Chapter 5

Environmentally Related Levies

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5.1 INTRODUCTION

Thirty years ago, the environmental policies of countries that are members of the Organisation for Economic Co-operation and Development (OECD) relied almost exclusively on direct 'command-and-control' (CAC) types of regulations. Although economists have long promoted the use of 'economic instruments' (mainly taxes, charges, and tradable permits), such instruments have only gradually been implemented (Barde, 1992, 1999; OECD, 1994). Today, the picture remains uneven: economic instruments are used in all countries, but only to a limited, albeit varying, extent. Nevertheless, more consideration is being given to the use of tradable permits, in particular to reduce CO_2 (carbon dioxide) and other greenhouse gas emissions. In addition, greater use is gradually being made of environmentally related taxes, fees, and charges, sometimes in the context of broader 'green tax reforms'.

The theoretical advantages of using taxes – in contrast to regulations – to correct environmental externalities have been clear since the publication of Pigou's book *The Economics of Welfare* in 1920.[1] OECD (2001c) provides an overview of relevant theory on environmental taxation, gives a description of the current use of environmentally related taxes in OECD countries, and provides indications of how obstacles to broader use of such taxes can be overcome. The publication gives due emphasis to the many, sometimes conflicting, objectives the taxes are intended to serve – often forgotten in theoretical discussions of these instruments.

Better and more comprehensive use of market-based instruments, and a reduction or phasing-out of environmentally harmful subsidies, are widely recognized by policy-makers as requirements for sustainable development. This was, for instance, underlined by both finance and environment ministers in the communiqué issued after the OECD's council meeting in 2001. Cur-

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rently, many large polluters *hardly pay any environmentally related taxes at all*. Hence, including these polluters in the coverage of environmentally related taxes should be a step in the right direction – even if the optimal, or Pigouvian, tax level in many cases is not known. A recent OECD survey undertaken among member governments clearly singles out the fear of loss of sectoral competitiveness and the negative impact on the income distribution as the most important political obstacles to the broader use of environmentally related taxes. That survey and OECD (2001*c*) are the starting points of the present chapter, which aims to provide an updated description of the use of environmental levies in OECD member countries and to suggest ways of overcoming the political obstacles to their wider use.

Section 5.2 defines environmentally related taxes, fees, and charges. Subsequently, Section 5.3 provides an overview of the current use of these levies and Section 5.4 lists additional details of recent green tax reforms in OECD countries. Section 5.5 then discusses the distributive and competitiveness impacts of environmentally related taxes in greater detail, while Section 5.6 illustrates the environmental effectiveness of such taxes. Section 5.7 provides some concluding comments.

The focus of this chapter is on OECD member countries, although some information is also given on the use of environmentally related taxes in some non-OECD countries that have relationships with the European Environment Agency. While many of the issues discussed are relevant to the situation in developing countries, the specifics – for instance, concerning institutional capacities – are not discussed.

5.2 DEFINITION AND USE OF ENVIRONMENTALLY RELATED TAXES, FEES, AND CHARGES

There will always be an element of arbitrariness when defining a concept such as 'environmentally related taxes'. This chapter draws to a large extent on information in the OECD/EU (European Union) database on such taxes, fees, and charges, and we use the definitions of that database. The OECD (2001d) defines a *tax* as a *compulsory, unrequited payment to general government*. Accordingly, our definition of environmentally related taxes includes *any tax levied on tax bases deemed to be of particular environmental relevance*. The European Commission, the International Energy Agency (IEA), and the OECD have singled out energy products, motor vehicles and transport services, measured or estimated emissions to air and water, ozone-depleting substances, certain non-point sources of water pollution, waste management, noise, and the management of water, land, soil, forests, biodiversity, wildlife, and fish stocks as the most relevant tax bases in this context.[2]

Obviously, the *name*, or the *expressed purpose*, of a given tax is not an appropriate criterion for deciding whether or not it is 'environmentally related' – *inter alia*, because the names used and the expressed purposes are often arbitrary, and because the purposes of a particular levy can change over time. Therefore, we focus on the potential environmental *effects* of the particular tax, which is determined by its impact on producer and consumer prices, as calculated on the basis of the relevant price elasticities.

A distinction should be made between *taxes* and *fees* or *charges*. Environmental fees or charges are payments for specific services, such as waste collection, treatment of sewerage, and collective water treatment facilities. The term *levy* can be used to cover both taxes and fees and charges.

5.3 CURRENT USE OF ENVIRONMENTALLY RELATED LEVIES

5.3.1 *General Overview*

The use of taxes, fees, and charges in environmental policy clearly goes beyond OECD member countries. The number of levies used in some Central and Eastern European countries (not members of the OECD) is, for example, relatively high compared with the number of levies in OECD countries. Levies on motor vehicles and on motor vehicle fuels constitute a large share of the levies covered by the OECD/EU database, but the number of levies used in, for example, waste management is also important.

A much-focused-on characteristic of environmentally related taxes is the revenues they raise – even if, from an environmental point of view, one would like the tax to be so effective that the revenue diminishes substantially. Figure 5.1 illustrates the revenues from these taxes (i.e. excluding revenues from fees and charges used, for example, in water supply and waste handling) measured as a percentage of GDP in each of the OECD member countries in 1994 and 2000. It can be seen that environmentally related taxes raise revenue of, on average, approximately 2–3 per cent of GDP. For the OECD area as a whole, there is no clear trend in this share between 1994 and 2000. However, in some countries (for example, Austria, Denmark, Finland, Hungary, Korea, and Turkey), the revenues increased considerably as a percentage of GDP. The database demonstrates that this was caused in part by the introduction of new taxes – and the inclusion of more tax bases under existing taxes – and by increases in a number of pre-existing tax rates. At the same time, it should be noted that revenues as a percentage of GDP fell – sometimes noticeably – over this period in a number of other countries, such as Australia, Canada, Greece, Mexico, and the Slovak Republic. The reasons for the fall differ between countries, but to some extent it is linked to the broadening of tax bases not being of particular environmental importance.

Figure 5.2 illustrates estimates of the amount of revenue raised from various environmentally relevant tax bases in OECD member countries. Again, revenues from fees and charges are not included. Motor fuels and motor vehicles dominate the picture: taxes on these products raise more than 90 per cent of all the revenues from environmentally related taxes. Very small revenues are raised from tax bases such as heavy fuel oil, coal, and coke – which are typically used in large quantities by heavy industries.[3]

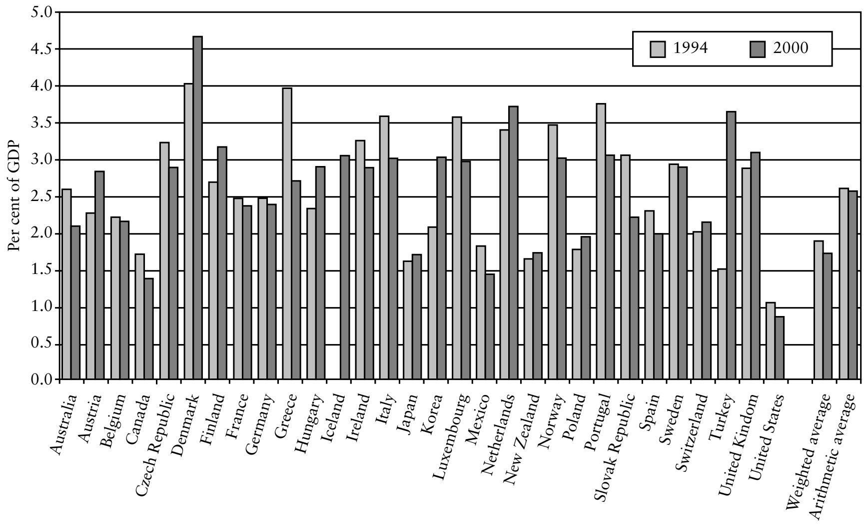

Figure 5.1. *Revenues from Environmentally Related Taxes as a Percentage of GDP*

Note: Revenues from fees and charges are not included.
Source: Based on information from www.oecd.org/env/tax-database.

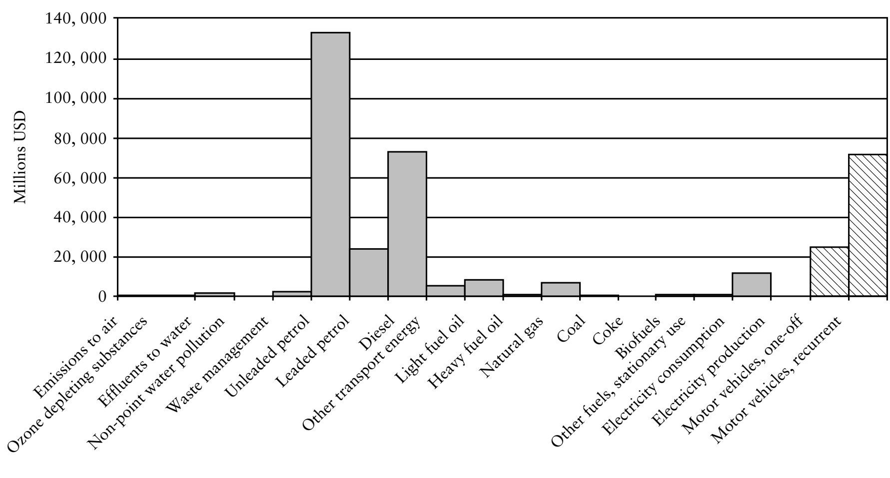

Figure 5.2. *Revenues Raised from Environmentally Relevant Tax Bases: Twenty-One OECD Countries, 1995*

Note: Revenues from fees and charges are not included.
Source: Based on information from www.oecd.org/env/tax-database.

5.3.2 *Some Categories of Environmentally Related Levies*

Motor Vehicle Fuels Taxes

All OECD countries levy one or more taxes on motor vehicle fuels, but – as shown in Figure 5.3 – the tax rates applied vary considerably between countries and between fuels. Historically, taxes on motor vehicle fuels were often introduced primarily to raise revenues, but in some countries, significant emphasis is now also placed on using such taxes to limit transport activities – and thereby, *inter alia*, greenhouse gas emissions. With four exceptions (the UK, Switzerland, Australia, and the USA), the tax rates are lower for diesel than for petrol; in many cases, the difference is very substantial – which is undesirable from an

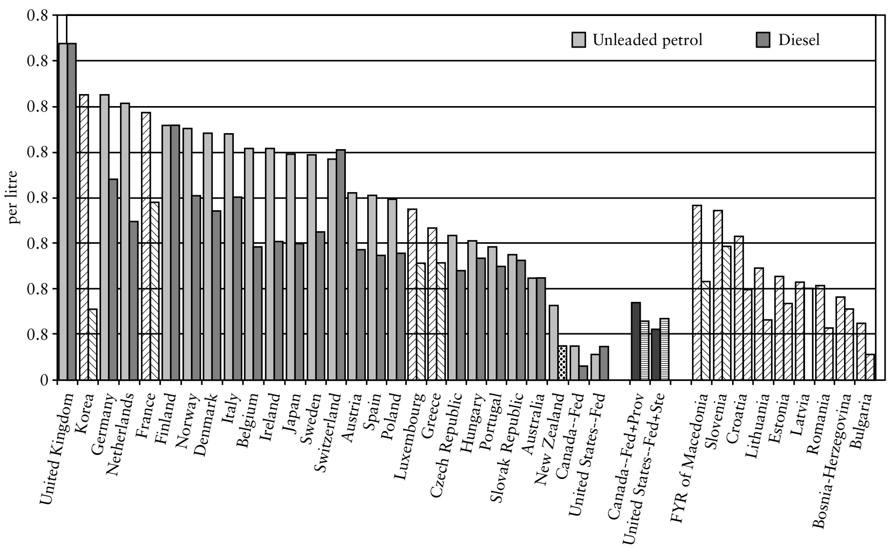

Figure 5.3. *Tax Rates on Unleaded Petrol and Diesel, 1 January 2002*

Notes: For countries with diagonally shaded bars, tax rates on 1 January 2000 are shown. Average exchange rates for 2001 were used to convert tax rates into euros for OECD member countries, while average 2000 rates were used for other countries. When a country applies several tax rates for different environmental qualities of petrol or diesel, the tax rate for the most environmentally friendly quality is included in the graph.

There is no direct taxation of diesel in New Zealand. Instead, there is a tax per 1,000 kilometres driven in diesel vehicles, with tax rates depending on the weight of the vehicle. In this graph, an implicit tax rate per litre of diesel is given for a vehicle weighing less than 2 tonnes assumed to consume 125 litres of diesel per 1,000 kilometres driven.

For Canada and the USA, the graph shows a set of bars that include only federal taxes. In addition, a shaded set of bars include both taxes levied at the federal level and an average of the taxes levied at the provincial or state level. The US average is calculated based on information concerning seventeen states included in the database.

Finally, it should be kept in mind that there are many exemptions in diesel tax rates for the transport sector, which are not reflected in this graph.

Source: Based on information from www.oecd.org/env/tax-database.

environmental point of view.[4] The tax rates for petrol and diesel in the UK are 4.4–6.8 times as high as the combined federal and provincial/state taxes on these fuels in Canada and the USA.

Parry and Small (2002) estimated the optimal petrol tax rates for the UK and the USA under the assumption that the revenues from the petrol tax would substitute for a distorting tax on labour income. Under their central parameter values, the second-best optimal petrol tax is €0.22 per litre ($US1.01 per gallon) for the USA and €0.29 per litre ($1.34 per gallon) for the UK. The congestion externality is the largest component in both countries, and the higher optimal tax for the UK is mainly due to a higher assumed value for marginal congestion cost. Revenue-raising needs also played a significant role in their estimates, as did accident externalities and local air pollution. Climate-related damages only played a minor part in their estimate (€0.02 per litre of petrol or $25 per tonne of carbon).

The current tax rate in the UK is more than twice as high as Parry and Small's estimated optimal level, while the current rate in the USA is only half their estimated optimal level. Parry and Small (2002) found that large gains could be achieved in both countries by switching to a tax on vehicle kilometres with equal revenue yield.[5]

Relatively high crude oil prices triggered substantial political attention in many countries in 2000 and 2001. For example, between 1 January 2000 and 1 January 2002, the tax rate on unleaded petrol was reduced by 15 per cent in nominal terms in Norway and 22 per cent in Portugal, but it was increased by 11 per cent, 12 per cent, and 21 per cent in Ireland, Germany, and Denmark, respectively. A relatively similar pattern can be found for changes in diesel tax rates. Hence, OECD member countries responded rather differently to the increase in crude oil prices. Norway had the second-highest tax rates on both petrol and diesel before the significant reductions were made, while both Germany and Denmark already had relatively high tax rates even before the increases.

Electricity Consumption

The use of fossil fuels in electricity generation causes externalities that, from a theoretical point of view, should be taxed – according to the externalities caused by the fuels used. Taking account only of the climate-change-related damages of Parry and Small (2002) implies that black coal – which contains almost exclusively carbon – should be taxed at about €25 per tonne of coal. Brown coal contains about 70 per cent carbon; hence, a climate-change element in the taxation of such coal used in electricity generation should – based on the numbers used by Parry and Small – be of the order of €17.5 per tonne of coal. The use of (in particular brown) coal can, in addition, cause other serious externalities (for example, sulphur and particles emissions); hence, a Pigouvian tax rate for coal used in electricity generation could be significantly higher than indicated here. Due to a lower carbon (and – often – sulphur) content, the

Pigouvian tax rate on a comparable unit of natural gas used in electricity generation would be lower than that on coal.

However, hardly any country taxes fossil fuels used in electricity generation.[6] This is in part related to the opening-up of electricity markets to cross-border trade. It can be difficult to tax imported electricity on the basis of the fuels used in its generation, and fear of loss of competitiveness of domestic power plants makes countries reluctant to tax fuel usage in such plants unilaterally if some form of border tax adjustment is not possible (see Section 5.5.2).

Instead, a number of countries tax electricity consumption, most often independent of how the electricity has been produced.[7] Figure 5.4 illustrates such tax rates in thirteen OECD member countries.[8] A number of points can be made. First, the tax rates vary significantly between countries, with the highest rates by far being applied to electricity used for (households' and businesses') heating of dwellings and other non-business uses in Denmark, and to the first 10 MWh of annual use of electricity in the Netherlands. Secondly, in almost all countries, the tax rates, if any, that apply to manufacturing and other industries are lower than those that apply to households. The major exception is the UK, where households are completely exempted from the climate change levy. Thirdly, rather different criteria are used to distinguish between groups of taxpayers. For example, in Belgium, only low-voltage electricity consumption is taxable – and hence heavy industries are 'automatically' exempted, as their electricity is supplied at high voltages. In Denmark, the tax rate depends on the purpose the electricity is used for – which requires separate metering in some facilities. In the Netherlands, the tax rate decreases with increasing energy usage, and is zero for any use above 10 GWh per year. In Austria, a tax ceiling is used to protect manufacturing industries, in that the marginal tax rate is zero for goods-producing firms where tax payments under the energy tax constitute more than 0.35 per cent of the firm's value added.

In some countries, the nominal tax rates on electricity consumption increased significantly between 1 January 2000 and 1 January 2002, as follows: Austria (100 per cent, but the tax ceiling concerning goods-producing firms was kept unchanged in nominal terms); Denmark (for example, heating of dwellings: 18 per cent); Norway (non-manufacturing: 20 per cent); and Sweden (non-manufacturing: 22 per cent). In addition, the climate change levy was introduced in the UK on 1 April 2001. No decreases in tax rates for electricity consumption are recorded in the OECD/EU database over this period.

Taxes on the Final Treatment of Waste

A number of countries have introduced taxes related to the final treatment of waste and/or on packaging and certain specific products that can cause special waste-related problems. For instance, some European countries have responded to EU targets on packaging and landfill waste by implementing such taxes. The taxes discussed in this section are in addition to user charges concerning waste collection and treatment, which are levied in most OECD member countries.

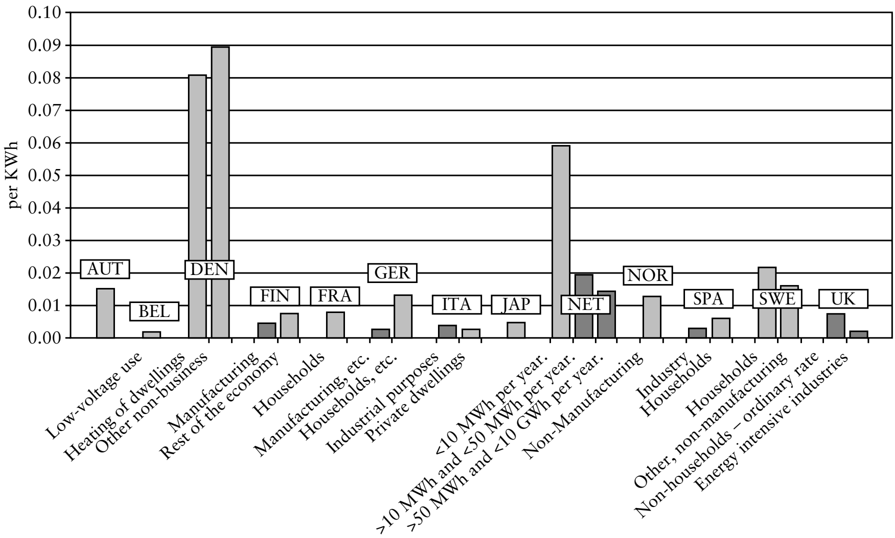

Figure 5.4. *Tax Rates on Electricity Consumption, 1 January 2002*

Notes: The tax rates shown for France and Spain relate to 1998 and 1999, respectively, and are from International Energy Agency (2001). The tax rate in Spain (in 2002) is expressed as 4.864 per cent of the electricity price, which varies between types of users. The dark bars in the graph represent tax rates facing manufacturing industries. In Austria, goods-producing firms face the standard tax rate, but the tax is refunded if electricity use exceeds 0.35 per cent of value added and the tax is more than €363 per annum.

Source: Based on information from www.oecd.org/env/tax-database.

There are many studies of the environmental externalities related to different types of waste treatment. For example, a report prepared for the European Commission (COWI, 2000*a*, 2000*b*) reviews and discusses available studies of environmental externalities related to waste disposal and presents estimates of the externality costs for different categories of both incinerators and landfills.[9]

For an incinerator fulfilling the existing directive on incineration of waste (89/369/EEC), with energy recovery used to generate electricity only, the *net* external costs were estimated by COWI to be €37 per tonne of waste incinerated.[10] If it is assumed that the incinerator generates both electricity and heat, implying a high rate of energy recovery (83 per cent), the net external costs of a tonne of waste incinerated was estimated to be negative: –€43 per tonne. Damage from air pollution (NO_x (nitrogen oxides) and SO_2 (sulphur dioxide) emissions) dominates the gross costs, while replacement of alternative energy generation fully or partially counterbalances the gross costs. For landfills, the COWI studies (COWI, 2000*a*, 2000*b*) distinguish between sites that fulfil the requirements of EC directive EC/31/1999, having a leachate collection and treatment system, and where the landfill gas is collected to generate electricity and heat, and an old site without a liner and with no collection of the landfill gas. In the former case, gross external costs are estimated to be €15 per tonne of waste, while the displacement of pollution from other energy-generation sources reduces net external costs to €11 per tonne of waste. For the old landfill site, both gross and net external costs are estimated to be €20 per tonne. For both cases, the gross external costs are dominated by assumed disamenity costs of €10 per tonne, but the assumed contribution to global warming (€5 and €8, respectively) is also significant.[11]

Figure 5.5 illustrates some of the tax rates on final treatment of waste that apply in OECD member countries. For example, in the UK, an explicit consideration of the externalities involved formed the basis of the rates that were applied when the landfill tax was first introduced. In recent years, the tax rates have, however, been increased beyond the estimated damage levels, in order to achieve EU targets on waste recycling (OECD, 2004). The graph shows that there is considerable variation in tax rates between countries and between different waste categories, with the highest rates being applied for ordinary (municipal) waste in the Netherlands. Rates applying to such waste

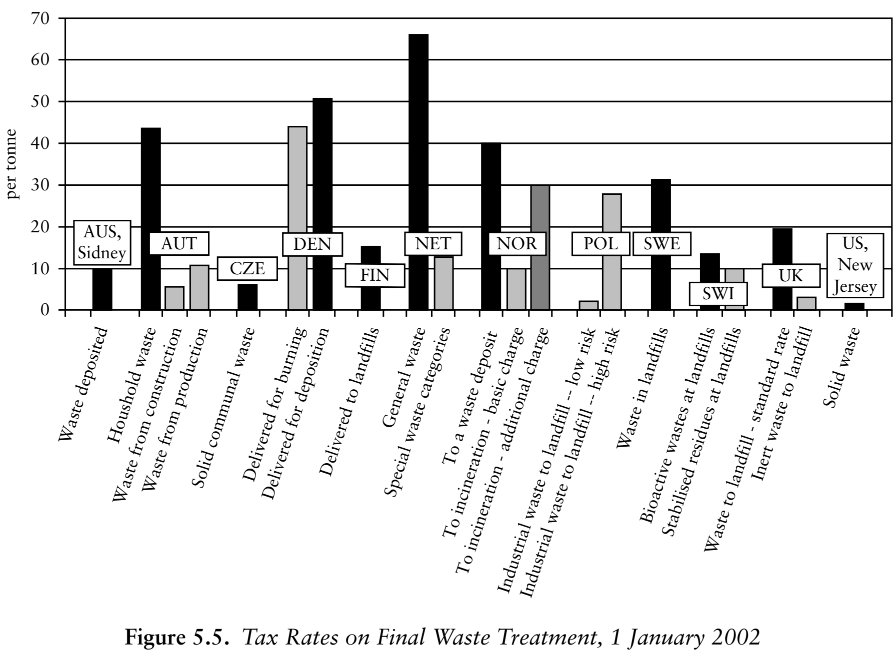

Figure 5.5. *Tax Rates on Final Waste Treatment, 1 January 2002*

Notes: Dark bars represent tax rates that are thought to be best comparable between countries. In Norway, there is a basic charge levied on all waste delivered for incineration. There is also an additional charge that varies proportionally with the degree of energy recovery at the plant, but the bar in the graph represents a case where none of the energy is recovered. The Norwegian parliament has decided to convert this tax into a tax on measured emissions from incinerators of a number of pollutants.

Source: Based on information from www.oecd.org/env/tax-database.

in Austria, Denmark, Norway, and Sweden are more or less of the same magnitude. Rates for ordinary industrial waste – which normally causes less methane emission – tend to be lower than the rates for municipal or household waste. In some cases, tax rates are also lower when waste is delivered for incineration – which can allow for energy recovery, but can also cause other environmental problems (for example, harmful air emissions; see the discussion above).

It should also be noted that in Denmark there is a special tax rate of €1.7 per GJ on heating by incineration of waste, applied under the duty on coal. The aim of this tax rate is to stimulate waste recycling and waste minimization measures.

5.4 GREEN TAX REFORMS

The previous section described some uses of environmentally related levies in OECD countries – in isolation. It showed that whilst there is a wide variety of environmentally related taxes, energy and transport taxes represent by far the largest shares of revenue, an important consideration when deploying and analysing green tax reforms.

Most OECD countries have undertaken significant (general) tax reforms since the end of the 1980s, chiefly in three ways:

1. by reducing tax rates in the higher income tax brackets (which fell on average by more than 10 percentage points between 1986 and 1997) and lowering corporate tax rates (down 10 points over the same period);
2. by broadening the tax bases; and
3. by giving a greater weight to general consumption taxes such as value added tax (VAT).

Such reforms provide an excellent opportunity to introduce an environmental dimension in taxation, i.e. a 'greening' of tax systems. Starting in the early 1990s, a number of countries, in particular in the EU, have implemented so-called 'green tax reforms', which generally consist of three types of approaches:

1. reduction or elimination of environmentally harmful subsidies, including direct public expenditures, 'market price support', and/or exemptions and other provisions in environmentally related taxes;
2. restructuring of existing taxes according to environmental criteria; and/or
3. introduction of new environmentally related taxes.

A 'greening' of fiscal policy could start with a systematic inventory of the environmental impacts of both tax rules and public expenditures. Measures that are harmful for the environment could then be corrected. A green tax reform would normally combine these 'green' components with a reduction of some (other) tax – for instance, social security contributions or taxes on labour income.

5.4.1 *Eliminating Environmentally Harmful Subsidies*

Many fiscal measures can either directly or indirectly produce adverse effects for the environment. One such measure is direct subsidies.[12] For example, subsidies to agriculture in OECD countries (estimated at $US318 billion in 2002, or 1.2 per cent of GDP – see OECD (2003)) are one of the causes of overfarming of land, excessive use of fertilizers and pesticides, soil degradation, and other environmental problems (OECD, 1996, 1998). Similarly, irrigation water is often charged below marginal social cost, which results in wastage. Subsidies for energy production in OECD countries, intended mainly to protect domestic producers and maintain employment in given industries, are estimated at $20–$80 billion per year. Approximately a third of these energy subsidies go to support coal production, the most polluting fossil fuel. Coal subsidies amounted to $5.4 billion in 2000 in five OECD countries, which admittedly was lower than the $11.4 billion for 1990. Industry is also subsidized, although it is difficult to obtain detailed data (industry subsidies were estimated at $44.1 billion in 1992). When subsidies encourage the use of certain raw materials and greater energy consumption, there can be negative fallout in terms of recycling and waste, and a lock-in of inefficient technologies. Subsidies to fisheries are also important: $6.0 billion in 1999, representing 20 per cent of the landed value (OECD, 2000*a*, 2001*b*), contributing to overcapacity in fishing fleets and depletion of fish stocks.

More indirect subsidies arise from specific tax provisions (tax rate variations or exemptions) that are environmentally harmful. For instance, coal, the most polluting fuel of all, is only taxed in five OECD countries, and in

Table 5.1. *Trends in Subsidy Levels in OECD Countries*

	Billions of US dollars		
	1992	**Most recent data [Year]**	**Comparison**
Agriculture	394	318 [2002]	Equivalent to 1.2% of GDP
Marine capture fisheries	—	5.8 [2000]	Equivalent to 19% of landed value
Coal production	11.9	5.4 [2000]	
Industry	44.1	—	

Notes:
Agriculture: total support estimate for agriculture; data for 1992 represent an average of 1991–3 data.
Fisheries: government financial transfers to marine capture fisheries; does not include market price support.
Coal production: producer support equivalent in selected OECD countries (Germany, Japan, Spain, Turkey, and the UK).
Industry: reported net government expenditures to industry.

Sources: OECD, 2001*a*, 2001*b*, 2003*a*, 2003*d*.

these countries the most important coal users are subject to many tax exemptions and rebates. The transport sector, a major source of pollution and other harmful effects, is also affected by many indirect subsidies: a case in point is the widespread undertaxing of diesel oil in many countries (see the discussion in Section 5.3.2). This contributes to a constant increase in the number of diesel-driven vehicles, which are more polluting[13] and noisier than petrol-driven vehicles, and to a sharp increase in road freight transport. In OECD countries, the consumption of diesel fuel for road transport grew from 15 per cent of total motor fuel consumption in 1970 to 32 per cent in 1997 (OECD, 1999). Other indirect transport subsidies in many countries include deductibility of commuting expenses from taxable income, the exclusion of the imputed value of company cars from taxable income, and tax exemptions for aviation fuels.

5.4.2 *Restructuring Existing Taxes*

Many existing taxes could be changed so as to benefit the environment, by increasing the relative prices of the most polluting tax bases. Since energy is one of the main sources both of pollution and of tax revenue, an 'environmental' restructuring of energy taxes is essential. For instance, in most OECD countries, taxes on motor vehicle fuel account for over 50 per cent of the pump price (see, for example, figure 12 in International Energy Agency (2003)). This leaves large scope for restructuring fuel taxes on the basis of environmental parameters, such as sulphur content, as the Nordic countries, Germany, Ireland, and the UK have done. Taxes on other energy products – for example, fuels used for heating purposes and in industrial processes – can also be differentiated according to environmental criteria, such as carbon and/or sulphur content.

It is also possible to restructure taxes on motor vehicles (both one-off sales taxes and annual taxes on vehicle usage) – for example, according to the environmental characteristics of the fuel the vehicle uses, according to the estimated fuel consumption, and/or according to whether or not the vehicle is equipped with a catalytic converter. In Switzerland, such differentiation has now been combined with accurate metering of the number of kilometres driven by various types of heavy vehicles.

5.4.3 *Introducing New Environmental Levies*

An obvious option is to introduce new levies whose prime purpose is to protect the environment. These may be taxes on emissions (for instance, on atmospheric pollutants or water pollution) or on products that are closely related to environmental problems. The latter are more frequent. Some examples of such taxes were described in Section 5.3.2. Since the early 1990s, other taxes have been introduced on a few types of measured or estimated emissions and on many types of products with harmful environmental impacts, ranging from packaging to fertilizers, pesticides, batteries, chemical substances (solvents), lubricants, tyres, razors, and disposable cameras. The OECD/EU database provides more information on a large variety of such levies.

5.4.4 *Green Tax Reforms in OECD Countries: An Overview*

Since the early 1990s, several countries, mainly in the EU, have introduced comprehensive green tax reforms, in most cases in an equal-yield context in the sense that new environmental taxes are offset by reductions in existing taxes. A constant tax burden is often seen as essential for the political acceptability of a green tax reform, although some countries that need to reduce public deficits, or with relatively low tax revenue, consider revenue-raising reforms.

Finland was the first country to introduce a 'carbon tax', in 1990, followed by a gradual 'greening' of the tax system. While the carbon tax started in 1990 at a fairly modest level of €4.1 per tonne of carbon, the rate was steadily increased until 1998, to reach €62.9 per tonne of carbon. The 'greening' of the tax system included other measures, such as the implementation of a landfill tax in 1996. In addition, Finland has, *inter alia*, taxes on motor vehicles, taxes on beverage containers, and a charge on electricity generation in nuclear power plants which is meant to finance nuclear waste management. The increase in environmentally related taxes was (more than) compensated by a reduction in income tax and social insurance contributions, with the explicit objective of reducing unemployment.

Norway implemented a CO_2 tax on mineral oils in 1991. The scope of the tax has been gradually extended and it covered about 64 per cent of total Norwegian CO_2 emissions in 2002. A tradable permit system in line with the EU's new carbon trading scheme will be introduced from 2005. The intention is to broaden this trading system to other sectors from 2008, as a replacement of the current CO_2 tax. A tax on the sulphur content of fuels is also applied. A reduced rate was levied for a number of years on some industrial uses of coal and coke, but since 2002, this rate has been replaced by a negotiated agreement under which the companies concerned commit to reduce SO_2 emissions. A number of other environmentally related taxes apply to products such as motor vehicles, pesticides, and various types of packaging and waste.

In Sweden, a major revenue-neutral tax reform was introduced in 1991. It included a significant reduction in income taxes, offset by a broadening of the VAT and by a series of new environmental taxes, especially on carbon and sulphur.[14] Energy taxes on industry were halved, nevertheless resulting in higher energy taxation overall. At present, the manufacturing sector pays 50 per cent of the ordinary rates of the CO_2 tax and is totally exempted from the general energy tax. The tax applicable to various categories of diesel and petrol is differentiated according to content of sulphur and benzene, etc. There are consumer and producer taxes on electricity and on domestic air traffic, and Sweden has a charge on NO_x emissions – with the revenue being refunded to the power plants affected, in proportion to the amount of energy they generate.

Denmark introduced a CO_2 tax on fuels in 1992 and continued to broaden its environmentally related taxes until 2002 (Larsen, 1998). The tax reform aimed to: reduce marginal tax rates in all income brackets; eliminate a series of loopholes in the tax law; and gradually transfer tax burden from income and labour to pollution and scarce environmental resources (Danish Ministry of Finance, 1995). The introduction of the 'Energy Package' in 1996 was a milestone, consisting mainly of an increase in the CO_2 tax (with considerably reduced rates for industry) and a new tax on SO_2 emissions. The revenue raised by these taxes is returned to industry through reduced employers' social security contributions and as investment aids for energy saving. Many other taxes – for example, on motor vehicles, waste, waste water, water abstractions, and pesticides – have also been put in place.

The Netherlands introduced a 'general fuel charge' through the 'General Environmental Provision Act' in 1988, which replaced five charges on air pollution, traffic and industrial noise, chemical waste, and lubricants. Between 1992 and 2000, a series of other taxes were introduced (on waste, groundwater, uranium, and small energy users). The 'regulatory tax on energy', introduced in 1996, is levied on small, non-transport, energy consumers, with the revenue recycled in the form of reduced social security contributions (Vermeend and Van der Vaart, 1998). A number of other green taxes – for example, on waste, groundwater, and aviation noise – are in force, and a new kilometre levy to replace existing motor vehicle taxes was discussed but subsequently shelved.

In France, a restructuring of environmental taxes and charges started in 1999. As in the Netherlands, one objective was to streamline and simplify a set of earmarked emission charges. In January 2000, existing charges on air pollution, household waste, special industrial waste, lubricating oils, and noise were merged into a single 'general tax on polluting activities' (TGAP). Taxes on pesticides, granulates, and detergents were also introduced. A progressive reduction of the tax differential between petrol and diesel fuel for cars was initiated in 1999, but discontinued due to political pressures. Also, an extension of the TGAP with a new tax on energy use by industry was rejected by the French Constitutional Council in late 2000 on grounds of an unequal treatment of specific segments of industry.

Germany initiated a green tax reform in April 1999. The main goals were to stimulate energy savings – in the context of the German objective to reduce CO_2 emissions by 25 per cent by 2005, compared with 1990 levels – and to increase employment. The reform comprised two main components: a new tax on electricity and a gradual increase in the taxation of mineral oil over the period 1999–2003. The increased tax burden on energy was compensated by reduced social security contributions for both employers and employees.

In Italy, a carbon tax was introduced in January 1999, to be phased in over five years. The revenue will be used to reduce taxes on labour. However, since 2000, the implementation of the reform has been put on hold.

In the UK, fuel excises were increased by 5–6 per cent per annum in real terms between 1993 and 1999. This 'road fuel duty escalator' was designed to reduce CO_2 emissions and to take into account other environmental factors. A 'climate change levy' on energy use by business and the public sector was introduced in April 2001. Industries entering into negotiated agreements setting targets for emission reductions can obtain an 80 per cent reduction of the tax rate. The revenue is recycled back to industry through lower employers' social security contributions and tax breaks for investments in energy efficiency and renewable energy. As of 2002, firms can opt into a CO_2 emission trading scheme to meet their targets. Firms with negotiated agreements can also fulfil their obligations by buying permits in the domestic UK CO_2 emissions trading scheme (OECD, 2003*b*; Braathen (forthcoming)).

5.5 IMPLEMENTATION ISSUES

Generally speaking, the implementation of environmental taxes is subject to a number of difficulties. There are, of course, technical difficulties, in particular in relation to the design of the taxes. These include ensuring an appropriate 'linkage' between the tax base and the potential environmental damage, without introducing excessive complexity that would undermine the implementation; and fixing an appropriate tax rate that will achieve the environmental objective, while taking into account social and economic constraints. Other issues relate to the use of the tax revenue (for example, earmarking and tax shift), governance and institutions (for example, effectiveness of tax administration, enforcement capacity, tax evasion, pressure groups, and stakeholders), and acceptance building. Dealing with all these aspects would be beyond the scope of this chapter.

A survey undertaken by the OECD clearly indicates, however, that the main political obstacles to broader implementation of environmentally related taxes relate to their impact on the distribution of income between different households and on the competitiveness position of certain industrial sectors. These issues will be briefly analysed below.

5.5.1 *Environmentally Related Taxes and the Distribution of Income between Households*

Environmentally related taxes can have several distributional implications – for instance, increasing regional income disparities. But the issue receiving most political attention in OECD member countries is the distributional impact across household categories – in particular, the possibly regressive impact, measured against income, of such taxes. The income distribution effects of environmentally related taxes, especially those on energy, may be observed in three ways (Smith, 1998):

1. There will be a direct distributional impact related to the structure of household energy expenditure (on heating and transport) for different income brackets. The greater the proportion of low-income households' expenditure devoted to energy, the more regressive will be the impact of the tax.

2. Indirect distributional effects will emanate from the taxation of production inputs. The more energy-intensive the processes, the greater will be the incidence of a tax on the goods produced. Of course, the more the products fall into the basic necessities category, the more regressive the tax will be.
3. The distributional impact will be related to the incidence of the tax. An energy tax may affect end consumers, but it may also affect energy producers or production factors (for example, through a fall in wages or through a lower return on capital). At the same time, part of the tax may be borne by energy-consuming countries, and another part by energy-exporting countries, depending on the elasticities of supply and demand.

In so far as many environmentally related taxes apply to mass consumption products, such as motor vehicles and energy, they can have a negative effect on low-income households.[15] The level of the tax also matters. Other environmental taxes, on products such as detergents, fertilizers, batteries, and pesticides, produce very limited revenue (see Figure 5.2); whether this implies a limited distributive impact, compared with large-scale and fiscally heavier environmental taxes such as those on energy, is an open question. Certain categories may be affected, such as farmers paying taxes on fertilizers and pesticides, and more so if they have to pay water charges according to full social costs.

An evaluation of the distributive implications should also take into account the overall context of the tax reform. For instance, any positive employment effects of a tax reform could reduce the possible regressive effects of the environmental tax. Also, a comprehensive tax reform might comprise reductions in income and/or indirect taxes, which could have positive distributional effects.

The results of an analysis of impacts of a tax reform on income distribution will generally depend on whether the impact on annual or lifetime income is being studied. Most empirical studies address annual income implications.

Finally, one should take into account the distribution of improvements in environmental conditions caused by the reform.[16] For example, low-income households often live in areas in large cities that would benefit the most from measures that would limit road traffic.

Evidence

Evidence on the distributive implications of environmental taxes remains scant. It indicates some, but limited, regressivity, as can be expected from any indirect tax. But little systematic, in-depth, *ex-ante* or *ex-post* analysis has been carried out.

An analysis of possible distributional effects of the carbon–energy tax in the UK, as initially proposed by the European Commission, showed that this tax would clearly hurt poorer households. While a tax of $US10 per barrel (i.e. $88 per tonne of carbon) would reduce total household energy consumption by 6.5 per cent, the reduction would be 10 per cent for the poorest 20 per cent of households (Pearson and Smith, 1991). The figures vary considerably from country to country (Pearson, 1992). To achieve targets concerning climate change, however, a tax on energy might have to be much higher. As mentioned above, the distributive consequences of a reform will depend on the way in which the revenue of the environmentally related tax is recycled.

In its 1997 report, the Swedish Green Tax Commission estimated that doubling the CO_2 tax (from a 1997 rate of SEK0.37 [about €0.04, using exchange rates of April 2003] to SEK0.74 [about €0.08] per kilogram of CO_2) would have a fairly marked regressive impact – see SOU (1997)). In order to maintain the same consumption level, people on the lowest incomes would need to receive compensation of 1.24 per cent of their consumption expenditure, and those on the highest incomes 0.78 per cent. In Norway, environmentally related taxes have not been found to be significantly regressive. However, one issue that has received some political attention is differences in impacts between regions where public transportation is available (and hence it is possible to switch to public transport when fuel taxes increase) and regions where it is not.

A recent study by Bach et al. (2002) estimates the distributive effects of the German green tax reform. The study shows that this reform in itself leads to an increased tax burden for most households, while enterprises in total would benefit. However, as a percentage of household income, the increase in the tax burden is small – below 1.5 per cent of annual disposable income for all the household categories studied. For almost all household categories – grouped according to social status or according to the number of adults and children – the percentage reduction in annual disposable income was estimated to be larger for households with a gross yearly income of under approximately €25,000 than for households with higher incomes.[17]

Policy Options

Basically, two categories of corrective measures to counterbalance any distributive effects of environmentally related taxes can be envisaged: mitigation and compensation.

Mitigation is an *ex-ante* measure consisting of reducing environmental tax rates to alleviate the tax burden on specific segments of the population. This could take at least two forms: establishing a consumption floor below which no tax is levied; or introducing a dual-rate structure with a reduced or zero rate for low-income households.

The main limitation of mitigation measures is that they weaken or even cancel out the desired environmental impact of the tax. Furthermore, the income distribution objective may be poorly achieved; for instance, a consumption floor also benefits the higher-income segment of the population, and hence the deadweight loss is considerable. Using taxable income as a reference also raises difficulties; for instance, taxable income does not necessarily reflect ability to pay when the taxpayer claims significant deductions from gross income, such as mortgage interest. Finally, mitigation measures based on income measures involve substantial administrative complexities and costs.

Nevertheless, a large number of special tax provisions are applied in OECD countries. The OECD/EU database indicates hundreds of provisions such as tax exemptions and reduced rates. Note that these provisions are introduced on both distributive and competitiveness grounds, to the benefit of both households and the business sector, which makes the assessment of the strictly 'social' benefit of these measures quite uncertain.

Compensation measures are basically *ex-post* and outside the realm of the environmentally related taxes as such, i.e. they do not affect their rates or structure, thus maintaining the incentive effect of the tax. They are corrective measures, such as lump-sum compensation, calculated on the basis of average tax payments per household, or subsidies for heat insulation of homes. In this case, compensation will have a progressive incidence on the assumption that, on average, the poorest households pay less tax than the richest. Tax refunds are a typical compensation measure (see Box 5.1); for instance, in several countries, energy taxes are partly repaid to households and/or businesses in the form of subsidies for energy-saving investments or expenditures. Three main forms of compensation can be identified (de Kam, 2002):

1. *Lump-sum compensation*, calculated on the basis of average 'green' tax payments per household, in the form of cash transfers or credits against the income tax liability. Cuts in income taxation may not benefit low-income households because they pay little or no income taxes (Smith, 1998). Tax credits are amounts deductible from tax payable (as distinct from deductions from the tax base). A distinction must be made between so-called 'wastable' and 'non-wastable' tax credits (OECD, 2001c). In the case of wastable tax credits, the environmental tax refund cannot exceed the amount of the income tax liability and will therefore not give rise to a payment by the government to the taxpayer. In the case of non-wastable tax credits, the environmental tax refund can exceed the tax liability, so that the taxpayer can receive a net payment. Therefore, from an income distribution point of view, non-wastable tax credits are the preferred

Box 5.1. Examples of Exemptions and Rebates Motivated by Income Distribution

Germany offers a 50 per cent rebate on the electricity tax for storage heaters installed before April 1999. Such heaters are concentrated in low-income households.

The Netherlands has a tax on domestic energy use (natural gas and electricity), with a fixed tax reduction of €142 (in 2002) for each household connected to the electricity network.

The UK exempts domestic use of energy from its 'climate change levy'.

The Swiss taxes on volatile organic compounds (VOCs) and light heating oil are fully redistributed to the population through the health insurance system. Basic health insurance is compulsory in Switzerland, and the insurance companies will credit each person the amount to be redistributed per person.

Source: Based on OECD (2001*c*).

option, because there is no ceiling to the tax refund poorer households would be entitled to receive. However, such credits can be relatively complicated to administer.

2. *Income-tested compensation*, with two options (in the case of energy taxes): the compensation paid to *all* households equals the tax due from *average* energy users or polluters; or the compensation is paid only to households below a certain income level, by comparing *actual* 'green' tax payments of households and household income. The rationale for this latter variant might be that poor households sometimes have limited options for reducing their energy use, such as in the case of block heating. However, if it were decided that households need not pay more than, say, 2 per cent of their income in the form of a green tax, the price signal would be ineffective once a household had exceeded this threshold.
3. *Tax shifts*, i.e. the reduction of other taxes, such as labour and income taxes. These are a widespread form of compensation. It is assumed that the regressive impact of the new environmental tax will be compensated by the reduction of other taxes. The net distributional implication of this approach is not clear, however, considering that the poorest households pay the least income tax whereas wealthy households will benefit most from any lowering of income tax. According to Smith (1998), this form of compensation may even prove to be regressive.

Obviously, measures for offsetting the regressive effects of environmental taxes would need to be tailored to specific national and local situations. Scott and Eakins (2001) analyse eleven possible measures in the context of Ireland. Furthermore, Ekins and Dresner (2004) discuss distributive implications of taxes and charges on water, waste, transport and energy in the UK. They show that in most cases a way can be found to redress the regressive effects. In the area of domestic energy, however, the low thermal energy efficiency of many British dwellings makes this difficult to achieve.

Clearly, compensation measures outside the realm of the environmentally related tax are to be preferred to mitigation as they involve a lower risk of defeating the environmental purpose of the tax. For instance, subsidies for more efficient heating systems can be more effective in reducing the burden of increased energy taxation for poorer households living in low-standard apartments.

5.5.2 *Environmentally Related Taxes and International Competitiveness*

A Stumbling Block

It is often claimed in political discussions that environmentally related taxes, particularly on energy, substantially increase the production costs of certain industrial sectors, thus putting them at a competitiveness disadvantage. This is why these industrial sectors (in particular, energy-intensive industries) are strongly opposed to environmental taxes and often formulate an explicit threat of relocation to countries that do not apply such taxes.

In the case of purely local environmental issues, the threat of closing down a heavily polluting firm might not worry political authorities too much. The 'costs' involved in such a closing-down could be (more than) balanced by the environmental benefits reaped. For issues involving cross-border pollution – which is most often the case, for example, in relation to taxes on energy – the situation can be different. Here, the closing-down of a source of pollution in a particular country might not result in any lasting environmental gains if the close-down causes pollution to increase across the border. Hence, there is a fear among policy-makers that the pollution might 'leak out', while they face the political difficulties involved in any plant closures.

If environmentally related taxes are economically efficient (i.e. minimize abatement costs), they should increase the overall competitiveness of the country where they are applied. Reduced damage cost and an improved environment may also enhance competitiveness – for certain sectors and for the country as a whole in the form of, for example, cleaner water for food production and greater attractiveness of the country.

The business community tends to argue in favour of other policy instruments, such as voluntary agreements. Indeed, some countries use 'policy packages', whereby firms can avoid paying taxes (or are granted reduced rates) if they enter into agreements comprising commitments to achieve certain emission reduction targets – see, for example, the CO_2 tax in Denmark, the climate change levy in the UK, and the SO_2 tax in Norway. In practice, such packages often shift a greater part of the total effort to abate a certain type of pollution on to other sectors of the economy – for example, households – or lead to a reduction in the combined abatement effort (OECD, 2003*b*).

The impact of environmentally related taxes on the international competitiveness of a sector is a complex issue depending on various factors:

1. *The market structure*. In relatively competitive markets, increased taxes will result in reduced profits as firms will have no, or limited, opportunity to pass the tax on to consumers through higher prices. Firms with market power will have more opportunity to pass on additional costs in higher prices.
2. *Whether or not taxes replace existing command-and-control regulations*. If taxes replace pre-existing CACs, the impact on competitiveness will depend on whether or not this implies a cost increase, and whether or not the preceding regulatory requirements were devised in a cost-effective way. If efficient taxes are replacing inefficient CACs (thus enabling static efficiency gains), the competitiveness impacts might be positive overall. Note, however, that firms must pay the taxes (for example, on residual emissions and remaining input use) in addition to the abatement cost; this explains the strong opposition from industry. In all cases, with taxes or CACs, there will be winners and losers, depending on the firms' marginal abatement costs. It should also be noted that, in a number of instances, taxes do not replace CACs but come as an additional measure; a negative competitiveness impact is then more likely to occur.

3. *Whether or not the tax reform is revenue neutral*. In a revenue-neutral context, the overall tax burden on the economy remains constant. As environmentally related taxes offset other pre-existing taxes, the tax shift implies primarily a redistribution of the tax burden across the economy. Nevertheless, the tax burden will rise for some firms and sectors of the economy (for example, energy-intensive sectors in the case of a carbon tax).
4. *The nature of the tax shift*. If the revenue of environmentally related taxes is recycled in the form of a reduction in income taxes or social security contributions, thus reducing labour costs, labour-intensive sectors will gain some competitiveness advantages. However, as environmentally related taxes are for the most part paid by members of the labour force, the impact on the tax wedge on labour of such a shift is limited. If the revenue is used to reduce taxes on capital, this could – in isolation – benefit capital-intensive firms or sectors.
5. *The effects of the environmental improvements*. If the tax is environmentally effective, some environmental benefits may improve the competitiveness of certain firms (for example, reduced water-cleaning cost, reduced crop losses, and reduced health cost). This argument is, however, equally valid for any other policy instrument.

Policy Options

Confronted with the competitiveness issue, countries can adopt either of two strategies. One is a wait-and-see attitude: who will go first? This is a 'prisoner's dilemma', where no one wants to start before the others. The other strategy is to introduce environmental taxes, but with special provisions to protect sectors subject to international competition; this is a widespread policy in practice: the OECD/EU database indicates a large number of tax exemptions, many of them for industry (see below).

Five main policy options are open to countries that decide to increase the use of environmentally related taxes but that worry about possible negative impacts on sectoral competitiveness:

1. *Exempt specific sectoral activities or products from the new tax*. This option is widely used: the OECD/EU database includes more than a thousand exemptions in OECD countries. However, the data must be interpreted with caution: exemptions are introduced for a number of social, environmental, and economic reasons, and only part of these exemptions are directly motivated by sectoral competitiveness concerns. One often-applied approach is simply to exclude the main industries completely from the application of a tax, or, for example, by saying that a particular tax does not apply to the use of fuels as input or reduction agents in industrial processes. In other cases, the tax is paid at the outset, but later refunded for polluters that satisfy certain criteria.

2. *Apply reduced tax rates for certain sectors, products, or inputs* – thus providing at least some incentive at the margin to reduce emissions. Many countries apply reduced tax rates – for example, to industrial sectors. For instance, Sweden initially gave a 75 per cent rebate on the carbon tax (and total exemption in the case of the energy tax) to industry and horticulture; this rebate was reduced to 50 per cent in July 1997. In Denmark, a 50 per cent rebate on the CO_2 tax was granted to industry for the period 1993–5. Both countries are interesting 'front-runners' as they were amongst the first to introduce CO_2 taxes. In Germany, electricity taxes are significantly lower for the production sector than for households, and in the UK, tax rates under the climate change levy for energy-intensive companies are 20 per cent of the 'normal' rate.
3. *Apply full tax rates for all polluters, but recycle, fully or partially, the revenue to the affected firms.* One example of such an approach is the Swedish charge on NO_x emissions from power plants. All revenues from this charge are recycled back to the plants in proportion to the amount of energy they have produced. In this way, a strong incentive at the margin is given to the plants to reduce their emissions – but the customers of the power plants do not have an incentive to lower their demand for a polluting product.
4. *Apply border tax adjustments (BTAs).* Environmentally related taxes place domestic producers at a competitive disadvantage if foreign competitors are not subject to similar taxes. Conceptually, BTAs can apply to both products and production processes. Often, it is relatively easy to subject imported products to similar taxes to domestically manufactured products. It is, however, more complicated to tax a product based on the way in which it has been produced. If domestic firms are subject to environmental taxes at the production level (for example, input or emission taxes), applying taxes on foreign competitors implies, *inter alia*, that production processes are deemed to have similar environmental effects. This type of approach can raise formidable legal and practical difficulties. However, such mechanisms do exist under the ozone depletion substances tax in the USA (see US Department of the Treasury, 2002).
5. *International coordination.* The many special provisions and exemptions for industry gravely undermine the environmental effectiveness of environmentally related taxes today. This indicates that, in the absence of international coordination to establish some minimum 'level playing field', green tax reforms are not likely to make significant progress. However, international tax coordination requires consensus among countries, and many countries are reluctant to take part. This is well illustrated in the EU context, with the rejection of the proposed carbon–energy tax in 1992 and the blocking of proposed increases in minimum levels of excises on energy.[18]

Often, competitiveness can be softened through a gradual phasing-in of taxes. For instance, the phasing-in of energy and CO_2 taxes in Denmark was designed to provide industry with clear advance signals, enabling it to plan accordingly. A similar approach is being used with the landfill tax in the UK, where the tax rate per tonne of standard waste will increase by £3 (approximately €4.5) per year until a level of £35 per tonne is reached.

Conclusion

Available studies and data show no significant impact of environmental policies on international trade or on employment in polluting sectors. Jaffe et al. (1995) examined over a hundred studies on the potential effect of environmental regulations (i.e. not only taxes) on the competitiveness of US industry. They concluded: 'Overall, there is relatively little evidence to support the hypothesis that environmental regulations have had a large adverse effect on competitiveness, however that elusive term is defined'. Morgenstern, Pizer, and Shih (2002) found, when examining four heavily polluting sectors in the USA, that 'increased environmental spending generally does *not* cause a significant change in employment'.[19]

These results do, however, provide few indications of the sectoral competitiveness impacts of the broader use of environmentally related taxes. Given the large number of special provisions for industry at present, it is not surprising that no negative competitiveness impacts of environmentally related taxes have been noted to date: when the tax burden is close to zero, the impact of this 'burden' would, in any case, be small.

OECD (2003*e*) does, however, indicate that the negative impact on the competitiveness of certain heavy industries of the general application of (relatively high) taxes to address climate change would be very significant if a country or a small region applied them unilaterally.[20] This is why international coordination is essential. A useful starting point could be to foster the environmental effectiveness of current taxes by gradually removing the numerous exemptions currently granted to industry. A second step would be to initiate a concerted action between OECD countries for the gradual introduction of environmentally related taxes. Accordingly, OECD (2001*c*) concludes that 'countries concerned with competitiveness implications of adjusting certain environmentally related taxes on a unilateral basis could consider possible concerted policy options and changes, decided and implemented at the national level, but within a framework which provides for a multilateral dialogue'.

5.6 ENVIRONMENTAL EFFECTIVENESS

5.6.1 *Price Elasticity Estimates*

The environmental effectiveness of a tax can be measured as the extent to which it delivers a reduction in pollution or actual emissions. This is closely connected to the price elasticities of the tax bases to which the tax applies – and to the extent the tax base is comprehensive (see references above to the many important exemptions under existing taxes). The environmental effectiveness will obviously be limited if major relevant tax bases are exempted from the levy.

An important first step, therefore, in evaluating behavioural responses to environmentally related taxes is the collection of up-to-date information on the price elasticities of demand for energy, transport, and other environmentally related goods.

Table 5.2, taken from OECD (2001*c*) – which in turn was based on OECD (2000*b*) – summarizes some of the available price elasticity estimates with regard to petrol or gasoline. While most estimates show relatively low own-price elasticities in the short run (−0.15 to −0.38), some estimates indicate significantly higher values (−0.51 to −1.07). Long-term own-price elasticities are generally estimated to be higher than short-term elasticities (−0.23 to −1.4).

A recent paper by Sipes and Mendelsohn (2001) examines 'whether charging higher taxes [on gasoline] would result in significant emissions reductions'.

Table 5.2. *Selected Estimates of Price Elasticities of Gasoline*

		Short run	Long run	Ambiguous
Pooled time series / cross section	Micro	−0.30 to −0.39 (USA)	−0.77 to −0.83 (USA)	
	Macro	−0.15 to −0.38 (OECD*)	−1.05 to −1.4 (OECD*)	
		−0.15 (Europe)	−1.24 (Europe)	
			−0.55 to −0.9 (OECD 18**)	
		−0.6 (Mexico)	−1.13 to −1.25 (Mexico)	
Cross section	Micro	−0.51 (USA) 0 to −0.67 (USA)		
	Macro	Mean −1.07 (−0.77 to −1.34) (OECD*)		
Time series	Macro	−0.12 to −0.17 (USA)	−0.23 to −0.35 (USA)	
Meta-analyses and surveys		Average −0.26 (0 to −1.36) (international)	Average −0.58 (0 to −2.72) (international)	Average −0.53 (−0.02 to −1.59) (USA)
		Mean −0.27 (time series)	Mean −0.71 (time series)	Mean −0.53 (time series)
		Mean −0.28 (cross section)	Mean −0.84 (cross section)	Mean −0.18 (cross section) −0.53 (panel data) −0.1 to −0.3 (22 estimates)

* OECD except Luxembourg, Iceland, and New Zealand.

** OECD 18 covers Canada, the USA, Japan, Austria, Belgium, Denmark, France, Germany, Greece, Ireland, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland, Turkey, and the UK.

Sources: OECD, 2000*b*, 2001*c*.

Both experimental survey data and actual behaviour in Southern California and Connecticut are evaluated to explore whether people would change their driving behaviour in response to higher gasoline prices. Both sets of results reveal that drivers are price inelastic in the short run (−0.4 to −0.6) as well as the long run (−0.5 to −0.7). Imposing environmental surcharges on gasoline would result in only a small reduction in driving and thus only a small improvement in the environment. Such taxes would therefore place a heavy and clear burden on drivers, and make gasoline taxes extremely unpopular. 'Our results indicate that if an environmental surcharge is added to gasoline taxes, then the additional tax will decrease gasoline consumption only slightly and, therefore, will have little effect on air pollution. For example, the price elasticity estimates suggest that a 33% increase in gasoline prices (a $0.50 per gallon tax) would decrease gasoline consumption by only 13–23%.'

We find this interpretation of the estimated elasticities too negative. First, if a tax of $US0.50 per gallon of petrol were added on top of existing federal and state taxes, the combined tax rate in all US states would still be lower than the tax rate applied in all European OECD countries.[21] Secondly, although it is common practice to say that a product with a price elasticity below 1 in absolute value is 'inelastic in demand', we believe that a long-term reduction in petrol use of about 20 per cent would be quite significant. Furthermore, the price elasticity of petrol is likely to be comparatively low anyway in a region such as Southern California, with large distances and little public transport – in other words, few substitution possibilities.

Another illustration of possible impacts of changes in petrol prices is given in Figure 5.6. While more detailed studies would be needed to determine the precise interaction, it is interesting to note that when real petrol prices in the USA increased in the period up to the early 1980s, a significant increase in fuel efficiency of new cars occurred. Later, as real petrol prices decreased significantly (to levels well below those before the first 'oil price shock' in 1973), the increases in fuel efficiency of new cars were brought to a halt. Indeed, the growing popularity of 'sports utility vehicles' has probably led to decreases in fuel efficiency in recent years.

Popp (2002) points to another advantage of environmentally related taxes: 'The most significant result is the strong, positive impact energy prices have on new innovations. … My results also make clear that simply relying on technological change as a panacea for environmental problems is not enough. There must be some mechanism in place that encourages new innovation'.

Price elasticity estimates of other energy categories are also available. Table 5.3, taken from OECD (2000*b*), presents estimated own-price elasticities of household electricity demand. Furthermore, Nesbakken (1998) quotes a number of estimates, which are reproduced in Table 5.4. Again, the available estimates indicate that a tax on electricity could lead to a relatively significant reduction in electricity consumption. If, for example, a tax increased the price that electricity consumers are facing by 25 per cent, electricity consumption could decrease by some 5–15 per cent in the long term, which would entail clear environmental benefits.

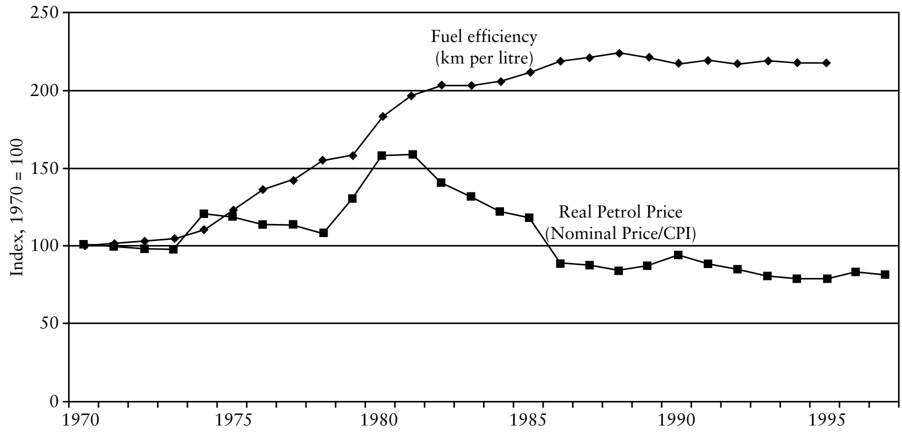

Figure 5.6. *Petrol Prices and Fuel Efficiency of New Cars: USA*
Source: OECD (2001*c*), based on Birol and Keppler (2000).

Bjørner and Jensen (2002) use a micro-panel database covering the majority of Danish industrial companies over the period of 1983–1997. They find that the average price elasticity of energy in Danish industry is −0.44. Interestingly, the various price elasticities depend on the energy prices firms were facing at the outset. When ranked in increasing order according to energy prices they were facing, the estimated price elasticity of energy for firms in the 10% decile is about −0.4, about −0.6 for firms in the median decile, and about −0.7 for firms in the 90% decile.

Fullerton (this volume) presents a number of estimates of price elasticities related to unit-based garbage collection fees. He concludes: 'The basic message here is that the demand for garbage collection services is inelastic. Substitutes are not readily available. Advocates of unit-based pricing suggest demand may become more elastic in the long run as households learn of available substitutes for garbage disposal, but the empirical literature has yet to address this point.'

5.6.2 *Ex-Post Studies of Environmental Effectiveness*

Ex-post studies of the environmental effectiveness of environmentally related taxes, implicitly or explicitly, incorporate estimates of relevant price elasticities, but also have to disentangle the effects of the taxes from other developments that have affected demand for the products or services involved. It is obviously always debatable what would have happened if a given tax had not been introduced.

In Belgium, the tax differentiation between heavy fuels with a sulphur content below or above 1 per cent induced a decrease in the use of the fuel with the higher sulphur content from 20 per cent of the market in 1994 to less than 1 per cent in 1998 (also due to a switch to natural gas) (OECD, 2001*c*). Taxes on non-reused or recycled beverage containers, disposable cameras,

Table 5.3. *Selected Estimates of Own-Price Elasticities of Residential Electricity*

		Short run	Long run	Ambiguous
Pooled time series / cross section	Micro	−0.433 (Norway)	−0.442 (Norway)	
		−0.2 (USA)		
	Macro	−0.158 to −0.184 (USA)	−0.263 to −0.329 (USA)	
Cross section	Micro	−0.4 to −1.1 (Norway)	−0.3 to −1.1 (Norway)	
	Macro			−1.42 (53 countries)
Time series	Macro	−0.25 (USA)	−0.5 (USA)	
		−0.62 (USA)	−0.6 (USA)	
Meta-analyses and surveys		−0.05 to −0.9	−0.2 to −4.6	−0.05 to −0.12 (4 studies)

Source: OECD (2001*c*), based on OECD (2000*b*).

Table 5.4. *More Estimates of Own-Price Elasticities of Residential Electricity*

Study	Country	Details	Short run	Long run
Aasness and Holtsmark, 1993	Norway	Household data		−0.2
Halvorsen and Larsen, 1998	Norway	Household data, dynamic model	−0.33	−0.42
Parti and Parti, 1980	USA	Household data	−0.58	
Morss and Small, 1989	USA		−0.23	−0.38
Baker, Blundell and Micklewright, 1989	UK	Paper includes results for subgroups of households		−0.76
Dennerlein, 1987	Germany	Household data, discrete−continuous choice		−0.38
Dubin and McFadden, 1984	USA	Discrete−continuous choice		−0.26
Bernard, Bolduc and Bélanger, 1996	Canada	Discrete−continuous choice	−0.67	
Branch, 1993	USA	Expenditure Survey data	−0.2	
Garbacz, 1983	USA	Partial elasticities	−0.193	

Source: Nesbakken, 1998.

batteries, and various packaging, introduced in 1993, led industry to meet all recycling and reuse targets, thus avoiding payment of the taxes.

In Denmark, the sulphur tax caused a reduction of emissions by 34,000 tonnes between 1996 and 2000. The tax on non-hazardous waste reduced the net delivered waste to municipal sites by 26 per cent over the period 1987–96, and waste to smaller fills and private waste sites by 39 per cent over the period 1990–6. Industrial waste, however, increased by 8 per cent. Recycling also increased considerably: up 77 per cent for paper and cardboard and up 50 per cent for glass (Andersen, 1998).

In Finland, it is estimated that, in the absence of the CO_2 tax, carbon emissions would have been 7 per cent higher in 1998 if taxes had remained at the 1990 level (Finnish Economic Council, 2000).

In Norway, CO_2 taxes introduced in 1991 lowered CO_2 emissions of some stationary combustion plants by some 21 per cent, whereas the drop was much less in other sectors. It is estimated that CO_2 emissions produced by mobile household combustion devices fell by 2–3 per cent as a consequence of the CO_2 tax (Larsen and Nesbakken, 1997). It is also estimated that CO_2 emissions per unit of oil produced by the Norwegian oil sector fell by 1.5 per cent due to measures taken by the industry in response to the CO_2 tax (ECON, 1994).

The Swedish sulphur tax (introduced in 1991) contributed to a fall in the sulphur content of oil-based fuels of more than 50 per cent *beyond the legal standards*.[22] The sulphur content of light oils has now fallen below 0.076 per cent (i.e. less than half the legal limit of 0.2 per cent). The tax is estimated to have reduced emissions of SO_2 by 80 per cent compared with 1980 (Nordic Council of Ministers, 1999). Also in Sweden, a tax differentiation was introduced in 1991 on diesel fuels in order to stimulate the use of less-polluting fuel oils. From 1992 to 1996, the proportion of 'clean' diesel sold in Sweden rose from 1 per cent to 85 per cent, which led to a reduction of more than 75 per cent on average in the sulphur emissions of diesel-driven vehicles (Swedish Environmental Protection Agency, 1997).

In most countries, the tax differentiation between leaded and unleaded petrol, combined with regulations ordering service stations to offer unleaded petrol and the introduction of new emission standards for motor vehicles – based on such requirements as catalytic converters – led to a rapid fall in the market share of leaded petrol (which has now been withdrawn from sale in most OECD countries). The fiscal incentive greatly speeded up the process, despite slow penetration of new vehicles equipped with catalytic converters. Similarly, tax preferences given to ultra-low sulphur petrol and diesel fuels in several countries have lead to a rapid disappearance of fuels with higher sulphur contents.

5.7 CONCLUSIONS

The use of environmentally related levies still remains relatively limited in scope, and their environmental and economic effectiveness is hampered by a number of shortcomings.

- In many instances, the 'linkage' between actual tax rates and calculated externalities is weak or non-existent. For instance, while the tax rate on petrol in a number of countries is relatively high compared with estimated 'optimal' or 'Pigouvian' levels, in many other cases the rates are low compared with such levels.
- This is most evident concerning industry and some other economic sectors, where the existence of a very large number of exemptions, refund mech-

anisms, and other provisions severely undermines the environmental and economic effectiveness of the existing taxes.

- Important tax bases, such as coal, are largely not taxed at all, despite the substantial externalities involved, creating significant distortions and an incoherent picture.
- The levies are often complex, with a confusing variety of tax rates and special provisions. While a complex rate structure might be required to reflect properly the differences in environmental externalities between different products and/or different uses of these products, many of the complexities in existing taxes seem to be due to other political concerns being taken into account. It is often not clear that these concerns are most effectively addressed through special modifications of environmentally related taxes.
- Taxes often combine with other environmental policy instruments in an inconsistent or overlapping way. For example, it is possible that certain regulations on the sulphur content of fuels are redundant if taxes are also levied on it.
- There can also be conflicting incentives between different taxes. For example, while fuel tax rates tend to be lower for diesel than for petrol, one-off or recurrent motor vehicle taxes are sometimes higher for diesel-driven vehicles than for petrol-driven vehicles.
- The fear of loss of international competitiveness of certain industrial sectors remains the main political obstacle to a broader use of environmentally related taxes. The importance of this obstacle could be reduced through increased international coordination. While global cooperation would be required to eradicate the sectoral competitiveness problem, OECD (2003*e*) indicates that the problem could be very significantly reduced if even a much smaller group of countries decided to cooperate.

In conclusion, environmentally related levies are a potentially effective way of protecting the environment and thus enhancing economic efficiency. It is likely, that countries will give environmental taxes (as well as tradable permits) an increasingly important role in combating greenhouse gas emissions. There is also significant scope for using environmentally related levies to address other environmental externalities. The reduction of environmentally harmful subsidies to agriculture, for example, could be incorporated in a green tax reform. Such reforms should be implemented in the context of broader tax reforms, providing an opportunity to reduce existing tax distortions and modernize taxation systems.

Notes

1 For an excellent, recent presentation of the theory of environmental taxation, see Sandmo (2000).

2 See www.oecd.org/env/tax-database. Figures 5.1 to 5.5 are all based on information from this database.

3 Information for 1995 was used to prepare Figure 5.2, but the main findings are still valid. One exception is that less revenue is now collected from leaded petrol while more is collected from diesel.

4 The lower tax rates on diesel than on petrol – particularly in European countries – probably reflect to a large extent a fear of loss of tax revenues through purchases in neighbouring countries of diesel for heavy vehicles involved in cross-border traffic. The competitiveness position of such vehicles would not be much affected by an increase in diesel tax rates, as they can in practice buy much of their fuel abroad. Vehicles only involved in domestic transport would, however, face increased competition from foreign transport companies if diesel tax rates were increased.

Another argument sometimes used in the discussion on the relative tax rates for petrol and diesel is that the rates on diesel should be lower than those on petrol since diesel vehicles use less fuel per kilometre, and hence contribute less to the climate-change problem. This argument appears invalid, however, since the Pigouvian tax rate on diesel is higher than that on petrol, due to the higher – non-internalized – externalities related, for example, to NO_x (nitrogen oxides) and particles emissions from diesel-driven vehicles.

5 For an extended discussion of the theory of motor vehicle taxation, see Newbery (this volume). The European Conference of Ministers of Transport (2000) discusses efficient transport taxes and charges in a number of European countries. OECD (1997) presents a number of case studies of the external effects of road transport. Parry (2002) compares the efficiency of alternative policies for reducing traffic congestion.

6 The climate change levy in the UK includes electricity generation, except for high-quality combined heat and power plant. A new tax on coal in Japan also includes coal used for electricity generation.

7 In addition, to serve as a proxy for taxes related to externalities caused by electricity generation (fuel use, landscape damage in the case of hydro-based power, etc.), taxes on electricity consumption can reflect externalities related to electricity distribution, such as damage to the landscape and scenery caused by power lines. There are also claims that power lines can cause harmful radiation.

8 As mentioned, some countries (also) levy taxes on (certain types of) electricity production. For example, in the Czech Republic there is a tax of €0.0015 per kWh of electricity produced in nuclear power plants. In the UK, the tax rate of the 'non-fossil-fuel obligation levy' is 0.7 per cent of the electricity price.

9 Fullerton (this volume) presents an extensive discussion of the marginal social costs of waste generation and the optimal fees on garbage collection. Several chapters of OECD (2004) discuss similar issues.

10 In this estimate, it is assumed that the recovered energy replaces coal-based electricity production. If the incinerator instead replaces electricity generated by an oil-fired power plant, the net external costs increase to €44 per tonne of waste incinerated.

11 The figure for disamenity costs is based on US studies, and COWI (2000*a*) underlines that it might not be applicable to European conditions. For *all* the cost estimates, intervals representing upper and lower bounds are shown in the report.

12 For a detailed assessment of environmentally harmful subsidies, see OECD (1998 I, 2003*c*).

13 This is true particularly for NO_x and particles emissions.

14 According to Statistiska centralbyrån (2002), the tax reform of 1990–91 entailed a SEK18 billion (about 2 billion Euro, using exchange rates as at April 2003) increase

in environmentally related taxes and a SEK71 billion (about 8 billion Euro) decrease in taxes on labour income. Between 1993 and 2000, the share of environmentally related taxes as a percentage of GDP *decreased* 8 per cent, while taxes on labour increased 13 per cent. The 2002 budget included a SEK2 billion (200 million Euro) tax shift from labour to energy.

15 In developing countries and some transition countries, taxes on motor vehicles and motor vehicle fuels can be made progressive in terms of their effect on income distribution, as the poorer parts of the population do not own motor vehicles.

16 For the theoretical underpinning of this point, see, for example, Sandmo (2000, section 5.5).

17 Bach et al. (2002) also include estimates of the impacts on income distribution of the (revenue-neutral) ecological tax reform in combination with a broader tax reform initiated by the German government, involving increases in child allowances and changes in the income taxation of families. The combined reform was found to *increase* the annual disposable income of almost all household categories. However, as the broader reform incorporates a substantial net revenue loss, this finding is not very surprising.

18 For an issue such as climate change, where emissions anywhere in the world cause similar impacts, coordination at a global level would, in principle, be necessary to ensure that no 'leakage' of pollution takes place. Such coordination seems unlikely. The chance is somewhat greater that a limited number of countries – for example, the thirty OECD countries – could agree to some form of coordination. OECD (2003*e*) indicates that the negative impacts of a relatively high carbon tax on steel production in any of five OECD sub-regions would be significantly reduced if such a hypothetical tax were applied simultaneously in all OECD countries rather than introduced in one of the sub-regions.

19 However, Xing and Kolstad (2002) *do* find a 'significant negative linear relationship between FDI [foreign direct investment] of the US chemical and metal industries and the stringency of environmental regulation in a host country'. However, they point out that 'our empirical study only identifies the impact of environmental regulations on capital outflows and reveals the role of environmental regulations in the decision-making of the FDI of polluting industries. It would not be appropriate to conclude that environmental regulation alone can decide the direction of FDI flow for a polluting industry.'

20 This does not necessarily mean that such taxes should not be applied. For example, it can be cost effective for a country to meet its obligations under the Kyoto protocol by closing down plants.

OECD (2003*e*) also indicates that the negative competitiveness impacts can often be significantly reduced through various types of revenue recycling or border tax adjustments.

Bovenberg and Goulder (2000) and Goulder (2002) show that profits in some of the potentially most affected sectors can be maintained through the grandfathering of a limited share of permits under a tradable permits system, with a modest loss of economic efficiency. As explained in Goulder (2002), 'CO_2 abatement policies have the potential to produce very large rents to the regulated firms. By compelling fossil fuel suppliers to restrict their outputs, the government effectively causes firms to behave like a cartel, leading to higher prices and the potential for excess profit. To the extent that the environmental policy enables the firms to retain these rents – such is the case under a CO_2 policy involving freely offered (or "grandfathered") tradeable permits – the firms can make considerably higher profits under regulation than in its absence. Correspondingly, the government needs to leave with firms only a fraction of these potential rents in order to preserve the profits of the regulated industries.'

Bjertnæs and Fæhn (2004) found similar results in the case of a tax reform in a small, open economy.

21 Incidentally, a $0.50 per gallon tax increase is – in absolute terms – significantly less than the €0.15 per litre tax increase that was phased in in Germany between 1 April 1999 and 1 January 2003. Comeau and Chapman (2002) have also commented on the article by Sipes and Mendelsohn.

22 According to Statistiska centralbyrån (2002), the tax reform of 1990–91 entailed a SEK18 billion (about 2 billion Euro, using exchange rates as at April 2003) increase in environmentally related taxes and a SEK71 billion (about 8 billion Euro) decrease in taxes on labour income. Between 1993 and 2000, the share of environmentally related taxes as a percentage of GDP *decreased* 8 per cent, while taxes on labour increased 13 per cent. The 2002 budget included a SEK2 billion (200 million Euro) tax shift from labour to energy.

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