congestion costs		19·1[a]	19·1[a]	52	60
(456 bn PCUkm @ 4·18 p/km)					
Road damage etc		1·5[a]	1·5[a]	4	5
Air pollution					
Particulates	2·4–7·0[b]			(19)	
NO_x	0·3[c]			(1)	
Other	0·1[c]			(0)	
Total air pollution		2·8–7·4	2·4[d]	20	8
Global warming (CO_2)		0·4[c]	1·8[d]	1	6
Noise		0·6[c]	1·2[d]	2	4
Accidents		4·5–7·5	5·5[d]	20	17
Total externality costs £bn		29·3–36·9	31·9	100	100
As ratio to fuel tax		29·3–36·9	25		
per PCUkm[e] pence/km		6·4–8·1	7·0		

Sources: [a] Appendix Tables A 1, A 2.
[b] Pearce and Crowards (1995).
[c] Pearce (1993).
[d] Royal Commission on Environmental Pollution (1994).
[e] 1 PCUkm (Passenger Car Unit km) is the congestive effect of 1 car per km.

omission and collects the various estimates of the costs of the first two groups of externalities. The top panel provides reference data for 1993/94 road taxes (£16·4 bn, from DoT, 1993*a*) and road costs, which are the cost of providing and maintaining the infrastructure, taking a required rate of return of 8% on

[2] Though the cumulative stock of acid depositions is also important in sensitive, poorly buffered areas.

an estimate of the capital value of the road network (provided in Appendix Table A 1 to this paper).[3] This rate of return is the same as that required by the Treasury in charging for rail track costs when Railtrack is privatised and the regulatory regime is fully in place.

The middle panel of the table gives two different sets of estimates of the external costs of road transport. The figures for congestion and other road costs are discussed in the Appendix to this paper. Congestion costs are the congestion externality which averaged 4·18p per passenger car unit per kilometer multiplied by the number of PCUkm.[4] For reasons that are unclear, and which may reflect the *Report*'s confusion on this issue, congestion externalities are not separately identified as an external effect to be costed (though there are brief mentions in 6·8 to estimates of their cost).

Column *A* gives estimates taken from Pearce (1993), but updated by Pearce and Crowards (1995). Recent work by Ostro (1994) suggests that the mortality and morbidity effects of particulates may have been seriously underestimated. Pearce and Crowards (1995) have taken Ostro's estimated dose-response relationships and applied them to the UK to estimate the mortality and morbidity costs of vehicle-generated particulates as $7 bn per year.[5] However, one could argue that they have taken a rather high value for a life lost, that they may have over-estimated the proportion of damaging emissions by transport relative to domestic sources, and that the morbidity costs, which are less securely based, seem rather high as they have unit costs only 10–25% below their US source value. Making appropriate adjustments might lower the (very imprecisely estimated) cost of transport particulate damage to £2·4 bn, not far above the original figure of £2 bn.[6]

Column *B* gives numbers from the *Report*, table 7·2 (and they clearly used Pearce's (1993) estimates of the costs of air pollution). The *Report*'s figures in the column *B* at £32 bn are close to the lower (and more defensible) estimates of column *A*, and are nearly twice the total revenue collected in road taxes, (or 2·5 times that collected in road fuel taxes), averaging 7 p/PCUkm. Column *C* gives the percentage breakdown of the figures in column *A* while column *D* gives that of column *B* supplemented by the congestion costs and road damage

[3] Note that this figure is lower than that provided in table 7·1 of the *Report*, which is projected for 1994/95, incorrectly includes VAT (which is a general tax, not a tax specifically on road use), and allocates an excessive level of road damage costs to HGVs, despite the findings reported in Newbery (1988*a*).

[4] The fact that the optimal level of congestion is not zero (6·8) does not mean that the entire cost should not be measured, as the *Report* seems to imply. Any congestion is an externality, which should be charged for to ensure efficiency.

[5] Transport is assumed to be responsible for 50·5% of the total costs (Pearce and Crowards, 1995, table 4), UK total mortality costs are £7·86 bn, morbidity is £6·21 bn, giving a total of £14·07 bn at 1994 prices, (ibid, table 9) of which 50·5% is £7 bn. Pearce and Crowards are continuing to revise their estimates, so the figures reported should not be taken as their final or best estimate. Pearce, in a private communication, remarks that some pollutants such as benzene remain to be costed, and other externalities have been ignored, so even their high figures may be an underestimate of the final cost.

[6] Pearce and Crowards (1995) take the value of a life as £1·5 million for those at risk, identified as the elderly with a shorter life expectancy, which seems high compared to their representative life value of £2 million, and that of the Department of Transport of £0·75 m. If, as seems reasonable, the damaging effect of domestic PM10 emissions is at least equal to that of transport (as it clearly is more closely correlated with population), then transport costs fall to 34% of the total, or to £4·75 bn. Halving the value of a life saved, and of morbidity, would reduce the figure to £2·4 bn.

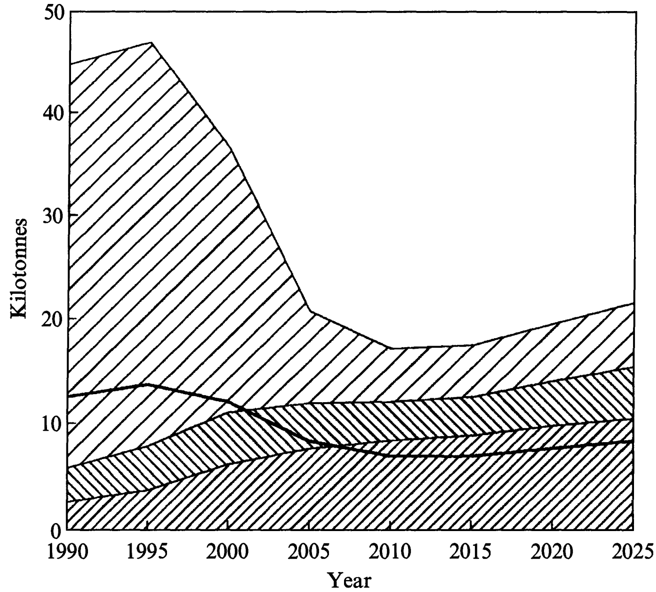

Fig. 1. Projected emissions of particulates: high forecast. Royal Commission on Environmental Pollution (1994). *Key*: ▨, cars; ▧, LGVs; ▨, HGVs and PSVs; ——, urban.

costs from column *A*. The figures in column *D* show that congestion costs are the largest single item, accounting for 60 % of externalities, and that accidents are the next largest at 17 % (though accident costs are extremely difficult to attribute at all precisely, as Newbery, 1988, 1990 argues). The bottom panel provides three different measures of the total cost – as an annual sum, as a ratio to the fuel tax revenue, and as an amount per PCUkm.

There are several striking features to note in Table 1. First, the total quantified pollution costs identified (including noise) are only 19 % of total current measured externality costs (which exclude the consequential inefficiencies in land use). Even taking the highest revised estimates of particulate damage and the high figures for accidents (which also depend on the value of a statistical life), pollution only accounts for 23 %. Second, road transport would appear to be paying less in taxes (which can best be thought of as road charges) than the social costs would seem to warrant. Third, congestion costs exceed road costs (that is, the cost of supplying road space). Newbery (1989, 1994) has argued that if congestion costs exceed the marginal costs of highway expansion, then there is a *prima facie* case for further highway provision. This result has to be qualified, in that it assumes that users pay the full social costs of road use, including all costs identified in Table 1. If road pricing and/or other environmental taxes achieved this, then demand would fall on currently under-charged roads, and congestion would then be reduced. It is this equilibrium level of congestion that should be compared with the cost of extra provision. Of course, where road users are currently overcharged, as on most trunk and rural roads, the case for expansion is relatively easier to make, as discussed later.

If the marginal costs of expanding the road network are similar to the average costs (as they are in many cases), then it is clear that road costs are far short of road damage and congestion costs, so the main reason why congestion costs are so high is that the road capacity is so inadequate.

If current pollution costs are only a small proportion of the total external costs, are they projected to rise rapidly, either in absolute terms, or as a share of the total? The tables shown in Appendix B of the *Report* project the emissions of various air pollutants under a low and high forecast of traffic growth to the year 2025. The most important pollutant in Table 1 is particulates, followed by NO_x. Figures 1 and 2 give the projected emissions for particulates and NO_x

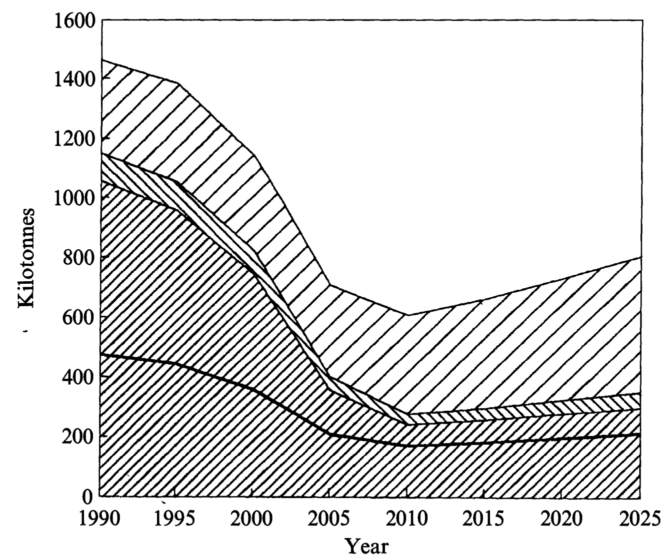

Fig. 2. Projected emissions of NO_x: high forecast. Royal Commission on Environmental Pollution (1994). *Key*: ▨, cars; ▧, LGVs; ▨, HGVs and PSVs; ——, urban.

under the high traffic growth forecast. It is striking that even on the high forecast of traffic growth with a high share of particulate-emitting diesel cars, emissions in 2025 are less than half their 1990 level. Nitrogen oxides will be between 43 and 55 % (low and high forecast) and the only increasing emission is CO_2, which increases by 40 % between 1990 and 2020 (*Report*, table 7·5).

It is very difficult to see how a halving of the most damaging form of air pollutants is 'unacceptable in terms of emissions' and that the appropriate response is to place significant constraints on the evolution of the transport system, which will undoubtedly increase congestion, that already is five times as costly as air pollution. Indeed, as argued above, the fact that congestion costs are so high suggests that the appropriate response is to increase the supply of transport capacity, unless there are other important factors to take into account. The case for a restrictive transport policy must, therefore, rest on the market failures associated with land use, rather than the comparatively modest estimated costs of air pollution. Unfortunately, while it is possible to estimate the costs of air pollution, even if very imprecisely, nobody knows what the ideal balance of land use and transport is, so that we cannot begin to judge the social costs of accepting the present very imperfect balance rather than attempting to move towards a more desirable balance.

II. THE RECOMMENDATIONS

One way to assess the desirability of the 110 recommendations listed in chapter 14 is to ask to what extent they address this major market failure. Chapter 14 groups recommendations by the objectives they address, and the two most important objectives are *Objective A*, 'To ensure that an effective transport policy at all levels of government is integrated with land use policy...', and *Objective C*, 'To improve the quality of life, particularly in towns and cities, by reducing the dominance of cars and lorries and providing alternative means of access'.

The first twenty recommendations bear on air quality, and are disappointing to an economist in their failure to provide any cost-benefit analysis to see whether the recommendations are justified, of the kind that is becoming standard in the United States in the Environmental Protection Agency (EPA). In some cases the recommendations are sufficiently broad that such cost-benefit studies could be conducted when the time comes to decide the form of implementation, but in others, where specific emission limits are proposed, the omission is more serious. The *Report* endorses the principles of the government's sustainable transport policy, the last of which proposes that '...users pay the full social and environmental cost of their transport decision...' (1·13, 14·2), and it is interesting to see what these might be if the air pollutants were costed and related to fuel consumption in transport and other sectors, using EPA data for costs.

Figures 3 and 4 give externality costs for various fuels, using figures taken from Viscusi *et al.* (1994), which in turn are largely based on benefit assessments that have served as the basis for United States EPA's standards, updated to \$1993, and supplemented by the carbon–energy tax at \$10/bbl (which might be thought of as an estimate of the damage caused). Figure 3 compares these costs with the UK 1993 prices of fuel before tax, and with the 1993 fuel tax rates, both as percentages of the net price. Figure 4 gives the cost in \$/GJ, comparing the costs and taxes with the energy contents of the fuels. In both cases the transport-related air toxics have been entirely allocated to gasoline and diesel. The figures for the costs of SO_2 depend critically on the health effects and are subject to great uncertainty (far more so than the health effects associated with particulates). The lower confidence bound for the SO_2 damage costs provided by Viscusi *et al.* (1994) might be only 4% of those shown here, and would considerably alter the relative externality costs associated with different fuels.

The striking feature about both figures is the relatively low level of air pollution costs, even including the carbon tax, compared to taxes on road transport fuels, and the relatively low or non-existent levels of taxes on other

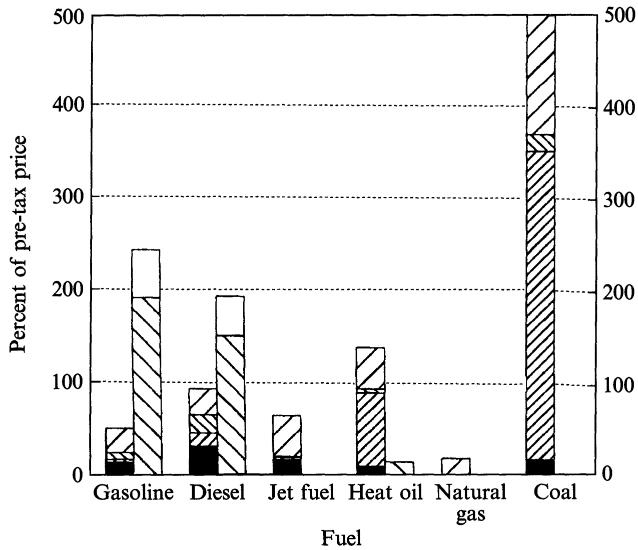

Fig. 3. Externalities and taxes 1993; UK prices and US external costs. Viscusi *et al.* (1994). Carbon energy tax ($10/bbl). *Key*: ■, PM10; ▨, SO2; ▧, other (lead, ozone, visibility, air toxics); ▨, C-E tax; ▧, excise; □, VAT.

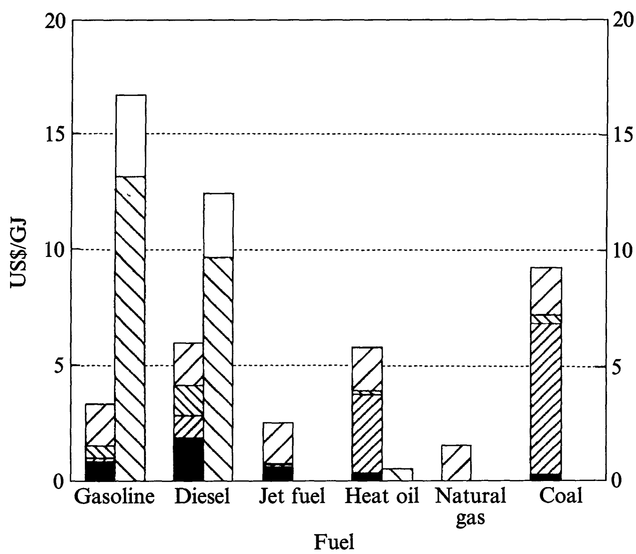

Fig. 4. Externalities and taxes 1993; UK prices and US external costs. Viscusi *et al.* (1994). Carbon energy tax ($10/bbl). *Key*: ■, PM10; ▨, SO2; ▧, other (lead, ozone, visibility, air toxics); ▨, C-E tax; ▧, excise tax; □, VAT.

fuels compared to their externality costs (although the SO_2 costs may have been overstated by a factor of 25). The simplest interpretation is that no fuel is taxed to reflect these pollution externalities, and that road transport fuels are taxed in large part as road user charges, though HM Treasury is certainly unwilling to concede that point, and considers a large part of the transport fuel tax to be a sumptuary tax. The other striking feature of these figures is that air pollutants appear to be more of a problem for domestic heating oil and coal combustion (if there is no desulphurisation) that for road transport. While coal use is falling rapidly, domestic heating oil is unlikely to achieve the rates of reduction forecast for transport shown in Figs 1–2. That road transport is not the major source of most air pollutants is confirmed by Fig. 5, though its dominant share

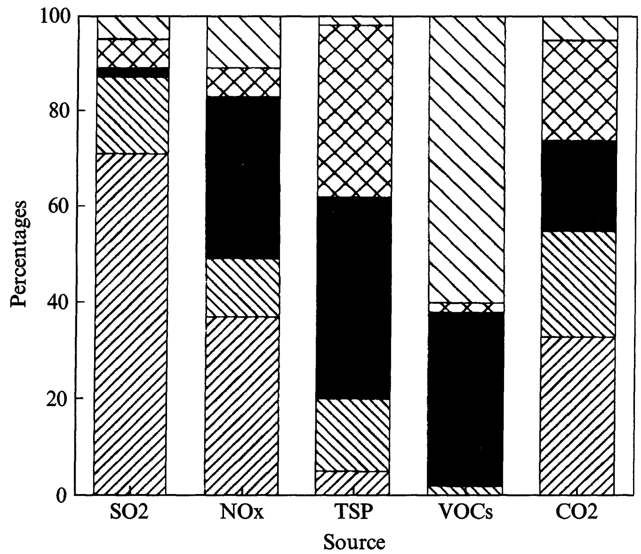

Fig. 5. Sources of air polution in the United Kingdom 1991. Digest of Environmental Protection and Water Statistics, 1992 HMSO. *Key*: ▨, power; ▧, other industries; ■, road; ⊠, domestic/community; ▧, other.

of TSP, or particulates, whose adverse health effects seem to have been best identified, is obviously of concern.

Recommendations 21–27 bear on noise and the use of materials, while recommendations 28–36 are directed to reducing carbon dioxide emissions from transport by increasing fuel efficiency, to be encouraged by a doubling of the price of fuels relative to the prices of other goods by 2005 and steeply graduated annual excise duties based on fuel efficiency for new cars. This specific recommendation is an example of attempting to correct the price signals facing transport users, and is considered in the next section.

Recommendations 37–40 are directed to ensuring a proper social cost-benefit analysis of the loss of scenic amenity or conservation value of land used in road transport, in keeping with taking account of the impact of transport on land use.

The main *Objective A* on integrated land use and transport policy is dealt with in recommendations 41–68. The core of these concerns the need to develop readily accessible methodologies 'to assess the transport implications of land use policies and location decisions as well as the land use implications of transport policies'. (14·55, recommendation 45). An interesting recommendation is 47, 'that the government consider ways of making developers responsible for a charge reflecting the external costs of traffic induced (9·58)'. It is worth pointing to the similarities between this and the idea that new sources of generation or demand placed upon the National Grid should be confronted with access charges that reflects the full marginal cost imposed upon the system. One should not underestimate the difficulties in this task, as the impacts of connection or additional transport may spread over a wide area, and if they are to be charged, then the charges have to be sufficiently objective to be upheld against appeal. In practice, the National Grid has chosen a simpler methodology and doubtless the same would have to be done for any development charges. The fate of the earlier Betterment Levy on the gains realised by planning permission, together with the difficulty of obtaining finance for the infrastructure to supply Canary Wharf, further suggest that this will be difficult.

Recommendation 8, that vehicle excise duty (VED) be graduated according to the emission limits their engines are designed to meet, in an intelligent use of price signals rather than standards, which often encourage the keeping of old polluting vehicles longer than would otherwise be warranted. It has a logic quite lacking in the idea of imposing heavier VEDs on less fuel-efficient vehicles (recommendations 30–31), which, if fuel were properly priced (and the recommendation is to over-tax fuel), would not be necessary.

Recommendation 51 (14·59) urges that 'all significant applications for planning permission should contain an analysis of the transport implications, including pedestrians, cycling and public transport access...'. The *Report* is excellent at showing how far Britain is behind other continental towns in making better use of cycle transport to serve urban use in a more environmentally friendly, healthy, and less congested way. If cycle users could be perceived as non-car using, but tax paying and probably car owning road users who are therefore contributing through the vehicle excise duty to the supply of road space, perhaps the very modest capital requirements to improve the cycle infrastructure could be recognised as a legitimate claim on DoT funds, and the transport planning could be extended to include all modes, not primarily motor vehicles. Later, at 14·62, the failure to address the quality of life in urban centres, and the impact of road investment in decentralising and hence impoverishing city life is stressed, with the implication that the prime emphasis should be placed on providing a satisfactory quality of life, including space, access, and mobility, rather than just concentrating on transport needs independently of the more fundamental determinants.

The critical *Objective C* on improving the quality of life in towns is taken up again in recommendations 84–102. Recommendations 94 and 95 address road pricing and recognise the problems associated with its local implication. Recommendations 97–102 are directed to improving the attractiveness of making journeys on foot or bicycle by reallocating funds to local authorities to support the necessary modest investments required.

These and other recommendations stress the importance of a more important comprehensive cost-benefit analysis of land use and transport. It is therefore disappointing to encounter recommendation 58 that 'planned expenditure on motorways and other trunk roads should be reduced to about half its present level (12·65)'. A more rational response would be to require that the same standards of social cost-benefit analysis be applied systematically not just to urban developments, and by-passes, but also to trunk roads and motorways. Indeed, recommendation 63 proposes that by-passes designed to improve the environment should not be designed for large increases in traffic. Again, this prejudges the results of the kind of detailed cost-benefit study that should properly account for environmental impacts, land-use changes, and growth in the transport network elsewhere. It is most unlikely that a top-down judgement of the kind embodied in this recommendation will be true in all cases.

Recommendations 69–75 concern the objective of increasing the proportion of personal travel carried by public transport without addressing the central problem, that private transport may be undercharged in congested areas. If transport users were to face the right relative prices of public and private transport, they would presumably make the right choice. Subsidising public transport is likely to be relatively ineffective in urban areas, given the high degree of under-pricing of private transport there. Road pricing, if it can be introduced, should solve this problem without further fiscal interventions, though the ideas of coordinating interchange between modes is obviously sensible (recommendation 86).

III. THE CASE FOR INCREASING FUEL TAXES

Recommendation 28 calls for fuel duty be doubled by 2005, as a means of reducing carbon emissions from transport. This case is particularly weak, as carbon dioxide emissions for transport are no different in their impact than CO_2 emissions from elsewhere, and efficiency suggests that all producers of CO_2 should pay the same tax per ton of carbon. The figures given in table 1 from Pearce (1993) in column *A* are consistent either with a carbon tax at £13·33/tC, or with the proposed carbon-energy tax at about $2/barrel of oil, split equally between carbon and energy content. (The CEC proposal is that member states of the EC should introduce a carbon–energy tax of $3 per barrel of oil equivalent in 1993, rising by $1/bbl per year in real terms until 2000, when the tax would be $10/bbl.) The *Report*'s figure, in column *B*, is 4·5 times as high and would correspond to $9/bbl oil,[7] presumably entirely on carbon at £58·2/tC (though for motor fuels the division is unimportant, as they have about the same carbon-energy mix as oil itself. This would not be true for other fuels like coal and gas.) If the proposed doubling of the fuel duty is entirely to be attributed to the carbon tax, the additional tax would translate into £600/tC, which would be a penal rate if applied to other fuels.

If we allow *all* external road costs to be reflected in fuel taxes, then Table 1 suggests that doubling the tax would be justified, though consistency would then argue for rather heavy taxes on coal, depending on sulphur content (with rebates for emissions abatement). The obvious problem is that fuel taxes are a

[7] At the 1993 exchange rate of $1·49/£, close enough to $10/bbl using a different exchange rate.

relatively blunt instrument to achieve efficiency in transport use. The larger part of the external costs arise from congestion, and these costs vary widely across different roads and at different times of the day.

Appendix Table A 2 gives the marginal time cost (MTC) of congestion in vehicle hours per 100 PCUkm, which can be multiplied by the cost of time per vehicle hour to give the marginal congestion cost (MCC), being the extra costs visited upon other road users in pence per km driven on each class of roads by a standard car. The table shows that while 59% of distance travelled is in rural areas (including motorways), these appear to account for only 3% of the total congestion costs.[8] Many of the other externalities, noise, accidents, and air pollution, are likely to be strongly associated with populated urban areas and hence congestion.

Attempting to reflect these external costs in fuel duties will therefore overcharge rural transport, and undercharge urban transport. If most of the externalities are allocated to urban traffic, the average cost would be 17 p/PCUkm, and for a private car paying 3 p/km in petrol duty (excluding VAT), doubling the duty would not go far towards confronting the motorist with the correct charge. On the other hand, rural driving would be paying 6 p/km when the supply price of rural roads is only a fraction of this amount. Newbery (1994) estimated the supply price of expansions of a typical motorway as 2·2 p/km, and for a heavily used motorway such as the M25, which is more costly to expand, the figure might be 3 p/km, rather less than the 1993 level of road taxation per km.

Thus the case for doubling fuel duties as a form of carbon tax seems completely out of line with plausible level of carbon taxes elsewhere in the economy, while using fuel taxes to deal with other externalities is to use a very blunt instrument to tackle what is primarily an urban problem, one best dealt with by road pricing, traffic management and integrated land-use and transport planning, all of which are mentioned in the *Report* but not adequately related to this central spatial aspect of the problem.

IV. ECONOMIC EFFECTS OF RECOMMENDATIONS

The *Report* identifies the quality of urban life and the impact of transport upon it as a critical issue that needs to be addressed at the strategic level of land-use planning as well as at the more immediate level of transport management, urban access, and charging. The *Report* implies that a radical change in urban management, guided by sophisticated social cost-benefit analysis taking account of the land-use and transport interactions will be required. It may be that quite modest expenditures, exemplified by the road cordon in the centre of London provoked by the IRA bombing, and a modest allocation of funds to creating cycleways and pedestrian areas, could significantly improve the quality of urban life and reduce many of the adverse effects of excessive urban traffic. Anything that improves the quality of urban life has a potentially large

[8] Motorway congestion may be underestimated, and the split between urban and rural areas is not precise, but the conclusion that congestion is overwhelmingly an urban problem is surely robust.

impact on the well-being of a significant fraction of the population, and deserves high priority.

The worry is that the main headline-catching features of the *Report* will distract attention from the very valuable contribution these ideas suggest. These headline-catching recommendations are that fuel taxes be greatly increased and trunk road construction be drastically reduced. Neither case is well argued. The fact that congestion costs are high relative to the costs of supplying road space suggests that, if anything, we have too little transport infrastructure, not that we are over-investing in roads. Admittedly, congestion costs are highest where the full social costs of expanding road space is also very high, in congested urban areas, but the appropriate response is to argue for a systematic and comprehensive social cost-benefit analysis of all transport schemes, rather than setting arbitrary targets which are unsupported by the evidence provided.

Rural roads and motorways give rise to fewer externalities than urban transport schemes and provided the visual impact is properly costed, current cost-benefit techniques used by the Department of Transport probably need only minor modification. In general, the road-building programme is constrained not by the shortage of projects but by the shortage of finance, and that suggests that a considerable fraction and perhaps all of the proposed rural road-building programme may continue to be justified on the revised social cost-benefit criteria. In that case, halving the level of investment will give rise to excessive congestion, higher travel costs, and hence a lower standard of living than might otherwise have been the case. Increasing travel costs (both through increased rural congestion and higher road taxes) will probably adversely affect the regional distribution of production, since production and transport costs for exporting industries will be reduced by locating closer to export ports in the South East.

If urban quality is improved while rural transport costs are greatly increased, then the imbalance between the cost of living and quality of life in urban and rural areas will be shifted towards urban areas, possibly a justifiable response to the contrary impact of the Common Agricultural Policy, but one that is hard to justify on social or economic grounds.

Appendix. Estimating Congestion Costs

The costs of providing transport services are the interest on the capital cost of the highway system, the costs of maintaining it, and providing other services (lighting, police, etc.). To find the interest charge we need an estimate of the value of the capital stock. Until 1982 the COS published an estimate of the gross capital stock at depreciated replacement cost in the *National Income and Expenditure Blue Book*, and Newbery (1988, p. 168) uprates these values to give a 1986 value of £50 bn, or, including land, perhaps £56 bn.[9] Since then the

[9] Valuing land used for roads, which in turn affects the value of land rendered accessible, is complex, and properly done can give counterintuitive results, as Arnott (1978) demonstrates. As there is no simple rule that says market prices will over or understate shadow values, the land value here is taken at market prices. A more extensive research project would doubtless improve on this estimate, though it seems unlikely that it would change the results very much.

Table A 1

Road Costs in 1993/94 prices (£m)

Cost category	Annual average 5% TDR	8% TDR
Interest on capital	4500	7200
(Capital expenditure)	(3060)	
Maintenance *less* costs attributable to pedestrians	3252	3252
Policing and traffic wardens	408	408
Total road costs of	8160	10860
which attributable to		
Road damage costs	437	314
Gross vehicle mass	666	495
VKT	275	275
Balance attributable to PCU	6782	9484
PCUkm (bn)	456 bn km	
Cost per PCUkm pence/km	(1·49 p/km)	(2·08 p/km)
Cost per PCUkm incl. VKT costs pence/km	(1·55 p/km)	(2·14 p/km)

Source: Department of Transport (1994*a*, *b*).
Notes: Figures are annual averages for the years 1991/92 to 1993/94 at 1993/94 prices. TDR: Test Discount Rate; VKT: vehicle km travelled. Costs attributable to Gross Vehicle Mass taken from Department of Transport (1994*a*), entirely allocated. VKT costs from same source adjusted in the same proportion as in Newbery (1988, table 2).

Table A 2

Marginal Time Costs of Congestion in Great Britain, 1993

	MTC (veh h/ 100 PCUkm)	VKT (%)	MCC p/PCUkm	Congest cost share (%)	Index of MCC
Motorway	0·05	17	0·32	1	8
Urban central peak	5·41	1	44·74	13	1071
Urban central off-peak	4·35	3	35·95	27	861
Non-central peak	2·36	4	19·51	17	467
Non-central off-peak	1·30	10	10·75	26	257
Small town peak	1·03	3	8·47	6	203
Small town off-peak	0·63	7	5·17	9	124
Other urban	0·01	14	0·08	0	2
Rural dural carriageway	0·01	12	0·06	0	1
Other trunk and principal	0·04	18	0·23	1	6
Other rural	0·01	12	0·06	0	1
Weighted average	—	—	4·18	—	100

Source: Updated from Newbery (1990, table 2).

CSO publishes figures for the gross capital stock in 'Civil engineering works', and roads form the largest single item for local authorities and central government. The 1986 estimate at current prices was £75·4 bn, but in 1975 the total was £23·6 bn, compared to the estimated value of roads alone on £14·5 bn, so about 60% of civil engineering works were then roads. If the same relationship held in 1986, the figure would be £46 bn, close to the estimate of

£50 bn. Newbery (1988) also estimated the value from the length of the road network and the construction cost (in 1986 prices, excluding land, of £0·47 m, £0·30 m and £0·07 m per km of motorways, peri-urban divided roads, and rural secondary roads). The result including land came to £60 bn in 1986, reasonably close to the capital stock estimates. Uprating these by cumulative investment and price changes to 1990 gave a figure of about £80 bn (Newbery, 1990), and further uprating to 1992/93 but recognising that the construction cost index is temporarily very low and hence not a good long run predictor of the replacement cost) gives a figure of perhaps £90–100 bn.

If we attempt to value the construction cost of new roads using the published data on the cost of completing motorways and trunk roads (Department of Transport, 1993*a*, table 3·19) we find that the most recent figures for the cost of completed motorways and principle roads gives a figure of £0·67 per lane km. The 1992/93 index of construction costs has not changed since 1985 (though it rose by 23% to 1989) so price changes do not explain why these figures are six times as high as the earlier figures for 1986, themselves derived from TTRL (1970). If we further assume that all motorways have six lanes, all dual carriageways have four lanes, trunk roads have an average of three lanes, principle roads two lanes, that *B* and *C* roads cost £0·15 per km, and unclassified roads cost £0·1 per km, then the total replacement cost of the UK road network would be £128 bn, or, including land at 14%, £146 bn.

There is thus a great deal of uncertainty about the capital value to impute to the stock of roads, perhaps ranging between £80 bn and £150 bn. If we take a figure of 5% to earn on the larger sum, the interest charge would be £7·5 bn, not far from that shown using the lower capital sum of £90 bn at 8%, as in Table A 1. But the figure might be as high as £12 bn at the higher capital value and interest rate.

Table A 1 also shows (in brackets) the actual capital expenditure, which the Government allocates as part of its total road costs. This is, of course, just a confusion between capital charges, which are a cost, and investment, which should be financed out of revenue to expand the network appropriately. Total maintenance costs are shown, and these are allocated between road damage costs (40% of that shown in DoT, 1994*b*, as in Newbery, 1988), costs associated with gross vehicle mass (allocated to bridges, but arguably not a marginal damage cost), VKT (the same fraction as in Newbery (1988), which were based on a detailed analysis of the raw data). The balance is allocated to supplying road space as such, the demand for which is measured by PCU. The cost per PCUkm can then be compared with the demand price, which should be equal to the congestion cost if that were reflected in an efficient rationing price. Of course, if road pricing successfully charged these scarcity prices, demands would alter, and the actual adjustments required to reach a long-run equilibrium might differ from those indicated by the apparent differences between congestion costs and road costs.

Table A 2 is updated from Newbery (1990), table 2, which in turn was based on Newbery (1988, table 1), assuming a growth in the wage cost per hour of 23% as measuring the increase in the value of time. It should be stressed that these estimates are very rough, as they are based on increasingly out-dated information (for example, the time costs of congestion in urban areas outside London are derived from traffic flows measured by Marlowe and Evans in 1978), and the breakdown of traffic between urban and rural roads is no longer given in *Transport Statistics Great Britain* in the same detail as in 1985 when the original calculations were made.

The marginal time costs of congestion for each area has been left unchanged since 1990, reflecting the level volume of traffic since that date and the negligible expansion of the road network. Congestion on motorways may have increased but accounts for a very small fraction of total congestions costs.

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