THE EUROPEAN CARBON TAX:
AN ASSESSMENT OF THE EUROPEAN COMMISSION'S PROPOSALS

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PREFACE

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CHAPTER 1
INTRODUCTION

The Commission's Proposals

After a lengthy internal debate within the European Commission, the Environment Commissioner Mr Carlo Ripa di Meana announced the broad structure of the Commission's proposals for a European carbon tax towards the end of September. Many details have still to be worked out, especially those concerning how the tax will be administered and enforced, but the statement, and a subsequent written Communication to the Council (SEC(91)1744 final), clarified the main features of the proposed new tax.

The proposed tax would be a combination of a tax on the carbon content of fossil fuels, and a tax on all non-renewable forms of energy. Thus, fossil fuels such as gas, coal and oil would bear a tax comprising two components, one related to their carbon content, the other related to their energy content. Non-renewable forms of energy other than fossil fuels (mainly nuclear power) would be subject to the energy-related part of the tax, but would not bear the carbon component. Overall, the two components would be combined in equal proportions, in the sense that half of the tax on a typical barrel of oil would be related to the carbon component and half to the energy component.

The tax is intended to be introduced in stages. The tax would be introduced in 1993, at a level equivalent to $3.00 per barrel of oil, and would then be increased by $1.00 per barrel annually, until it reached a level of $10.00 per barrel of oil in the year 2000.

Revenues from the tax would accrue to the exchequers of member states. It would be for member states to decide what would be done with the revenue — for example, to choose which other taxes might be reduced. However, the Commission's proposals stress that the tax should be introduced on a revenue-neutral basis — in other words, the revenue should be used to reduce other taxes rather than to increase public spending.

The possibility of a number of sectoral exemptions was also included in the statement. These would exempt from the tax a number of highly energy-intensive sectors, such as the steel and cement industries. The rationale for these exemptions is set out in terms of the effects that a carbon tax could have on the international competitiveness of energy-intensive sectors, and it has been suggested that the subsequent removal of the sectoral exemptions might be made conditional on the adoption of similar legislation in competitor countries, especially in the United States and Japan.

Carbon Taxes in Other Countries

To date, only a few countries have introduced a carbon tax, and none has long experience of the effects of such a tax. Finland introduced a modest carbon tax in 1990, Norway introduced a somewhat larger one in January 1991, as did Sweden. The Danish Parliament passed a law calling for the introduction of a carbon tax (against the wishes of its minority government) although this has yet to be implemented. Similarly relatively detailed proposals exist for a federal carbon tax in Switzerland.

However, a key feature of existing carbon taxes in Finland, Norway and Sweden is that the tax rate is not uniform across different forms of fossil fuels. All countries tax or intend to tax coal at a lower rate per tonne of carbon dioxide emitted than petrol, despite the fact that none of these countries has an indigenous coal industry. Gasoline also is taxed more heavily than other fuels. Both Norway and Sweden have particularly high taxes on natural gas. Calculated as an average across all fuels, the carbon tax in Sweden is equivalent to $32 per tonne of carbon dioxide emitted, in Norway $29, and in Finland $6. By comparison, the $10 per barrel of oil proposed by the Commission is approximately equal to a tax of $22 per tonne of carbon dioxide emitted (though the combined energy/carbon tax structure of the EC proposals means that the tax would vary by fuel). Hence the Scandinavian taxes are generally at least as heavy as the proposed EC tax.

The other feature of the carbon taxes currently introduced is that they have exemptions and exceptions for energy-intensive industries. For example, industry in Sweden is refunded any taxes exceeding 1.7 per cent of total value of sales. The electricity-generating sector is exempt from all taxes. In common with the EC proposals, the governments concerned have sometimes expressed a willingness to extend the scope of the tax, provided similar measures are taken in the rest of the world.

Policy Objectives

The aim of a carbon tax would be to control the problem of global warming that appears likely to be caused by growing concentrations of greenhouse gases (carbon dioxide, CFCs, methane, etc.) in the earth's atmosphere. Since this is a global problem, the context for policy is global too — the contribution that the European Community alone can make to improving the situation is limited. Total EC emissions of carbon dioxide, the principal greenhouse gas, amount to only some 13 per cent of current global emissions,[1] and given the growth rates of emissions projected elsewhere in the world, especially in the developing countries, even a large cut in European carbon dioxide emissions would not be able to reverse the upward trend in emissions.

The European Commission's proposals come against the background of international discussions and negotiations about the possibility of concerted action to combat the greenhouse effect. Many countries have already committed themselves to quantitative targets to stabilise or reduce carbon dioxide emissions by a given date, but not all countries have so far been willing to contemplate major policy measures. The United States, in particular, appears to be unpersuaded of the need for action to reduce carbon dioxide emissions. Whether unilateral action by the Community is appropriate in these circumstances has been the subject of considerable debate (see, for example, Barrett (1990b)).

There are, indeed, some major uncertainties surrounding the greenhouse effect. Although a broad consensus appears to exist that some amount of global warming will take place if emissions of carbon dioxide and other greenhouse gases continue to rise (see IPCC (1990)), there is uncertainty about the range of mechanisms that might be involved (for example, whether increased cloud cover could help to counteract the impact on surface temperatures), and little firm basis on which to assess the risks and uncertainties involved in changes in temperatures beyond the range of past experience (see Cline (1991) for a review of some of the principal scientific arguments).

Over and above these economic uncertainties, there is also scope for legitimate debate about the need for policy measures to combat global warming. As Nordhaus (1991) discusses, measures to reduce greenhouse gas emissions would involve significant economic costs, and these can only be justified if they are exceeded by the costs of

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[1] Commission of the European Communities, SEC(91)1744 final, Annex 2.

uncontrolled global warming. These costs include the costs of sea level rise, and of climate changes causing changes in agriculture. The latter are particularly difficult to estimate, and it is possible that, taking the earth as a whole, the effects on agriculture could in fact be in either direction — some regions could gain whilst others lose. It is also conceivable that strategies of adaptation (building sea walls, and moving activities to reflect the change in climate patterns) could prove cheaper than the policy measures required to prevent global warming taking place.

There are thus important areas of uncertainty in relation to both the physical science and the economics of global warming. Nevertheless, as Pearce (1991) points out, it may not be possible to postpone policy action until conclusive evidence has been assembled on all of these areas of uncertainty, without in the mean time experiencing irreversible changes in climate and in the global environment. Where policy measures can be taken which have low cost, immediate action would then avoid the risk of irreversible damage, whilst leaving the full range of policy options open, should future studies make major revisions to the scientific and economic assessments of the risks of global warming.

Plan of the Report

In this report we take the objectives of policy, in the form of the goal of reducing carbon dioxide emissions, as given. We aim to consider the implications of tackling the problem in one particular way — namely through the introduction of a carbon tax of the form proposed by the European Commission.

We examine in Chapter 2 the general issues involved in the use of taxation as an environmental policy instrument. When are taxes such as the proposed carbon tax a better response to environmental problems than alternative measures such as specifying technologies or emissions levels through government regulation? What issues and problems are encountered with tax instruments of this sort?

In Chapter 3 we assess the specific case for the use of a carbon tax to control global warming. Does the efficient reduction of emissions require a substantial rise in the price of energy? What evidence is there that a carbon tax would be effective? Should the tax take the form which the Commission proposes, based partly on the carbon content of fuels and partly on the overall energy content?

Chapter 4 looks at the practical aspects of the introduction of a

European carbon tax. The Commission's proposals leave much of the practical and administrative detail of the carbon tax for later discussion. Nevertheless, some of the practical issues are important, since there are trade-offs between the optimal design of the tax and its administrative feasibility. Where in the energy 'chain' should the tax be applied — at the level of primary fuel extraction and import, or at the level of final fuel products? How does the choice made between these two alternatives affect the ease with which international trade can be handled, and the allocation of tax revenues between member states? What problems will the proposals for sectoral exemption pose for administration, and how might these problems be minimised?

Chapter 5 looks at some of the 'public finance' aspects of a carbon tax, including the level of revenues that member states might expect to obtain from the tax, and the possible uses of the revenue. A carbon tax need not increase the overall burden of taxation, since other taxes could be reduced using the revenues, but it might change the distribution of the tax burden. How would the carbon tax burden be distributed across different groups of the population, and what supplementary or offsetting measures might be appropriate?

Chapter 6 draws our conclusions.

CHAPTER 2
MARKET MECHANISMS IN ENVIRONMENTAL POLICY

The Case for Market Mechanisms in Environmental Policy

The need for public intervention to control environmental pollution arises because of the 'externalities' involved in pollution — the costs that the polluter imposes on other members of society. Without government intervention, a polluter may have no reason to take these external costs into account. In particular, the atmosphere and water systems may be treated as free methods for disposing of unwanted waste products, despite the fact that unrestricted pollution of the atmosphere, or of rivers and seas, may impose costs on other firms or individuals.

From an economic point of view, the objective of environmental policy should be to ensure that these external costs of pollution are fully taken into account by those responsible for causing the pollution. An optimal environmental policy would require a balance to be drawn between the costs of pollution and the costs of controlling pollution. Ideally, pollution should be restricted up to the point where the benefits to society as a whole from further reductions in pollution are less than the costs of pollution control devices or the curtailment of polluting activities, or, in other words, where the marginal damage of pollution equals the marginal benefit of polluting activities.

In principle, any given pattern of pollution reduction could be achieved either by regulations restricting polluting emissions to a given level, or by the use of pollution taxes or charges to provide an appropriate incentive to reduce emissions to the same level. However, there may be considerable differences between polluters in the costs of reducing pollution — some firms may, for example, be able to install pollution control devices more cheaply than others. Regulations requiring all polluters to reduce emissions by the same amount will not then be the least-cost way of achieving any desired reduction in total pollution.

In comparison with the conventional regulatory approach to the control of environmental pollution, market mechanisms such as charges, taxes and tradable permits have two principal attractions. First, they can allow firms and individuals to choose to reduce pollution where the costs of doing so are least, and can thus achieve a given degree of pollution control at lower economic cost than regulations applied across-the-board. Second, market-based instruments provide a continuous incentive to develop less-polluting products and processes, whereas regulations tend to encourage only minimum compliance.

Taxation as a Market Mechanism

Much economic analysis of the role of taxation in environmental policy implicitly assumes that a system of measurement or metering can be used to charge polluters for each unit of pollution emitted. However, taxation of measured emissions will remain impracticable in many instances, such as where there are many emission sources, or no single point where emissions can be monitored. Thus, for example, the huge number of emission sources of carbon dioxide (motor vehicles, domestic heating appliances, industrial energy combustion, etc.) rule out the use of direct metered charging. Moreover, even if it were to be confined to a limited number of large emission sources, explicit emissions taxation would also require the establishment of new administrative procedures, with associated administrative costs.

The existing indirect tax system provides a route for the introduction of market-based incentives for pollution control, which may sometimes be able to use existing administrative procedures and apparatus. Rather than taxing each unit of pollution emitted, using the existing tax system to pursue environmental objectives would involve indirect incentives, making use of the relationship between polluting activities and the various transactions which can be taxed. Thus instead of taxing the emissions from car exhausts, additional tax may be levied on petrol purchases, on the assumption that the environmental damage caused is proportional to the amount of petrol used.

For taxes to be an acceptable substitute for direct pollution charges based on measured emissions, it is necessary that there should be a close 'linkage' between the basis on which the tax is levied (usually the value of a transaction) and the activities causing environmental pollution. Where the relationship between the tax base and emissions is insufficiently close, a policy based on taxes may not always encourage pollution reductions in the most efficient form. Actual or potential alternative technologies may change the relationship between pollution and the tax base. This may be a particular problem where the environmental aspects of a production process can be chosen independently of the choice of process. For example, where the technological options for pollution control include effluent-cleaning technologies (as in the case of the sulphur emissions that contribute to acid rain), input taxes will not provide any encouragement to deal with pollution by effluent-cleaning, and could therefore distort the pattern of pollution control away from the most efficient areas.

Circumstances where taxation instruments may be less effective than other market-based instruments or direct regulation as a means of pollution control include cases where the *concentration* of pollution, either in particular localities or over certain time periods, is of importance. It is in general difficult to envisage tax structures that would adequately reflect the different values of pollution reductions in different places or at different times. Consequently, where pollution control objectives have a 'spatial' aspect, pollution taxes may be inappropriate instruments.

Whilst there are a number of pollution problems for which changes to the system of indirect taxes would therefore seem to be a less appropriate choice of instrument than the use of charges for measured pollution emissions or other market-based incentives, the use of indirect taxation would appear to be particularly relevant to the control of carbon dioxide emissions, as part of a package of policies to combat the risk of global warming. A 'carbon tax' on energy sources in proportion to their contribution to the greenhouse effect would appear to have the following advantages over taxation for measured emissions:

- there are many emission sources, and so metering would be impracticable;
- the use of inputs is closely related to polluting output; there is currently no cost-effective end-of-pipe treatment technology;
- pollution damage from carbon dioxide emissions does not differ depending on the location of the emission sources; there are no local 'hot spots' that require more stringent emission controls.

Implications of the Tax Payments and Revenues

One major difference between direct regulation of polluting emissions and market-based incentive mechanisms such as taxation is the additional fiscal revenues that are obtained from the latter. Both direct regulation and market-based environmental policies will increase the (private) costs of producing and consuming energy, although the logic of using market-based instruments is that these costs will generally be lower under the market-based policy. However, over and above this, market instruments such as a carbon tax have a more direct, and perhaps more politically sensitive, impact on household and industry resources, in the form of the additional tax payments.

In the case of a carbon tax, the additional revenues (and hence the tax burden paid by individual and business taxpayers) could be substantial. For example, Poterba (1990) estimates that a carbon tax in the United States set at a level of $100 per tonne of carbon ($27 per tonne of carbon dioxide emitted) would raise revenues equivalent to some 3 per cent of GNP. In general, it is to be expected that the revenues from any environmental tax will be rather larger in the short run than in the long run, when behavioural adjustments to the tax have had more time to take place.

These additional revenues present both problems and opportunities. On the one hand, the distribution of the environmental tax payments across taxpayers may conflict with other objectives of policy. On the other hand, the additional revenues provide scope for various forms of offsetting policy measure, either in the form of reductions in other taxes, or through additional expenditures.

If the extra revenues are used to reduce other taxes, such as those on labour and capital, welfare gains may be made by reducing the economic costs of raising government revenues. In this sense, there may be a 'double dividend' from a carbon tax: not only does it tackle the problem of global warming, but it also provides the opportunity to reduce taxes elsewhere in the economic system which may have distortionary costs. We return to these issues in Chapter 5.

CHAPTER 3
USE OF A CARBON TAX TO CONTROL CARBON DIOXIDE EMISSIONS

Whatever the theoretical attractions of a carbon tax, would it work in practice? What evidence is there that it would succeed in reducing emissions of carbon dioxide, and how large an impact might the tax proposed by the Commission be expected to have? In this chapter, we describe the various channels through which a carbon tax would be expected to affect carbon emissions, and assess the range of evidence available about the likely scale of its effects. We then go on to consider how far these effects are weakened by two proposed features of the carbon tax proposed by the Commission, namely the mixed carbon/energy tax base, and the exemption of the six most energy-intensive sectors.

The Structure and Level of the Carbon Tax

The carbon tax would have effects on fuel use of two main sorts. First, it would establish an incentive for fuel substitution, away from the most carbon-intensive fuel sources towards those that generate less carbon dioxide per unit of energy. Second, it would encourage energy conservation, in the form of reductions in the overall level of energy consumed.

Substitution

The carbon tax would impose different levels of tax per unit of energy on different fuels, according to their carbon content. Table 3.1 shows the carbon content per unit of energy of some major fuels. The carbon content per unit of energy is lowest for natural gas, and highest for the various coal-based fuels. A carbon tax would have a similar pattern, and, in comparison with a tax structure that taxed all units of energy at an equal rate, would thus tend to encourage substitution away from coal and towards gas.

The existing pattern of taxation of fuels does not reflect the pattern of carbon contents shown in Table 3.1. Tables 3.2 and 3.3 show the existing taxes on fuels in EC member states, expressed as 'implicit

TABLE 3.1

Carbon Content per Unit of Energy

	Tonnes of carbon dioxide per terajoule
Oil-based fuels	
Crude oil	75
Petrol	72
LPG	65
Coal-based fuels	
Hard coal	94
Coke	108
Brown coal	105
Natural gas	55

Source: Eurostat estimates.

carbon taxes — in other words, expressed as the amount of tax per tonne of carbon dioxide emitted. Table 3.2 shows three of the main fuels purchased by households — motor fuel (petrol) and oil and gas for domestic heating — and Table 3.3 shows a similar comparison between the pattern of implicit carbon taxes on coal, oil and gas used by industry. In both cases, it is clear that the relative taxation does not correspond to the pattern of relative taxation that would result from systematic taxation according to carbon content. In particular, petrol tends to be taxed more heavily than other fuels purchased by households, and coal tends to be favoured strongly by the tax system in comparison with other industrial fuels.

Obviously, various non-environmental objectives can be seen to lie behind the existing tax structure. The lower rates of tax on domestic fuels compared with petrol may reflect distributional considerations, and a concern that all households should be able to afford at least a minimum level of heating. The higher rates of taxation on petrol may be an attempt to reflect various other social costs associated with motoring. Coal may be fiscally advantaged both because for some countries it is a more secure energy supply, and because of concerns about the social impact of employment losses in mining areas. Imported energy may be taxed more heavily for balance of payments reasons. The relative importance of these various considerations may be seen in the differences in the tax structure between countries.

TABLE 3.2

Implicit Carbon Taxes on Household Energy Purchases in EC Member States

US$ per tonne of carbon dioxide, 1990

	Petrol	Heating oil	Gas
Belgium	244.79	13.74	29.78
Denmark	287.29	155.97	49.85[a]
France	298.74	52.31	31.35[a]
Germany	204.85	26.96	26.67[a]
Greece	190.36	39.30	n.a.
Ireland	284.48	36.66	26.62
Italy	379.53	201.69	54.60[b]
Luxemburg	152.05	5.60	n.a.
Netherlands	251.11	46.48	20.26
Portugal	266.86	126.78	n.a.
Spain	208.66	51.41	27.16[a]
UK	200.19	7.55	0.00
Japan	163.39	3.37	11.19[a]
US	33.64	4.52	n.a.

[a] Data for 1989.
[b] Data for 1988.
Note: n.a. = Data not available.
Source: Based on data from IEA (1991).

TABLE 3.3

Implicit Carbon Taxes on Industrial Energy Purchases in EC Member States

US$ per tonne of carbon dioxide, 1990

	Light fuel oil	Steam coal	Natural gas
Belgium	0.00	0.00	0.00
Denmark	0.00	0.00	n.a.
France	36.05	0.00	0.00
Germany	13.37	0.00	7.86
Greece	30.56	n.a.	n.a.
Ireland	22.79	n.a.	0.00
Italy	155.62	0.00	0.00
Luxemburg	0.00	n.a.	n.a.
Netherlands	20.80	0.00	0.62
Portugal	94.28	n.a.	n.a.
Spain	27.07	n.a.	1.82
UK	6.69	0.00	0.00
Japan	1.59	0.65	5.31
US	0.00	n.a.	n.a.

Source: Based on data from IEA (1991).

Nevertheless, although these various considerations may lie behind the existing tax structure, it does not seem that any systematic effort has been made to assess the cost of pursuing these various social and economic objectives through the pattern of taxation of different energy products. In large measure, the existing pattern of taxation is haphazard, without any coherent justification or rationale. In any event, from the point of view of environmental policy, significant gains could be made from moving the tax structure towards a pattern given by the relevant carbon content of fuels.

It should be noted that governments influence the price of energy in other ways than simply through the tax rates they impose on consumption. Many countries within the EC subsidise coal production (in 1990–91, the UK spent £2.4 billion on subsidies to British Coal). In addition, it is often the case that electricity-generating companies are made to sign contracts with domestic suppliers of coal at a price exceeding the world rate. For example, in Germany 87 per cent of the coal burned to generate electricity must be bought from domestic sources (although 25 per cent of this is paid for at the prices which would have been paid for imports). The difference in price between German coal (around £89 per tonne) and the world price (around £24) is paid for by a tax on electricity, raising DM10 billion per year. Similar arrangements operate in Belgium. Where electricity production is in state ownership, it may also be the case that the purchasing policy of the nationalised industry is such as to buy more domestically produced coal than otherwise would be the case. The effect of such policies is to increase the world supply of coal above the level it otherwise would be, so depressing the world price of coal and increasing world coal consumption. Since coal emits more carbon dioxide per unit of energy than other fuels, a reduction in these subsidies and purchasing policies would reduce the average price of energy at the same time as encouraging substitution towards fuels that contribute less to the greenhouse effect.

The Tax Level

In addition to its impact on the pattern of relative taxation of different fuels, the carbon tax proposed by the European Commission would increase the price of all fuels above current levels. Given the pattern of taxation, and the fact that the price of each unit of energy tends to be higher for households than for industry, the percentage impact of the carbon tax on the prices of fuels will vary widely. As Table 3.4 shows, the carbon tax would increase the price of fuels used by industry by between one-third (for gas) and three-fifths (for coal). Domestic fuel would rise in price by about 15 per cent, whilst the price of petrol (which already contains a substantial tax component) would rise by only 6 per cent.

TABLE 3.4

Effect of a Carbon Tax at $10 per Barrel on Fuel Prices
(percentage increase in price, based on 1990 prices and exchange rates)

Power-stations and industry	
Hard coal	58
Heavy fuel oil	45
Natural gas	34
Households	
Light fuel oil	16
Natural gas	14
Transport	
Petrol	6
Diesel	11

Source: Commission of the European Communities (1991), SEC(91)1744 final.

The Effects of a Carbon Tax on Fuel Use

Would a carbon tax be effective in reducing the output of greenhouse gases? The experience of the oil price rises during the 1970s provides a useful source of historical evidence from which to assess the likely impact of the energy price rises that would result from the introduction of a carbon tax.

As already noted, a carbon tax would affect energy consumption in two ways, both by encouraging substitution between fuels and by reducing the overall demand for energy. Consequently, disaggregated modelling of the demand for different fuels is important if the full range of effects is to be identified.

Some widely quoted estimates for the effects of changes in the price of energy on fuel use for the UK are those of the Department of Energy (1989). These predict energy demand on the basis of a sectoral model of the UK economy, which has estimated elasticities for both the short run (effects apparent in the first year) and the long run (around 10 years). Results for two sectors of the economy — Industry (excluding

Iron and Steel) and the Domestic sector — are summarised in Tables 3.5 and 3.6.

TABLE 3.5

Long-Run and Short-Run Cross-Price Elasticities of Demand for Energy by Industry, excluding the Iron and Steel Industry

1% increase in the price of:	*Percentage change in demand for:*							
	Electricity		Coal		Oil		Gas	
	Long run	Short run	Long run	Short run	Long run	Short run	Long run	Short run
Electricity	–0.4	(–0.2)	0.1	(0)	0.0	(0)	0.1	(0)
Coal	0.2	(0)	–2.4	(–0.4)	2.9	(0)	1.4	(0.1)
Oil	0	(0.1)	1.2	(0.2)	–2.3	(–0.2)	–0.1	(0.1)
Gas	0	(0)	0.8	(0.2)	–0.7	(0.1)	–1.5	(–0.3)

Source: Department of Energy, 1989.

TABLE 3.6

Long-Run and Short-Run Cross-Price Elasticities of Demand for Energy by the Domestic Sector

1% increase in the price of:	*Percentage change in demand for:*							
	Electricity		Coal		Oil		Gas	
	Long run	Short run	Long run	Short run	Long run	Short run	Long run	Short run
Electricity	–0.6	(–0.1)	0.3	(0)	0.3	(0)	0.3	(0)
Coal	0.1	(0)	–2.1	(–0.2)	0.3	(0)	0.3	(0)
Oil	0	(0)	0.1	(0)	–2.6	(–0.2)	0.1	(0)
Gas	0.4	(0)	1.5	(0)	1.7	(0)	–1.1	(–0.2)

Source: Department of Energy, 1989.

These results show considerable scope for fuel substitution in response to price changes; in the long run, there are a number of large cross-price elasticities. For example, a 1 per cent increase in the price of coal is expected to have no effect on demand for oil by the industrial sector in the year of the increase, but when all adjustments have been made, and industry has been able to invest in new technology using other fuels, the demand for oil would increase by up to 3 per cent, with the demand for coal falling by 2.4 per cent. In general, it is to be expected that electricity has the lowest own-price elasticity of demand, as it is used for lighting and for powering machinery, which have few alternatives. In contrast, coal and oil are strong substitutes as they tend to be used by industry as fuels for bulk heating.

Elasticities are lower in the domestic sector in both the short term (few households are able to substitute between different heating fuels in the short term — all that can be changed is the amount currently consumed) and in the long term (energy consumption is not heavy enough to justify the fixed costs of moving from one form of energy to another).

Note that these tables show 'electricity' as a separate source of energy. In fact, of course, there is a further set of relationships between coal, oil, gas, nuclear energy and renewable energy sources behind this figure. A change in the relative price of one of the fuels will be expected to result in a shift in its use both in the short term (the generating industry will 'switch on' power-stations using another source of fuel when extra energy is necessary) and in the long term (new power-stations using cheaper fuels will be built to replace those using expensive fuels). In that the 'cleanest' technology for electricity generation (with respect to carbon emissions) is nuclear energy, the extent of the possible gain from fuel substitution in the very long term is critically dependent on how much substitution is feasible towards nuclear energy.

Other studies of energy demand in the UK have generally found a rather lower overall price elasticity of the demand for energy. Hunt and Manning (1989), using time-series data on aggregate UK energy demand, found a short-run price elasticity for energy of about –0.1 and a long-run elasticity of about –0.3. As they noted from a survey of other studies, their results were consistent with the broad range of estimates from recent UK studies. Lynk (1989), for example, in a time-series study of the energy demand of UK manufacturing industry, found a long-run price elasticity of –0.69, whilst Manning (1988), estimating a time-series demand system for UK households, found an energy price elasticity of –0.09.

Microeconometric estimates of the effects of higher energy prices on the demand for domestic energy and petrol by private households seem to confirm this general conclusion that the price elasticity of demand for energy is low.[1] Estimates using the IFS model of consumer

[1] Although the cross-price elasticity of demand for domestic energy for cooking and heating may be quite high — see Baker and Blundell (1991).

expenditures[2] indicate that an increase in domestic energy prices of 15 per cent would cut household energy consumption by 5.5 per cent, and an increase in petrol prices of 55p would cut petrol consumption by something over 8 per cent (Pearson and Smith, 1990).

The implication of a low price elasticity is that relatively high taxes would be necessary to have a significant impact on the overall demand for energy. Thus, if a long-run price elasticity of –0.3 is assumed, energy prices would need to be increased by one-third to reduce overall energy demand by 10 per cent.

A number of other studies have considered the likely quantitative impact of a carbon tax on energy use and carbon dioxide emissions in the context of assessments of the carbon tax required to meet particular quantitative targets for emissions reductions. Given the objectives of these exercises, the nature of the analysis is rather different; generally these studies seek to compare the reduction in energy consumption or carbon dioxide emissions that would result from a carbon tax, with the likely increase in demand for energy that would be expected over any given time period from the effects of income growth. If the price elasticity of demand for energy (the response to the tax) is low relative to the income elasticity, very high rates of tax may be necessary to stabilise emissions of carbon dioxide by a given target date. For example, suppose that any growth in GDP were such that the overall energy intensity of the economy were unchanged — a 1 per cent growth in income would lead to a 1 per cent increase in energy use. With a price elasticity of demand for energy of –0.3, energy prices would have to be increased by 10 per cent for every 3 percentage points of growth in the economy. Of course, income growth could lead to greater energy consumption (for example, if there is a growth in car ownership and use) so that income elasticities of demand could easily be in excess of 1.0.[3] Over time the cumulative effects of growth could require very large carbon taxes.

For example, Barker and Lewney (1990) used Department of Energy demand elasticities to consider the level of carbon tax that would be necessary to stabilise UK emissions in 2005 at their 1990 level. They find that by 2005 the tax rates would be 132 per cent, 92 per cent and 48 per

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[2] The Simulation Program for Indirect Taxes (SPIT) — based on an Almost Ideal Demand System estimated across over 100,000 households from the UK Family Expenditure Survey. See Baker, McKay and Symons (1990) and Blundell, Pashardes and Weber (1989) for details.

[3] Ingham, Maw and Ulph (1991) estimate the income elasticity of demand for energy for the domestic sector to be 0.911 in the short run, and in the long term 2.317.

cent on coal, oil and gas respectively (UK electricity prices would rise by 27 per cent). Similarly, Barrett (1990a) found that to reduce the rate of emissions of carbon dioxide per unit of GDP by 20 per cent, tax rates on coal, oil and gas would need to be 67 per cent, 54 per cent and 40 per cent in the short term, and 24 per cent, 19 per cent and 14 per cent in the long term. Ingham, Maw and Ulph (1991) discuss the appropriate tax rates to meet various different targets under assumptions about rates of growth in the economy, changes in the base price of fossil fuels, and the speed at which a carbon tax is increased after being originally introduced. To stabilise the output of carbon dioxide at the 1990 level by 2005 requires a wide range of possible tax rates, depending on the assumptions chosen (see Table 3.7). Clearly, if it is assumed that there is rapid economic growth, the tax rates required in order to stabilise emissions will be very large.

TABLE 3.7

Tax Rates Needed to Stabilise Carbon Dioxide Emissions by the Manufacturing Sector by 2005 under Different Assumptions[a]

	Coal	Oil	Gas
(1) Low growth, high fuel prices, fast growth in tax	19	19	11
(2) As (1), but fast economic growth	249	244	135
(3) As (1), but low fuel prices	24	23	13
(4) As (1), but once introduced, increase the tax more slowly	22	21	12

[a] Figures show tax rates necessary to have been introduced in 1990 in order to stabilise carbon dioxide emissions at their 1990 level by 2005.
Source: Ingham, Maw and Ulph, 1991.

The various studies of elasticities seem to suggest a rather pessimistic conclusion that high tax rates will be necessary to reduce overall energy consumption and carbon dioxide emissions. However, in practice, estimated price elasticities of demand may tend to be minimum estimates, and the actual long-term effects of an increase in energy prices could be somewhat higher. This is because it is very difficult to separate out the effects of increasing the price of energy on the demand for energy from the effects on the whole global economy of increasing the price of energy. For example, the oil shocks reduced the demand for energy, but part of this was no doubt due to the consequent recessions, and not simply the increase in the relative price of energy.

It is unlikely, too, that the estimates can fully take account of all the possible ramifications of a change in prices. In addition to changes in energy demands which reflect reduced energy use or fuel switching with the existing capital stock, there are likely to be longer-term adjustments in the capital stock itself. Thus, when industry and households replace their current stock of energy-using capital they will choose replacements which are more energy-efficient. In addition, the capital goods supplied by capital goods manufacturers will change over time to emphasise energy conservation more than before the introduction of the energy tax.

Such long-term effects are unlikely to be fully reflected in econometric studies of energy demand. Yet they undoubtedly exist, and it would be surprising if they were not an important way in which the carbon tax affected energy demand. Since the first oil shock of 1973, the fuel efficiency of motor cars of any given engine size has increased by approximately 30 per cent according to official road tests. It is difficult to believe that such gains would have been made without the impetus provided by the increase in prices. Technological progress cannot be certain and cannot be predicted, but one of the strongest influences a carbon tax could have on energy use may be through its impact on research and development effort.

Carbon Tax or Energy Tax

A feature of the tax proposed by the European Commission is that it is not a pure carbon tax but a combined carbon/energy tax. The tax is partly on how much carbon dioxide can be expected to be produced when fossil fuels are burned, and partly on how much energy is produced when they are burned or when other (non-renewable) fuels are used to generate energy. What is the justification for such a combined tax?

One reason for proposing the energy part of the tax, which is given prominence in the Commission's document (SEC(91)1744 final), is to promote energy efficiency. It adds that 'studies carried out by the Commission indicate that energy efficiency could be increased considerably (by 15–20%) with the techniques already available'.

The difficulty is in thinking of reasons for wanting to pursue energy efficiency as a policy *per se*. Of course, if energy efficiency were improved by 15–20 per cent, industrial costs would fall significantly, but this is only desirable if the measures taken to improve energy efficiency are cost-effective, or if measures which are not cost-effective in purely private terms can be justified in terms of the contribution they make to reducing social costs associated with energy use. As far as the first is concerned, it is generally recognised that there may be important market failures in the market for energy-efficiency investments, which may prevent genuinely cost-effective measures being undertaken. Measures to tackle these market failures may be an important part of a package of complementary measures to reduce carbon dioxide emissions. However, since these market failures may often reflect informational and decision-making failures, increasing the energy price will be a poor way of overcoming the underlying problems. Second, social costs associated with energy use that would warrant the use of energy taxation to encourage energy efficiency beyond the point at which it was privately profitable are hard to identify; apart from global warming, for which a carbon tax would be more appropriately targeted, the other external environmental costs such as acid rain either involve locational differences in the importance of emission controls, or technologies in which the linkage between input taxation and emissions is weak. In both cases, taxes on energy would be inappropriate instruments.

A second reason for introducing an energy component into the tax could be to reflect the externalities involved in nuclear power. The difficulty with a pure carbon tax is that the principal source of energy not produced by burning fossil fuels is nuclear power, and a carbon tax would thus confer a fiscal advantage on nuclear power generation. This report is not the appropriate place to discuss the pros and cons of nuclear power. What does need to be addressed is the possibility that a carbon tax could correct one externality at the cost of increasing others. For example, externalities associated with the nuclear industry may include adverse health effects, including those relating to day-to-day operation and those that would follow a nuclear accident. Perhaps more substantial and less controversial are the externalities caused by the fear of these effects. Taxation may not be the appropriate way of dealing with the externalities from nuclear power. However, some nuclear tax element may be required if the carbon tax is not to encourage greater use of nuclear power.

However, although an energy tax would encourage energy saving and reduce the emission of greenhouse gases, it would be less efficient than a carbon tax in reducing carbon dioxide emissions, since it would not encourage fuel substitution between fossil fuels. The introduction of an energy tax component into the Commission's proposals weakens the incentive for reduced carbon dioxide emissions in the pattern of relative taxation of the various non-nuclear fuels. If it were intended to include a tax to reflect the externalities associated with nuclear power, it would therefore be more efficient to do so directly through the introduction of a nuclear externality tax to complement the carbon tax, *rather than through the indirect route* of an energy tax element, which at the same time dilutes the incentives to substitute away from high-carbon fossil fuels to lower-carbon fossil fuels.

A third argument which may support the choice of an element of an energy tax in the proposals is that otherwise the tax would have particularly large effects on some countries and not on others. The reason for this is that nuclear power accounts for a large proportion of the electricity produced in France (and to some extent Belgium) whereas in Greece and Denmark the major fuel is coal, which would be taxed at a high rate with a carbon tax. Table 3.8 takes current fuel inputs into the electricity-generating process in each country, and calculates the emission of carbon dioxide per unit of energy produced. Whatever their commitment to reducing greenhouse gas emissions, many countries would balk at the difference in carbon tax burdens indicated by this table, and the possible implications for the pattern of competitiveness between energy-using industrial producers located in different Community member states.

General Carbon Tax or Differentiated by Sector

Higher taxes on energy use by industry could have a range of macroeconomic and structural effects on the European economy, including effects on output and employment in particular sectors and on average, and effects on the price level. These effects may differ in the short run, during the transitional phase of adjustment to new relative prices, from the effects in the long run, once all producers and consumers have fully adjusted to the new situation. They may also be affected by how the revenues from the additional energy taxes are used; effects on the price level, for example, could be broadly offset if the revenue was used to reduce the level of other indirect taxes.

TABLE 3.8

Emissions of Carbon Dioxide per Unit of Energy Produced in the EC Electricity Industry

	Emission factor (tonnes of carbon dioxide per 10 million kCal)
Belgium	1.75
Denmark	6.20
France	0.62
Germany	3.39
Greece	6.19
Ireland	4.86
Italy	3.42
Luxemburg	n.a.
Netherlands	3.61
Portugal	n.a.
Spain	2.81
UK	4.33

Source: IFS calculations.

An important consideration in evaluating higher taxes on industrial energy inputs is how they would affect the international competitiveness of European industry. Here the impact will depend not only on how the revenues are used, but also on any exchange rate adjustments between the Community countries and the rest of the world that take place in response to the initial change in cost-competitiveness. Even if exchange rates adjusted fully, however, so as to ensure no overall change in the balance of trade, there would be a change in the *composition* of the Community's exports and imports, and consequently in the industrial structure and pattern of employment. Adjustments to the exchange rate could ensure *average* competitiveness was unchanged. However, those sectors relatively unaffected by the input tax would benefit from the fall in the exchange rate, so becoming more competitive and expanding output, whereas industries requiring large amounts of the taxed input would be imperfectly compensated by the exchange rate change and their activity would contract.

As a result, countries imposing carbon taxes would produce less carbon dioxide per unit of GDP. However, precisely the opposite effects occur elsewhere in the world, where the competitiveness of energy-intensive branches of industry would improve, and carbon dioxide emissions would thus rise. This last point rather undermines the case for unilaterally implementing a carbon tax. The most effective route to limiting carbon emissions is in fact likely to be through international agreement and co-ordinated implementation rather than unilateral policy actions by a single country.

The European Commission's proposals provide for the exemption of six energy-intensive industries (steel, chemicals, non-ferrous metals, cement, glass, pulp and paper) from the carbon tax, at least until it is clear that other countries adopt similar policies to control carbon emissions. The benefits of exemption in circumstances where other countries do not adopt similar measures are obvious: the loss of sectoral competitiveness of industries which would be most severely affected by the carbon tax is avoided. If such industries were not exempted, then they would be disadvantaged in world competition, leading to a relocation of energy-intensive production to other countries which have not undertaken measures to control carbon emissions. Exemption of energy-intensive sectors would make it possible to avoid the most serious parts of the dislocation that might result from changes in the pattern of competitiveness, as first the Community and then other countries introduced policies to control carbon dioxide emissions.

At the same time as preventing the loss of sectoral competitiveness of energy-intensive industries, the exemption of energy-intensive sectors reduces the gain in competitiveness that other sectors would enjoy as a result of exchange rate adjustments. However, this may be justified, during the short term at least, by the observation that such gains could be quite short-lived, if other countries decide to implement equivalent measures at a later date.

Nevertheless, despite this case in favour of exemptions, there are also arguments against.

First, it is clear that if certain energy-intensive industries are exempted from having to pay the carbon tax, the overall impact of the carbon tax on carbon emissions will be reduced. Hence to obtain any given reduction in carbon dioxide emissions, a larger carbon tax would need to be applied to other sectors.

Second, because only some sectors are exempted, the exemption encourages changes in the industrial structure which are in the opposite direction to those which would be desirable. For example, if there are parts of the exempt sectors which are not significantly exposed to international competition (for example, because they produce goods which are not traded, or because their products have other characteristics which insulate them from strong price competition) then exemption will actually tend to stimulate these activities, both relative to others which are less energy-intensive, and over and above the current level. Hence exemption of some sectors cannot be seen as a no-cost strategy, doing no harm to other industries and the overall welfare of the Community. It distorts the structure of the economy, and does so in such a way as to increase carbon emissions.

Third, and most importantly, it is not clear how long-lived the exemptions would be. The world economy is littered with 'temporary' measures of assistance and protection that have become institutionalised and permanent. There are in particular two key areas of ambiguity which may make it difficult to remove the exemptions at a later date. One is over the actions which other countries would have to take before the Community abolished the exemptions. The second is over the Community's response if some competing countries do not take the action which is being demanded as a precondition for abolishing the exemptions.

What policy measures would satisfy the Community's conditions for abolition of the exemptions? Clearly, introduction in all major competitor countries of an identical carbon tax to the Community's tax would be enough to warrant abolition of the exemptions. But should the exemptions also be abolished if major competitors decide to reduce carbon emissions by policies of equal stringency, but using instruments which do not impose a carbon tax burden on their industrial producers?

In theory, in such circumstances the exemptions should indeed be abolished, since the burden which is placed on an economy by taking action to reduce carbon dioxide emissions is the cost of the adjustments in energy use and emissions, and not the tax burden. From the point of view of the economy as a whole, the tax burden is merely a transfer, and there is a very real sense in which, if the carbon tax were not used to raise revenues, other taxes would have to be increased to do so. It is therefore important that, if the Community is to exempt sectors from the carbon tax until other countries introduce similar measures, it should be made clear at the outset that the actions which are required of other countries are effective control of carbon emissions to the same extent as in the Community, and not necessarily the introduction of an identical carbon tax.

What happens if other countries do not control carbon dioxide emissions in the way that the Community requires? Would the Community then retain the sectoral exemptions in perpetuity? In practice, of course, the circumstances in which this question arises are those where some other countries do take measures to reduce carbon emissions; if no other countries do anything to control emissions the case for the Community continuing to try to control emissions at all is weak. However, difficult questions would arise where one important competitor in the activities of the exempt sectors chooses to 'free-ride' on the carbon control activities of the Community and the rest of the world.

One possible course of action would be to cease to exempt the six sectors from the Community carbon tax, but to impose import duties on the products from that competitor, at a level reflecting the costs involved in carbon control. This would prevent the competitor gaining a competitive advantage, without continuing to encourage the energy-intensive sectors in the Community, relative to other sectors. In an ideal world, this may be the best course of action, but such tariffs carry the risk that they begin to undermine the general trend away from trade protection, and may weaken the defensibility of the current GATT arrangements.

Another course of action would be to admit that in the long run, special favours to particular sectors within the tax system hurt the Community as much as they protect it. By preventing adjustments in the sectoral pattern of industry, the exemptions require higher carbon taxes on other sectors, and prevent them gaining as much from the carbon tax as they would without the exemption of the six energy-intensive sectors. The danger that such exemptions may become permanent is a strong reason to be extremely cautious about introducing them in the first place.

CHAPTER 4
ADMINISTRATIVE ASPECTS OF THE PROPOSED TAX

The practical details of how a carbon tax would be administered are not discussed in detail in the Commission's proposals, and appear, indeed, to have been the subject of less consideration than other aspects of a carbon tax by academic and other commentators.[1] In this chapter we try to set out some ideas about how a carbon tax could be operated, and to identify some of the issues and difficulties that would arise.

To simplify the discussion, we conduct the argument simply in terms of a carbon tax, in which the amount of tax is related to the carbon content (and, hence, the potential to give rise to carbon dioxide emissions) of each different fuel. Although the Commission is in practice proposing a hybrid carbon-and-energy tax, in which the tax base would be related both to the carbon content *and* the energy content of fuels, the administrative issues are much the same as those for a pure carbon tax; the description of the tax base is merely a little more cumbersome.

In both cases, the tax takes the form of a specific tax, in other words, a tax related to the quantity of some physical attribute of the taxed product — tonnes of carbon, or joules of energy. The tax thus would have similarities with some of the excise duties operated by European Community countries, such as those on mineral oils, and some aspects of the administration of excise duties could be used as a model for the design of an administrative system for carbon taxes. Indeed, it could be appropriate to seek to incorporate the existing excise duty mechanisms for mineral oils into the carbon tax system, although, as we will describe below, this may not always be straightforward.

This quantity-related aspect of a carbon tax is one respect in which the tax would be different from the value added tax systems of Community countries — these tax the value of products rather than their quantities. A value-related structure for the carbon tax would clearly be inappropriate, since some of the cheaper fuels, such as coal, are associated with particularly high carbon emissions. A second major difference between the carbon tax and VAT is the deductibility of VAT on industrial inputs. This means that the VAT on industrial inputs is a

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[1] One notable exception is the discussion of administration in Cnossen and Vollebergh (1991).

matter of indifference in business decision-making, and does not affect the price of the finished product, or the pattern of industrial production. Exactly the opposite effect, in principle, is sought with the carbon tax: the level of the tax *should* be perceived by business as a cost, so as to provide an appropriate incentive for the industrial use of carbon-based fuels to be reduced.

A 'Primary' or 'Final' Carbon Tax

The most difficult decision about the administration of a carbon tax concerns the stage in the production chain at which the tax should be levied. Most fuel products go through a series of stages of production, refining the raw, or 'primary', fuel to produce the fuels which are actually used by industries and households — 'final fuel products'. It should be possible to conceive of a carbon tax imposed at various points during this successive process of refinement. We will discuss here the implications of levying a tax at the beginning or the end of the process. Thus the two basic types of carbon tax we will discuss are:

- a 'primary' carbon tax, levied on primary fuel products where they are mined, extracted or imported;
- a 'final' carbon tax, levied on final fuel products — in other words, on the fuels sold to industrial users or households.

A primary carbon tax would thus apply to products such as crude oil, coal, and gas. A final carbon tax would apply to the fuel products produced from these primary fuels, such as coke, anthracite, four star petrol, and so on. For the purposes of operating a final carbon tax, it would be possible to consider the electricity industry as either a producer of a final fuel product, electricity, or as a user of final fuel products in an industrial process. We will discuss the issues involved in the electricity industry later in this chapter, and for the time being will leave on one side the special issues raised by this industry.

At first sight, a carbon tax of the 'primary' type would appear to be more straightforward to administer. The range of fuels involved is less, and the number of taxable individuals is much smaller. Generally, the plants involved in mining or extracting primary fuels operate on a very large scale, and the number of producers which need to be controlled and taxed is therefore small. With fewer taxable individuals, administrative costs would be expected to be low, and there would be scope for tight supervision to prevent evasion.

The fact that the tax would be applied at an earlier stage in the production chain would not necessarily imply that it would have different economic effects from an equivalent tax levied on final fuel products. Whilst there is an important economic issue about whether the ultimate burden of the carbon tax would be borne by fuel consumers and the consumers of goods produced using fuels in the course of manufacture, rather than being passed back to the owners of fuel resources, no great difference would be expected in the effects on fuel prices of a primary carbon tax compared with a final carbon tax. To the extent that a carbon tax would be borne by fuel consumers rather than the owners of fuel resources, the burden of a primary carbon tax would generally be passed on in the prices of fuel products according to their carbon content, and the prices of fuels purchased by industry and consumers would be likely to be much the same as if an equivalent final carbon tax had been levied.

A final carbon tax would be levied on the fuel products sold to final consumers. It would not actually be necessary to levy the tax at the retail level, but merely to identify those wholesale deliveries that were being made to distributors and retailers, rather than for further processing. Broadly, therefore, it would operate at a similar point in the production and distribution chain to the existing excises on mineral oils, and would require similar administrative and enforcement procedures, including close supervision of all fuel extraction, distribution and processing activities up until the point when the tax is levied (see Cnossen and Vollebergh (1991)).

A final carbon tax would require the system to cope with a greater number of fuels and producers than a primary carbon tax, although it would have the offsetting advantage that the existing mineral oil excise system could be used to administer part of the carbon tax. Its principal drawback, however, is that unlike a primary carbon tax, the level of tax that should be applied to a particular fuel cannot be determined simply on the basis of the characteristics of the fuel. During the various stages by which primary fuels are transformed into final fuel products, considerable amounts of energy may be used, with associated emissions of carbon dioxide. Thus, for example, in transforming coal into coke, a process of combustion takes place, resulting in a refined fuel product, containing less carbon and less energy than the original coal, but in a form which can be burned more efficiently in certain industrial and domestic applications. Unless the use of coke is not to be fiscally advantaged, the emissions of carbon dioxide during the process of coke production cannot be disregarded in calculating the amount of carbon tax that should apply to coke. To do so would encourage the inefficient use of coke over coal in applications where the overall emissions of carbon dioxide, taking into account both the emissions in coke production and from the subsequent burning of coke by final users, actually exceeded the carbon dioxide emissions from the direct use of coal. In effect, unless the carbon emissions during fuel refining were reflected in the taxes applied to final fuel products, there would be an undesirable incentive towards the use of highly-refined fuel products, in which as much as possible of the carbon dioxide emissions have taken place before the tax is applied.

The implication of this, however, is that to calculate the carbon tax to be applied to a final fuel product requires information not only about the actual carbon content of the fuel, but also about the carbon emissions associated with its production. This means that the amount of tax to be applied to a particular final fuel product can no longer be determined simply by reference to its physical characteristics (which would provide a straightforward and uncontroversial basis for administration of the tax) but requires in addition that these measurements be supplemented by assumptions about the carbon emissions associated with its past history.

Unless a final carbon tax is to be applied in an essentially arbitrary manner, based on judgements about each individual case, it will be necessary for the amounts of tax relating to carbon emissions during processing to be based on specified standard amounts, based for example on average emissions (carbon 'losses') during processing. Unfortunately, to do this weakens the incentives for economy in carbon emissions during processing, since producers that have emissions during processing which exceed the average are taxed on the basis only of the standard amount.

It also does not deal adequately with the situation where a particular final fuel product can be produced from primary fuels which differ in the amount of processing needed to get to the final fuel product. A given final fuel product would be taxed at the same average rate, regardless of whether it was produced from 'near' or 'distant' primary fuels. Moreover, it is clear that in such cases the possibility of establishing actual emissions during processing may not even exist; the fuel may have passed through various stages, and the firm producing the final fuel product may not even know the full details of its past history.

The difficulty of defining appropriate rates of tax for final fuel products is enhanced where a process of refining leads to more than one final fuel product. In the case of oil refining, for example, a single input (crude oil) is transformed into a large number of different fuel products (heating oils, petrol, kerosene, etc.), and the process of transformation involves the use of energy, with associated carbon dioxide emissions. How should these emissions be allocated between the various final fuel products, so as to calculate the rate of carbon tax that should apply to each?

All of these arguments amount to a strong case for considering a carbon tax on primary fuels to be much more practicable from the point of view of administration than a carbon tax on final fuel products. Unfortunately, however, the difficulties of defining appropriate carbon tax rates for final fuel products cannot be avoided, even if a carbon tax that is basically of the primary type is adopted. There are two reasons.

First, since fuels are traded internationally both in the form of final fuel products and in the form of primary fuels, it is necessary to define a set of tax rates for intermediate and final fuel products to be applied when fuels are imported. These tax rates need to reflect both the carbon content of the fuel product, and the carbon emissions involved in its processing, so that the burden of tax on the imported fuel matches the burden of the primary carbon tax passed on to final fuel products.

Second, if a carbon tax is imposed on fuels at the primary stage, the initial allocation of carbon tax revenues between Community member states will not match the pattern of carbon dioxide emissions. If it is intended that the allocation of revenues should match the pattern of emissions, it will be necessary to devise a mechanism to channel revenues to the country of consumption, and this will generally require information on the carbon content of all fuels traded within the Community. We discuss the specific issues that this raises in the next section.

Revenue Allocation between Member States

The European Commission's carbon tax proposals make clear that the revenues from the carbon tax should accrue to member states, rather than to the Community as a whole. The issue thus arises as to how the revenues should be divided up between member states. Although the administration of a carbon tax may be undertaken by the revenue authorities of member states, different types of carbon tax will allocate the revenue between member states in different ways. The allocation of revenues by different types of carbon tax may be a consideration in choosing the type of carbon tax to be operated. Alternatively, it may be worth considering whether it is possible to adjust the pattern of revenues, so that objectives regarding the allocation of revenues can be separated from the choice of taxation system.

Where a carbon tax is levied on primary fuels, the pattern of revenues accruing to member states will reflect the pattern of primary fuel production. If the carbon tax is also applied to fuel imports, the initial allocation of revenues from fuel imports will accrue to the country in the Community where the fuel import takes place. A primary carbon tax would thus tend to make a larger revenue contribution to those member states where coal, oil and gas are mined or extracted, and to member states with ports through which fuels from outside the Community are imported.

On the other hand, a carbon tax imposed on final fuel products would tend to allocate revenues to member states according to the pattern of deliveries of final fuel products to industrial and domestic purchasers. In general, the allocation of revenues between member states will be much closer to the pattern of consumption of carbon-based fuels.

Clearly member states may differ in their interests as regards the choice of one or other revenue allocation. But are there any general considerations which might suggest a revenue allocation based on production or on consumption should be preferred?

One consideration is that the allocation of revenues between member states is likely to be more uneven if based on the pattern of production. Production of primary fuels is concentrated in few member states (UK oil and gas production, Dutch gas production), and a large proportion of the Community's imports of fuel from outside the Community arrive in a few large ports.

A second consideration reflects the incidence of the ultimate burden of the carbon tax. If the effective incidence (the final 'destination' of the tax burden) is on the consumers of carbon-based fuels, then a pattern of tax revenues which corresponds to the pattern of consumption will minimise the redistributive impact of the tax between member states; broadly speaking, national governments will receive revenues which will correspond to the additional costs of fuel to their residents. On the other hand, if the carbon tax is incident on fuel producers (or on the owners of carbon-based fuel resources), then an allocation of carbon tax revenues which leads to little redistributive impact between member states may be harder to achieve. It is unlikely that the allocation of revenues resulting from a 'primary' carbon tax would have this effect, for two reasons. First, the owners of oil and gas resources will not necessarily be residents of the country where the resources are located. In addition, if the burden of the carbon tax falls on resource owners, the revenues from the carbon tax on imports would accrue to the importing member state without any corresponding burden of final incidence on any Community resident.

The arguments would tend to favour a consumption-based allocation of revenues in circumstances where the carbon tax burden was borne by final consumers. At least partial incidence on consumers is to be expected, and the incidence on consumers will be stronger where the Community introduces a carbon tax without corresponding measures being taken by other major countries. A consumption-based allocation of revenues is also the basis on which existing indirect taxes (VAT and excise duties) in Community countries operate.

Taking a consumption-based revenue allocation as an objective for a Community carbon tax does not necessarily require that the carbon tax should be levied on final fuel products, although a carbon tax of this form would certainly achieve this pattern of revenues. It may instead be possible to separate the form of carbon tax chosen from the pattern of revenue allocation between member states, although the mechanisms by which this separation can be achieved can be a source of administrative complexity, and can give rise to problems of co-ordination and incentives. Similar issues arose during the debate over indirect tax harmonisation in the Community, and are discussed in Lee, Pearson and Smith (1988).

How might a revenue allocation according to the pattern of consumption be reconciled with a carbon tax levied on primary fuels rather than final fuel products? Broadly speaking, two possible approaches to the problem would appear to be available, based on statistical reconciliation and administrative 'chaining' respectively.

Statistical reconciliation would appear to offer a relatively cheap solution to the reallocation of carbon tax revenues between member states. What would be required are statistics on the aggregate consumption by domestic consumers and industry of each of the range of final energy products, together with an agreed set of factors by which the actual carbon content of each final energy product can be translated into the total carbon emissions to be associated with the fuel product (including emissions during fuel refining and processing). Aggregate carbon emissions associated with the pattern of energy consumption can then be compared with the pattern of carbon tax revenues from taxes imposed at the point of resource extraction or import, and the appropriate set of revenue transfers between member states calculated, so as to leave member states with the revenues that they would have had, if a 'final' carbon tax had been imposed.

Given the required data for the statistical reconciliation, the calculation of the revenue transfers would be straightforward, inexpensive and uncontroversial. The main difficulties of this approach have to do with obtaining data of the sort required. Aggregate fuel consumption could be calculated either by subtracting net exports from production, or from a direct survey of consumption. The abolition of internal frontiers within the Community will reduce the ease with which statistics on trade flows of particular commodities can be obtained, and it will be necessary instead to rely on sample surveys and other statistical inquiries about trade flows conducted away from the actual frontier. Inevitably, it will be harder to corroborate the information provided in such inquiries, since it will not be possible to observe the actual goods in transit, and the greater the reliance placed on sampling rather than comprehensive returns by all traders, the more room for argument will be opened up about the accuracy of the data. Where large revenue transfers between member states are at stake, the accuracy of statistical inquiries will come under an unusual degree of scrutiny. Similar problems would arise if the alternative was pursued of instituting a direct survey of fuel consumption by industrial and domestic users. Indeed, the controversy over a consumption survey could be exacerbated by the lack of scope for verifying the answers obtained; with trade data, it is possible to use import statistics to corroborate estimates of trade flows based on export statistics, and this can help to identify errors (or deliberate misreporting).[2]

Administrative 'chaining' provides a basis for revenue adjustments based on individual transactions, rather than aggregate estimates of the overall revenue transfers required. The basic idea would be that the carbon tax would be imposed on primary fuels, but the fuels would then be tracked by some administrative mechanism up until the point at which they were sold to industrial or domestic consumers. Where fuels moved between member states, appropriate revenue adjustments would

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[2] See Cornilleau, Pearson and Smith (1989) for a discussion of the scope for statistical approaches to VAT 'clearing'.

be made, which would have the effect of transferring the carbon tax revenue paid in the exporting country to the revenue authorities in the importing country. The precise mechanism by which this transfer takes place is unimportant; what is crucial is the 'chaining' of the two parties in the transaction, so that the revenue authorities in both countries are notified and can verify the transaction.

The procedure has some similarities both with the system of linked bonded warehouses envisaged for the control of the movement of dutiable goods (alcohol, tobacco and mineral oils) between member states, and with the administrative mechanisms by which VAT is to be operated on transactions between Community countries after the abolition of VAT frontier formalities.[3] However, it has the crucial difference that the chaining for carbon tax would merely serve to reallocate between member states a given total of carbon tax revenues which have been collected at an earlier stage, rather than (as in the case of bonded warehouses) to maintain the integrity of the revenue system, to ensure the collection of tax due at a later stage.

This difference between the chaining mechanism for a carbon tax and bonded warehousing for consumer excises is important because it highlights the role of the tax rates to be applied to each transaction in fuels between chained parties. This tax rate does not have any role to play in determining the amount of tax on the fuels in question; this is determined by how the carbon tax levied on the primary fuel stage has been passed on and divided up in later stages of fuel processing. Instead, the tax rate applied to the chained transaction is simply used to determine how much revenue should be transferred between member states' revenue authorities. Thus, although the carbon tax rates appropriate to various intermediate and final fuels are like the final fuel product carbon tax rates discussed earlier in the sense that they require assumptions to be made about carbon emissions during processing, *unlike* a final carbon tax, the tax rates are not liable to give rise to perverse incentives for fuel processors or users, even if they are set at the wrong level. All that will be affected is the allocation of tax revenues between member states, not the decisions of producers and consumers.

Separating revenue allocation in this way from the procedures for levying the carbon tax has the attraction that the acute difficulties that would be encountered in operating a carbon tax on final fuel products and in levying appropriate carbon taxes on imported fuels, do not cause

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[3] See Lee, Pearson and Smith (1988).

problems of the same magnitude in intra-Community trade, even though this trade is in intermediate and final fuel products as well as in primary fuels. Nevertheless, the mechanism is not without its problems. In particular, although the process of chaining depends on a link being drawn between fuel exporters and fuel importers, and the corresponding revenue authorities, it is clear that only one of the parties involved has any interest in ensuring that transactions are recorded fully — namely the importing member state. Since the tax has already been levied, and the process of chaining does not affect the tax liability of either exporter or importer, neither the exporter nor the importer has any interest in the process. Moreover, it is clearly in the interests of the exporting member state to ignore as many transactions as possible, since each export transaction that is recorded reduces the exporting state's tax revenues. How comprehensive the chaining process can be expected to be in these circumstances is unclear.

Some Further Issues

The discussion above has suggested reasons to prefer a carbon tax levied on primary fuels rather than one levied on final fuel products — especially the difficulty of defining tax rates for final fuel products that take appropriate account of the carbon emissions during processing. This section treats briefly some further administrative issues.

Exempt Users

The Commission's proposals envisage that certain major energy-using sectors should be exempt from the carbon tax. Quite apart from the desirability of such exemptions in principle, there are also questions of the practicability of administering industry-specific exemptions.

It is clear that administration of exemptions would be easier with a carbon tax on final fuel products than with a carbon tax on primary fuels. From information about the quantities and types of fuels purchased by an exempt user, it would be possible to determine the amount of carbon tax that had been paid on fuel purchases, and fairly straightforward procedures could thus be set up whereby exempt users were refunded the carbon tax they had paid, after providing suitable documentary evidence about fuel purchases. Clearly, a number of supplementary rules would be required, governing matters such as the resale of fuels by exempt users, the proportion of tax to be refunded where enterprises produce a mix of products only some of which count for exemption, and so on. Given the level of the carbon tax and the consequent substantial gains from evasion, the exemption of energy-intensive industries would require considerable supervision and enforcement, and would have a far from trivial administrative cost.

Administration of sectoral exemptions would be less practical where a carbon tax was levied on primary fuels, since some of the fuel purchased by exempt sectors would be processed or refined fuels, with an unknown carbon tax element in their price. It would be possible to refund the tax on fuel purchases on the basis of the carbon tax rates applied to similar intermediate or final fuel products imported from outside the Community, but there are obvious dangers that the refunded tax would be arbitrary, and could provide considerable scope for concealed production subsidies. Also, unless the administrative chaining procedure described above were in operation, the fuel purchases made by exempt industries may be from fuel suppliers not otherwise involved in the carbon tax process; supervision of both buyer and seller by the carbon tax revenue authorities may be required, solely for the purposes of administering the exemption.

Electricity Generation

With a carbon tax on primary fuels, there would be no reason to involve the electricity industry in the administrative system for the carbon tax; its carbon-based inputs would be taxed, and the impact of the carbon tax on electricity prices would arise from the effect of the higher prices for inputs on the industry's output pricing decisions. With a mixed carbon/energy tax such as that envisaged by the Commission levied at the primary fuel stage, it would be necessary in addition to levy a tax on the nuclear generation of electricity, but otherwise there would be no need to tax electricity producers.

Where the carbon tax is imposed on final fuel products, two possibilities exist — either to treat electricity as a final fuel product, or to treat electricity generation as an industrial user of final fuel products. The latter will generally be more convenient, since it will minimise the number of taxable individuals, but it may not be practicable, if it is intended to allow certain industries to be exempt from the carbon tax.

Exempting industrial users of electricity from the carbon tax on the electricity they purchase illustrates in a particularly acute form the difficulties of administering a carbon tax at the level of final fuel products. Where an electricity supplier uses various fuels for generation, what is the carbon content of the electricity purchased by one customer?

It is at least possible to argue that the straightforward answer, that the carbon content of a supply to one customer is the average carbon content of all the electricity supplied by the generator, is actually inappropriate. Many large users have a steady demand for electricity, without the time-of-day peaks that domestic usage shows. A case can obviously be made for saying that the carbon tax refunded should then reflect the fuels used in generating base-load electricity, rather than peak-load electricity, although identifying the appropriate amount of carbon tax to be refunded in such cases will clearly be far from straightforward.

Non-Fuel Uses

A number of fuels have significant non-fuel applications. Thus, for example, oil is used to make plastics and various other products, and natural gas is used in the manufacture of some fertilisers. Where these non-fuel uses do not result in carbon dioxide emissions, it will not be necessary for the carbon tax to be applied, and in general it will be desirable for non-fuel uses to be exempted from the tax.

Non-fuel uses create a requirement for an administrative mechanism to monitor and enforce the exemption arrangements, to ensure that fuels destined for non-fuel applications are not diverted instead for use as fuels. It is also necessary to determine the appropriate rates of tax at which exempt users should be credited. As with sectoral exemptions, this is straightforward with a carbon tax levied on final fuel products, but considerably more complicated where the carbon tax has been levied earlier on primary fuels.

CHAPTER 5
PUBLIC FINANCE ASPECTS OF THE PROPOSED TAX

Implications for Fiscal Revenues

A carbon tax at the level proposed by the European Commission would raise substantial revenues, and have a major impact on the public finances of member states. Table 5.1 makes some estimates of the revenues that would be raised from a tax on carbon and energy applied to all industrial and domestic energy uses, based on the 1988 pattern of energy consumption. On this basis the tax would have raised revenues equivalent to some 1–1½ per cent of GDP, and, on average, about 3 per cent of existing tax receipts.

TABLE 5.1

Tax Revenues from a Mixed Carbon/Energy Tax Equivalent to US$10 per Barrel of Oil
(based on 1988 energy use and carbon dioxide emissions, and 1988 prices and revenues)

	Carbon/energy tax revenue:			
	ECU million	As percentage of GDP	As percentage of total tax revenue	As percentage of indirect tax revenue
Belgium	2,112	1.7	3.1	12.2
Denmark	953	1.0	1.7	5.0
France	8,440	1.0	2.0	6.8
Germany	13,484	1.3	3.0	11.9
Greece	787	1.8	4.2	9.2
Ireland	492	1.8	3.7	8.7
Italy	6,404	0.9	2.1	7.4
Luxemburg	147	2.6	4.5	17.9
Netherlands	3,146	1.6	2.9	11.1
Portugal	471	1.3	3.3	6.8
Spain	3,404	1.2	3.0	9.8
UK	9,459	1.3	3.1	9.9

Note: The calculations assume that the carbon tax would apply to all industrial energy users, including the six sectors which the Commission suggests may be exempted. Excluding these sectors would reduce revenues by about 14 per cent.
Source: IFS calculations.

In practice, of course, the revenues that would be raised from a carbon/energy tax will differ from these estimates for two main reasons. First, to the extent that the tax encourages fuel substitution and energy conservation, the revenues would be lower than those shown; since behavioural responses are greater in the long term than the short term, the estimates are probably rather better as an indication of the initial impact on revenues than at measuring the long-run revenue effect. Second, as economic activity and incomes rise over time, energy use would be expected to rise, and consequently by the time a Community carbon tax could be introduced, the base-line level of energy use will be greater than the 1988 figures used here. The net effect of these two qualifications to the estimates is unclear, and the numbers should be regarded as indicating the likely order of magnitude only.

Assuming that the revenues from the tax accrue to member states in proportion to their consumption of carbon and energy, either because the tax is levied on final fuel products or because revenues from a primary carbon tax are redistributed to member states according to their fuel consumption, the impact on the public finances of individual member states would be as shown in Table 5.1. The rise in revenues would be highest as a proportion of GDP in Luxemburg, Ireland, Greece and Belgium, and would be one per cent of GDP or less in Denmark, France and Italy. In France, the high proportion of nuclear-generated electricity is of course a major factor reducing the revenues obtained from the carbon component of the tax.

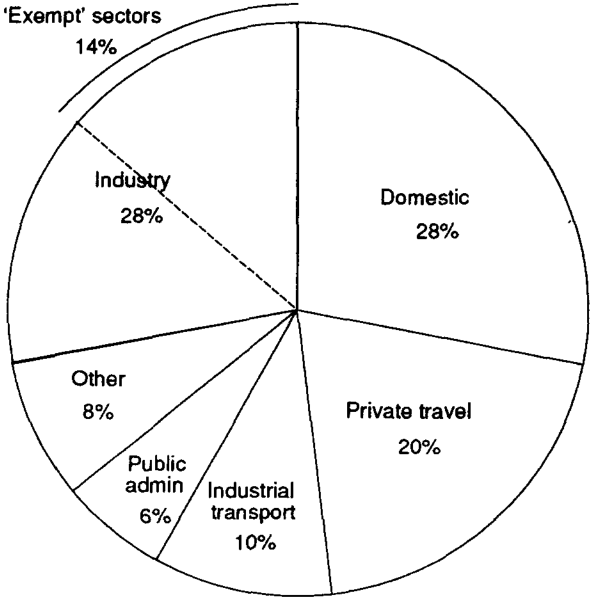
Distributional Implications

How would these additional tax payments be distributed, between industry and consumers, and across households at different levels of income? Clearly, much depends on where the ultimate burden of the carbon tax falls — whether it is passed on in higher prices for fuels and products manufactured using energy, or whether it is passed back, for example to the owners of energy resources in the form of lower pre-tax prices for energy, or to various other factors of production. The extent to which the tax is passed on in prices will depend, in part, on the international context in which a carbon tax is introduced in the European Community; if other countries also implement similar measures, it is more likely that some of the burden of the tax will be borne by the owners of energy resources, rather than by energy consumers.

Figure 5.1 indicates the pattern of energy use in the UK in 1988. About half of all energy is used by households, for domestic heating and lighting, and for motor fuel. About a quarter is used in industrial production, and a further 10 per cent for industrial transport, including distribution. If a carbon tax was reflected fully in the price of fuels purchased by industry and consumers, then Figure 5.1 shows the broad division between industry and consumers of the additional tax payments. The share of industry in the additional tax payments would be rather less than half, and would be reduced still further if the six energy-intensive sectors being considered for exemption (steel, chemicals, non-ferrous metals, cement, glass, and pulp and paper) were entirely exempted from the carbon tax.

FIGURE 5.1

Sectoral Pattern of Final Energy Consumption
(UK, 1988, heat supplied basis)



Source: Calculated from data in *Digest of United Kingdom Energy Statistics*, 1989.

Of course, this initial division of tax payments between industrial and domestic taxpayers is not the end of the story. Ultimately all taxes on industry are borne by households, as shareholders, customers or employees of businesses. The division between the initial impact on industrial and domestic consumers is thus a simplification of a more complex pattern of ultimate incidence, in which both direct and indirect distributional effects need to be taken into account. Higher taxes on household purchases of domestic energy and motor fuels will affect household living standards in a direct manner, in that more of their spending will be subject to tax. Higher taxes on industrial energy inputs will affect household living standards in an indirect manner, increasing the prices of energy-intensive products that households buy, and through a range of other effects — on industrial profits and dividends, employment, etc.

The distributional effects of higher prices for domestic energy (fuels for domestic heating, lighting and power) may bear particularly heavily on poorer households. Household spending on energy in most European countries is only weakly related to income; in the UK, for example, the spending of the richest quintile of households is only some 60 per cent higher than the spending of the poorest quintile (Table 5.2). A general carbon tax on all forms of energy purchased by households would be likely to be less regressive in its direct distributional impact than a tax on domestic energy alone. Spending on motor fuel tends to rise sharply with income, so that the spending on petrol of the richest quintile is more than ten times that of the poorest quintile. Additional taxes on motor fuel would thus have a broadly progressive effect on the overall income distribution.

The calculated impact of a tax on carbon and energy at a level equivalent to $10 per barrel is shown in Table 5.2 for the sample of about 7,000 households in the 1988 UK Family Expenditure Survey. Estimates of the impact are made on two bases. The first takes the existing pattern of household energy consumption as given, and calculates the level of carbon tax payments excluding any behavioural response to the higher prices that households would face for energy products. On this basis, the average household would have paid an additional £2.21 per week in tax, equivalent to 1.4 per cent of household spending. The poorest 20 per cent of the population would have paid an additional £1.45 per week, and the richest 20 per cent an additional £2.95 per week. Expressed as percentages of total spending, however, the burden of the additional tax would be higher for the poorest decile (2.4 per cent) and lower for the richest (0.8 per cent). The second basis of calculation uses the IFS Simulation Program for Indirect Taxes to predict how household spending patterns would adjust to the higher prices for fuel, and calculates the carbon tax payments, after allowing

TABLE 5.2

Household Spending on Domestic Fuel and Petrol:
The Distributional Effects of a Carbon Tax at $10 per Barrel in the UK
(by quintile of gross equivalent household expenditure)

1988 prices

	All households	*Quintile of equivalent expenditure* Poorest	2	3	4	Richest
Household total expenditure (£ p.w.)	£205.34	£67.38	£125.84	£174.09	£233.59	£425.94
Spending before tax change on:						
Domestic fuel (£ p.w.)	£10.43	£8.10	£9.22	£10.48	£11.57	£12.78
Petrol (£ p.w.)	£6.18	£1.02	£3.73	£6.42	£8.73	£10.99
Carbon tax payments:						
Excluding behavioural response						
£ p.w.	£2.21	£1.45	£1.84	£2.25	£2.58	£2.95
As % of spending	1.4%	2.4%	1.5%	1.3%	1.2%	0.8%
Including behavioural response						
£ p.w.	£2.08	£1.29	£1.69	£2.08	£2.45	£2.91
As % of spending	1.3%	2.1%	1.4%	1.2%	1.1%	0.8%
Change in consumption of:						
Domestic fuel (%)	–6.7%	–12.0%	–9.6%	–8.0%	–6.2%	–0.5%
Petrol (%)	–5.2%	–5.0%	–5.2%	–5.4%	–5.4%	–5.0%

Source: Calculations based on the 1988 UK Family Expenditure Survey, and simulations using the IFS Simulation Program for Indirect Taxes (SPIT).

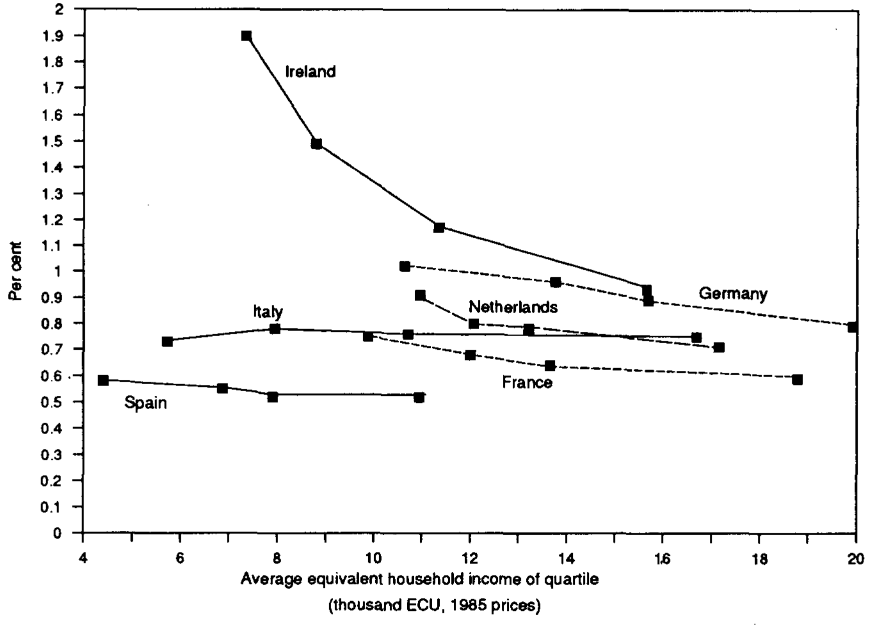
for the behavioural responses of households. The figures are slightly lower, but show broadly similar effects: higher tax payments amongst the rich than the poor, but the burden of the tax in relation to household spending being higher for the poor than for the rich.

Similar distributional calculations are shown in Figure 5.2 for six other EC countries, based on 1985 Eurostat data, and show a surprising contrast with the UK results. In five of the six countries, the burden of carbon tax payments is only weakly related to income, if at all. Only in Ireland is there evidence of a significantly regressive pattern to household carbon tax payments, similar to the pattern in the UK.

The differences between countries in the distributional incidence of the carbon tax on domestic energy reflect principally the pattern of household energy spending in different countries, although they are also affected to some extent by differences in the consumption of particular fuels with high carbon content.

FIGURE 5.2

Payments of a Mixed Carbon/Energy Tax as a Percentage of Household Total Expenditures
(by quartile groups of gross household income)



Over and above the distribution of the additional tax payments, the distribution across households of the welfare costs of the changes in consumption behaviour induced by environmental taxes may also be of some importance. Some indication of the scale of these costs can be obtained from the simulation of the effects of energy and petrol price changes on the pattern of household spending. In the case of the UK, simulations using the IFS model suggest that the increase in energy prices that would result from a carbon tax at a level equivalent to $10 per barrel would lead to an overall reduction of some 6½ per cent in domestic energy consumption (in volume terms), but that this would be unevenly distributed; there would be a greater percentage reduction in energy consumption amongst poorer households than amongst the better-off. Petrol spending would fall by about 5 per cent on average, and the reduction in consumption would be more evenly spread across income groups than in the case of domestic energy.

These quantity changes by income level are based on statistical estimates, and as with all such estimates there is some uncertainty about whether the distribution of changes in consumption is accurately represented. There are two important effects, pulling in opposite ways. On the one hand, the poor will be more acutely affected by the change in tax as they spend a much higher proportion of their income on energy; on the other, they may have more difficulty in raising finance for undertaking energy-efficiency investments, so may have greater difficulty in adjusting their energy requirements.

Distributional Effects of Taxes on Industrial Energy Use

In addition to the direct distributional effects working through the prices of household purchases of domestic energy and motor fuels, a carbon tax applied to all fuels would have a number of indirect distributional effects, as a result of the taxes imposed on industrial purchases of energy. These indirect effects reflect the fact that the ultimate incidence of all taxes is on households — the burden of taxes on business can in principle always be traced to the households or individuals who are the shareholders or owners of each business, or to its suppliers, employees or customers. Which of these various groups shoulders the ultimate burden of any tax, and what place they occupy within the income distribution, will thus determine the distributional incidence of taxes on industrial inputs.

The indirect distributional effects of taxes on industrial inputs can be divided into two broad groups — effects on final consumers, and effects on the owners of factors of production, including capital, labour and natural resources.

If higher prices for industrial energy inputs are passed on to consumers in the form of higher prices for industrial outputs, there will be distributional effects amongst households of a similar sort to the direct effects discussed above. Where the prices that rise are those of goods that form a higher proportion of the spending of the poor than of the spending of the rich, the distributional impact will tend to be regressive.

Data on the input–output structure of the economy have been used by Common (1985) and Symons, Proops and Gay (1991) to calculate the impact of a change in the price of energy inputs on the prices of different consumer purchases, assuming the tax is fully passed on to consumers and that no change takes place to the pattern of inputs used in production. These assumptions are, of course, strong, and probably only a reasonable approximation in the short term. Over a longer time period, the assumption of no factor substitution in production is clearly restrictive.[1] However, despite the limitations of the method, it none the less may provide a reasonably straightforward source of information on the first-round distributional effects of environmental taxes on industrial inputs.

Common (1985) uses the 1974 UK Input–Output tables to estimate the distributional implications of higher energy prices in the UK. He calculates the impact on the prices of 27 commodities sold to final consumers of a doubling of the price of each of the four primary fuels — coal, gas, oil and electricity. With the exception of the effects on the prices of fuels purchased by consumers, the effects on the relative prices of consumer spending are comparatively modest; only in the case of public transport and the category 'other household goods' do the simulated price increases exceed 5 per cent, and the only prices to rise by less than 2 per cent are those for housing, communications services and domestic services. The impact of these price changes on household living standards is presented in terms of Laspeyres price indices, for a variety of different household types and income groups. Overall, the rise in prices of domestic energy alone increased the price index faced by households by about 3.6 per cent. Taking account of the increase in the price of motor fuel, this rose to 5.2 per cent, and if the price changes for all commodities are included, the index rises to 8.1 per cent. Thus, the increase in the price of domestic energy accounted for only about half the overall increase in consumer prices. There was, in addition, some evidence that the increase in domestic energy prices had a more regressive impact than the overall price change.

Symons, Proops and Gay (1991) present estimates of the effects on consumer prices of a carbon tax at various levels, based on the 1984 UK Input–Output tables. These prices are then used as inputs to a version of the consumer spending simulation program employed in this report, to derive effects on household tax payments by income decile. The principal effects of the carbon tax appear to be on the prices of direct consumer purchases of fuels, rather than indirect effects on the prices of other goods. A carbon tax of 6p per kilo (ECU 90 per tonne) of

[1] Clearly the assumption of fixed coefficients and no factor substitution allows the carbon tax to have little impact on carbon emissions from production — the only reduction in carbon emissions under these assumptions comes from changes in final consumption spending.

carbon dioxide emitted has 'dramatic adverse distributional effects' on low-income households.

Unless all of the burden of a carbon tax on energy inputs can be passed on in higher prices, without any change in the pattern of consumers' expenditure, at least some of the burden of the tax will be borne by the owners of the different factors of production, including capital, labour and natural resources, especially energy resources. One obvious possibility is that at least part of the carbon tax on energy will be borne by the owners of reserves of carbon-based energy sources, as a result of lower pre-tax prices for carbon-based energy, and the profitability of existing extraction activities may fall. Changes in the profitability of extraction activities will affect the real incomes and wealth of the households owning shares in resource extraction businesses. The profitability of other firms may change too, especially if consumer demand switches away from energy-intensive goods and services, and this may affect the profits received by their owners, and the wages and employment prospects of their employees. Depending on the complementarity or substitutability of different factors in production, effects could be felt on the return to capital and labour even outside the sectors directly affected.

The balance of these various effects on the distributional incidence of environmental taxes on industrial inputs cannot be predicted a priori. Some important considerations affecting the strength of different effects include the degree of monopoly in factor and product markets, whether international competitors face similar taxes, the degree of substitutability of different factors in production, and the speed of adjustment.

To quantify the full range of effects set out above would require a comprehensive general equilibrium model, based on detailed information about consumer demands and the substitutability of different factors in production. Many of the key behavioural and technical parameters are unknown, and those estimates that do exist are often subject to a wide margin of error.[2]

Requirements for Offsetting Fiscal Policies

What should be done with the large amounts of revenue that

[2] Considerable research effort is, however, currently being devoted to these questions. See, for example, the analysis for Belgium by Proost and Van Regemorter (1990).

Community member states would raise from the carbon tax? There would seem to be broadly two possibilities, corresponding to the objectives of economic efficiency and equity which tax policies must balance.[3]

Economic efficiency would be maximised by using the revenues to reduce the most distortionary aspects of other taxes. Thus, for example, if existing income tax rates were believed to discourage work and effort, or high corporate tax rates were believed to discourage investment, the carbon tax revenues would make it possible to reduce these rates of tax. In this sense, there would be a 'double dividend' from the carbon tax (Pearce, 1991); not only would the tax have environmental benefits, but it would also have a second set of benefits, in terms of a reduction in the overall economic cost of raising government revenues. Existing estimates of the distortionary costs of government taxation in the United States suggest that the marginal welfare costs of existing tax revenues could be quite substantial — of the order of 20–50 cents for each dollar raised (Ballard, Shoven and Whalley, 1985). If the tax systems of Community member states have similar costs, the use of carbon tax revenues to reduce other tax rates could have an appreciable double dividend effect.

Unfortunately, the use of carbon tax revenues in a way which maximises the efficiency gains may conflict with objectives of equity. As we have described above, a carbon tax would have a regressive impact on the distribution of income in the UK, in the sense that the additional tax would be a greater percentage of the spending of poorer households than of richer households. For the poorest 20 per cent of the population, the extra tax would be equivalent to more than 2 per cent of their total spending, compared with less than 1 per cent for the richest 20 per cent.

How the additional tax revenue is used will be critical in determining the overall distributional impact. If the revenue is used in a way which maximises the double dividend efficiency gains, it will tend to be used to reduce tax rates, which will confer much greater benefits on better-off households, and the overall distributional impact of the carbon tax will

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[3] In addition to the possibilities which we discuss here for using the revenue within the Community, there has been some debate over possible uses of the revenue *outside* the Community, for example to fund energy efficiency improvements in Eastern Europe or the less developed countries. It is clear that such expenditures could make a large impact on global carbon dioxide emissions, possibly at lower economic cost than emissions reductions within the Community. However, full consideration of this issue is beyond the scope of this report.

remain regressive. The revenue could, however, be used in a way which returned at least as much, on average, to poorer income groups as they paid in carbon tax, by making a lump-sum return of revenues. In Table 5.2 it can be seen that a weekly lump sum of £2.08 per household could be financed from the carbon tax revenues, and would be more than enough to compensate households in the bottom two quintiles (on average) for carbon tax. Designing an effective lump-sum redistribution mechanism within the existing tax and social security system is complicated (Johnson, McKay and Smith, 1990), but one could be approximated through a package involving increases in state pensions, social security benefits and income tax allowances.[4] It is clear, however, that these measures are not those that would be chosen if it was intended to maximise the efficiency gains from reductions in other taxes that the carbon tax would permit. There is thus a clear trade-off between efficiency and equity in the use of the revenues, and the double dividend efficiency gains can only be achieved by sacrificing the distributional neutrality of the package.

Indeed, the requirements for effective compensation for the additional burden of the carbon tax may go beyond lump-sum compensation. There may be substantial variation around the average in the adequacy of lump-sum compensation, reflecting the large range of energy spending of the households within each income group. These differences in energy spending may reflect not only differences in preferences, but also household characteristics affecting the need for energy spending. The elderly, for example, may have a need for more spending on heating, both because they are at home more of the day than the working population, and because of their greater vulnerability to the cold. Also, residential accommodation may differ in insulation and thermal efficiency; older houses may require greater energy inputs than new houses to reach the same internal temperature.

Where policy is concerned with the amount of heating available to certain groups of the population such as the elderly, redistribution of the tax revenues may be inadequate, and a package of measures, perhaps including reduced energy costs for the vulnerable elderly, or measures to improve the heat efficiency of their homes, may be

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[4] It will be noted that some of these measures constitute public expenditure rather than tax measures. We see no difference in principle between increasing public expenditures by increasing the level of social security benefits and increasing 'tax expenditures' by raising tax allowances, and the former cannot be avoided if poorer households are to be adequately compensated.

required.

More generally, to rely solely on pollution taxes on energy will not be an efficient way of reducing domestic energy use if there are significant market failures in the energy market which prevent economically efficient projects for investment in fuel efficiency from being carried out. A carbon tax would remove one impediment to optimal investment in energy efficiency, that of the divergence between the private and social costs of energy consumption, and would increase the private profitability of marginal investments in energy efficiency. However, as discussed in Brechling, Helm and Smith (1991), there are a number of other possible market failures in energy efficiency, including a lack of information, poor incentives in rental property, current income constraints, 'myopia' and, perhaps, 'irrational' behaviour by certain consumers. Market failures in energy efficiency, as in other markets, present a prima-facie case for government intervention on efficiency grounds, targeted towards the specific sources of the market failure.

CHAPTER 6
CONCLUSIONS

The European Commission's proposals for a carbon tax attempt to harness market forces to the protection of the environment. By levying a tax on fossil fuels in proportion to their carbon content, the Community carbon tax would aim to encourage industries and households both to economise on the overall use of fossil fuel energy sources, and to switch to fuels with lower carbon dioxide emissions for each unit of energy.

The problem of global warming, which the carbon tax proposals address, is a global problem, requiring co-ordinated international action. The impact that individual countries or the European Community as a whole can make is limited. Targets for the control and reduction of greenhouse gas emissions are currently the subject of international discussion and negotiation, and the extent of the Community's commitment to reduce carbon dioxide emissions must naturally depend on the outcome of this process. Nevertheless, the instruments that the Community should use to achieve these targets are principally for the Community and its members to choose.

Market-based environmental policy measures such as the carbon tax discussed here have two principal advantages over regulatory policies specifying standards or technologies for products and processes. First, they allow industries and domestic consumers to choose to reduce carbon dioxide emissions where the costs of doing so are least, and can thus achieve a given degree of pollution control at lower economic cost than regulations applied across the board. Second, market-based instruments provide a continuous incentive to develop less-polluting products and processes, whereas regulations tend to encourage only minimum compliance.

The evidence on the price elasticity of energy demand surveyed in Chapter 3 shows that demand for energy has in the past responded to price changes, but not very strongly. Given that future economic growth will tend to increase energy use and carbon dioxide emissions, the rates of carbon tax needed to stabilise or reduce carbon dioxide emissions will be substantial. However, this is not a reason to choose regulatory policies in preference to policies based on taxation. The implication of a low price elasticity is that the costs of reducing emissions will be high, whatever instrument is chosen. If anything, evidence that the carbon tax rate would need to be high strengthens the case for using cost-minimising methods of reducing pollution, and hence for choosing market mechanisms rather than the conventional regulatory approach.

An important part of the environmental gains from a carbon tax will come from fuel substitution. As Chapter 3 showed, the existing 'implicit carbon taxes' in Community countries are uneven, providing fiscal incentives for the use of high-carbon fuels such as coal. Unfortunately the Community's current plans dilute the incentive to substitute to low-carbon fuels by basing the tax partly on the energy content as well as on the carbon content of each fuel. The reasons for doing this are weak; if the aim is to avoid increasing the incentive to generate power from nuclear sources, it would be more efficient to do this by an explicit nuclear tax than by weakening the pattern of incentives for carbon-reducing substitution between fossil fuels.

The revenues from the carbon tax proposed by the Commission would amount to about 3 per cent of existing tax receipts in Community countries. These tax revenues present both problems and opportunities. The problems have to do with the burden of the additional tax payments on both industry and households; the opportunities arise because the carbon tax revenues would allow other taxes to be reduced.

The carbon tax will impose high costs on energy-intensive industries. Such an effect is deliberate, and is the mechanism by which an incentive is given to reduce carbon dioxide emissions. However, if similar measures are not implemented in other countries, the carbon tax will also affect the competitive position of energy-intensive Community industries relative to the same industries in other countries. Because of the scope for exchange rate adjustments and the potential for using some of the tax revenues to lower other taxes on industry, a more general loss of competitiveness is unlikely, and the competitive position of less energy-intensive Community industries could improve. Nevertheless, recognising the possible effects on the competitiveness of energy-intensive industries, the Commission has suggested that the six most energy-intensive sectors should be exempted from the carbon tax until similar measures are adopted in other countries. Exemption of some industrial sectors would increase the administrative complexity of the tax. The most serious risk, however, is that the exemption would prove permanent. Other industries and consumers would then face a higher carbon tax to achieve any given reduction of carbon dioxide emissions.

Concern has also been expressed about the impact of higher energy taxes on poorer households. Domestic energy expenditures in the UK are only very weakly related to household incomes, and higher taxes on domestic energy have a sharply regressive distributional impact, in the sense that the additional tax would constitute a higher proportion of the total spending of poorer households. With a carbon tax applied to all energy spending, higher taxes on petrol will provide some offset to the regressivity of taxes on domestic energy. None the less, a carbon tax of the form proposed by the Commission would have a regressive overall incidence in the UK, though less so in some other member states.

The additional revenues from the carbon tax could be used to offset these distributional effects, by reducing taxes and increasing social security benefits in a way which provides a roughly lump-sum return of revenues. However, the revenue could alternatively be used in other ways. In particular, the carbon tax revenues would permit other, distortionary taxes to be reduced, giving a 'double dividend' — both environmental benefits and a reduction in the welfare costs of raising tax revenues. However, it is clear that the offsetting reductions in other taxes which would maximise the double dividend are different from those which would adequately compensate poorer households; the greatest reduction in welfare costs would generally come through a reduction in tax *rates*, and this will confer little benefit on poorer households.

The administration of a carbon tax has received little public attention, but as Chapter 4 discussed, there are some important administrative issues. In particular, there is a basic choice between a 'primary' carbon tax, levied on the mining and import of fuels, and a carbon tax on 'final fuel products', levied once fuels have been processed and refined into the form in which they are sold to industrial and domestic consumers. There are advantages and disadvantages to each. A primary carbon tax would require fewer producers to be taxed and controlled, but exemptions would be more difficult to administer. A carbon tax on final fuel products could build on the existing administrative arrangements for mineral oil excises. In the European context, a final fuel products tax also has the advantage that it would tend to allocate revenues to the country where the fuel was consumed. With a primary carbon tax the pattern of carbon tax revenues across the Community would be very uneven and some mechanism for revenue redistribution would be required. However, the tax rates under a final fuel products tax could not be defined simply in relation to the carbon contained in each fuel, since carbon losses during processing should also be included in the tax base; these adjustments will inevitably be imperfect and, to some extent, arbitrary.

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