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The Political Economy of Environmental Taxation in European Countries

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Abstract

Since the Kyoto Protocol entered into force in February 2005, many Parties to the Protocol have shifted their domestic policies into high gear to achieve the quantitative reductions in greenhouse gas emissions undertaken for the period from 2008 to 2012. While the basic design of environmental taxation in European countries has received widespread attention, its actual performance has not been systematically assessed. This report aims at examining, against pre-determined criteria (e.g. impact on costs and prices, competition and trade, environmental impacts and recycling mechanisms), how effectively environmental taxation systems are functioning. Most importantly, the report analyses the political dynamics behind these systems and how they have changed the 'optimal' tax design into a 'politically feasible' tax design.

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THE POLITICAL ECONOMY OF ENVIRONMENTAL TAXATION IN EUROPEAN COUNTRIES

NORIKO FUJIWARA, JORGE NÚÑEZ FERRER AND CHRISTIAN EGENHOFER

1. Introduction

Since the Kyoto Protocol entered into force in February 2005, many Parties to the Protocol have set their domestic policies and measures in full gear to achieve the quantitative commitments to greenhouse gas (GHG) emission reductions undertaken for the period from 2008 to 2012. Among various policy instruments to meet the targets, taxation remains a viable option alongside permits trading. For example, New Zealand has decided to introduce a carbon tax from April 2007.[1] Switzerland has passed the carbon dioxide (CO_2) law that requires the introduction of a CO_2 tax if voluntary and other CO_2-related measures turn out to be insufficient.[2] These recent decisions over climate change-related taxes have been influenced through the consultation process by precedents set in EU member states and Norway.

While basic designs of environmental taxation in European countries have been widely and frequently referred to, their performance has not been adequately assessed nor sufficiently fed back into the policy-making process. This report aims at re-examining, against pre-determined criteria, whether and how taxation systems are functioning with the help of existing but scarce literature on post-evaluation studies, and analysing the extent to which the performance can be attributed to certain design features such as the tax base and tax rate.

This report is organised into seven sections. The next section locates the debate over environmental taxation in the context of the EU and its member states. The third section summarises the theoretical merits of taxation while the fourth section checks the reality in its implementation against its theoretical merits. The fifth section sets out criteria for the evaluation of environmental taxes. Against the criteria, the sixth section assesses environmental taxation in the EU. The final section concludes with key findings and policy implications. Case studies of the EU and its member states are compiled in an annex.

2. The emergence of the environmental tax debate in the EU and its member states

Traditionally, the European Union (EU) has mainly relied on command and control methods or public investment to rectify the effects of pollutants. Compared with other pollutants such as sulphur dioxide (SO_2), nitrogen oxide (NO_x) or methane (CH_4), which have declined considerably in the last two decades, CO_2 emissions have stayed constant or increased (Figure 1).

Taxation as a means to reduce pollution is a relatively recent development. The theoretical merits of environmental taxation, which will be introduced in the next section, have been highlighted by the OECD in a large number of documents since 1993 and in particular theoretical analyses by OECD (1996; 1997), and by the European Commission in repeated attempts at convincing countries to coordinate their tax policies in this respect.

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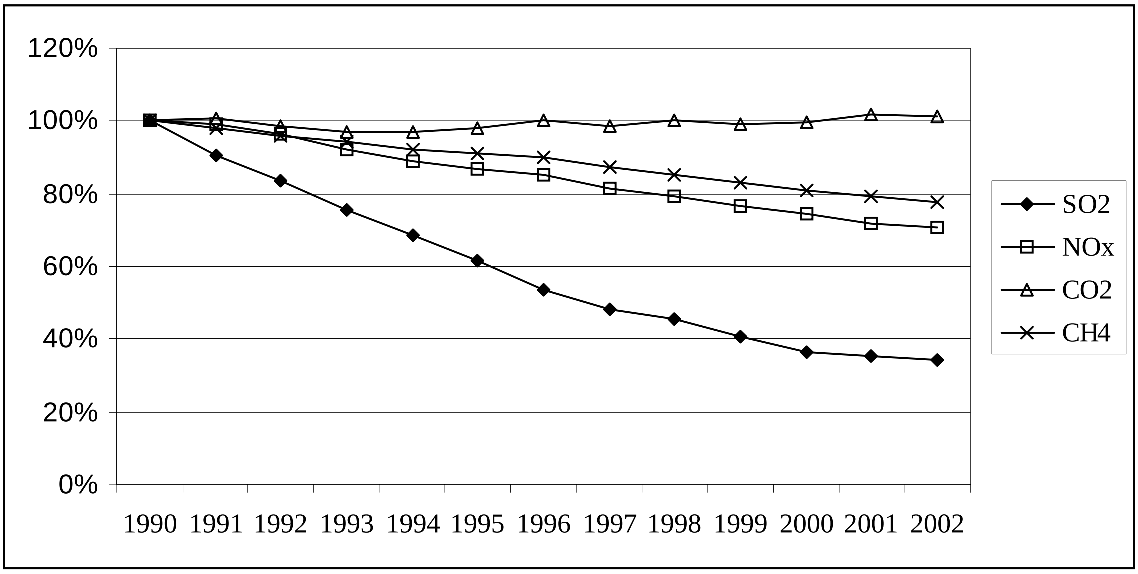
[1] See http://www.climatechange.govt.nz/policy-initiatives/carbon-tax.html

[2] See http://www.umwelt-schweiz.ch/buwal/eng/fachgebiete/fg_klima/politik/CO2-Red/CO2-Umsetz/index.html

The EU treaty requires unanimous agreements by EU member states in the Council of Ministers on any decisions over taxation, including environmental taxation, which gives each member state a veto over taxation.[3] Member states fear that majority voting on environmental taxation may just be the beginning of member states' loss of autonomy over other forms of taxation. Member states are weary – not without justification – that the loss of such autonomy would undermine the fiscal position.[4] Under these circumstances no proposal for introducing an environmental tax has ever found a quorum. A proposal for a Community level CO_2 taxation was introduced as early as 1992 but failed to be adopted.

Figure 1. Trends in air pollution in the EU, 1990-2002 (index 1990 = 100)



Data source: Eurostat database.

The intellectual works by the OECD and the European Commission have induced several EU member states to adopt such tax measures. These member states have attempted to induce others to follow suit, by sharing their experience and through diplomatic pressure. Consequently, CO_2 or other environmental taxation has gradually been adopted by other member states of the EU. Studies by Tews (2002) and Agnolucci (2004) analyse in detail the pattern of diffusion of environmental taxes related to energy and in particular CO_2 emissions.

This report also covers Norway in the analysis of environmental taxation, despite its being only a member of the European Economic Area (EEA).[5] Norway is one of these front-runners that adopted tax measures alongside other Nordic countries and the Netherlands.

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[3] In some policy areas EU member states retain control over policies. This is also true for taxation; in some cases harmonisation of tax bases and rates can be important in a single market with a single currency, and for cases of cross-border pollution.

[4] In fact, the EU has increased the importance of Community-wide environmental protection since 1973, and has even reinforced it. The Maastricht Treaty of 1993 introduced environmental protection as one of its main objectives (Christiernsson, 2004: 6) with a strong emphasis on the need to integrate it into all Community policies (Articles 2 and 6). In addition, the EU Treaty cites the 'polluter-pays-principle' as one of the fundamental principles of environmental protection alongside the precautionary, preventive action (rectifying damage at source), integration (to all Community policies) and subsidiarity principles.

[5] Nonetheless, EEA member states – Norway, Iceland and Liechtenstein – have taken on board some 2,900 legal acts of the EU single market regime, and continue to do so (Emerson et al., 2002).

3. Theoretical merits of taxation

3.1 Theory of environmental taxation

The theoretical basis for introducing economic instruments such as taxation rests on the existence of negative environmental externalities from an economic activity that are not incorporated into the costs of goods produced. The effect of externalities is that production will be in excess of the optimal quantity as prices and demand are subsequently distorted, giving rise to environmental degradation beyond the social optimum. This so-called 'Pigouvian approach'[6] to negative externalities suggests that taxation will provide a mechanism by which polluters de facto have to internalise the cost of environmental damage (Helm & Pearce, 1991: 7, 18) and thereby correct market distortions.

In a perfect market with perfect information, environmental taxes could achieve the optimum social environmental target on their own if designed appropriately. In reality, however, this is difficult as the ideal Pigouvian taxes must exactly reflect the marginal damage costs of pollution in order to achieve an environmental target. The accurate setting of an optimal tax level depends on accurate information regarding the actual damage costs and the benefits of associated goods being produced. Uncertainty about the actual damage costs associated with certain pollutants (e.g. to tax carbon emissions from power stations) led to a number of proxy solutions (e.g. to tax carbon-producing fuels, to tax emissions on an installation basis, to tax the output of electricity) (Helm & Pearce, 1991: 18; EEA, 2000: 20; Turner et al., 1994; 166, 170).

The problem of imperfect information is particularly acute in evaluating the damage caused by carbon emissions and calculating the appropriate carbon tax rate. Among the sources of high uncertainties in estimating the abatement costs are the price elasticity of resource (e.g. fossil fuel) use in response to alternative taxes on carbon (see section 5.2), and the rate of technological progress.

3.2 Advantages of taxation over regulation

Environmental taxation is one of a number of instruments used to correct market failures. Traditionally, market failures have been addressed by regulatory controls, commonly described as 'command and control measures'.

In fact, regulation is often the preferred approach by governments to environmental management mainly for reasons of effectiveness. It is generally perceived that regulation offers better protection than taxation since the environmental objectives are clearly specified in terms of physical limits that cannot be exceeded and the technology to reach such objectives is often prescribed. This preference also reflects the important role that engineers played in environmental decision-making (Potier, 1996). Another reason for politicians to prefer regulation was its ability to hide full costs and their distribution, avoiding difficult debates on equity. Regulators' (i.e. governments') preferences have been mirrored by regulated firms' preferences, which have for a long time seen environmental regulation as a cost factor and have chosen to minimise the costs of complying with command-and-control regulations. Firms relied primarily on problem avoidance and risk management rather than exploiting opportunities in the form of markets for new products and processes or gaining a competitive advantage from environmental decisions (Reinhard, 2000). As long as the costs of environmental protection remained relatively limited and/or exposure to international competition was low, there was

[6] A Pigouvian tax is a tax levied on an agent causing an environmental externality (environmental damage) as an incentive to avert or mitigate such damage.

little need for other instruments that could provide better incentives to exploit the opportunities of environmental legislation. Yet the governments have started recognising the limits of regulatory approaches while realising the potential of markets in environmental management. During the 1980s and the 1990s, not the least due to increased international competition and a general trend towards preference for 'markets', economists, politicians and businesses (especially in OECD member states) became interested in a regulatory reform of environmental policies, introducing a shift towards the increased use of incentive-based and fiscal or economic instruments (OECD, 1996; OECD, 1997) and voluntary agreements (Storey, 1996). More recently, tradable permit schemes were added to the environmental tool box. See Box 1.

Box 1. Typology of incentive-based instruments

- Charges or taxes set a price on pollution.
- Deposit refund systems levy a surcharge on the price of potentially polluting products. The payment of surcharge is refunded to the payer when the product is returned.
- Cap-and-trade emissions trading schemes set a limit on emissions from a certain product or process. Emitters hold users' rights for all allowances under the ceiling.
- Baseline-and-credit or simply credit-based schemes are another variant of emissions trading. In this case, emitters have to earn credits by over-complying with the target.
- Subsidies cover forms of financial assistance to provide the polluter with incentives to alter its behaviour. Subsidies can take the form of grants, soft loans, tax allowances or R&D subsidies.
- Subsidy reform aims at reducing the distorting effects of government policy that keeps pollution control costs artificially low through direct subsidies or tax incentives.[a]
- On grounds of environmental liability, the public or private law requires polluters to compensate for the damage they have done.[b]
- Voluntary agreements include many different approaches including codes of conducts and responsible care programmes, voluntary measures such as voluntary restraint agreements or unilateral commitments, implementation of (accredited) environmental management systems (e.g. European Environmental Management Systems), voluntary auditing, voluntary environmental reporting as well as more formalised negotiated agreements.
- Renewable energy quotas constitute obligations to either produce (if targeted at electricity producers), supply (if targeted at electricity suppliers) or consume (if targeted at electricity consumers) a set amount of electricity produced from renewable sources. This instrument is increasingly linked to tradable permit schemes.
- Green government purchasing attempts to create markets for more environmentally friendly (i.e. green) products. Similar to renewable energy quotas, it aims at overcoming market barriers to entry of environmental beneficial products.
- Information programmes play an indispensable role in the successful application of incentive-based instruments. Examples of such instruments include energy-efficiency labelling requirements, eco-labels as well as freedom of information acts, environmental management systems and environmental impact assessments.

[a] See OECD (2000).

[b] The claim for compensation can be justified where both conditions are met: the source of the damage can be easily identified and the damage can be easily assessed.

Source: Egenhofer (2003) (based on OECD, 1994; OECD 2000; Clinch, 2000; and Stavins, 2001).

Taxes offer a number of potential advantages over regulation and other incentive-based schemes. First is operational simplicity. Taxes, if properly implemented, can reduce administrative and transaction costs relative to traditional regulatory approaches. Second, taxation is expected to provide an incentive for further emissions reductions which mean cost savings. The assumption is that the market is more efficient than the government in identifying the cheapest way of reducing pollution. Third, taxes have advantages regarding dynamic efficiency. Regulatory controls do not send a market signal to facilitate research for abatement technologies or increased efficiency. Taxes are expected to encourage technological change (e.g. EEA, 2000: 15) and therefore can stimulate innovation, leading to new technologies, processes and products. The second form of dynamic efficiency is that taxes can enhance the exit and entry of firms through changing relative factor prices, and in so doing induce large-scale structural changes in production and consumption (ECOTEC, 2001). Fourth and lastly, taxes provide the government with revenues. Details will follow in sections 4.1 and 4.2.

4. Environmental taxation in practice

4.1 Definitions and evidences

Existing literature distinguishes between taxes and charges. 'Taxes' refer to revenues going to the general budget and 'charges' to those that are earmarked for specific purposes. In practice, however both terms have been used without clear distinction and interchangeably. For the most part, the term 'taxes' is used to cover both taxes and charges (EEA, 2000: 19). In some instances, the literature uses 'levies', which refer to both 'taxes' and 'charges' (ECOTEC, 2001). The OECD/Eurostat[7] identifies earmarked revenues with 'unrequited' payments, (i.e. taxes) and those being recycled or used for purposes related to the charge base are interpreted as charges. OECD (2001) adopts a distinction without reference to earmarking: 'taxes' are unrequited in the sense that benefits provided by government to taxpayers are not normally in proportion to their payments while 'fees' and 'charges' are requited payments to the government and levied more or less in proportion to services provided. This report may refer to taxes and charges interchangeably.

Environmental taxes or charges may be targeted at either consumers or producers. In both cases, taxes create incentives for both consumers and producers by changing relative prices. However, they exhibit different implications for distributional impacts (see section 5.4), competitiveness and effectiveness (see section 5.3).

Charges and taxes can aim at either emissions or products. The main operational field of environmental taxes include energy, transport or pollution taxes and taxes on natural resources (other than energy). The main tax base consists of fuel, wastewater, emissions, packaging (EEA, 2000: 19-21). This report mainly focuses on taxes used by EU member states to reduce greenhouse gas (GHG) emissions, e.g. carbon taxes, energy taxes,[8] taxes on process emissions such as N_2O.

In addition there is a strong potential to reduce greenhouse gases by taxing non-CO_2 GHG sources. The OECD (2001: 119) lists those that are the best candidates:

- CH_4 from modern landfills;
- CH_4 emissions from natural gas and oil production;
- N_2O from use of fertilisers (with the tax placed at point of production or sale);

[7] Eurostat is the EU's statistical body. Select 'Energy and Environment' at: http://epp.eurostat.cec.eu.int/.

[8] For the European Commission's data on excise duty for energy products and electricity from January 2005, see: http://www.europa.eu.int/comm/taxation_customs/resources/documents/excise_duties-part_II_energy_products-en.pdf. For the 2003 revenue from excise duty on mineral oils, see: http://www.europa.eu.int/comm/taxation_customs/resources/documents/excise_duties_energy_products_en.pdf. The EU data are also available from following databases: http://www.oecd.org/ecoinst/queries/index.htm and http://www.economicinstruments.com/.

- HFCs (and some PFCs) that are used as Ozone Depleting Substance replacements; and
- SF_6 during magnesium production.

An intervention in these sources of non-CO_2 GHGs would assist reducing the greenhouse effects. For some of these products, however, the OECD (2001: 121) considers that market mechanisms alone are not sufficient, i.e. PFC, HSF and SF_6 and regulatory measures should also be introduced.

True environmental taxes and charges – where these are intended as offering environmental incentives rather than simply applied as revenue-raising instruments – accounted for only a very small percentage (6.5% in 2001) of total tax revenues in the EU member states. Out of the environmental tax revenue, 2.6% came from pollution and resources taxes, i.e. charges on emissions (e.g. NOx), chemical substances, products, waste (e.g. landfill) and natural resources. Energy-related revenues accounted for 77% of environmental tax revenues in the EU-15 while transport-related revenues for 21% (Johansson & Schmidt-Faber, 2003; European Commission, 2005). Even though the share of pollution taxes in total tax revenues had been growing slowly (EEA, 2000: 24), the share of environmental taxes in total tax revenues had remained small.

A critical element is the definition of beneficiaries (e.g. enterprises or production processes) that are eligible for tax exemptions or rate reductions, and the kind of exemptions or rate reductions that should be granted to these beneficiaries. The definition of beneficiaries touches several conflicting objectives of taxation, such as mitigation of competitiveness impacts, environmental effectiveness, cost-efficiency, and legal and administrative requirements (Kohlhaas, 2003).

4.2 Fiscal neutrality, double dividends, and revenue recycling

In most cases, environmental taxes have been introduced as 'fiscally neutral', i.e. new environmental taxes were offset by a decrease in existing taxes such as labour taxes and social contributions (EEA, 2000: 20). Together as a package, this was often described as the double-dividend thesis; the 'first dividend' refers to environmental improvements while the 'second dividend' is usually interpreted as an increase in employment through reductions in labour taxes. Lower labour taxes or social contributions were expected as a means to improve macroeconomic policy. At the same time, commitment to fiscal neutrality was also fuelled by a desire to overcome political opposition mainly from industry, which was loathe to assume any new tax burdens. This double-dividend hypothesis has never been empirically proven (Carraro & Siniscalco, 1996; EEA, 2000: 16-17; Box 6 in O'Brien & Vourc'h, 2001: 63; de Kam, 2002: 19; and Babiker et al., 2002).

The 'fiscal neutrality approach' often opened the door to stakeholders' lobbying for generous exemptions with sometimes adverse effects on environmental effectiveness. In many cases, this ignored the polluter-pays principle and generally it deprived governments of revenue to compensate for possible distributional or competitiveness effects that would have occurred nonetheless (O'Brien & Vourc'h, 2001: 63).

Revenue recycling can also increase acceptability and alleviate competitiveness concerns. One common form of recycling has been provision of tax refunds (de Kam, 2002: 22). Another approach has been targeted spending programmes,[9] i.e. earmarking funds for specific purposes (de Kam, 2002: 22). In some cases, revenues were used for subsidies to generate environmental benefits (e.g. households' energy-saving investment). One such example was the UK Climate

[9] For example, direct subsidies for energy saving, pollution-abatement investments or R&D in pollution-control technologies.

Change Levy (CCL), which operates a number of programmes for assistance to business and the public sector (see section 6.3).

The merit of recycling depends on the absence of government failure, i.e. that governments allocate and recycle revenues efficiently and thereby avoid distortions and/or significant transaction costs. Earmarking can become a source of efficiency losses just like the 'fiscal neutrality' approach, by attracting vested interests in receiving subsidies. Earmarking especially may lead to inefficient spending including over-investment which would not be financed from general expenditures (de Kam, 2002: 19; ECOTEC, 2001: 33). Moreover the parliament, whose most important power is control of the budget, has generally been reluctant to accept earmarking.

4.3 Environmental taxation in the policy mix

Moving away from the traditional debate over which instrument is best, there is a growing interest in developing optimal instrument mixes. Now the centre of the debate is increasingly directed towards the question as to which combination of instruments is the most effective and efficient and the conditions under which the use of multiple instruments is likely to be preferable to the application of a single instrument (Bygrave & Ellis, 2003: 14-15; Egenhofer, 2003a: 57-64; and EEA, 2000: 17-18, 25).

In practice most instruments are either linked explicitly to other instruments within a package (e.g. lumped together) or designed to work together with other instruments that have been created outside such an explicit package. This is because optimal designs of an isolated instrument can be more expensive than the theory suggests (EEA, 2000: 9).

There are at least three reasons for which use of pricing measures alone is unlikely to be desirable (Brechling et al., 1991: 263-264). First, there is a general consensus that the overall price elasticity of demand for energy is low and that the level of tax rates on energy necessary to induce substantial behavioural change will be high – in most cases too high to be acceptable (see section 5.2). Second, the regressive nature of environmental taxes will have negative effects on wealth re-distribution, i.e. low-income groups are affected in a disproportional way (see section 5.4). Third, there may be various obstacles or 'market failures' which prevent efficient levels of energy-efficiency investments (see section 6.5).

Taxes can be linked to standards, other levies, deposit-refund schemes, Voluntary Agreements (VAs), awareness campaigns, R&D, funds, subsidies and exemptions. Taxes and VAs can be used together either in a complementary way (i.e. implemented at the same time) or in an evolutionary way (i.e. one policy follows another).[10] Some complementary policies can target the same entities. This was the case in the UK where industry that had accepted a voluntary agreement benefited from a 80% rebate from the CCL (see e.g. Egenhofer, 2003: 42). Other complementary policies target different entities. This is the case in the EU, where only the energy-intensive and power sectors are covered by the EU emissions trading scheme while all other sectors are subject to other regulations (see Bygrave & Ellis, 2003: 25-27).

In theory, tradable permit schemes – quantity-based policies – are incompatible with taxes (i.e. pricing policies) as well as regulations (which prescribe technology standards). Choosing a tradable permit scheme leaves no room for additional measures for a particular pollutant as it would undermine a firm's freedom to identify a compliance strategy. Nevertheless, taxation can be a stick to 'entice' firms to opt for tradable permit schemes, which they might otherwise not prefer (FIELD, 2000; Hasselknippe & Høibye, 2001; EEA, 2000: 9, 17; UNFCCC, 2002a as

[10] E.g. Switzerland will introduce taxes where VAs are not effective.

discussed in Bygrave & Ellis, 2003: 15; Joumard, 2001: 24). Firms may be more willing to accept an absolute cap and participate in cap-and-trade programmes if they are exempted from environmental or carbon taxes. For example, UK companies that have accepted to participate in the EU ETS (emissions trading scheme) are exempted from up to 80% of the CCL.

5. Criteria for evaluation of environmental taxes

Environmental taxes are in theory conceived to address an environmental problem and improve overall economic efficiency. However, introduction of an environmental tax is likely to have a number of implications, some of which would seriously affect the effectiveness of the tax. This section will discuss the economic implications of the tax in terms of various implementation issues such as barriers and political considerations. Ultimately, the environmental, economic and social implications of a particular tax will depend on the society's willingness to pay to avoid the damage. Evaluation of environmental damage under uncertainty remains imperfect, and is heavily influenced by preferences of consumers, voters and an array of other social aspects. Unfortunately, existing literature is scarce on these implications due to a lack of *ex-post* evaluations – at least of environmental taxation in the EU – with the rare exceptions of Tews (2002) and Agnolucci (2004).[11]

5.1 Policy choices on environmental taxation

This section analyses and summarises problems elucidated in the existing literature on climate change-related taxes, and in particular on CO_2 taxation. For this purpose we first describe different hypothetical cases depending on the point of regulation: whether the tax is placed on the primary input causing pollution, the producer or the final consumer of the product. The following example of a hypothetical EU member state clarifies the range of available policy choices of EU member states for taxation on CO_2 emissions.

Case 1. A tax on the inputs

Imagine a country in the EU that produces energy, using coal, the most carbon-intensive source of energy, as a primary input. The government calculates a cost to the environment for each unit of CO_2, i.e. the most upstream case. This cost is introduced into an electricity price as a tax on the inputs causing CO_2 emissions, i.e. on coal, fuel or other primary sources in proportion to the CO_2 pollution they generate. As a consequence, each unit of CO_2 produced in the country generates a revenue to the government.

The first and direct consequence of the tax is an increase in the price of the inputs, raising the price of domestically-produced electricity and costs incurred by consumers of domestically-produced or distributed electricity. For power companies the impact is clear: an increase in production costs, which is transmitted to consumers in the price of electrical power, and a subsequent fall in demand.

The power market is closed

If the power market is closed, i.e. not trading, the effect of the input tax would be a general increase in prices in the economy, as energy is a primary input for other domestic producers. The tax would in fact induce a behavioural change by consumers, seeking to reduce costs and searching for more efficient sources of energy, as relative prices of technologies change.

[11] However, *ex-post* evaluation in most instances remains inconclusive.

In the short- to mid-term, the power price change through the tax might have an effect on the competitiveness of local companies, and will be compounded by an increase in prices of fuel and other sources of CO_2 emissions. In the longer run, investments to increase energy efficiency and wider use of renewable energy could offset any negative short-term impacts. However, transition to a more energy-efficient and renewables-based economy may be painful, and recovery from negative short-term impacts may not be assured. Imports of cheaper goods from other countries that have not introduced the tax might reduce the competitiveness of the local economy, and damage it. Moreover an increase in industrial activity in other countries free of the tax would offset the CO_2 reductions achieved in the country. The government could use revenues from the tax and recycle them either for consumers, producers or both to mitigate possible adverse effects. But that would open a debate over wealth re-distribution on who gets what for what reasons.

A closed energy market is rare in the EU, but may be found elsewhere.

An open energy market

If the country trades in electricity, the situation is more complex. If the country imports power and neighbouring countries do not introduce similar energy taxes, imported power would have a lower price, driving the local energy sector out of the market (e.g. the Nordic power market). Similarly, if the energy sector exports electricity, a tax on the inputs would increase the export value, reducing export demand.

The primary impact on the electricity market through the input tax would be an increase in imported electricity, a fall in exported electricity, with the risk that the local energy sector would be severely hit before it changes technology, crippling its financial ability to develop the technology. The effect of the tax on CO_2 emissions on local industries may be alleviated by an increase in electricity imports (if infrastructure allows), which leads to an increase in energy output abroad and thus CO_2 emissions (unless they use a cleaner technology but then may not be so competitive). With this substitution effect, the tax would have little or no effect in driving the local industries to cut their energy use. This phenomenon is described as leakage. With leakage, global CO_2 emissions might remain unchanged.

The use of border tax adjustments (BTAs) or taxing imported energy is not possible in the EU. Moreover, the issue is highly controversial within the World Trade Organisation (WTO) (Brewer, 2003; Swedish Board of Trade, 2003).

The input tax shows a similar effect with motor fuel. In the EU, without border control, this tax drives inhabitants at the border to refuel in neighbouring countries. The case of Luxembourg is very well known: citizens from Belgium, Germany and France near the border drive daily to refuel in Luxembourg, making the tiny country the most energy intensive in Europe.

To protect local industries from the input cost rise, export credits or subsidies could be used, but this kind of state aids is not compliant with competition rules in the EU and is generally not allowed by the WTO.

Case 2. A tax on the product – electricity

As in the first case, a tax is imposed at source, but it is set on the output, rather than on the input. The tax will create a behavioural response by consumers, but again that will depend on the nature of the economy, especially the level of liberalisation.

A closed power market

The output tax induces a change in behaviour, reducing demand for energy. The impact of the product tax is nearly analogous to that of the input tax in this sense. The impact of the output tax on industries is also similar to that of the input tax. However, in the long term, the tax does not assist the search for alternative sources of energy but only boosts the search for energy-saving technologies. This is because the tax is set on energy regardless of its source; thus energy from coal, nuclear, wind or hydro-electrical power stations has the same price.

This is the reason why the product tax is less efficient than the input tax in reducing CO_2 emissions in the power sector. It is possible to design a system which differentiates a tax between energy sources without imposing the tax on non-fossil fuel-based energy producers. If such a differentiation is made, incentives created by the output tax to change technology are nearly equivalent to those of taxing coal or fuel. The output tax would not be directly related to the CO_2 equivalent emissions per unit of input. A power industry that improves the technology by using coal more efficiently (and thus reducing the coal input) would not benefit from a tax on the energy output.

For the government, however, the output tax has the advantage that it can easily target particular groups of consumers by exempting electricity producers or distributors from paying the tax on their sales of electric power to these consumers. This would allow the power industry to offer better prices. The problem with this approach is obvious. The more concessions are given for particular groups of consumers, the less behavioural change will occur. Industrial lobbies can successfully press for exceptions due to their importance to the economy.

An open energy market

The output tax has effects similar to that of the input tax, but it is easier for the government to address trade effects. A tax break for electrical power exported or for power sold to industries can be introduced so that the power industry can offer more competitive prices to those consumers.

However, the problem of cheaper imported power still exists. If electricity is taxed at source, then the tax cannot affect the foreign production. Any tax on the foreign product would be equivalent to border taxation as in Case 1.

Furthermore, if the tax effectively reduces domestic consumption, this does not necessarily mean that the production of energy and subsequently emissions would fall. The energy not used domestically might just be redirected, increasing exports. Domestic CO_2 emissions could therefore remain unchanged, thereby undermining the original goal of reducing them.

The administrative costs of an output tax are higher than in Case 1, but still straightforward, but they can increase considerably if tax exemptions for electricity sold to specific consumers are introduced. A weakness of the tax is the lack of its visibility as the consumer is not taxed directly.

Case 3. A tax on consumers

Finally, a tax can also be imposed on consumers, i.e. the most downstream case. This is politically the easiest as it gives the government total control on who to tax. In economic terms and for the purpose of reducing CO_2 emissions, however, it is the most inefficient.

A closed energy market

This tax, if imposed on all consumers, would be equivalent to the product tax in Case 2. However, this tax does not easily allow for tax breaks for sources that have low or no CO_2 emissions. Consumers generally have no choice on the energy source. Governments will need to find other incentive structures for shifts in energy sources.

Another weakness of the tax is the relative ease with which the government can exempt particular groups of consumers from the tax or reduce their tax rates. As a consequence, large industries with high energy consumption would be exempted from the tax due to their political power rather than real adjustment problems. The use of competitiveness arguments is common across industries.

An open energy market

In an open energy market, it is easy to eliminate practically all competitiveness concerns through these taxes. Exported energy will not be affected by the tax. Any competitiveness concern of industries can easily be addressed through tax breaks. Also any concerns about tax regressivity can be accommodated by exempting specific consumer groups from the tax or reducing their tax rates. As the tax is set on consumers, the source of the energy is irrelevant. Therefore, concerns about tax-free imported energy are eliminated.

The biggest disadvantage is most likely the loss of environmental effectiveness. The tax will have no effects on CO_2 emissions partly because energy exports may substitute for reductions in domestic demand, and partly because a large number of exemptions may be granted to private and industrial consumers.

Administrative costs of the tax on consumers are higher than in case 1, but the tax is easily enforceable as it is equivalent to taxes such as a VAT.

5.2 Elasticities of demand and tax effectiveness

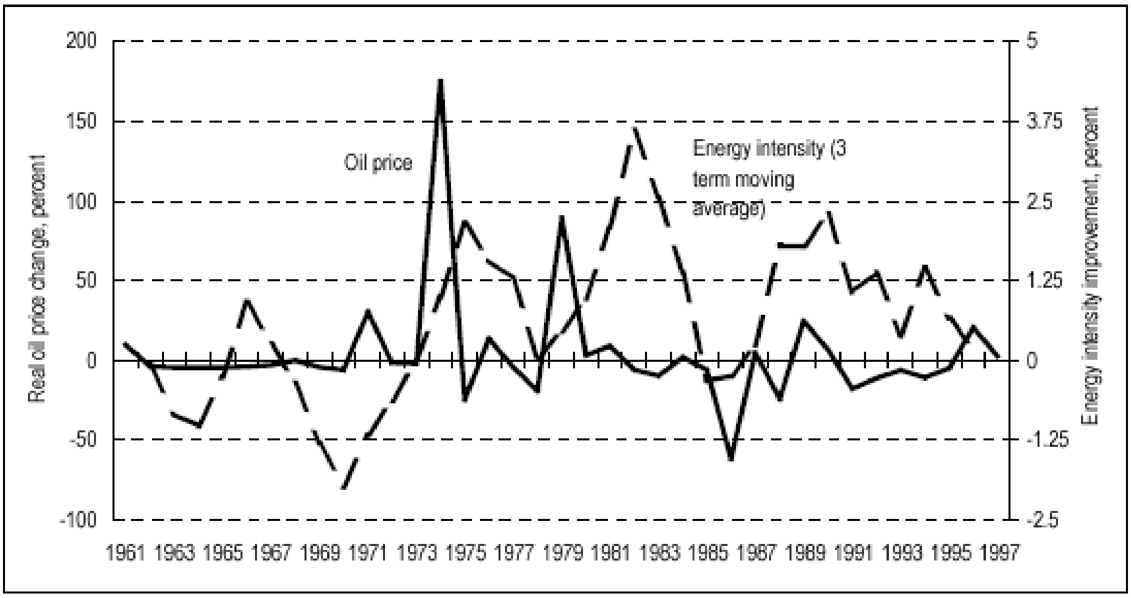
Elasticities of demand are very important for the effectiveness of environmental taxes. Possibilities for rapid and successful implementation of an environmental tax exist where the elasticity of demand is the greatest. The example of the Irish levy on a plastic bag is particularly telling. The overuse of plastic bags is related to consumers' preference for convenience and the lack of a visible cost to the consumers for their use. The individual consumer has no financial benefit from not using plastic bags as these were provided free of charge. On the contrary the consumer would face costs of switching to reusable bags which can be easily used to substitute for plastic bags. The government of Ireland reported that consumption of free plastic bags reached 300 per person per year.

The introduction in Ireland of a levy per bag caused a drastic and fast reduction at minimal implementation cost. Already a small charge on plastic bags triggered a significant reduction in usage as expenditure on these bags now exceeded alternative solutions, such as the use of reusable bags. The reduction has been estimated at 90-95% (Convery & McDonnell, 2003). However, as the study described, plastic bags have two particular characteristics that allowed for this outstanding success: i) there are easy alternatives and ii) there were no competitiveness concerns for the cost of reusable bags or even charged plastic bags is not sufficient to induce consumers to buy ones abroad (Northern Ireland in this case).

However, this is not the case for carbon taxes. Elasticity of demand in the short term is lower. Energy is also an important input for large sections of the industry, and the use of fossil fuels as a basis of energy production is widespread. Investment costs of pollution abatement and/or reductions in fossil fuel use are often large. Alternatives to fossil fuels are generally more expensive or not necessarily more reliable.

According to the European Commission (2000), energy users are proven to be responsive to price changes. In fact energy intensity in Europe over 40 years has been responsive to movements in the oil price (Figure 2). The figure shows that energy-intensity improvements followed price hikes in oil prices and the converse is also true, i.e. when prices fall, energy-intensity improvements vanish. The European Commission (2000) thus concludes that the economy-wide energy use is sensitive to price changes. The IEA (2004) comes to similar conclusions.

Figure 2. Oil price and energy intensity in Europe, 1961-97

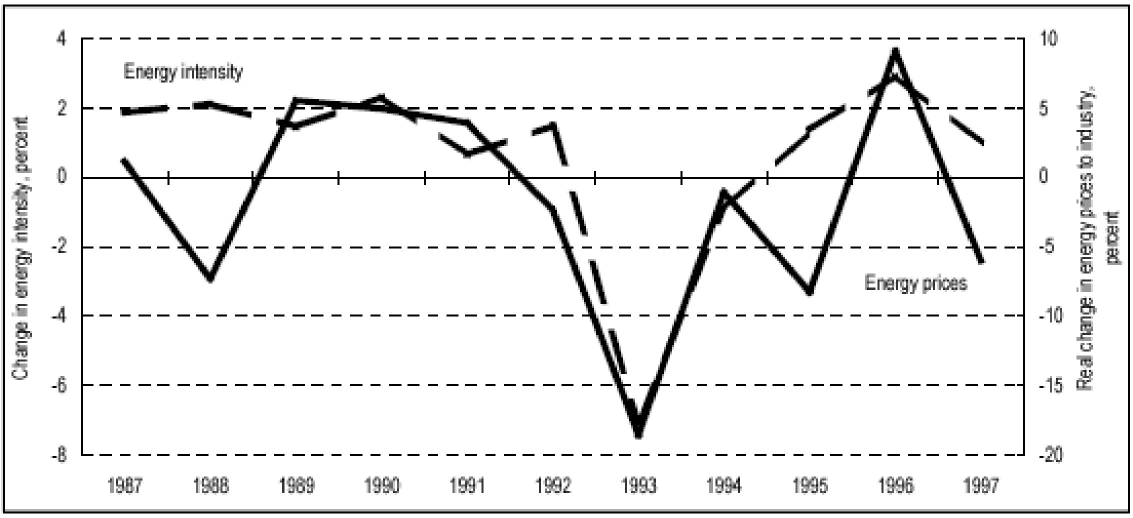


Source: European Commission (2000: 169).

That demand was responsive to oil price changes indicates the existence of an elastic demand over time. Hence a case is made for energy taxation. However, three aspects have to be mentioned. First, the elasticity of demand was caused by world price changes, and thus international competitiveness was not an issue. Second, a considerable adjustment occurred through output reductions and economic slowdown. Third, oil-price hikes have affected economic performance while only partially inducing a switch to alternative fuels. The European Commission (2000) explains this elasticity-of-demand effect by the price rises, and acknowledges that these oil-price increases disrupted the economies and are partially responsible for the end of low unemployment in European countries (European Commission, 2000: 169), especially after the 1974-75 oil crises. The OECD (2001; 73) states that if companies were to operate in a competitive trade environment as price-takers, price increases due to taxation in their own country would lead to lower outputs and loss of labour. This is the reason for the need for environmental taxation at supranational level. In technical terms, this indicates that the scope for static efficiency gains is limited in the energy sector in open economies.

However, the same European Commission document shows a strong correlation in the industry response to energy tax changes in Sweden for which no other explanatory variables were found, arguing that this is a sign of effectiveness of the tax. Figure 3 shows the change in energy intensity given price changes. Energy intensity deteriorates when the change is negative.

Figure 3. Energy prices and industrial energy intensity, Sweden 1987-97



Source: European Commission (2000: 170).

This Swedish responsiveness to environmental taxes, which the European Commission uses as another example of price responsiveness (Figure 3), also needs cautious interpretation.

Taxes on fossil fuels suffer from a limited elasticity of demand, which can be considered to be genuinely connected to difficulties with a shift to non-fossil fuels. In fact, as soon as oil prices fall, demand increases relatively quickly, indicating that alternatives are not equivalent in cost and efficiency. On a global scale, it is evident that the short-term elasticity of demand for fossil fuels is low. Data for crude oil demand in the US show a constant increase in demand during the years 2003 and 2004, and a projected increase for 2005 and 2006, despite a doubling of oil prices (see US Energy Information Administration, 2005).

Underpinning these trends is likely the lack of viable, reliable and cost-effective alternatives to fossil fuels at the necessary scale. This does not eliminate the case for taxation as a means for reducing CO_2 emissions, but means that taxation needs particular care to be effective without causing adverse effects. Special attention needs to be paid to the methods, phasing in and structure of taxation.

Nevertheless, price differences have an impact in the longer run. For Europe the short-term elasticity of demand for gasoline, for example, has been calculated at 0.15. Only in the long term, larger effects of price differences are expected with an elasticity of demand at 1.24 (OECD, 2001: 101). In the transport sector, different tax levels on petrol between the EU and the US seem to have had an impact on changing behaviour and improving technology. Price differences in fuel costs explain the 22% difference in CO_2 emissions per kilometre between the EU and the US. The recent world price hike for oil has affected the demand of Sport Utility Vehicles (SUV) in the US and increased the demand for cars with hybrid motors.[12]

Price signals have also been crucial in shifting consumption of fuel from leaded petrol to unleaded petrol. The use of taxes to encourage the shift to unleaded petrol was very successful (European Commission, 2000: 172; OECD, 2001: 101). Here again, the success of the policy points to the readily available alternative source, unleaded petrol.

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[12] Standard and Poor's, "North American Automaker Outlook for 2006 Marked by Weak Demand, Lower Market Share, and Japanese Competition", 29/11/2005.

Another example is a diesel fuel tax in Sweden, introduced in 1991 to stimulate the use of 'clean' diesel. The effect was rapid with consumption of the 'clean' diesel increasing from 1% to 85% in just four years between 1992 and 1996, which reduced sulphur emissions by 75%. Similar tax-based systems aimed at shifting the consumption of diesel to the cleaner version were also very successful. There is no doubt in theory and in practice that price signals through taxation that change the relative prices between substitute energy sources are very effective.

Elasticities and revenue-minded carbon and energy taxes

CO_2-related taxes, while having some impact, have not been as effective as taxes on other pollutants. The OECD (2001) indicates that the reason for the lower impact of these taxes is not only attributed to the difficulties of finding non-fossil fuels or improving technology, but on the tendency for governments to tax energy use in transport and households rather than industrial sectors. The elasticity of supply in transport and household sectors is lower than that in industrial sectors.

The consequence is that a large proportion of energy remains untaxed, especially in these areas where elasticities are high.

Unequal taxation of CO_2 across member states would create distortions in the market, giving inconsistent price signals. In Germany, for example, the most CO_2-intensive input, coal, remains untouched.

Long-term elasticity of demand and technological change

The previous section indicates that non-fossil fuels or improvements in the efficiency of fuel use are the key to reducing the use of fossil fuel and thus reducing CO_2 emissions. A well-structured tax system with long-run price signals could provide an incentive to increase energy efficiency and create renewable sources of energy. This tax would then promote dynamic efficiency gains expected from the Pigouvian taxation. It is clear, however, that balancing the speed of adaptation of the sectors concerned with higher costs through taxes is not a simple task. One such attempt, which failed, was the UK's fuel tax escalator.

The UK's fuel tax escalator – An elasticity victim?

The UK's fuel tax escalator was introduced in 1993, with an official aim to increase fuel efficiency. This policy was based on an annual increase in fuel taxes above the inflation rate by 3% but was abandoned after protests in 2000. While the demise of the tax escalator has been attributed to the importance of pressure groups in society, a factor that influenced this failure lies in the lack of sufficient demand elasticity and of a convincing alternative to road transport in the UK. Parkhurst (2002) notes that the technological changes for improving fuel efficiency needed some years to filter through the car market. At the same time, however, public transport prices in the UK have also been rising above inflation during the same period, giving the wrong signal to society. Users understood the fuel tax escalator as a 'revenue escalator' for the government, not an environmental policy instrument because no clear alternative to road transport or fuel was available. This appears to be the consequence of a lack of attention to cross-price elasticities of demand, i.e. relative prices of alternative modes of transport.

Nevertheless, while the UK government may not have implemented the taxes with due care, the tax fuel escalator induced the transport sector to increase its fuel efficiency.

From the UK case, one can come to the conclusion that the design of environmental taxes needs to take into account the public perception of the taxes introduced. The lack of a coherent policy in the transport sector led to a difficult situation. In the case of the UK it was not possible for the citizens to understand price increases in the public transport sector that clashed with the fuel escalator's objective to reduce road transport.

5.3 Competitiveness effects

OECD (2001) identifies fear of reduced competitiveness with one of the two major obstacles to the implementation of environmental taxes. Prospective losses of competitiveness have led to sectoral lobbies for exemptions or tax rate reductions.[13] The strength of these lobbies (e.g. organisation, networking, resources), fear of carbon leakage and concerns with widening disparities across regions have led to concessions from government. One of the main challenges is for the government to strike a balance between the need to create an incentive effect and to demonstrate sensitivity to competitiveness concerns in industry. The latter also means prevention of carbon leakage.

The competitiveness effect on industry has been a major concern in the introduction of environmental taxes. Some aspects of this concern were mentioned in section 5.2. It is important that carbon or energy taxes are designed to produce the desired effects, which is to foster the search for non-fossil fuels or improvements in energy efficiency. To do so, the selection of tax method is crucial. Detailed studies determining when environmental taxes might entail economic losses or adverse effects are very important but difficult to carry out.

In fact, competitiveness issues at a national level appear to be more important for CO_2 emissions. It is a very complex issue due to real global nature of the environmental damage. For more localised pollution, even a tax that reduces domestic production and increases imports would bring benefits to the environment. The tax aimed at reducing local pollution could in turn improve economic performances of other sectors and benefit the whole economy. Take the example of reduction in water pollution from domestic industries. Even if the industry were to close down and the product to be imported, the economy could gain in aggregate due to improvements in health and reductions in health costs or growth in tourism. Water quality at the Mediterranean seaside is an important factor for tourism, for example. With CO_2 emissions, there are no gains if production is substituted by imports from polluting industries abroad (OECD, 2001: 75). Thus, the domestic economic effects would depend on policies adopted abroad. Taxing imports is not a solution, as we have shown above. There is of course the possibility of granting tax exemptions to industries facing competitive pressures from abroad, which would however neutralise part or all of the environmental effect.

Difficulty in estimating all the possible implications might however lead the government to grant concessions where it is not required. The OECD (2001) considers that there are important cases where this occurs, undermining tax policies considerably as these exemptions usually accrue to the most energy-intensive industries. Furthermore, the concern over competitiveness is too often seen from the perspective of the affected industries, and not for the whole economy.

Different rates of taxation for different industries give a distorted price signal. Pollution has then different values from different sources and might redirect investment into those sectors that are less taxed but in many cases are the most polluting. The OECD (2001) quotes the estimates that costs of abatement in Europe are 30% higher due to exemptions provided and that other methods such as wage subsidies (lower rates of social security contributions such as tax shifts used in environmental tax reforms) are clearly superior. The tax shifts can provide necessary public acceptance for the taxes but they will reduce pressure on affected industries to innovate.

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[13] For a cross-country analysis of Norway, Denmark and the Netherlands, see Kasa (2000) and specifically for Nordic countries, see Kasa (2004).

The idea that environmental policy undermines competitiveness is often based on a static view of competitiveness in which technology is considered exogenous (i.e. decoupled from environmental regulation). Environmental policy – with its dynamic effects such as inducing technological change, first-mover advantages in new markets or green consumerism – can indeed induce innovations in products and processes and then enhance competitiveness. This is usually referred to as the 'Porter hypothesis'.[14]

5.4 Equity issues

Taxes on energy are considered to be potentially regressive. The overall impact of the tax burden will depend on the incidence of the tax, the use of revenues generated by the tax and the indirect implications of the tax. A tax on energy has inflationary implications as a key input of the economy, although much of the existing literature is only concerned with direct burden of environmental taxation.

More difficult to estimate are the behavioural changes caused by a tax and the burdens imposed after these changes have taken place. Behavioural changes are or should be the ultimate aim of an environmental tax, but they take place over the longer-term. In the long term, however, the tax may not be the only factor affecting such changes.

In analysing the short-term implications before behavioural changes take place, it is especially important to pinpoint which sectors of society are hit the hardest and which will not be able to adapt to the impact of the tax.

According to Hamond et al. (1999), equity implications have to be considered when analysing the effect of the tax on annual direct and indirect incomes for affected parties with and without behavioural changes (i.e. short- to longer-term developments). The authors are critical of the fact that most studies ignore a broad range of effects. The overall impact of CO_2 taxes, such as fuel taxes, is not as regressive as some studies of direct impacts suggest. In fact, CO_2 emissions are a good candidate for taxation on equity grounds and only regressive in a limited way (Hamond et al., 1999).

In order to avoid weakening of behavioural changes and tax signals, the OECD (2001: 89) recommends against using tax exemptions even for low income groups, but rather to use other compensation measures.

6. Assessing environmental taxation in the EU

This section assesses the performance of environmental taxes vis-à-vis five key criteria we have identified: economic impact, environmental effectiveness, recycling mechanisms, promotion of clean technologies and maximising economic efficiency.

6.1 Impact on costs and prices, competition and trade

Contrary to common perception, there is little or no evidence that environmental taxes have a negative impact on competitiveness at the macroeconomic level (OECD, 2001; ECOTEC, 2001: 40; EEA, 2000: 51). Smith (2001) and OECD (2001) consider that these exceptions have no proper foundation. An analysis by the European Commission (2000: 174-175) shows no

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[14] Named for the American economist Michael E. Porter, who proposed that stringent environmental regulation (on the condition that it is efficient) can lead to a win-win situation, in which social welfare as well as the private net benefits of firms operating under such regulation can be increased. See Porter & van der Linde (1995).

evidence that taxing energy-intensive industries would cause significant damage to most of these industries.

There are at least three possible reasons. First, the current tax rates are either too small to induce an incentive effect at the macroeconomic level. Second, firms subject to international competition are exempted. Third, the targeted groups are not subject to competition.

More importantly, according to theoretical and empirical literature, environmental policy is but one of many factors that firms take into account when making investment decisions. Empirical knowledge of country-specific relocation effects is very limited, especially in Europe.

Existing empirical evidence of interaction between environmental policy and effects on competitiveness remains largely inconclusive (Scholz & Stähler, 1999; Ederington et al., 2003).

6.2 Environmental impacts: Does the price signal created by a carbon tax cut emissions?

Evidence mainly from practices in northern EU member states shows that environmental levies have positive impacts on the environment (ECOTEC, 2001; EEA, 2000).

There are some cases where taxes have offered significant incentives for environmental benefits. Particularly effective examples of incentive taxes include the NOx charge in Sweden and to a lesser extent in Denmark.

In other cases, environmental effectiveness of taxes is lower, reflecting the conservative designs, mainly to ensure political acceptability. The current rates of these levies are kept lower than environmentally optimal levels out of concern with political feasibility. They therefore failed to provide a sufficient incentive effect but served to raise revenue (ECOTEC, 2001: ii; EEA, 2000: 10, 19; Bygrave & Ellis, 2003: 17).

The exception is taxes on transport fuels. Fuel taxes such as motor fuel and motor vehicle taxes pre-date the environmental tax reforms (ETRs) – see Case Studies in Annex – and usually have been introduced for fiscal rather than environmental reasons. These taxes are not systematically related to environmental damage but have mainly been motivated by their revenue-raising effect (O'Brien & Vourc'h, 2001: 19, 40; Jourmand, 2001: 23; EEA, 2000: 45; Newbery, 2001: 4).

The environmental effectiveness has been further undermined due to – in some cases deliberate – design choices, such as the lack of differentiation by the carbon content of the primary energy in most EU member states (Joumard, 2001: 24). An example of failure of taxes to reflect the pollutant content of products or activities is the lower taxation of diesel than gasoline in the EU. The gap between excise taxes on diesel and petrol (gasoline) cars cannot be justified on grounds of pollution alone as diesel overall is thought to be more polluting than gasoline. Diesel releases even more CO_2 per litre. However, as a result of higher efficiency of diesel engines, it has been argued that the overall CO_2 balance might be positive (Newbery, 2001: 7; O'Brien & Vourc'h, 2001: 7, 12; Joumard, 2001: 24). The same example shows potential inconsistencies. Annual motor vehicle taxes on diesel cars are usually set at a higher rate than those on petrol cars (EEA, 2000: 47). A number of countries, including Denmark, Germany and Italy, impose differentiated rates of annual motor vehicle tax according to emissions characteristics (e.g. Austria, Germany) and/or energy use (EEA, 2000: 47-48).

The environmental outcome is better in production differentiation than content differentiation. Environmental tax differentiation has been considered to be successful in promoting the market penetration of unleaded petrol (OECD, 1997 as discussed in EEA, 2000: 46; Newbery, 2001).

6.3 Recycling mechanisms: How is the revenue recycled to the economy?

In addition to exemptions, revenue recycling has been the key to acceptance of environmental taxation schemes. Hence, management of recycling becomes critical. There are examples of both governmental bodies and private organisations managing the funds to recycle revenues.

The UK has developed a recycling mechanism through which the government will return revenues collected from the levy to non-household consumption (e.g. industry, commerce, agriculture and the public sector) partly through reductions in the rate of employers' National Insurance Contributions and partly through schemes aimed at promoting energy efficiency and renewable energy. The government has introduced a scheme of 100% capital allowances in the first year for certain energy saving investments (i.e. Enhanced Capital Allowances Scheme). While promoting the government's scheme, the Carbon Trust offers a range of schemes to help business and the public sector reduce carbon emissions. These schemes include grants to support R&D projects in UK business and academia, interest-free loans to small- and medium-sized enterprises (SMEs) (i.e. energy-efficient loans), and funding for carbon emissions reductions in key industry sectors (i.e. the Networks Initiative).[15]

In expenditure £100m (approx. €150m) was allocated over three years from the Climate Change Levy (CCL) revenues to the Carbon Trust for the energy savings programme (Agnolucci, 2004: 28). This amounts to about £24 million in 2001-02 and £36 million in 2002-03 or around 4% of CCL revenues per year (Pearce, 2005: 38). Pearce (2005) questions how far these expenditures take on board the revenue effect argument because the sums are too modest to secure long-run substitution effects. The effectiveness of the Trust in this context has to be assessed together with that of the climate change agreements (Pearce, 2005).

It is important to note that there are a few studies aimed at evaluating initial effects (Agnolucci, 2004; 27-28; Cambridge Econometrics et al., 2005; Köhler et al., 2005) and that consultation for the review of the UK Climate Change Programme has been undertaken in 2005 (IPA Energy Consulting, 2005; Carbon Trust, 2005). The evaluation and consultation with stakeholders suggest that changes will be possibly needed to the CCL.

Revenue recycling in the Danish system takes several forms. Following the principle of fiscal neutrality, most of the revenues collected from CO_2 taxes on industry in the period 1996-2000 were repaid to the firms. About €600 million were recycled through a reduction in employers' payment of social security contributions, about €160 million through special funds for SMEs, and about €240 million through subsidies earmarked for investments in energy savings listed on the agreements (Enevoldsen, 2003 in Agnolucci, 2004: 19). The law permits subsidisation up to 30% of the required investment and created a special fund called the 'Electricity Saving Trust'. The Trust has an annual budget of approximately Dkr 90m financed by an electricity savings charge of Dkr 0.006 per kwh levied on dwellings and the public sector. The evaluation of the Trust activities concludes that the scheme has been successful, given the finding that the electricity savings are assessed at Dkr 7.8bn or more than ten times the electricity savings charge collected (Rambøll Management, 2004: 4). In 1999, an additional refund of about €270 million was granted to compensate for the re-distribution from energy-intensive to labour-intensive firms caused by the reduction of social security contributions (Agnolucci, 2004: 19).

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[15] See http://www.thecarbontrust.co.uk. Also see http://www.defra.gov.uk.

6.4 Promoting existing clean technology such as energy efficiency improvements in existing facilities

Speed of development and diffusion of new technologies depends not only on the tax rate and market size but also on credibility of the tax for the longer term. The designs of taxes such as revenue-recycling mechanisms and exemptions may have long-term impacts on the development of new technologies and/or the development of the industrial structure of the country. A key advantage of a carbon tax is the dynamic efficiency that creates incentives for firms to change production processes in favour of less carbon-intensive ones (OECD, 2001: 74). In reality, however, exemptions tend to 'lock in' energy/carbon-intensive or polluting processes and perpetuate harmful effects on the economy (OECD, 2001: 79; also see Jaffe et al., 2004: 17-18). Even worse, an interview survey covering Finnish industry showed that no one representing the industry would give any role to electricity tax in either promoting innovations or in enhancing the diffusion of energy-efficient solutions. The survey concludes that electricity taxation in Finland has not had any major effect on innovation or diffusion possibly due to design of the tax and its low level (Hildén et al., 2002).

6.5 Maximising economic efficiency

One of the strongest theoretical merits lies in the ability of a levy to reduce administrative and transaction costs. Generally speaking, it is easier and cheaper to collect energy taxes than direct taxes such as income tax (Newbery, 2001: 3).Yet, benefits from cost savings can be outweighed by high administrative costs relative to the size of revenue and, more importantly, by the costs of revenue recycling. Over all, there are little data on administrative costs of environmental taxes. And only very few countries have planned measures to reduce administrative costs (OECD, 2001: 91-92).

The main question, whether environmental taxation and notably an environmental tax reform (ETR) maximise economic efficiency, remains unanswered, for there are full or partial exemptions to large sectors of the economy and in particular to those who emit most intensively. In many cases, therefore the burden falls on households (OECD, 2001; O'Brien & Vourc'h, 2001: 38, 53-56; see also de Kam, 2002: 20, 22). Often environmental taxes have been imposed on household consumption rather than production inputs. In many instances elasticity for household spending, especially for low-income households, is low or even non-existing. Further complications can arise from the complication of design schemes to accommodate political interests (e.g. Pearce, 2005).

7. Key findings & policy implications

The following conclusions draw together the findings from the previous sections. In particular, they relate the findings from the theoretical and empirical literature to the case studies in the Annex.

The academic literature has identified a number of theoretical merits of environmental taxes such as incentive effects, dynamic efficiency and an increase in revenue. There is a wide range of modelling exercises. However, there is limited empirical evidence due to lack of *ex-post* evaluations, at least for the EU. And even if *ex-post* evaluations exist, they tend to be non-conclusive by and large. One reason is that most taxes are recently introduced, providing a limited evaluation period. Another reason is that the evaluation of environmental taxes in their entirety is difficult as such taxes are usually part of a package with other instruments. It remains difficult to identify the share of contribution of each instrument to the overall environmental impacts. Nevertheless, taxes have been successfully used to induce product substitution, e.g. from leaded to unleaded petrol.

In practice, the incentive effect of environmental taxes is often limited for three main reasons. The overall tax rate is too low to achieve substantial environmental improvement. Energy-intensive industries in most cases are exempt or benefit from rebates. And finally, taxes that are imposed tend to be directed to households, where in many cases price elasticity is low and/or product substitution – at least in the short term – is not possible.

Taxes in general face three obstacles: i) overall price elasticity of demand for energy is low and in most cases the necessary level of tax rates to induce substantial behavioural change will not be politically acceptable; ii) distributional effects will create additional barriers because of the regressive nature of environmental taxes (i.e. low-income groups are affected in a disproportionate way); and iii) there are various obstacles or 'market failures' that prevent optimal levels of energy-efficiency investments.

There is no clear-cut empirical evidence on the negative impact of environmental taxes, and in fact the literature seems to agree that industry's claim on negative economic impact is overstated. In reality, however, governments have been subject to intensive lobbying by industry for exemptions or at least for recycling of revenues. In most cases governments have been giving in to industry demands. Exemptions and/or recycling of revenue reduce not only their effectiveness but undermine the simplicity of environmental taxes. While tax collection in general and collection of environmental taxes in particular, if compared to that of direct taxes, remain simple, the design and administration of tax exemptions and revenue recycling may add substantial transaction costs.

The UK has developed a recycling mechanism through which the government will return revenues collected from the Climate Change Levy to the business sector partly through reductions in the rate of employers' National Insurance Contributions and partly through schemes aimed at promoting energy efficiency and renewable energy. The Carbon Trust offers a range of schemes to help business and the public sector reduce carbon emissions.

Should taxes be considered as a suitable instrument, in the case of the power industry, the best tax system would be taxation on the primary input, which is usually coal. The tax will increase incentives to use other sources of energy if possible, increasing costs of production with coal but not affecting costs of alternative sources of energy. The energy industry will gradually shift production of energy to other sources. The incentive effect directly aims at the power industry which benefits from improving technology to reduce costs.

However, the main effect of input taxes is to be expected in the longer run, e.g. discouraging the construction of energy plants based on coal. Overall prices of energy will increase in case the energy price is set industry-wide. It is unlikely that consumers are directly paying for one source or another. The advantage of these taxes will be to motivate consumers and hence the economy to become more energy efficient.[16] The price increase will induce more energy efficiency in the economy.

In addition, taxing the primary energy source does not allow tax differentiation between consumers. This decreases the likelihood that the effectiveness of the policy implementation

[16] For the specific case of climate change, such a tax may generate unintended consequences. Inducing a fuel switching to gas will discourage investment and technological development in clean coal technologies (e.g. carbon capture and storage), which are likely to play a central role in meeting the global climate change challenge. Therefore additional policies are likely to be needed to encourage technological development of clean coal technology.

will be undermined through granting of concessions on energy-related taxes to industries. Nevertheless, the government may want to compensate some strategic industries for lack of access to exemptions or rate reductions through other tax cuts.

Taxing the product or consumers would be less efficient than taxing the input as the former would dilute the incentive effect more than the latter.

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Annex

Case studies of selective member states and the EU

The following case studies briefly describe the key elements of major taxation schemes in EU member states. Principal sources are ECOTEC, 2001; Egenhofer & ten Brink, 2003; Bleischwitz, 2004; EEA, 2004; OECD, 2001, unless references in the specific sections indicate otherwise.

The use of environmental taxes started in the Scandinavian countries and the Netherlands, followed by larger EU member states (i.e. France, Germany, Italy and the UK). It was accompanied by the exploration of the possibilities for introducing environmental taxes as part of comprehensive tax reforms, later dubbed environmental tax reforms (ETRs).[17] An ETR meant shifting the tax base by reducing taxes on 'goods' (e.g. employment) in line with fiscal neutrality but raising taxes on 'bads' (e.g. pollution, overuse of natural resources) (EEA, 2000; OECD, 2001; ECOTEC, 2001: 24-25, 33).

ETRs combined new environmental taxes with reductions in existing taxes, such as labour taxes and income taxes. (For details, see Table A1 below and O'Brien & Vourc'h, 2001: 62; Schlegelmilch, 2000: 7). Soon an ETR became a core ingredient of the sustainable development agenda, seen as a means to move the economy towards a sustainable development path with the argued benefit of generating 'double dividends' (see section 4.2) of environmental improvements and job creation. Table A1 presents an overview of the tax shifts.

Table A.1. Implemented and proposed tax shifts in EU member states

Country	Tax Shift		Revenue Shifted
	From	To	(% of total tax revenue)
Finland 1990	Partly taxes on labour	CO_2 emissions	
Sweden 1991, 1993, 1995 (updated 2001)	Reduction of labour taxes of around 4.3 percentage points) & social security contributions	Environmental and energy taxes including CO_2 tax and SO_2 tax	1.9 % (environmental & energy taxes 18 bil SEK; 2 bil EUR)
Denmark 1992/3, 1995 & 1998	Personal Income, Employers' Social Security Contributions, Investment Incentives	Various (electricity, water, waste, cars), CO_2 and SO_2	2.5 % (2.5 bil DKK; 340 mil EUR in 2000)
Spain 1995	Personal Income	Motor Fuels	0.2 %
Netherlands 1996	Personal Income, Corporate Profits, Employers' social security contributions	Energy and CO_2 Regulatory Energy Tax)	0.8% (2.2 bil NLG; 1 bil EUR in 1998)
UK 1996	Employers' Social Security Contributions	Landfill	0.2 % (450 mil UKL; 640 mil EUR in 1996)

[17] It can be also called 'green tax reform' (GTR) (OECD, 2001; de Kam, 2002; O'Brien & Vourc'h, 2001), 'ecological tax reform' (ETR) (EEA, 2000) or 'environmental fiscal reforms' (de Kam, 2002).

Country	**Tax Shift**		**Revenue Shifted**
	From	**To**	**(% of total tax revenue)**
Finland 1997 (updated 1998)	Personal Income, Employers' Social Security Contributions	CO_2 and Landfill	0.5%
Italy 1998/1999	Reduction of Employment Charges	CO_2 on mineral fuels	0.1 to 0.2%[18] (around 600 mil EUR)
Germany 1999	Social Security Contributions (pension insurance) paid by employers & employees	Energy (mineral oils, natural gas and electricity)	0.6% (estimated) or a reduction by 0.8 % points (8.4 bil DM; 4.3 bil EUR in 1999)
France 1999 (suspended)	Plans to reduce taxes on labour and employment	Generalised pollution tax (known as TGAP)	NA
Austria 1999 (updated 2000)	Employers' Social Security Contributions	Energy and vehicle taxation	Up to 4.8% (up to 50 bil ATS; 3.6 bil EUR)
UK 2001	Social Security Contributions	Energy/CO_2 emissions under the Climate Change Levy	
UK (April 2002)	National Insurance Contributions	Aggregates tax (sand, gravel, crushed rock)	

Sources: ECOTEC (2001), OECD (2001), Bygrave & Ellis (2003).

Some countries (e.g. Belgium, Denmark, Germany, Norway, Sweden, the Netherlands, UK[19]) have formalised the ETR process by designating 'environmental/ green tax commissions' or inter-ministerial committees[20] (O'Brien & Vourc'h, 2001: 21) to address design issues and likely impacts. Among others these tax commissions dealt with the possibility to contemplate the scaling back of subsidies for goods that have detrimental effects on the environment (EEA, 2004; OECD/IEA, 2002; Varangu & Morgan, 2002; de Moor, 2001).

a) UK

The Climate Change Levy (CCL) was introduced in 2001. The UK government offered compensatory reductions in other taxes such as national insurance contributions upon introduction of the CCL. CCL is part of a broad policy package including voluntary agreements ('umbrella agreements'), regulation (i.e. the EU Integrated Pollution Prevention and Control,

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[18] See ECOTEC (2001). The 0.2% cut is based on total tax revenues of around €339 billion in 1995.

[19] In 1998 the UK government commissioned Lord Marshall to investigate the case for a tax on the business use of energy. His report published a year later supported the case, which resulted in the introduction of the Climate Change Levy (CCL) (Agnolucci, 2004).

[20] The government of Sweden appointed the Committee on Industrial Energy Taxation, whose findings led to the abolishment of the energy tax on industry and the reduction of the carbon tax on industry (Agnolucci, 2004). The 1998 Green Tax Commission appointed by the Norwegian government provided the basis for the later expansion of the CO_2 tax base to exempted industries and the introduction of a domestic system for GHG emissions trading (Agnolucci, 2004).

IPPC, Directive), exemptions and reductions, and the national emissions trading scheme (UK ETS).

The CCL has been designed not to be a carbon tax but an energy tax and electricity is taxed on production (Newbery, 2001: 9). The levy applies to non-household consumption (e.g. industry, commerce, agriculture and the public sector) while exempting electricity generated from 'new renewables' and CHP. The government exempts household energy use from the CCL. The government has ruled out environmentally related taxation on private use of fuel and power, and maintains the VAT rate on household fuels lower than the standard rate (O'Brien & Vourc'h, 2001: 60).

One of the reasons why UK companies entered into the UK ETS was to avoid the CCL. Arguably the whole package, which is a key to the implementation of the UK Climate Change Programme, would not have been possible without VAs or the 80% tax exemption. Energy-intensive industries could benefit from significantly lower tax rates if they agreed on targets for energy-efficiency improvements or carbon emissions reductions (i.e. an 80% reduction from CCL for the signatories of VAs until 31 March 2003).

The success of the CCL has been attributed to an element of hypothecation to induce taxpayers to reduce their energy use, and therefore to reduce their liability to tax (EEA, 2000: 56). All revenues will be returned to non-household sectors. The levy is used to finance a range of measures to assist energy users to improve their energy efficiency. These measures include Action Energy (formerly the Energy Efficiency Best Practise Programme) involving the Carbon Trust,[21] the Energy Saving Trust,[22] and a system of 100% first year capital allowances for energy-saving investments by the private sector (i.e. Enhanced Capital Allowance Scheme).[23]

The UK introduced a fuel-duty escalator in 1993. The government applied a reduced excise tax rate on ultra low-sulphur diesel (ULSD) in 1999 and ultra low-sulphur petrol (ULSP) in 2000. Evidence suggests that the UK fuel-duty escalator has led to a decrease in fuel consumption by the road transport sector (EEA, 2000: 45) but was later abolished due to political opposition (see section 5.2).

b) Germany

Germany introduced a set of taxes as part of the environmental tax reform in 1999. The mineral oil excises on mineral oils, gasoline and diesel, heating oil, and gas were raised. An electricity tax was introduced. The second to fifth phases further proceeded with ETRs (2000, 2001, 2002, 2003 respectively). The new phases increased mineral oil duty rate on motor fuel and electricity tax duty (Government of Germany 2003). Revenues from these taxes are recycled to the economy mainly by reducing social security contributions, especially those to the pension system. However, from the start of 2003 only 95% of the tax payments exceeding the (simple) savings of pension contributions are refunded (Kohlhaas, 2003: 10).

Under the scheme fossil fuels used as inputs for power generation are exempt. Until the end of 2002 a reduced rate of 20% applied to taxes on mineral oil and electricity for all producing business (i.e. manufacturing and mining) and agriculture and forestry (excluding their use of gasoline and diesel). The reduced tax rate on electricity, fuel oil and natural gas for manufacturing, agriculture and forestry was raised from the start of 2003 to 60% of the standard tax rate.

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[21] See http://www.thecarbontrust.co.uk

[22] See http://www.est.org.uk

[23] See http://www.eca.gov.uk

The German government also provided energy-intensive industry with several partial exemptions from taxes on electricity and mineral oils ('Spitzenausgleich'). In Germany large energy users whose payments on energy products exceed a threshold are able to pay only one fifth of the standard rate on electricity and of the tax increase for heating oil and gas. The tax rates for the manufacturing industry on electricity are phased in between 1999 and 2003, and doubled up to 0.41€/1000kWh in 2003 (Bygrave & Ellis, 2003: 15). Industry will be reimbursed the amount of tax burden above the factor if their energy tax burden exceeds the factor 1.2 of the reduction in social security contribution.

Preferential treatment (i.e. complete exemption or a reduced rate of fuel tax) is provided for efficient CHP plants. From 2002, efficient installations with Combined Cycle Gas Turbines (CCGT) are eligible for tax exemption. Installations with a rated burden up to 2MW are exempted from tax on electricity.

Tax exemptions are granted for electricity produced from renewable energies.

In addition the tax on electricity for rail transport (except operational transport within plants and mountain railways) or trolley buses and the tax on mineral oil for local public transport have been reduced to 50% of the standard rate (EEA, 2000: 66; Schlegelmilch, 2000: 8-9).[24]

Electricity used to operate storage heaters installed before April 1999 was taxed until the end of 2002 at 50% of the standard tax rate because low-income households are the main users of such heaters. However, its environmental impact was questioned and only granted on a transitional basis. The subsequent law allows for an increase to 60% of the standard rate from the start of 2003 and terminates the treatment at the end of 2006.

The German tax has been very controversial during election campaigns. The new government brought in at the end of 2005 has no intention of changing these taxes, as the potential revenue shortfall cannot be compensated for.

c) France

In 1999 France introduced the 'taxe générale sur les activités pollutants' (TGAP) (general tax on polluting activities) by bundling 17 smaller environmental taxes on waste, water and air pollution together under a uniform scheme (see Table A1). The tax base was to be broadened and tax rates were to be raised. However, the tax was regarded as 'unconstitutional' in 2000 and the proposed extension of the TGAP to fossil fuel combustion and electricity generation has been suspended (OECD, 2001: 52; EEA, 2000: 65; Schlegelmilch, 2000: 8).

Fuel taxes in France are higher than the EU average. In 1999, the government proposed to raise the mineral oil tax on diesel over a period of seven years in order to phase out a subsidy for diesel given its lower tax rate. Yet the plan was weakened by the exemption of long-distance transport through reimbursement.

d) The European Union

There is no EU-wide carbon tax.

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[24] Press release, "Commission approves modified German environmental tax, including special rules for energy intensive users", European Commission, 30 March 2004. Press release, "Commission approves prolongation of tax reductions from the German Ecotax after 31 March 2002", European Commission, 13 February 2002.

The EU Energy Taxation Directive[25] sets minimum rates of taxation for motor fuel, motor fuel for industrial or commercial use, heating fuel and electricity. Energy products will only be taxed when used as fuel for heating not as raw materials. Member states will be allowed to differentiate between commercial and non-commercial diesel. Business use of energy products can be taxed at a lower rate than non-business use. Energy products used for international air transport will remain exempt as long as international commitments are in place. Member states can opt to exempt renewable energy sources and energy used for public transport. For derogations, member states are authorised to continue to apply a range of reductions and exemptions set out in the Directive.[26]

e) Others

Denmark

Denmark has developed a package of energy, CO_2 and sulphur taxes. The Danish energy and CO_2 taxes are among the highest in the world. The taxation on energy covers oil, coal, gas and electricity. These taxes are not applied to fuel consumption in electricity *production* but to electricity *consumption* (Government of Denmark, 2004: 4-5).

In 1992, a CO_2 tax was introduced for households and extended to industry in 1993. The energy package introduced in 1995 altered the taxation of industrial energy use: a gradual increase in CO_2 taxation, a modification of energy taxation on industry, and the introduction of a new tax on SO_2 emissions. According to fiscal neutrality, the marginal taxation of labour income was reduced by a total 2% of the Danish GDP (EEA, 2000: 59).

In the new Danish scheme, CO_2 tax rates are differentiated according to energy intensity of the process and the voluntary agreement (VA) on energy conservation measures (Schlegelmilch, 2000: 7; see also EEA, 2000: 9, 29; Government of Denmark, 2004: 5). Light processes are subject to a slightly lower rate. Heavy processes listed are not exempt but benefit from a much lower rate. Danish entities participating in VA are granted a reduction in the energy tax rate from €2/t CO_2 (€3.3 for energy-intensive industries) to €0.4/t CO_2 in 2000. If VAs including energy audits are concluded, a further reduced rate can apply to heavy and some light processes (EEA, 2000: 59). This exemption for energy-intensive industries has to be repaid if the VA has not been met (Bygrave & Ellis, 2003: 15, 18, 27; Schlegelmilch, 2000: 7).

The Danish tax rates are differentiated over time as well as by industry type. Innovations induced by taxes can also help to improve competitiveness (EEA, 2000: 15).

Revenue recycling in the Danish system takes several forms. Following the principle of fiscal neutrality, most of the revenues collected from CO_2 taxes on industry in the period 1996-2000 were repaid to the firms. About €600 million were recycled through a reduction in employers' payment of social security contributions, about €160 million through special funds for small- and medium-sized enterprises and about €240 million through subsidies earmarked for investments in energy savings listed on the agreements (Enevoldsen, 2003 in Agnolucci, 2004:

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[25] Official Journal of the European Union, 'Council Directive 2003/96/EC of 27 October 2003 restructuring the Community framework for the taxation of energy products and electricity', L 283/51, 31.10.2003; Official Journal of the European Union, 'Council Directive 2004/74/EC of 29 April 2004 amending Directive 2003/96/EC as regards the possibility for certain Member States to apply, in respect of energy products and electricity, temporary exemptions or reductions in the levels of taxation', 2 June 2004. The latter establishes transitional arrangements for the new member states that acceded on 1 May 2004.

[26] Annex II of the Council Directive 2003/96/EC; Annex of the Council Directive 2004/74/EC.

19). The law permits the subsidisation of up to 30% of the required investment and created a special fund called the Electricity Saving Trust. The Trust has an annual budget of approximately Dkr 90m financed by an electricity savings charge of Dkr 0.006 per kwh levied on dwellings and the public sector. The evaluation of the Trust's activities concludes that the scheme has been successful, given the finding that the electricity savings are assessed at Dkr 7.8bn – or more than ten times the electricity savings charge collected (Rambøll Management, 2004: 4). In 1999, an additional refund of about €270 million was granted to compensate for the re-distribution from energy-intensive to labour-intensive firms caused by the reduction of social security contributions (Agnolucci, 2004:19).

The Danish tax on the sulphur content of energy products has had a rapid impact since it was introduced in 1996. The average sulphur content of fuel oil and coal significantly decreased in the same year. Moreover, the tax had a positive impact on the development of sulphur purification plants and technology (Danish Ministry of Taxation 1998, 31 in EEA, 2000: 46).

Sweden

In Sweden, an energy tax is imposed on most fossil fuels and is independent of energy content, whereas a CO_2 tax is set on all fuels except biofuel and peat (Government of Sweden, 2004).

As part of the major tax reform in 1991, Sweden introduced a number of taxes on fossil fuels (e.g. diesel oil, petrol), CO_2, sulphur, NOx, electricity, domestic air travel, vehicles as well as a producer tax on hydroelectric power and on nuclear power. Sweden introduced CO_2 tax in 1991. The tax was estimated to have reduced CO_2 emissions of 5Mt by 1994, which accounts for 9% of total Swedish CO_2 emissions (Swedish EPA, 1997 in EEA, 2000: 46). In 1992, since other EU member states did not follow suit, Sweden reduced the tax by 25% of the normal (i.e. households) rate and abolished the energy component. In effect the energy tax burden was partly shifted from industry to households. The reduction in the tax rate may have resulted in an increase in CO_2 emissions by a quarter by 1994 (Carlsson & Hammar, 1996 in EEA, 2000: 46). Consequently, the tax rates were doubled for industry in 1997 and further raised in 2001 in the framework of a tax shift (i.e. reducing taxes on work). The current CO_2 tax amounts to approximately €100 per tonne of CO_2 (Government of Sweden, 2004: 9).

Energy-intensive industries may be granted reduced rates (EEA, 2000: 71-72; Schlegelmilch, 2000: 11). Firms that have used fuels other than petrol and high tax fuels in industrial manufacturing processes may apply for a refund of all the energy tax and 79% of the CO_2 tax if the total amount of the refund exceeds a threshold. Heat producers that have delivered heat for use in industrial manufacturing processes or for agricultural, forestry or fish cultivation may apply for a refund of all the energy tax and 79% of the CO_2 tax on fuels other than petrol and high tax fuels as well as the energy tax above a threshold on electricity power that has been used to produce heat (Swedish Tax Agency, 2005) (c.f. the European Commission's assessment over several exemptions and reductions from the Swedish energy tax and from the CO_2 tax in favour of the manufacturing industry and the service sector).[27]

During the same period energy tax rates have been similarly reduced step by step: the Swedish energy tax rates have been changed in 1991, 1993, and 1995 (Bygrave & Ellis, 2003: 15, 17; see also Table A1).

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[27] Official Journal of the European Union, "State aid-Sweden, invitation to submit comments pursuant to Article 88(2) of the EC Treaty, concerning aid C 42/03 (ex NN 3/B/01) – Sweden, Energy Tax Scheme", 9.8. 2003.

The Swedish tax on the sulphur content of coal, peat, motor fuel and heating oil is estimated to account for 30% of the total reduction in sulphur emissions from 1989 to 1995, which is equivalent to 20% of total emissions in 1995 (Swedish EPA, 1997 in EEA, 2000: 46).

Taxes on diesel oil and petrol are differentiated according to an environmental classification. Evidence shows that the Swedish differential taxation on petrol contributed to the introduction of unleaded petrol (Swedish EPA, 1997 in EEA, 2000: 15, 46).

In addition there is an effective NOx charge scheme set in place since 1992. A charge has been imposed on NOx emissions from large stationary combustion plants since 1992, and gradually extended to smaller plants since 1996 (EEA, 2000: 48; O'Brien & Vourc'h, 2001: 36; for details see ECOTEC, 2001: 53-58).

The Swedish NOx charge is a pure incentive charge, an exception to the tendency of taxing product input, and more importantly is seen as a success case. It is estimated that NOx emissions in 1995 would have been 25% greater without the charge (EEA, 2000: 48). The NOx charge is based on recorded emissions irrespective of the fuel used and levied at a fixed rate.

Revenues from NOx charges are returned to the payers in proportion to their share in the total net energy production (EEA, 2000: 20, 48, 73; for details, see ECOTEC, 2001: 53-58). The Swedish NOx charge scheme allocates net benefits to any producer with emissions lower than the average industry per unit of energy consumed and net costs to those with higher emissions (O'Brien & Vourc'h, 2001: 36, 38; for details ECOTEC, 2001: 53-58).

There are no empirical studies that show the effect of carbon taxes on innovation in industry in Sweden. An interview study concludes that the current energy tax level did not give enough incentives to invest in energy efficient technology in industry (Energidata Göteborg AB et al., 1995 in Johansson, 2000). However, the tax level has been since then doubled to 50% of the general tax level. In contrast some technical developments can be attributed to the introduction of the sulphur taxes and nitrogen charges. These charges have led to development of simpler and cheaper instruments for emission measurements, calculations and evaluations (e.g. SCNR systems for NOx reductions, improvements in existing exhaust gas desulphurisation devices) (Swedish Environmental Protection Agency, 1997 in Johansson, 2000). Amongst others the refunding mechanism for the Swedish NOx charge has been effective in facilitating a dynamic innovation process (ECOTEC, 2001: xi, 53-58).

Finland

The Finnish CO_2 tax, which was introduced in 1990, is among the highest in Europe. In 1994 the CO_2 taxation was amended to cover all primary energy sources except wood, wind power and waste fuel according to their energy content. In addition a component of the fuel duties ('additional duty') applied to all fossil fuel according to their carbon and energy content. Since 1998 the basis for the part of the fuel duties has been only their carbon dioxide content. Additional duty on natural gas is 50% lower than the full rate (Agnolucci, 2004). The fuels used for power production are tax-free. The CO_2 tax rate is kept at a low level.

The initial input tax on electricity was transformed into a general tax on electricity (output tax levied at the consumption level), which means that only the energy content has been taxed since 1997. Since electricity taxation does not depend on the CO_2 content of the fuel used, the government designed the tax on electricity produced by wind, wood and wood-based energy to be refundable (Agnolucci, 2004). CHP installations are granted a preferential treatment.

Tax rates have been substantially increased. In addition, tax rates were differentiated across sectors (EEA, 2000: 65).

The modification of energy tax legislation in 1998 introduced a refund scheme for energy-intensive firms which have paid more than 3.7% of their value added in energy exercise duties as a whole. These firms can apply for a refund of 85% of the tax they paid above the threshold. Annually some €15 million is refunded to energy-intensive firms under this scheme (Agnolucci, 2004: 23).

Without energy taxation, it was estimated that emissions would have reached 4Mt, which is equivalent to 7%, higher than recorded in 1998 (PMOPS, 2000 in EEA, 2000: 47). Most of the reduction is attributed to the taxation on transport fuels. It is estimated that changes in industrial structure and energy consumption in industry account for a quarter of the reduction. Nonetheless the report states that the assessment is uncertain and is likely to indicate the maximum reduction level (PMOPS, 2000 in Hildén et al., 2002). Moreover the analysis does not take into account the improvements in efficiency that would have occurred without the tax or other factors contributing to energy saving and a shift in the use of fuel for energy production (Hildén et al., 2002).

An evaluation study suggests that reduction in the growth rate of energy use on a national level can only partly be attributed to the electricity tax. The more plausible factor could be the general shift in production structure. It is more likely that the low level of the tax accounts for its modest success in environmental effectiveness in the case of industry (Hildén et al., 2002).

Norway

Norway taxes CO_2 emissions through taxation on gasoline, natural gas, oils and coal. The tax is a product tax. CO_2 tax was first introduced in 1991. Since 1993 the fuel charges (e.g. mineral oil, coal, coke and natural gas) have been based exclusively on the CO_2 or SO_2 content (Agnolucci, 2004). From 1999, CO_2 components of several taxes were brought together to make up one single CO_2 tax (National Statistical Offices in Norway, Sweden, Finland and Denmark, 2003).

The CO_2 tax was expanded in 1999 to include the supply fleet in the North Sea, air transport and coastal transport of goods. Ships engaged in foreign trade, processing industry and fisheries are exempted from the tax. Natural gas utilised on the mainland as well as coal and choke used in the cement are also exempted. In addition Norway has a tax on sulphur in fuels which was doubled in 2000. Furthermore the government introduced a CO_2 and sulphur tax on aviation fuels in 1999. This tax applied to both domestic and international air traffic. Tax on international flights was abolished after a few months but the tax on domestic flights remained (EEA, 2000: 70; Schlegelmilch, 2000: 10).

The excise tax on electricity is not differentiated according to the energy sources used in the production of electricity (Agnolucci, 2004).

The Netherlands

Since the introduction of a fuel tax in 1992, the tax rates are based on the energy content as well as the carbon content of the fuels (50% each). An evaluation of the Dutch general fuel tax demonstrates that in 1994 CO_2 emissions would have been 1.7Mt higher than recorded (EEA, 2000: 47, 68).

The ‘regulatory energy tax’ (RET or REB after the Dutch acronym) introduced in 1996 has not yet produced measurable impacts. The tax is revenue-neutral. The Netherlands provide both tax rebates and a tax limit to large energy users in addition to differentiation of tax rates according to the total amount of annual electricity use. The RET/REB scheme exempts large energy users from taxation on excess consumption of gas and electricity above a threshold (Box 2 in de Kam, 2002: 21; see also Lijesen & Mannaerts, 2002).

In addition, small energy users are exempt from the regulatory tax with a zero rate band or ‘tax floor’ for the initial fixed amount of gas and electricity use. In 2001 these tax-free allowances were replaced by a fixed tax reduction of €142 (in 2002) for households connected to the electricity network (de Kam, 2002: 25, 28; Sijm, 2003: 10; Sijm & van Dril, 2003: 81-82; EEA, 2000: 52).

In 1998 the tax limits for electricity and gas were extended. Meanwhile the tax exemption floor remained at the same level.

All the revenues from RET/REB are fully recycled to the taxpayers on a sectoral basis (Agnolucci, 2004). Part of the revenues has been recycled to households through an increase in the income tax-free allowance and in the standard deduction for senior citizens, and through changes in the taxation on personal income. Part of the revenues has been recycled to the business sector through a reduction in the wage component of employers’ payment of employees’ social premiums, an increase in the deduction for small independent companies and through a decrease in the corporate tax rate. Other recycling measures include accelerated depreciation for environmental investments and tax deductions for investments in energy efficiency (Agnolucci, 2004). The tax has made investments in energy conservation more attractive to firms, providing shorter payback times and promoting the use of renewable energy. The tax offers refunds to sectors committing themselves to improve their energy efficiency (EEA, 2000: 47, 68-69; Schlegelmilch, 2000: 9; de Kam, 2002: 28).

The Dutch RET/REB system allows exemptions for natural gas used in CHP installations, heat supplied via district heating, and special arrangements for electricity generated from renewables, biogas and waste incineration (Agnolucci, 2004).

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