TAXATION AND ENVIRONMENTAL POLICY:
SOME INITIAL EVIDENCE

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1 INTRODUCTION

In the current debate about environmental policy the possible use of taxation to pursue environmental objectives has been widely canvassed. This Commentary assembles some initial evidence about a number of possible options for environmental taxation, setting out the costs and benefits of different policy options, and their likely effects. There has been little published work on this subject, and many areas of substantial uncertainty remain. This Commentary is intended as a contribution to the growing debate. It aims to provide some initial indication of the most important issues and effects, but is in no sense out last word on the subject.

The emphasis in this Commentary is on how *taxes* might be used to make the market economy more environmentally friendly. In restricting our subject in this way we recognise that taxes are only one of a number of available tools for managing scarce environmental resources: others include straightforward regulation of polluting behaviour and devices such as tradeable permits to pollute. However, taxes have certain desirable features which may make them an important part of a comprehensive set of policies to manage the environment and control pollution.

Pollution occurs because there are some scarce resources such as air and the sea, which are not the private property of some person (or organisation). Because these resources are not the property of anybody in particular, no prices are put on their use, with the result that everybody can use them without paying for any damage they do.

This is an economically inefficient state of affairs, with the consequence that too many resources are used. Consider, by contrast, an example where there are fully-defined property rights: imagine a company wants to build a golf course which involves the redevelopment of several private gardens. The developers will have to pay the owners of these gardens to compensate them for their loss. In many cases, the garden-owners will demand more for their gardens than the developers will be prepared to pay, and so the golf course will not be developed. Whether it is or not depends on whether the present owners value their gardens more than the developers value the rights to build their golf course (which in turn is a function of how highly their potential customers value playing golf, as this determines the profitability of the development).

In contrast, if there were no property rights to the gardens, more golf courses would be built, regardless of whether golf were valued more or less than gardens. So it is with the atmosphere, or with rivers and oceans. If a scarce resource (clean air or water, peace and quiet, clean streets) is free, it is used regardless of the fact that the clean air is sometimes valued more highly than any goods produced by the polluting firm. If a polluter cannot be forced to pay anyone in particular for damage caused, one way of ensuring that the environmental costs are taken into account in its decisions would be by requiring it to pay everyone in general – by taxing those who damage the environment in proportion to the damage they do.

A tax (if set at the right level – an important proviso!) will often be more economically efficient than directly stopping polluting behaviour by legal curbs. Taxes are better than regulation in controlling some sorts of pollution because they allow individuals to weigh up the costs and benefits of their behaviour on a case-by-case basis. For example, sometimes the benefits of increasing food production by using nitrogen on a particular field will be so large that a farmer will find it worthwhile to buy fertiliser, even though it is taxed and the price of the fertiliser therefore reflects the costs of removing the nitrogen from the water system. On another field, fertiliser use may not be worthwhile if its price reflects its environmental costs. Direct regulation might specify that a farmer is only allowed to use so much fertiliser per acre, in which case he would not be able to spread as much fertiliser on one field as he would like, even though he would be prepared to pay for the consequences of the pollution which he caused. On the other field, he would be allowed to use fertiliser even though the benefits from using it would be insufficient to pay for the environmental costs. As long as the tax level was set at a level which made the price of fertiliser reflect the environmental costs of using it, taxation would let *more* food be grown than direct regulation, with the *same* consequences for the environment.

Taxes to improve the environment have two further highly desirable characteristics. Firstly, not only do environmental taxes change incentives to reflect the true economic costs of goods, but they are also potentially an important revenue source. This point should not be underestimated: nearly all other taxes impose *costs* on the economy by worsening economic efficiency, whereas environmental taxes improve economic efficiency. For example, income taxes may distort individuals' work/leisure choices, corporate taxes may influence the amount and type of investment, expenditure taxes may distort the type of goods which people buy. Of course, these costs may be worthwhile, given the benefits gained when governments spend the revenue, but how much better to get benefits both from spending money, and from raising it?[1]

A second desirable characteristic of taxes compared to regulation is that they provide a continuous incentive for innovation to develop less-polluting products or processes. Unlike regulation, which merely encourages the minimum necessary compliance, taxes encourage a continuous search for less polluting solutions.

The major disadvantage of environmental taxes is that it is rare for it to be administratively feasible to tax pollution directly. Instead, the purchase or use of inputs to the process generating pollution might be the only possible tax points, but the relationship between inputs and pollution is not always precise. In the case of diesel engines, well maintenanced engines are thought to be quite clean, but badly maintenanced ones are quite dirty. A tax on diesel fuel would fail to discriminate between the two types of engines. If this problem is severe, then regulation, or some mix of regulation and taxation, may be more appropriate.

Ideally, the economically correct procedure in introducing an environmental tax would be to value the economic costs of activities which take place outside of any market, and to calculate a tax level per unit output to reflect these costs. Hence the stress placed by Professor Pearce et al. (1989) and others on finding economic values for the environment is relevant for pollution taxes as well as for many other environmental objectives.

However, in practice it is unlikely that generally accepted values will be forthcoming in the short term. This does not, of course, imply that nothing should be done until such time as they do exist. There are certain pollutants where a good deal of agreement does exist already that the current situation is unsatisfactory, and in these cases taxes might be justified at some level on an *ad hoc* basis.

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1 In fact, theory suggests that there should be a presumption that the money raised from environmental charges should be used to compensate those who suffer from any pollution which continues after the introduction of the charge. This reflects the fact that, to return to the golfing example, if the gardens were privately owned, the developers would have to pay the garden-owners – who would therefore become richer than they would be if the developers paid the government in general, following introduction of a tax on golfing developments. If, as seems likely, the richer someone is the more they are inclined to value the environment (they would be prepared to spend some of their extra wealth on ensuring they have beautiful views) then failure to compensate the garden-owners would be not be economically fully efficient. Most of the environmental topics covered in this report affect nations rather than localities so explicit compensation is unnecessary – increased government spending or reductions in other taxes would be sufficient.

This commentary considers three broad areas where environmental taxes might have a role in adapting economic behaviour to reflect the true costs of economic activity.

(i) Carbon Taxes: carbon dioxide is the most important greenhouse gas. Burning fossil fuels gives off carbon dioxide. A tax on fossil fuels would reduce the demand for energy and cause a shift to less environmentally damaging fuels.

(ii) Road Transport Taxes: Motor vehicles are a major source of polluting gases. Taxes can be used to provide incentives to emit less pollutants per gallon of fuel burned and to reduce the number of gallons burned.

(iii) Fertiliser Taxes and Trade Effluent Discharge Charges: Fertilisers leak into the water system, polluting it, killing some aquatic life, and preventing the use of water resources for other purposes. Discharges into rivers by companies as a way of getting rid of the unwanted by products of industrial processes pollute rivers and hence reduce the enjoyment and productive use of the river by others.

These three areas are not equally likely to receive government attention in the short term. Road transport taxes already exist at substantial rates, and some modification to them in order to promote environmental objectives has been tried in the UK (lead free petrol) and elsewhere (lead free petrol, catalytic converters, fuel economy) with a substantial impact. However, fertiliser taxes and carbon taxes are longer term options, for various reasons discussed in this report (although lesser alternatives, such as putting VAT on domestic fuel, are administratively relatively straightforward).

Obviously, there are many other areas where tax incentives might be useful – non-biodegradeable wrapping, non-returnable bottles, tax reductions for energy conservation etc. The areas considered in this paper were decided more because of their political profile than because of any assessment of environmental priorities.

2 CARBON TAXES

2.1 Why have a carbon tax?

2.1.1 A tax on carbon dioxide emissions has become one of the most commonly cited examples of how the price mechanism might be harnessed for environmental ends. Emission of carbon dioxide into the atmosphere is widely thought to lead to a greenhouse effect with the consequence being undesirable global warming. Nobody charges the producers of such emissions, so the costs of global warming are not reflected in the market prices of goods. As a result, consumers buy too many goods which involve burning carbon to produce them, and manufacturers use production techniques involving too much carbon dioxide production compared with the consumption and production patterns which would result if prices reflected the true economic costs of carbon dioxide.[2]

2.1.2 Figure 1 shows the sources of carbon dioxide emission in the UK (Department of Environment, 1989). The major sources of emissions are power stations burning fossil fuels which are responsible for over a third of the total, other industries which provide their own energy rather than buying in electricity, domestic burning of fossil fuels, and road transport.

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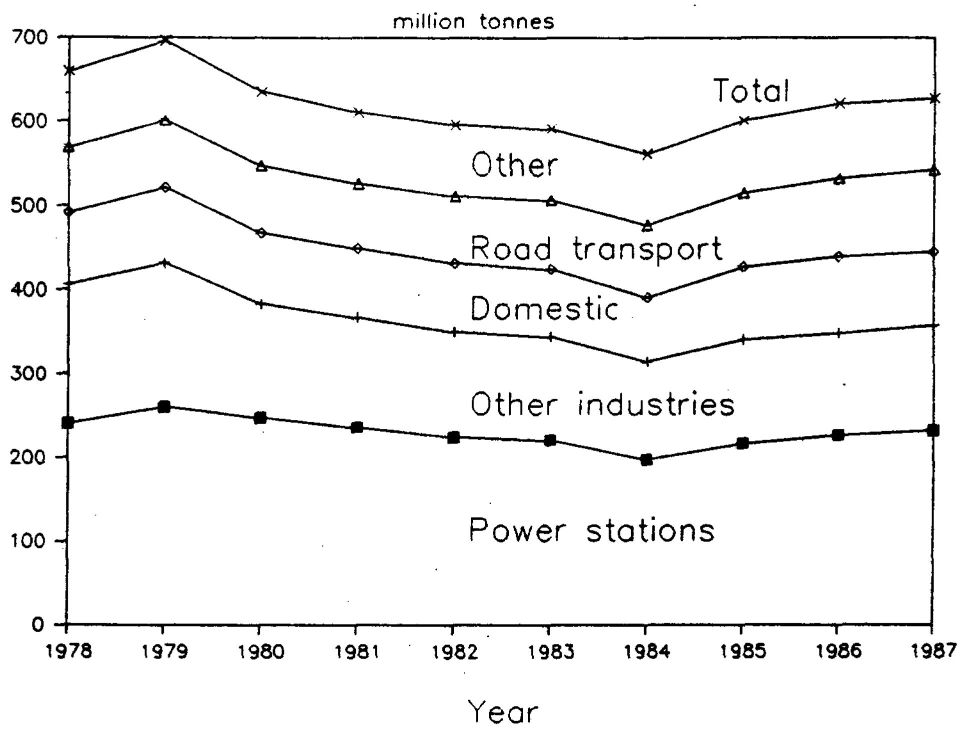
2 The evidence of global warming is not yet conclusive. It is at least possible that in sufficient quantities, carbon dioxide causes cloud formation and so would cool the earth. This raises the question as to the desirability of taking steps to cut carbon emissions. There are several responses to the global warming sceptics: the first is the pay-off matrix approach of e.g. Costanza (1989) - if the "optimists" are right, no policy response is called for. If the "pessimists" are right, then some form of action is required to prevent a disaster. If the policy response follows the line that the optimists are right, but they are wrong, then the disaster takes place. If policy-makers follow the prescriptions of the pessimists, but the pessimists are wrong, then they have imposed some unnecessary costs on society; if they were right, then catastrophe has been averted. As the potential costs of following the optimistic course of action are very high, it may be sensible to take some action now even in the absence of conclusive proof - the expected pay-offs to early responses to possible environmental problems are very high. There are other arguments in favour of such a "risk-averse" strategy. For a discussion of them, see Pearce et al. (1989).

Figure 1 UK Emission of Carbon Dioxide



2.1.3 Obviously, the environmental costs of carbon dioxide are the same, regardless of their source, Ideally therefore, all activities generating carbon dioxide should bear a charge proportionate to the amount of carbon dioxide produced. In practice, this may prove to be too administratively burdensome, although in fact some could be identified and indeed are identified under the UK current system of pollution regulation. In general, however, advocates of carbon taxes usually mean a tax on the major users of fossil fuels.

2.2 The effects of a carbon tax

2.2.1 **a) The demand for energy**[3]

The primary effects of a carbon tax would be to raise the price of energy, so reducing the amount of energy demanded by the economy, and also encouraging a reduction in the amount of carbon used per unit of energy generated. Hence energy conservation, hydroelectric and other sustainable energy sources, and nuclear energy might be expected

3 As petroleum is a major producer of other airborne pollutants, it is a special case and is discussed in the next section.

to play a larger role in the energy industry. However, if these sources of energy are themselves incorrectly priced, the resultant structure of the industry would not be economically efficient. In particular, a carbon tax without some sort of equivalent tax to reflect the external costs of nuclear power generation (risk of catastrophe, nuclear waste etc.) would seem inappropriate.

2.2.2 Because a carbon tax should relate to carbon dioxide production, and not directly to energy prices, the increase in the costs of generating energy should differ according to the type of fuel and the efficiency of the combustion of the fuel. Dr Scott Barrett of the London Business School has produced some figures based on the Department of Energy's estimates of the elasticity of demand for energy (Department of Energy, 1989a) illustrating the level and structure of a carbon tax necessary to achieve a 20 per cent reduction in the rate of UK carbon dioxide emissions.

Table 1: Scott Barrett's examples of required tax rates to reduce carbon emission by 20 per cent

	Short run (about one year)		Long run (about ten years)	
	tax rate (%)	change in demand (%)	tax rate (%)	change in demand (%)
gas	40	-4	14	3
oil	54	-9	19	4
coal	67	-11	24	-25

2.2.3 Note that the rates of tax need to be very high if it is intended to reduce carbon dioxide production in the short term, but comparatively low if the aim is longer term. This reflects the fact that research (based on the experience of substantial energy price rises during the 1970s) has generally shown users of energy to be quite responsive in shifting to energy conserving production techniques – but they need time to do so. For example, the Department of Energy estimates that of the total reduction in demand following an increase in energy prices, only 38 per cent takes place in the year of the price increase, 62 per cent after the first year, 85 per cent by the third year, and so on (Department of Energy, 1989a).

2.2.4 The second point to note is that because coal is a much "dirtier" fuel than either gas or oil,[4] it bears the brunt of any reduction in demand. Indeed, in the long run Barrett suggests demand for gas and oil might *increase* following the introduction of a carbon tax, despite bearing tax at 14 per cent and 19 per cent respectively, because of a switch out of coal into these fuels. Whilst environmentally a reduction in coal use by a quarter may be desirable, there are obviously serious industrial and balance of payments considerations.

2.2.5 After taking into account these demand effects, it is possible to apply the tax rates to current energy use and expenditures (taken from Department of Energy, 1989b), to get some idea of the amount of revenue which would be raised. The revenue raised from the short term tax rates would be around £8bn per annum. The tax rates required to reduce the rate of emission by 20 per cent in the long term would raise approximately £2.9bn each year.

2.2.6 **b) International aspects of carbon taxes**

The target rate of reduction of carbon emissions by 20 per cent considered by Barrett was chosen simply because 20 per cent has been mentioned as a possible target reduction in an international forum.[5] This raises an important point: is a carbon tax the sort of tax which should be imposed only if there is international agreement or is there a case for introducing it regardless of the actions of other countries?

2.2.7 If the UK decides to introduce a carbon tax unilaterally, without internationally co-ordinated action, this would have effects on the UK's trade and industrial structure. The increase in energy prices would raise the costs of all types of production activity in the UK. The effects of this increase in costs could, depending on what the proceeds of the tax were used for, have macroeconomic effects, particularly on the exchange rate.

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4 Burning coal produces more carbon than other fuels, but not more NO_x or sulphur if an FGD is fitted.

5 A 20 per cent target reduction in the level of carbon dioxide emissions by 2005 and 50 per cent by 2025 was called for by a meeting of conservationists and politicians in Toronto, 1988. It has not been accepted as a target by the UK government. Note that to achieve a 20 per cent reduction in the absolute *level* of emissions is harder than achieving the 20 per cent reduction in the *rate* of emission. After taking into account possible growth in the economy, Barrett believes that the reduction in the rate of emission per unit of output to achieve a 20 per cent reduction in the level of emission of carbon dioxide from the UK would have to be around 35 per cent. Carbon tax rates would have to rise accordingly.

If the exchange rate were floating, it would fall to restore UK industrial competitiveness, and to maintain equilibrium in the balance of payments. On average, therefore, industrial competitiveness would not worsen and the UK's trade balance would be the same as before. However the *structure* of industrial production would be altered, with the UK exporting more products with low energy content, but importing more high-energy products. As the rest of the world would not have a carbon tax in the scenario under consideration, this implies that carbon dioxide output in the rest of the world would rise. Hence the effect of any one country introducing a carbon tax would be to reduce carbon use in that country, but possibly to increase it elsewhere. This suggests that carbon taxes are more appropriately introduced by several countries together, rather than individually by relatively small economies such as the UK.[6]

2.2.8 In any case, if there is a greenhouse effect, carbon dioxide would lead to *global* warming. Any reduction in UK carbon emission would reduce the rate of global warming to the benefit of *all* countries, but the costs of the carbon tax would be felt mainly in the UK. Other countries should in principle compensate the UK for the unilateral imposition of a carbon tax, but this seem politically implausible.

2.2.9 Global introduction of a carbon tax would be the most desirable option. The effects Barrett calculates for the UK case would be repeated throughout the world. However, even were a carbon tax to be introduced generally, there would be an incentive for countries to "cheat" to allow their industries to obtain cheaper energy than their competitors.

2.2.10 However, in the absence of any such international agreement, individual countries can take certain actions which would minimise the industrial effects. Changing the relative price of energy inputs is possible with a much smaller impact on the price of energy than that following introduction of a full-blown carbon tax – for example, by imposing a tax on coal use, but a subsidy for gas and oil. The shift in the "merit-order" of fuels for energy production would reduce carbon dioxide production without significantly damaging the competitiveness of industry.

2.2.11 Another way of reducing the amount of carbon dioxide generated domestically without introducing a carbon tax is to tax *domestic* use of fuel, but not fuel used as inputs to

6 Although in fact Germany has unilaterally introduced more severe environmental controls than elsewhere.

make other goods. The prices of goods traded in the world market would therefore not be affected. This would suggest that imposing VAT on domestic gas and electricity should be considered.

2.2.12 **c) Distributive impact of energy taxes**

Currently, not only is there no carbon tax on domestic fuel, but VAT is levied at a zero rate on domestic gas and electricity, as compared with the standard rate of VAT of 15 per cent. The reason for having a zero rate is commonly thought to be in order to help the worse-off. However whilst the poor do spend more of their income *proportionally* on zero rated fuels than the rich, it has been extensively argued elsewhere (e.g. Davis and Kay, 1985) that if distributional objectives are the only justification for zero rating goods, these objectives can better be achieved through the social security system. One of the major reasons for believing this is that the rich spend more on domestic fuel in *absolute* terms, so the subsidy being given to the rich by zero rating goods is larger than that given to the poor.[7]

2.2.13 This argument has extra weight when it is realised that currently energy is taxed at a lower rate (because it is not taxed at all) than most other goods, whereas the fact that energy production involves the burning of fossil fuels and hence produces carbon dioxide implies that it should be taxed *more* heavily than other goods.

2.2.14 As shown in Table 2, all other EC countries have a positive rate of VAT on fuel (including Ireland, the only country with a more extensive use of the zero rate than the UK). The distributional problems of VAT on fuel seem therefore to have been overcome elsewhere in Europe.

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7 However, there is an alternative view of the zero rating domestic energy, as a way of ensuring "positive rights" are available to all (Dilnot and Helm, 1987). A minimum amount of energy is required by all, but for various reasons the domestic energy market might fail, and some households may not get their energy at minimum cost. In this case, keeping the price of energy low for some households may be desirable, although zero rating might not be the most effective way of ensuring this – Dilnot and Helm suggest an "energy supplement" paid to the elderly and the poor.

Table 2: Rates of VAT on household fuel within the European Community

Country	Coal	Oil	Gas	Electricity
Belgium	6	17	17	17
Denmark	22	22	22	22
France	18.6	18.6	5.5	5.5
Germany	14	14	14	14
Greece	6	6	6	6
Ireland	10	10	10	10
Italy	9	9	9	9
Luxembourg	6	6	6	6
Netherlands	18.5	18.5	18.5	18.5
Portugal	8	8	8	8
Spain	12	12	12	12
UK	0	0	0	0

2.2.15 However, although the pure distributional arguments for zero rating domestic energy are in fact very weak, it might well be noted that the UK does have a problem of elderly people suffering from hypothermia, and this problem has to be addressed when considering taxing fuel. It is perhaps sensible to subsidise energy for those at risk – the elderly poor – but this argument hardly extends to justifying low energy prices for the rich young, which is the effect of current policy.

2.2.16 Table 3 below illustrates the distributive effects of putting VAT on electricity and gas. The model used to generate Table 3 is a sophisticated model of UK consumer behaviour, based on the actual expenditure decisions of over 116,000 households surveyed over the period 1970–1986 (Baker et al., 1990). It estimates the responsiveness of household expenditure to changes in prices, incomes, and personal circumstances (the methodology is described in Blundell et al., 1989). The model not only allows for the level of expenditure on a good to change in response to changes in the price of all other goods.

In the case of imposing VAT on energy, households will not only respond by changing their level of expenditure on energy but since the price of energy has changed relative to that of other goods, (and the value of their real income has fallen) their overall pattern of expenditure will change. In generating the results shown in Table 3, the model attempts to take into account all these changes, and hence allows for the total expenditure and tax consequences of the imposition of VAT to be estimated.

Table 3: Effects of putting VAT on domestic fuel and power (15 per cent)

	DECILES BY INCOME									
	1	2	3	4	5	6	7	8	9	10
Household gross income per week	41.60	65.80	93.80	131.50	173.80	218.40	265.90	317.50	395.00	645.70
Spending on energy before tax change	7.46	9.63	10.06	10.83	11.03	10.88	11.91	12.10	12.80	15.11
Spending on energy after tax change	7.73	9.98	10.55	11.43	11.84	11.73	12.91	13.30	14.32	17.17
Total Increase in tax paid	1.02	1.32	1.38	1.49	1.49	1.46	1.60	1.59	1.67	1.92
% cut in consumption	9.9	9.9	8.8	8.2	6.7	6.2	5.7	4.4	2.8	1.2
Average number of retired people per household	0.6	0.7	0.9	0.5	0.4	0.3	0.2	0.1	0.1	0.1

2.2.17 Putting VAT on fuel would significantly cut consumption of energy – by over 5.5 per cent of current overall household demand. The total increase in tax revenue would be around £1.7bn.

2.2.18 The distributional effects of the change are strongly adverse. The increase in tax paid by households in the lowest decile by income would be £1 per week, and that of the richest 10 per cent of households would be around £2, yet the richest decile are sixteen times richer before tax than the poorest. Worse still, the poorest decile cut their consumption of energy by 10 per cent, whereas the richest decile would hardly reduce their consumption at all.[8]

8 Interpretation of the impact of these estimates is complicated by the fact that, detailed as the model is, it is unable to separate out spending on heating (which it might be public policy to maintain) from spending on energy for other uses. It is not obvious whether spending on heating is more or less responsive to price changes than other uses of energy.

2.2.19 Clearly, some form of redistribution of the burden of tax resulting from the introduction of VAT on domestic fuel is required. An increase in the income of the lowest decile decile of £1 per week would ensure that they are not any worse off (on average) following the increase in tax. Note that this would still lead to them consuming less fuel – given that the price of fuel is increased, households would be inclined to spend part of any extra income on goods other than fuel. However, the increase in cash income would at least enable them to buy as much energy as before, without being on average any worse off. Of course, if all the revenue raised by putting VAT on fuel were to be redistributed, then substantially larger increases in benefit levels would be possible, and the overall impact of such a policy would be progressive in terms of the effects on the distribution of income, whilst still reducing the demand for energy.

2.2.20 Nevertheless, the proviso "on average" is important because some households consume a lot of energy. In particular are pensioners, who may (need to) spend more on heating than other households.[9] The bottom row of Table 3 indicates that pensioners are predominantly in the lower half of the income distribution, where cuts in energy consumption are predicted to be greatest. Table 4 separates those households with a retired person in them from the rest of the population. On average, these households consume *less* energy than other households (on average, 16 per cent less), presumably because they are poorer and live in smaller houses. The average percentage cut in their consumption of energy is, however, somewhat *larger* than the non-pensioner households. This suggests that help targeted at the elderly would be necessary to offset the adverse social effects of increasing energy prices.[10]

9 Other groups which may spend more on energy are all households living in regions not covered by gas supplies – the South West, North Wales, Scotland etc – and so which have to rely on more expensive electricity supplies.

10 To increase the pension by around £2 per week would cost about £1bn per annum. A similar amount of money would increase child benefit by £1.90 per week.

Table 4: Effects of putting VAT on domestic fuel and power (15%) for those households containing a retired person

	DECILES BY INCOME									
	1	2	3	4	5	6	7	8	9	10
Household gross income per week	39.30	46.80	59.00	70.30	84.60	102.50	128.90	171.10	232.00	413.80
Spending on energy before tax change	7.14	7.19	7.75	9.40	9.53	9.77	10.77	11.21	12.24	13.90
Spending on energy after tax change	7.39	7.44	8.04	9.77	9.96	10.23	11.35	12.06	13.15	15.40
Total increase in tax paid	0.96	0.97	1.05	1.27	1.28	1.32	1.44	1.51	1.63	1.79
% cut in consumption	10.0	10.0	9.8	9.6	9.1	8.9	8.4	6.4	6.6	3.7

2.2.21 **d) The effect of carbon taxes on the prices of other goods**

A carbon tax will increase the price of industrial inputs, and hence will increase prices of consumer goods. The amount by which any particular price will rise will depend on a whole series of factors: the energy required to produce the good, the ability of producers to switch to lower – energy intensive techniques or to less heavily taxed energy sources, and the ability of industry and retailers to absorb any increase in costs without raising prices. It is, therefore, extremely difficult to predict by how much any particular price will rise following the introduction of a carbon tax.

2.2.22 However, it is possible to give some idea of how broad groups of industries might be affected. Table 5 combines information from Input – output tables on the value of outputs[11] of each of fourteen industry categories with information on the amount of energy used that industry. The last column of Table 5 gives output per unit of energy used. Clearly, the lower the value of output per unit of energy input, the more vulnerable is that industry to rises in the price of energy.

11 Defined as inputs from domestic sources plus imports, taxes, labour costs and gross profits. Such a definition is suitable for this sort of analysis if other countries do not have a carbon tax (otherwise the cost of imports would change). The source is Table 4, Input – output tables for the UK 1984 (CSO 1988). The 101 industry groups have been combined into industry categories as used in the Digest of UK Energy Statistics 1989 according to their SIC (80) codes.

Table 5: Energy use by industry type in the UK (1984)

CATEGORIES	Total value of output (£m)	Total energy used (million therms)	Output per therm of energy (£)	Therms per £100 of output
Transport	23609	14999	1.57	63.53
Iron and Steel	7276	2935	2.48	40.34
Chemicals[1]	19573	3659	5.35	18.69
Mineral Products[2]	7743	1440	5.38	18.60
Other Industries[3]	10335	1506	6.86	14.57
Non-ferrous Metals[4]	3741	502	7.45	13.42
Paper, Printing and Publishing	15326	820	18.69	5.35
Food, Drink and Tobacco	33948	1584	21.44	4.67
Vehicles[5]	18265	712	25.65	3.90
Textiles, Leather and Clothing	11488	441	26.06	3.84
Agriculture	14375	550	26.14	3.83
Mechanical Engineering[6]	28060	1042	26.94	3.71
Electrical Engineering[7]	20958	446	46.99	2.13
Construction	43850	409	107.14	0.93

Notes:
1) Including man-made fibres
2) Glass, concrete etc.
3) Including timber, water and rubber
4) Aluminium, etc.
5) Cars, shipbuilding and aerospace
6) Including metal goods and ordnances
7) Including instrument engineering

2.2.23 As would be expected, transport relies very heavily on energy, producing only £1.57 of output for every therm of energy input.[12] In contrast, construction uses one therm of energy to generate over a hundred pounds of output. (An alternative way of considering the same information is that it takes over 40 therms to produce £100 of output in the iron and steel industry, but less than one therm to produce an equivalent amount of output in the construction industry.) Clearly, a carbon tax will affect industries in the top half of Table 5 to a much greater extent than those towards the bottom.

2.2.24 The amount by which energy prices rise following a carbon tax will vary according to the type of fuel required if tax rates are differentiated according to the type of fuel, as Barrett suggests. Those who currently use coal for most of their power will

12 A million therms is equal to 2400 tonnes of petroleum, or 4000 tonnes of coal.

face larger price increases than those who use gas and electricity.[13] Information on the sources of energy for the different industry types given in Table 5 (Department of Energy, 1989b) suggests that the energy costs to the iron and steel industry would rise by significantly more than the increase in energy prices for the chemicals industry.[14] Of course, all industries would have a incentive to switch to lower-taxed fuels, and to cut overall energy consumption, so the final increase in the costs of production would be lower than those implied by use of current energy demands to weight tax increases.

2.2.25 The increase in energy prices would almost certainly make some marginally profitable projects in energy intensive industries become unviable. Phasing in any carbon tax over time might allow firms to adjust their strategies. Given that there is a regional tendency for northern industries to be energy intensive (chemicals and iron and steel, for example), consideration might be given to strengthening regional policy.

2.3 Conclusion

2.3.1 The following conclusions can be drawn about the imposition of carbon taxes.

1) Ideally, carbon taxes should be introduced on a global basis, for two reasons. Firstly the greenhouse effect is a global phenomenon, and a cut in one country's production of carbon dioxide would benefit all countries. In the absence of any compensation mechanism to reward that country, it is clearly inequitable for the rest of the world to let one country bear the costs of slowing the rate of global warming. Secondly, a consequence of one country raising the costs of energy and therefore cutting domestic energy consumption is likely to be an increase in energy consumption elsewhere (although not by as much as the decrease in the country with the carbon tax). Consequently it is desirable to raise the price of energy as an industrial input on an international basis, rather than unilaterally.

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13 Coal is by far the biggest source of energy for the electricity supply industry, but about 20% of electricity is generated from sources other than burning fossil fuels, so the average increase in the cost of generating electricity would by lower than the increase in the price of coal.

14 Taking Barrett's long term tax rates, for example, the weighted average of prices of energy for the iron and steel industry would rise 21 per cent, for the chemicals industry only about 16 per cent. The average increase for all industries would be around 18 per cent.

2.3.2 2) A carbon tax would raise the price of energy for industry. There is a substantial difference in the amount of energy required to produce one pound's worth of output between different industries. Some industries, such as iron and steel and chemicals would be particularly heavily affected by a carbon tax, because energy is a major proportion of their costs. To prevent substantial dislocation following the introduction of such a tax, it would probably have to be phased in, perhaps using some of the funds raised by the carbon tax to ease industrial and regional problems.

2.3.3 3) Changes in the "merit order" of energy production might be possible without increasing industrial costs. This might require increasing the price of coal but subsidising renewable energy sources or possibly even "clean" fossil fuels such as gas, so causing a shift in the type of energy used to generate electricity and in the type of fuel used directly by industry.

2.3.4 4) The price of domestic fuel could be raised so as to cut energy consumption and hence carbon dioxide emissions without major damage to the UK's trading position. Currently domestic energy is not subject to VAT (in contrast to *all* other EC countries) which means that it is priced relatively lower than all other goods whereas taking environmental costs into account means that it should be priced relatively higher. However, taxing domestic energy would be strongly regressive, so if adopted would have to be accompanied by substantial increases in income support, particularly for the elderly. Alternatively gas and electricity could remain VAT zero rated for pensioner households, but could be standard rated for all other households. There is also a political obstacle to be overcome – the Prime Minister has given a commitment not to put VAT on fuel before the next election.

3 TAXES ON ROAD TRANSPORT

3.1 Road transport and the environment

3.1.1 Road transport is likely to be a focus for environmentally conscious taxation, for three reasons. First, there already are significant taxes on cars and other vehicles, so there is no need to take the politically and administratively difficult steps of introducing a completely new tax. Instead, existing taxes can be raised or lowered, and the tax base modified, in order to achieve environmental objectives. Secondly, road transport is a significant source of "externalities" – the costs which are not subject to the price mechanism, as described in the introduction. These include congestion externalities – each car on the roads reduces the speed at which other cars can travel, as well as pollution. Thirdly, it is expected that there will be a substantial rise in road traffic over the next thirty years, a fact which will increase political awareness of environmental problems associated with road transport.

3.1.2 **Existing taxes on road transport**

The three major taxes on road transport are those on hydrocarbon oils (petrol and diesel fuel), the car tax and vehicle excise duty (VED). The rate of tax on leaded 4-star petrol is currently 93p per gallon. Unleaded petrol has a duty rate 12p per gallon lower. DERV (or diesel fuel) also is taxed at a lower rate than 4-star – at about 79p per gallon. As VAT is charged on the duty as well as the cost of the product, around 66 per cent of the price of petrol is tax. In total, 57 per cent of UK petroleum consumption is accounted for by road transport, of which 70 per cent is petrol, and 30 per cent is DERV. Car tax is charged at 10 per cent of the price of a new car. Vehicle excise duty is levied each year, at a rate of £100 per car – at which level it has been fixed since 1985.

3.1.3 The amounts raised from these three taxes, and also the VAT revenue which can be allocated to car expenditures in the 1989/90 fiscal year, are given in Table 6.

Table 6: **Revenue raised from taxes on road transport 1989/90**

Tax	£m
Hydrocarbon oil	8800
Car tax	1400
VED	2900
VAT	4300

Source: FSBR, 1989 and Department of Transport, 1989

3.1.4 Externalities and road transport

Road transport is also a significant source of pollution. The emission of lead is a problem which has already resulted in the use of a tax – that on fuel – to discriminate in favour of lead-free petrol. However, as Figures 2a – d show (Department of Environment, 1989), road transport is a major source of carbon dioxide (CO_2), a greenhouse gas,[15] carbon monoxide and hydrocarbons (both greenhouse gases) and nitrogen oxides (NO_x) which are greenhouse gases but also contribute to acid rain. Both hydrocarbons and nitrogen oxides result in ozone creation which at low altitudes has been implicated in the formation of acid mist and the acidification of soil. As already mentioned, another externality from road transport is congestion. The issue of road pricing is not considered in this commentary, although such prices would have implications for road usage and hence the volume of pollution.

15 Each car produces an average of 4 tonnes of CO_2 each year.

Figure 2a

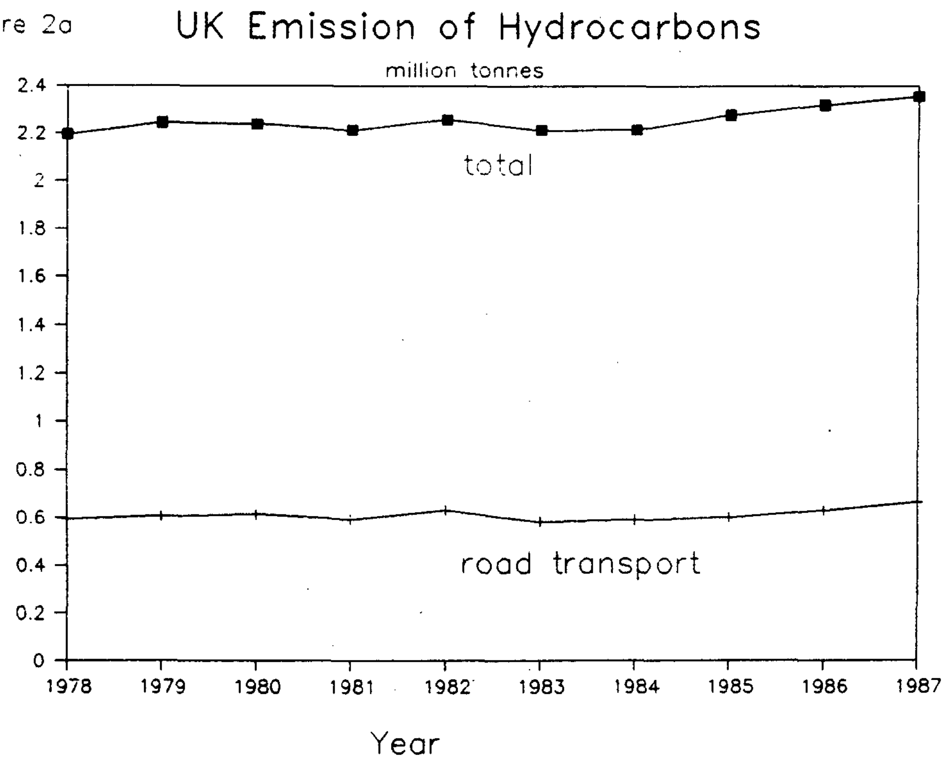


Figure 2b

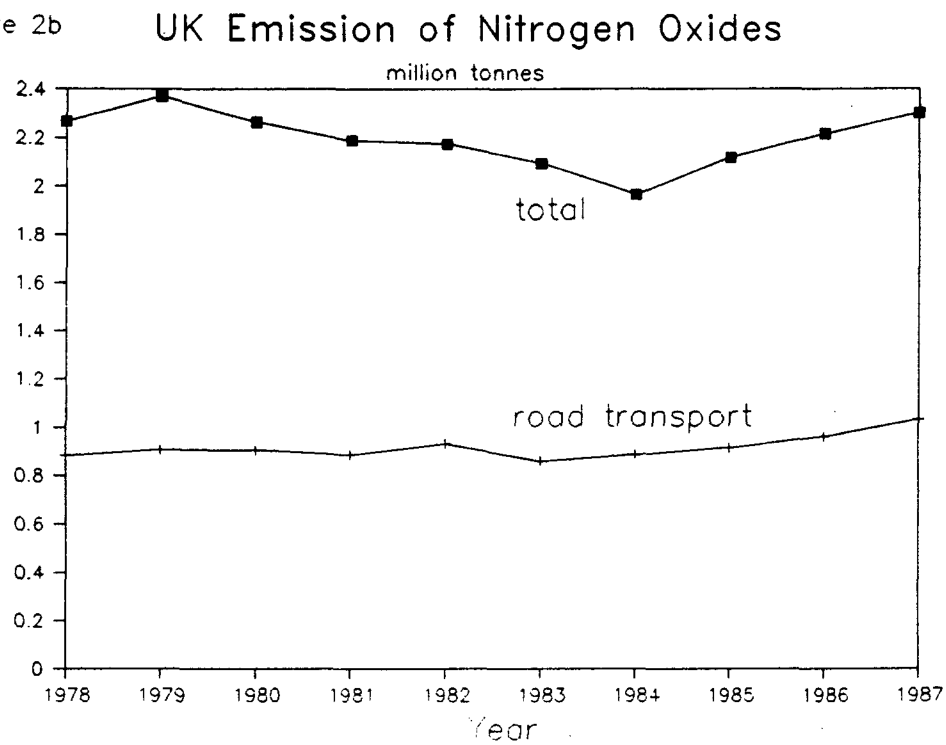


Figure 2c

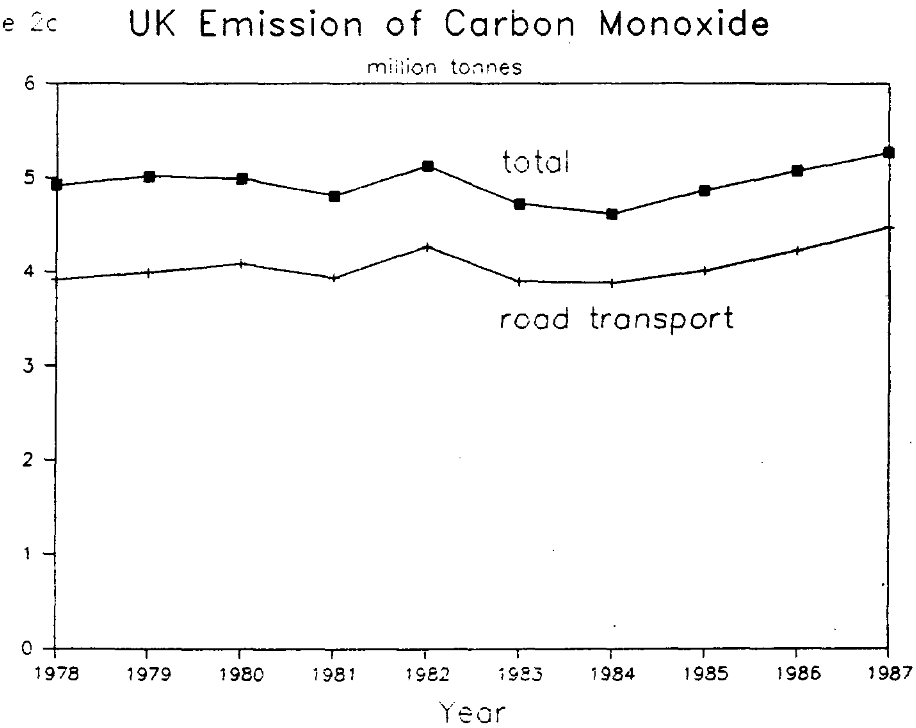
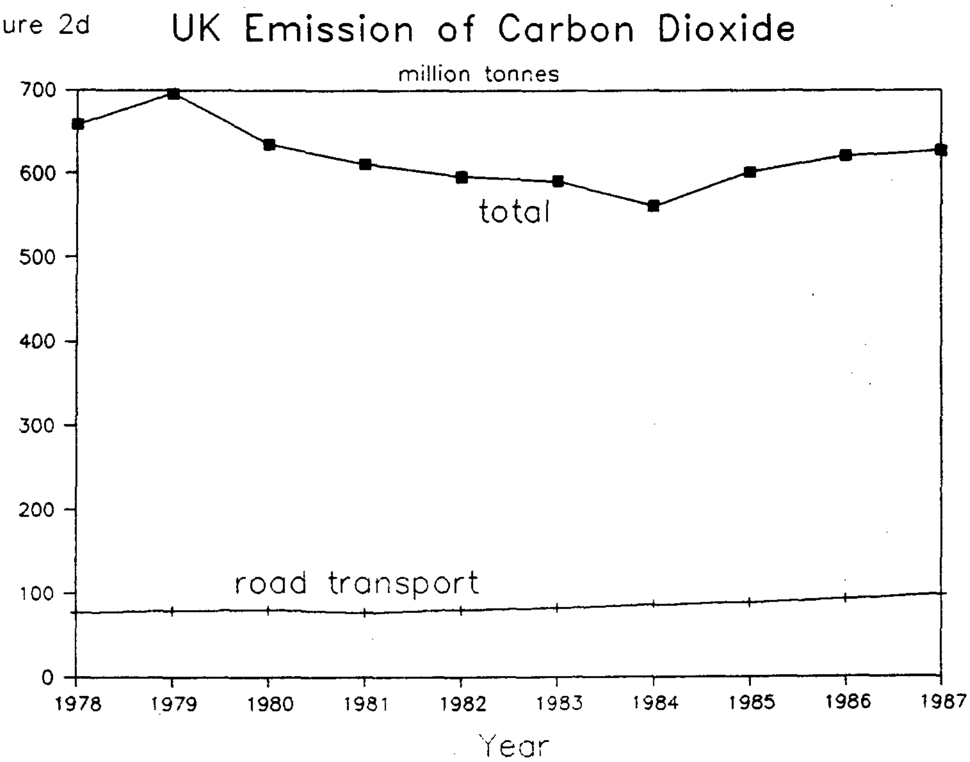


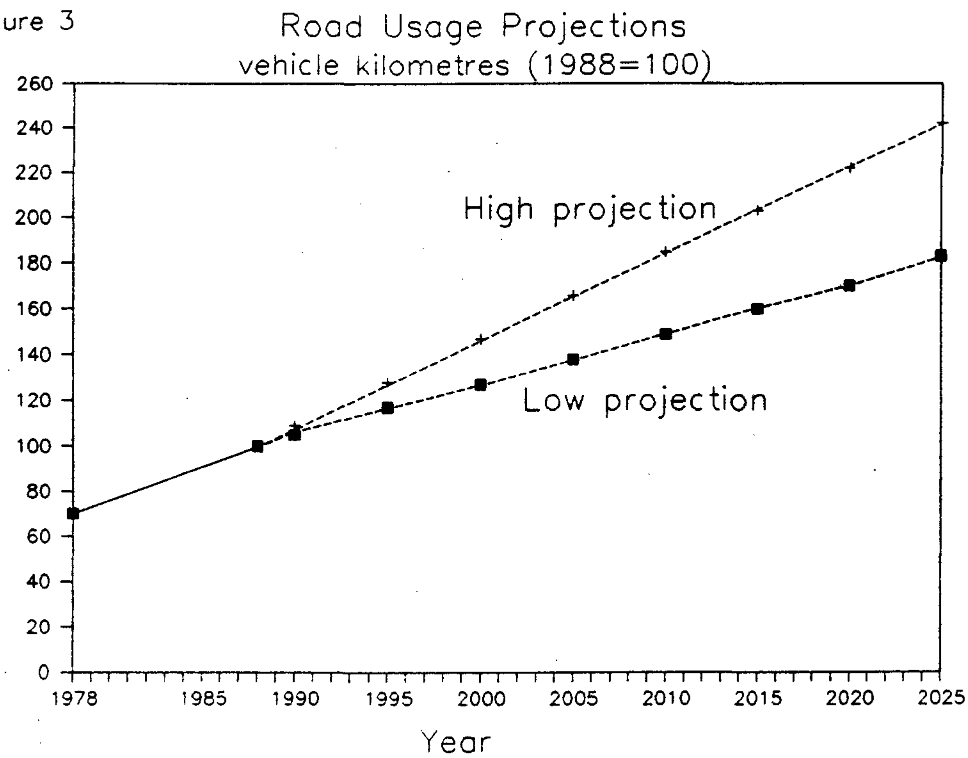
Figure 2d



3.1.5 **Future trends in road transport**

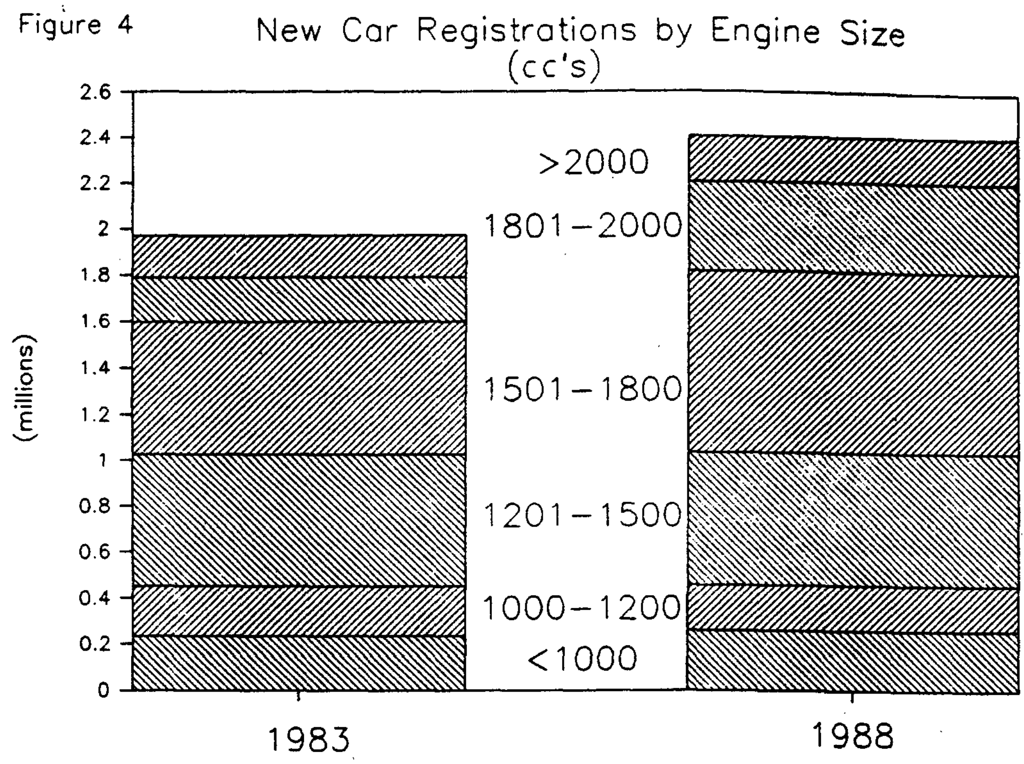
The third reason for believing that road transport is a candidate for environmentally motivated taxation is that future projections show an alarming increase in road traffic, and hence in pollution. Official Department of Transport projections (Table 2.45 Department of Transport, 1989) show that by 2025 the number of kilometres travelled on the roads may have doubled (see figure 3), and may be three times what they were in 1978. If these forecasts prove valid, then even to maintain current levels of emission of pollutants by cars requires a halving of pollutant emission per mile travelled.

Figure 3



3.1.6 Another trend which might be tending to increase pollution is the trend towards larger cars. As Figure 4 illustrates, the 20 per cent rise in new car registrations between 1983 and 1988 has been entirely due to an increase in registrations of cars with an engine size in excess of 1500cc (Department of Transport, 1989). There is, naturally, a relationship between engine size and fuel use, so if technology remains constant, any continued trend towards larger cars would increase emission of pollutants. Of course, technology does not remain constant, and since the first oil shock of 1973 fuel efficiency for any given engine size has increased by approximately 30 per cent, according to official car road tests. For example, a 1989 Honda Accord is 400 pounds heavier and has 26 more horsepower than the 1980 model, but does more than 3 miles more per gallon. Nevertheless, future technological progress cannot be certain, and the trend to larger cars remains a factor which needs to be taken into account when considering road transport.

Figure 4



3.2 Environmental effects of road transport taxes

There are several possible roles for tax to play in encouraging more environment-friendly road transport.

a) To further encourage use of lead-free petrol

b) To encourage use of catalytic converters

c) To reduce overall fuel consumption.

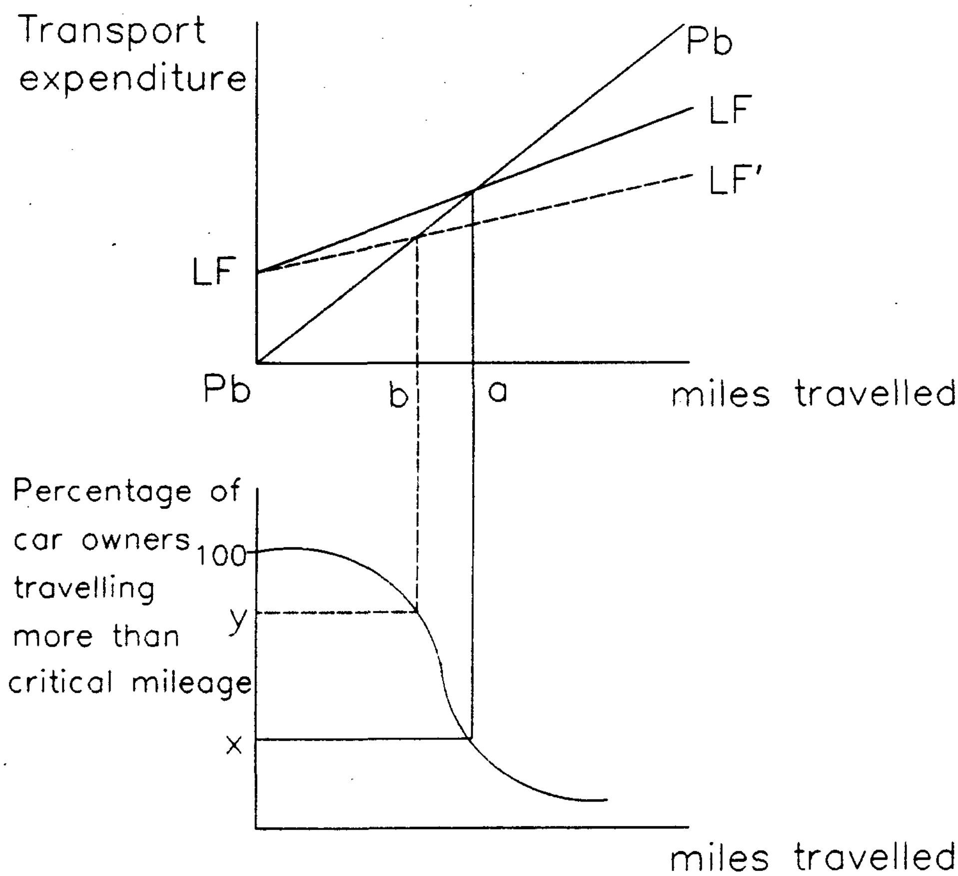
3.2.1 a) To further encourage use of lead – free petrol

In 1987 the Chancellor introduced a differential in the tax rate on mineral oils in favour of unleaded petrol, and this differential has been increased at both subsequent budgets. To a great extent, the response of consumers shows just how effective use of the price mechanism can be in "greening" people's behaviour. About 30 per cent of petrol sold is now lead free, and over 80 per cent of petrol outlets stock lead-free petrol. Soon all new cars will have to be able to run on lead-free petrol, and as old cars are scrapped the proportion able to run on lead-free petrol will rise steadily (around 10 per cent of cars are scrapped each year).

3.2.2 If this tax differential in favour of lead-free petrol has had such a substantial impact, would an even larger differential have an even larger impact, so accelerating the move towards lead-free petrol?

3.2.3 There are reasons for believing that the effect of increasing the differential would be rather less than the effect of previous moves in this direction. Consider Figure 5.

Figure 5 Unleaded Petrol: the effect of a tax differential



3.2.4 The effect of introducing a price differential between leaded and unleaded petrol is to give consumers the option of spending a lump sum (the cost of converting a car to run on lead-free petrol, signified by the distance PbLF in the top half of the diagram) but paying a lower price per mile travelled, than if the car were not converted. Hence expenditure for a car owner who does not convert is lower initially, but if more miles are travelled, it would become cheaper to convert the car. If the price of leaded petrol is the slope of the line PbPb and that of lead-free petrol is LFLF, the critical number of miles which makes conversion worthwhile is a. The lower diagram shows that this means that x per cent of car – owners will convert (x being the percentage of car – owners who travel more miles than a).

3.2.5 An increase in the leaded/unleaded price differential, such as reducing the price of unleaded to the slope of LFLF' will reduce the critical number of miles (to b in the diagram), and increase the number of users to lead-free petrol (to y per cent in the bottom diagram).

3.2.6 However, in fact the cost of converting most cars to run on unleaded petrol is quite low, so the critical number of miles is rather small – perhaps 10,000 – 15,000 miles. As the average number of miles travelled *per year* is around 10,000 miles (Department of Transport 1989, Table 2.4) most consumers on financial grounds alone will already have found it worthwhile to switch to unleaded petrol.[16] The fact that many people would in any case prefer to pay slightly more to pollute the atmosphere less – the "conscience effect" – will reinforce this tendency.[17] Those who have not yet switched to lead-free petrol will increasingly tend to be those owning cars which cannot be converted at reasonable cost. This implies that any further increase in the leaded/unleaded differential is unlikely to have much effect on lead emission, and its main effects could be contrary to environmental objectives. For example, if achieved by freezing the duty on unleaded petrol, or even reducing it as in the 1989 Budget, the increase in the differential is accompanied by a reduction in the real marginal costs of transport for those who have already switched to unleaded petrol – an undesirable result, since even

16 There may of course still be people who have not converted, either because of the non – financial costs of conversion (time, "hassle", etc.), or because they are unaware of the financial gains from conversion.

17 It seems likely that a major reason for the success of the tax differential in favour of unleaded petrol was this conscience effect. The introduction of a tax break "signalled" to car – owners the environmental benefits of lead – free petrol. Some car – owners were prepared to switch to a "green" product, and the tax simply indicated what the green product was. This suggests a role for green taxes as a signal to consumers about which products are environmentally – friendly, so reducing the amount of information which has to be gathered by consumers who want to be environmentally conscious but who do not have the time to collect all relevant information for themselves. If this interpretation is true, quite small tax differentials may have a substantial effect, because of the signal they send.

lead – free petrol contributes greenhouse gases and other environmental problems. In addition, any increased differential might encourage those with cars which run on leaded petrol and which cannot easily be converted to scrap their cars in favour of cars which can run on unleaded petrol – an effect which also may not be environmentally sound (especially given the resources wasted by premature scrapping and the tendency for new cars to have a larger engine size than older ones).[18]

3.2.7 The discussion in this section suggests that the incentive to use unleaded petrol may already be adequate – any further increase in the leaded/unleaded differential may not be an unambiguously "green" gesture if achieved by reducing the real level of duty on unleaded petrol.

3.2.8 **b) The use of taxes to encourage use of catalytic converters**

The European Community is in the process of setting limits to the production of other pollutants. By the end of 1992 it is probable that new cars will have to be fitted with a three-way catalytic converter.[19] Catalytic converters can reduce output of carbon monoxide, NO_x and hydrocarbons (hence the "three-way" aspect of the technology). This is done by passing exhaust fumes through a catalyst unit (containing platinum and rhodium) at a given rate. If the rate at which the gases pass through the unit is incorrect, the unit is much less effective, so fuel injection and electronic management systems are also required.

3.2.9 However, although output of carbon monoxide, NO_x and hydrocarbons are reduced by catalytic converters, the concentration of petrol to air required to allow the converter to work effectively is high. As a consequence, fuel efficiency might fall (by perhaps 5-10 per cent) and carbon dioxide emissions may be increased. The preferred option

18 Much of the analysis about the leaded/unleaded differential also applies to the petrol/diesel differential. The reason for this differential is that diesel is predominantly used by business, so a lower diesel tax reduces business costs. The UK differential in favour of diesel is smaller than the European average, and the European Commission has suggested a harmonised set of tax rates as part of the 1992 programme which would widen the UK differential to this average. In several European countries the differential has been sufficiently large to encourage private cars to run on diesel fuel. It is not apparent whether diesel is preferable to petrol on environmental grounds. Diesel gives off slightly less NO_x than petrol (although the Department of Environment has increased its estimates of diesel emission recently), and produces less CO_2 than petrol, but emits more particulates (smoke) and noise.

19 Strictly speaking, the limits will be on gaseous output per distance travelled. However, these limits have been set so low as to require the fitting of a three-way catalytic converter, because given current technology they are the only way of meeting the targets.

of the UK motor industry and of the UK government was (for a time) to encourage "lean-burn" technology, which aimed to reduce carbon dioxide emission. A possible lean-burn ratio of fuel to air was 1 to 19, whereas the catalytic converter may require 1 to 14. Lean-burn technology is compatible with catalytic converters for hydrocarbons and carbon monoxide, but not with using converters to cut NO_x emissions. The administrative requirement to use three-way catalytic converters therefore excludes lean – burn technology and may possibly lead to an increase in carbon dioxide emission.

3.2.10 As with the conversion of the UK car stock to run on unleaded petrol, taxes could be used to ease the transition to catalytic converters. The Commission directive explicitly allows for tax incentives to encourage use of catalytic converters before they are compulsory, and Germany and Holland have such incentives. For new sales, the car tax levied on new cars might be the administratively most attractive tax point for such an incentive in the UK, but the economic impact of using VED would be identical to the car tax for new cars and might also encourage conversion of the existing stock.

3.2.11 Catalytic converters will cost £300–£800 per car, and in addition may well reduce fuel-efficiency and increase running costs. Of course, many will wish to run environmentally-friendly cars, and so will be willing to pay for such converters, but some will not. Given that the "externalities" (the costs which the consumer does not pay for) of running a car are reduced when a catalytic converter is fitted, it could be economically justifiable if purchasers of cars with such converters were subsidised as compared with purchasers of cars which produced greater quantities of pollutant. Such an incentive would be a reduction in the rate of car tax by the equivalent to the cost of fitting a converter to the average car (or, equivalently, an increase in the rate of car tax on those cars without a catalytic converter).

3.2.12 Note that it would *not* be desirable to differentiate between the costs of fitting catalytic converters to each particular make of car. Economic efficiency requires that all cars be given the same subsidy, otherwise there would be no incentive to reduce the cost of fitting catalytic converters. Note further that it would be preferable to make the differential in tax a fixed sum, rather than differential percentage *rates* of tax. For example, having a car tax rate of 5 per cent on the price of cars with converters, but 15 per cent on those without, would result in a greater monetary saving when buying larger, more expensive cars than when purchasing smaller ones. Although it is generally true that because larger cars use more petrol than smaller cars (and hence give out more pollutants) the environmental benefits of ensuring such cars have converters attached are greater, a proportionate incentive would be too generous to rich purchasers of large cars (the saving on buying a £50,000 Porsche with a converter rather than buying one without would be £5000) and insufficient for small cars (only a £500 saving at the bottom end of the market). A formula such as 10 per cent plus £300 for cars without converters but 10 per cent minus £300 for cars with converters would be one such possibility.

3.2.13 However, one factor which mitigates against such a tax differential is that by 1993 all new cars must have converters. The differential would only be effective for a short time. There is a clear trade-off between the environmental benefits of increasing the number of new cars sold with catalytic converters, and the administrative costs of introducing such a differential.

3.2.14 **c) Using taxes to reduce overall fuel consumption**

Emission of carbon dioxide is directly related to fuel consumption. There are two ways of using taxes to reduce fuel consumption: taxes increasing the marginal cost of fuel use will reduce the number of miles travelled and give an incentive to increase miles per gallon, whereas more direct tax incentives might be used to reduce the use of fuel per mile travelled.

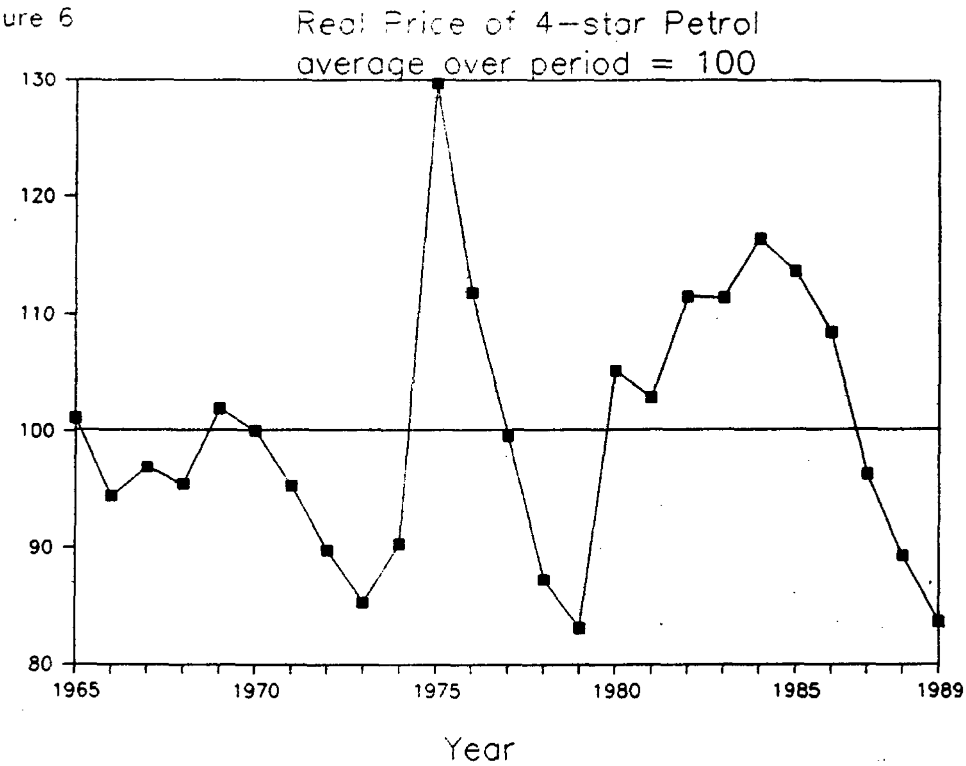
3.2.15 (i) Raising the marginal cost of road transport

Any increase in the marginal cost of travelling a mile by road will reduce the number of miles travelled in aggregate. If the price of petrol is increased, then consumers will travel fewer miles and will also have an incentive to do more miles to the gallon.

3.2.16 Figure 6 shows the recent real price of 4-star petrol (i.e. the price of petrol relative to all other goods) to have been rather low compared with the average of the past 25 years. To raise prices to their peak of 1975 would require an increase in duty of about 55p[20] which would lead to an increase in petrol prices of 63p after taking account of the fact that VAT is levied on the duty-inclusive price of petrol.

20 Based on the price of petrol in December 1989.

Figure 6



3.2.17 The effects of such a price rise are given in Table 7 below. (These results were obtained using the model described in the first section on carbon taxes.) When the price of petrol goes up, people will buy less petrol (the own-price elasticity of demand). The fact that the price of travel has increased will also affect purchases of other goods – it costs more to get anywhere, so households may spend their leisure time at home, altering the mix of goods bought (the cross-price elasticities of demand). Depending by how much petrol consumption falls, households may find that they still end up spending more money on petrol than before, so they will be poorer. This also will affect the pattern of purchases by households (the income elasticity of demand). All these elasticities must be taken into account in order to determine the *overall* revenue effects of a tax change on any *one* good – and the model used to generate the results reported in Table 7 does this.

Table 7: Effects of an increase in petrol duty of 55p per gallon

	DECILE BY INCOME									
	1	2	3	4	5	6	7	8	9	10
Household gross income per week	41.64	65.78	93.81	131.51	173.81	218.44	265.93	317.49	394.97	645.72
Spending on petrol before tax change	0.51	1.32	2.77	3.61	6.27	7.01	8.10	10.18	13.46	16.26
Spending on petrol after tax change	0.61	1.56	3.26	4.43	7.60	8.60	9.98	12.47	16.49	20.43
Increase in total tax paid each week	0.12	0.29	0.61	0.91	1.53	1.74	2.09	2.58	3.41	4.51
Percentage change in petrol consumption	11.5	12.6	12.9	9.2	10.3	9.3	8.9	9.4	9.4	7.1
Average number of cars per household (1986)	0.09	0.21	0.42	0.57	0.75	0.93	1.04	1.19	1.45	1.79

3.2.18 A rise in petrol duty of 55p is predicted to reduce consumption of petrol by nearly 8 per cent (in the longer term, the effect would be larger, as people switch to smaller cars). The increase in revenue is large – households will pay £2.1bn (of which £1.8bn is in petrol duty) more in taxes and assuming that commercial use of petrol mirrors the changes in private consumption, at least another £900m would be raised. As few poor people spend much money on petrol (fewer than one in ten of the poorest 10 per cent of households own a car – see the last row in Table 7) the increase in tax is borne mainly by middle and high income households. For example the average increase in tax paid by a household in the poorest 10 per cent by income is just 12p a week, whereas the average rise in tax paid by the richest 10 per cent is £4.50 a week. Expressing petrol duty paid as a percentage of income shows that the burden of the tax rises to the fourth decile, but remains approximately constant thereafter, so increasing petrol duty might reasonably be seen as a progressive change to the tax system.

3.2.19 The results in Table 7 show the *average* change in tax paid. Many households in the lower deciles do not pay *any* extra tax because they do not own a car, whilst the effects on car – owning households are much larger. Table 8 contains the effects of the duty increase on car – owners alone. Note that the average income in each decile is higher than in the population as a whole – car – owners earn more than non car – owners.

Looking at car-owners alone, increasing petrol duty has a regressive effect - the increase in tax paid is 2 per cent of gross income for the poorest decile of car-owners, but under 0.7 per cent for the richest decile.

Table 8: Effects of an increase in duty of 55p on car-owners

	DECILE BY INCOME									
	1	2	3	4	5	6	7	8	9	10
Household gross income per week	77.18	132.32	176.82	215.48	252.61	290.24	327.29	379.48	460.29	732.36
Spending on petrol before tax change	6.83	7.08	9.51	9.00	9.19	10.53	12.08	13.69	15.48	17.80
Spending on petrol after tax change	8.05	8.64	11.54	10.95	11.32	12.99	14.71	16.85	19.06	22.48
Increase in total tax paid each week	1.50	1.76	2.33	2.22	2.36	2.75	3.00	3.51	4.02	4.99
Percentage change in petrol consumption	12.8	9.7	10.2	10.0	8.9	11.5	8.9	9.0	8.9	6.6
Average number of cars per household	1.06	1.10	1.14	1.20	1.22	1.32	1.34	1.48	1.67	1.97

3.2.20 Whether raising petrol duty is regressive or progressive depends on which sample of analysis is appropriate - the whole population (in which case it is progressive) or just car-owners (in which case it is regressive). To some extent, the choice of the appropriate groups depends to some extent on how "voluntary" car ownership is. If some members of the population *must* have a car then the increase in duty is regressive. Those who live in the countryside might fall into this category (although they do arguably have the choice *not* to live in the countryside). For those who can choose to have a car or not (urban dwellers) the tax is progressive.

3.2.21 This distinction is returned to in the discussion of VED below. It is clearly important when deciding on the desirability of raising petrol duty to decide whether car ownership is voluntary for most people, because otherwise any increase should be accompanied by other measures to offset their regressive impact.

3.2.22 Of course, a 55p increase in petrol duty is very large. It is used here for illustrative reasons, as being equivalent to the highest real price level which has been experienced relatively recently. The qualitative effects of lower increases will be the same. Before dismissing such large tax increases as being completely out of the question, it should be remembered that the UK petrol duty is lower than the EC average and even a 55p increase would not raise UK duty levels to those of Italy.

3.2.23 **(ii) Increasing the number of miles per gallon**

Britain is the only country in the Community which has a tax such as VED but which is not differentiated according to engine size. Introduction of such differentiation would lead to a fiscal incentive to use smaller cars, and insofar as smaller cars use less petrol per mile, would reduce emission of pollutants.

3.2.24 However, it has to be shown that reducing petrol use by taxing smaller cars at a lower rate is more effective than simply raising petrol prices. It is difficult to see why this should be the case. Raising petrol prices increases the price of travelling an extra mile by car, as well as encouraging use of a smaller car to reduce the total cost of transport. A differentiated VED would encourage new purchases to be of smaller cars, but would do nothing to alter the decision about whether to use a car or a bus or bike for a particular journey.

3.2.25 A further reason for believing VED to be less attractive as an environmental tax than petrol duty is that it is a blunt instrument. On average, a 1000cc car is likely to be more fuel efficient than a 1500cc car, but for some models the converse is true. Petrol duty again seems targeted rather more closely on production of pollutants than is a tax on engine size.

3.2.26 Nevertheless, there are reasons why VED differentiation according to engine size might have a role. One is political acceptability. To reduce pollution through use of petrol duty requires increasing taxes. Reducing pollution by using VED could be possible in a revenue neutral framework. Table 9 gives one possible set of VED rates, which would raise roughly the same amount of revenue as the current flat rate of VED of £100 per car (around £2.4-£2.5bn) if purchasing patterns remained as they were in 1988.[21]

Table 9: A possible revenue neutral system of VED by engine size

Engine size (cc's)	VED (£'s)
<1000	60
1001-1200	72
1201-1500	90
1501-1800	108
1801-2000	120
2001-2500	150
2501-3000	180
>3001	240

3.2.27 However, it seems unlikely on these figures that the tax advantage from buying a smaller car can be expected to induce much switching to smaller sizes. The total tax saving is not very large, because the overall rate of tax is low (and has declined by a quarter in real terms since 1985).

3.2.28 A second reason for thinking that VED might still have a role in reducing emission of CO_2 is that it can be distributively more attractive than increasing petrol prices. There are two broad types of car users: those in cities, who usually have the option of switching to public transport, and those who live in rural areas, who must use private transport. An increase in petrol prices may cause some of the former group to switch to public transport, whereas the latter group simply finds itself paying more tax. Using VED to discourage large engines would encourage rural drivers to switch to small cars, without punishing them for living in areas with a poor public transport system.[22]

21 It is based on 6p per cc of the largest engine size in each tax bracket.

22 In 1986-87, for example, the South West region of England had one of the highest levels of car ownership, whereas it is not a particularly rich region. The probable explanation is the paucity of public transport in that area (Department of Transport, 1989, Table 2.11(a)).

3.2.29 A final observation on tax incentives to reduce fuel usage for road transport is that the current system of taxing company cars encourages large cars. Briefly, the assumed value of a company car is added to the income of the recipient to calculate income tax, but not for national insurance purposes. There is therefore a tax advantage in giving employees income in the form of a car rather than directly in the form of money. As a result, over half the new cars sold in the UK are company cars (Department of Transport, 1989 Table 2.18). To a significant extent, therefore, the way in which company cars are taxed determines the nature of the UK car stock.

3.2.30 As shown in Table 10, cars of differing engine size are grouped together for tax purposes

Table 10: Charges for company cars under 4 years old with an original market value less than £19250

Engine size	Scale charge	Fuel benefit charge
<1400cc	1400	480
1401-2000cc	1850	600
>2001cc	2950	900

Note: The figures in the table are the amount added to income for calculation of income tax.

3.2.31 As a result of this system of charging, the largest tax "perk" is achieved by giving a car towards the top of each engine size category. To avert this incentive to buy larger cars it is necessary to make the scale charges more progressive by engine size, or to remove the tax perk attached to company cars altogether.

3.3 Conclusion

3.3.1 In no particular order, possible uses of the current tax system to promote the greening of road transport are:

(1) to increase the leaded/unleaded differential. However, the present differential is large enough to induce most car-owners who can convert their engines to do so and so any further increase is unnecessary, and, if it takes the form of freezing the duty on unleaded petrol, amounts to a real fall in the price of petrol and hence encourages higher use;

(2) to use car tax to ease implementation of European Community directives on the fitting of catalytic converters;

(3) to raise the level of duty on petrol in order to raise the price towards the average real price level of the past quarter-century; even then, petrol prices would be lower in the UK than in Italy;

(4) to use VED to discriminate in favour of smaller engines. Whilst increasing petrol duty bears heavily on rural residents who have high mileages with little scope for alternative use of public transport, increasing VED would encourage fuel economy without taxing high – mileage car users more heavily than other car users.

(5) to end the tax benefit given to consumers of company cars, or, if the current system is maintained, to make scale charges increase more rapidly with engine size.

4 TAXES ON SOIL AND WATER POLLUTANTS

4.1 Pollution of the water system

4.1.1 Sources of pollutants of the water system can be conveniently divided into three types:[23]

1) Direct discharge (for example, those cases where industrial waste is emptied into rivers);

2) Indirect discharge (for example, the leaching of nitrates from fertilisers into the water system);

3) Incidents (accidental discharge).

4.1.2 Different types of policy response are necessary to ensure company behaviour reflects the environmental costs of their actions according to the source of pollutant. For example, it might be thought sensible to charge companies according to the type and quantity of pollutant which they directly discharge into rivers. No such simple relationship between individual actions and resulting pollution exists where the discharge is indirect. Instead, it may be appropriate to tax use of products which may on average result in pollution. The most obvious example of such a tax is a nitrate tax on fertilisers. In the case of incidents (which are not discussed here), use of the legal system would seem a sensible option.

4.2 Charges on trade discharges into rivers

4.2.1 The case for charging companies for their discharges into the water system is that (as described in the introduction) charges can protect the environment at lower economic cost than direct controls. Direct controls may permit some companies to emit pollutants when in fact the costs of this emission are less than the benefits which the company receive, whereas some companies may be prevented from discharging waste even though the benefits of the goods which could be created if discharges were allowed would exceed the costs of any pollutant. Putting charges on discharge of each sort of pollutant would permit a case-by-case comparison of the costs of damaging the environment and the benefits of producing a good (assuming that discharges are priced correctly). Such a pricing system would also give companies a clear incentive to develop systems of reducing their discharges (and hence reducing their costs).

23 This classification follows that of the Department of the Environment (1989).

4.2.2 The UK does not have any charges on the discharge of industrial pollutants into the water system, relying instead on a system of direct controls.[24] It does, however, charge for emission of trade effluent into the sewage system. These charges vary according to the region of discharge, and are based on the quality[25] and quantity of the emission.

4.2.3 Professor Judith Rees of Hull University has looked at the effects of these sewage discharge prices in England to examine whether they result in any changes in company behaviour. Over a five year period, it was found that some companies faced 400 per cent increases in discharge costs. However, Rees found little evidence that companies responded to these costs, either in the form of reducing the quantity of emissions, changing the location of the company to take account of lower prices in other parts of the country, or even by changing to new production methods or the fitting of new technology in order to reduce the amount of pollutant per litre of discharge. This was despite the fact that in some cases technology was available which would have resulted in net costs savings within a year. It seems likely that if charges on trade effluent discharges into rivers were introduced at similar levels, a similar lack of impact would result.

4.2.4 The key reason for the almost total ineffectiveness of these charges (except as a source of small amounts of revenue) was found to be a lack of information. Rees found that generally the charges were so small that accounts departments simply paid them without any company policy on how to reduce them being developed. Indeed, Rees found that 30 per cent of the firms she looked at did not understand how the charging system worked, so had no idea on how to go about reducing their charges in theory, let alone in practice!

4.2.5 Obviously, if charges were increased sufficiently, this situation would change. As charges took up a greater proportion of company budgets, so more attention would be paid to the charging system, and more energy expended on reducing costs. UK charges are currently so low as to give little indication on the size of charges necessary to change company behaviour. Elsewhere in Europe, where waste discharge charges are more widespread and are at slightly higher levels, there has still been slightly more success (OECD, 1989). For example, the Netherlands has increased its charge rates on the various

24 The new water privatisation act allows charges to be imposed by the water companies, but only to cover the costs of monitoring companies' behaviour.

25 The quality of emission is measured according to the chemical or biological oxygen demand of the discharge.

categories of water polluting discharges by several hundred percent since 1977. It now raises the equivalent of £10 per capita per year in water pollution charges (£125m in total). These charges are held to be principally responsible (by Bressers, 1983, for example) for a 50 per cent reduction in pollution between 1969 and 1975, and a further 20–30 per cent reduction since then.

4.3 Nitrate taxes on fertilisers

4.3.1 Nitrogen contained in fertilisers has been implicated as one of a number of sources for the substantial rise in nitrate levels in water supplies across England and Wales. Those regions with the highest nitrogen concentrations – East Anglia and the East Midlands – are regions of intensive cereal production and so large amounts of fertiliser are used, and generally, right across England and Wales, the rise in nitrate concentrations has followed increased use of nitrogen fertiliser. The cost of treating drinking water over the EC limit of 11.3mgN/l is estimated to be around £150m to £200m.

4.3.2 Fertiliser taxes already exist in Norway and Sweden. The Swedish tax rate is low – about 5–6p per kilogram of nitrogen, and half that per kilogram of phosphorous, leading to an increase in fertiliser prices of about 5 per cent (OECD, 1989). About £10m is raised each year. The effect on nitrogen usage is thought to have been very low.

4.3.3 Soil scientists from ICI and economists from the consultancy firm, London Economics, have developed a model of nitrates use in England and Wales. The model describes how nitrates enter the surface and ground water system, as well as the financial position of farmers and the response of farmers to increases in the price of fertilisers. Hence the effect of a nitrogen tax can be traced from the effects on the demand for fertilisers, through the profits made by farmers, to the effect on nitrogen concentrations in the water system.

4.3.4 About 1.3 million tonnes of fertiliser are sold in the UK each year, at an average cost of £300 per tonne. Table 11 gives the reported effects (London Economics, 1990) of imposing a nitrogen tax at various rates on revenue, farm profits, and nitrate concentrations. The key economic variable which generates these results is the price elasticity of demand for fertiliser – the amount by which farmers will cut fertiliser consumption if the price goes up. The estimates reflect a view that this figure is very low – Table 11 is based on an elasticity of 0.3. In other words, if the price of fertiliser goes up by one per cent, the volume of fertiliser bought will go down by 0.3 per cent.

Table 11: The Effects of a Nitrogen Tax

Tax rate	Revenue collected (£m)	Reduction in farm profits (£m)	Change in nitrate concentrations
5%	15.2	15.5	-0.7%
10%	31.4	31.1	-1.4%
20%	65.8	62.5	-2.6%
40%	142.0	126.3	-5.0%

Source: Tabulation of the ICI/London Economics England and Wales nitrates model

4.3.5 Because of this low elasticity, the volume of fertiliser consumed is barely changed by an increase in the price. As farmers pay the tax rather than change the way they farm, fertiliser use remains little changed, and there is little effect predicted on the concentration of nitrogen in the water system. Even at a tax rate of 40 per cent London Economics estimates the fall in nitrate concentration would be only 5 per cent.

4.3.6 The results reported by London Economics suggest that a fertiliser tax would have its main effects on government revenues and farm profitability. Because farm use of fertilisers remain little changed by the tax, revenues raised would be substantial. However, if farm output prices remain fixed by the CAP at their present levels, the implications of the tax for farm profitability could be substantial – farm profits and land prices might be expected to fall sharply.

4.3.7 Obviously, if tax rates were raised to high enough levels, then there would eventually be a fall in use of fertilisers containing nitrogen. The ICI/London Economics work suggests that these levels would have to be very high percentages of the cost of producing the fertiliser. Economically such levels of tax could be justified, given the very high costs of water-purification systems. However, as tax rates are increased, so enforcement problems grow, especially in a Europe without border controls, as the European Commission intends to be the case after 1992.[26]

26 A European Community fertiliser tax might reduce this problem.

4.3.8 Another problem with raising tax rates to high levels is that problems of excessive nitrate concentrations are limited to only some regions. As tax rates climbed, so some farmers in regions where nitrates in the water supply were not a problem would be needlessly damaged by the tax. This would not be efficient economically, and would be unpopular politically. One (administratively cumbersome) way of reducing this problem would be to combine a fertiliser tax with a system of rebating the tax to farms which used fertilisers in regions where nitrate concentrations were low.

4.4 Conclusion

4.4.1 Charges and taxes have been suggested as instruments to achieve reductions in direct and indirect discharges in the water system and to raise revenues for cleaning up polluted water resources.

1) Charges on industrial discharges into rivers would aim to encourage companies to adopt cleaner technology. However, as the Dutch experience shows, to give them a strong enough incentive requires high charges.

4.4.2 2) Current evidence on the price elasticity of fertiliser use in farming suggests that a tax on fertiliser may not have a substantial impact on nitrates concentration in the water supply, but would raise substantial revenues. The effects of the tax on farm profitability may be an important consideration, especially in current circumstances. A fertiliser tax would be a rather blunt instrument, since the damage done to water supplies by agricultural fertiliser use may vary greatly depending on local geographical conditions. To reduce effects on profitability in regions with low nitrate concentrations some form of rebate might be operated, differentiated by geographical area.

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