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Review of Competitiveness, Trade And Employment Effects of Environmental Taxes

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Introduction

Environmental taxes, as classified by EUROSTAT, refer to energy taxes, transport taxes and pollution taxes (Schlegelmilch, 2002). Unless stated otherwise, in this report we use the term 'environmental tax' as a synonym to energy/carbon tax since as much as 95% of environmental tax revenue in Europe comes from the energy and transport sector (EEA, 2000). Environmental taxes help to reduce energy-related carbon dioxide emissions by placing a financial cost on emissions. As a consequence, it creates an economic incentive to reduce carbon intensity in production processes and shift production to less carbon intensive sectors. Environmental taxes are based on the 'polluter pays' principle, which states that polluting agents – firms, individuals or households – should pay for the damage that their economic activities cause to others (the external costs or externalities). Charging the full social cost of pollution gives agents the incentive to pollute less when the cost of pollution abatement is less than the social cost of pollution. One way of internalising externalities is through environmental taxes (Hoerner and Bosquet, 2001).

However, higher taxes on energy use are likely to be responsible for a range of macroeconomic and structural impacts on the economy – through effects on the price level. These impacts include effects on output, inflation, employment, and competitiveness in particular sectors and/or in a region or country level. The extent to which environmental taxation affects the economy depends on how the revenue from environmental taxes is used to lower taxes on socially valuable economic activities such as employment or investment. In particular, the impact of environmental taxes, especially energy/carbon taxes, on competitiveness and trade potential of a firm, industry or country is difficult to predict, and divergent opinions are found in the literature (OECD, 1997; Mooji and Bovenberg, 1998; Bye and Nyborg, 2003).

The main objective of this report is to review the literature on the theoretical issues and empirical assessments of the impacts of environmental taxes on competitiveness, trade and employment. Other objectives are to examine the possible determinants of competitiveness impacts and to identify potential key sectoral competitiveness impacts in Czech Republic, indicating possible mitigating measures. It is organised as follows: section 0 reviews the literature on theoretical issues on competitiveness and trade impacts of environmental taxes; the literature on employment impacts and the double dividend effect is reviewed in section 0; we review the methods used to assess competitiveness, trade and employment impacts of taxes and empirics in section 0 and 2.4, while a review of the European studies that assessed the impact of environmental taxes is carried out in section 0. Section 3 deals with the potential determinants of competitiveness and trade impacts of environmental taxes, while next chapter examines sectoral competitiveness and trade impacts in the Czech Republic. We identify potential mitigation measures to be taken in order to minimise the impacts of environmental taxes in section 0. Conclusions are in section 0.

Literature review

This section reviews the main theoretical issues relating to competitiveness, trade[1] and employment impacts of environmental taxes. It also reviews the main features of various general equilibrium models used to estimate these effects in several countries, followed by a literature review of the empirical assessments of environmental taxes.

Theory and competitiveness and trade impacts

An energy/carbon tax is a combination of a tax on the carbon content of fossil fuels and a tax on all non-renewable forms of energy (Pearson and Smith, 1991). The rationale underlying this form of tax is that introducing a financial cost on carbon emissions creates an economic incentive to reduce carbon intensity in production processes, stimulating a shift in production to less carbon intensive technologies. The carbon tax would have two main effects on fuel use. First, it would create an incentive for fuel substitution – from carbon intensive fuel sources to those that generate less carbon dioxide per unit of energy. Second, it would encourage energy conservation in the form of reductions in the level of energy consumed.

It is argued that environmental taxes, like energy/carbon taxes, increase costs of affected industries and reduce their economic performance, including international competitiveness. Furthermore, the loss of international competitiveness is related to a decline in net exports and, in the extreme case, the relocation of industries, which introduces a negative impact on GDP and employment. On the other hand, the tax revenue generated by the environmental tax allows a reduction in other distortionary taxes in the economy, which could have a positive impact on GDP and employment. This is named the double dividend theory, and will be discussed in detail in the next section. We will first address the concept of competitiveness and its different levels of analysis before discussing the issues involving the theory of double dividend and its empirical implications.

Due to its dynamic and subjective context, competitiveness is difficult to define (OECD, 1997). In addition, competitiveness is closely linked to the concept of comparative advantage[2], and can be viewed at different levels – national, industrial or sectoral, or at the firm level – as well as domestically and internationally. The concept of country's competitiveness is often ambiguous. The World Economic Forum defines competitiveness as "the ability of a country to achieve sustained high rates of growth in GDP per capita". The International Institute for Management Development defines it as "the ability of a country to create value added and thus increase national wealth by managing assets and processes, attractiveness and aggressiveness, globally and locally, and by integrating these relationships into an economic and social model". According to another definition, competitiveness is "the country's ability to ensure the highest possible remuneration of production factors in the society, given full employment and long-term balance in the current account" (OECD, 1997).

[1] This section does not refer to the wider trade theory, which is extensively covered in Pearson, (2000), Chapter 7 – *Trade and Environment: an overview of theory*.

[2] Comparative advantage is often related to the country's factor endowments, such as its labour force, natural resources, and capital stock.

According to OECD (1997), the clearest analytical way to look at competitiveness is at the firm level, since national and even industry comparisons are based on aggregate measures. The competitiveness of the firm is considered to be the most precise level to evaluate the potential effects resulting from an energy/carbon tax, in the sense that the firms face the extra production costs. Their ability to maintain or increase their market share and profitability reflects their competitiveness and that of both the industry and the nation. Faced with an energy/carbon tax, firms generally have the following options:

a) If the tax is not significant to the firms' costs, the effect is minimal and operations are little affected;

b) If the firms act as price-takers, they can shift the extra cost to their consumers;

c) The firms can modify the production of their products to reduce the carbon intensity, via substitution of lower carbon-intensive inputs and/or introduction of more carbon efficient processes;

d) The firms can relocate production to locations where they are not subject to the tax;

e) Firms can cease operations.

OECD (1997) concluded that competitiveness – in terms of the ability to maintain or increase market share – results from factors such as technical efficiency, labour, product quality, and how an energy/carbon tax is reflected in the firm's cost structure. *Ceteris paribus*, the change in competitiveness will be determined by differences in factor prices, the firm's ability to minimise the cost impact from the tax, and the impact of the change in the various firms' costs on relative product prices. The ability to adapt to changes in factor prices can be considered as one measure of the firm's ability to compete. As an energy/carbon tax represents a permanent increase, the firm's ability to adapt relates to its ability to minimise the carbon content in its products or to avoid such tax via changing the location of production. Thus, the significance of the impact of the introduction of an energy/carbon tax is likely to be affected by the ability of a firm or sector to pass on the tax to consumers – which is affected by the extent to which competition exists, the extent of the tax itself, the extent to which emission mitigation can be taken at low or minimal cost and the potential for relocation of the industry to another country without the environmental tax.

Schlegelmilch (2002) argues that the crucial question in the competitiveness debate is to what extent a government can burden its energy-intensive industries without the companies relocating or closing down in the short run while providing incentives to increase demand for efficient commodities of advanced industries. Furthermore, to what extent may a country go ahead with implementing an ecological tax reform[3] if other countries have not yet done so, the so called "national go-it-alone effort"? Schlegelmilch (2002) claims that one or two countries must lead the way and experiment, learning from their experiences, and then other countries will follow on if the results were positive. The author cites examples of Denmark and the Netherlands as countries at the forefront of environmental taxation in Europe. Denmark has applied differentiated tax rates depending on the existence of environmental agreements and on the energy intensity of various processes, gradually increasing rates while recycling tax revenues through energy investment grants and

[3] The term environmental tax reform (ETR) is widely used to identify those situations where environmental taxes are combined with tax reductions in other sectors of the economy in a way that the bundle of tax changes is revenue neutral.

reduction of social security contributions. The Netherlands simply differentiated taxes according to the amount of energy consumed. Using these countries as examples, Schlegelmilch (2002) concludes that no company relocated abroad because of environmental taxes; on the contrary, the export of environmental technologies increased in Denmark.

Theory and employment impacts (the double-dividend effect)

This section is based on previous studies prepared for the European Commission (e.g. Heady *et al.*, 2000; EEA, 2000). The potential for an employment increase resulting from the introduction of environmental taxes and the subsequent reduction of distortionary taxation is a potentially important motivation for the introduction of environmental taxes. The theoretical literature relevant to the relationship between environmental taxation and employment creation is centred on the suggestion by Pearce (1991) that environmental taxation could lead to a double dividend. Environmental taxes may lead to environmental improvement at the same time as leading to significant revenues for the government. These revenues lead to potential for the reduction of other, more distortionary taxes (e.g. taxes on labour, capital), and consequently potential for improved efficiency in the economy. In other words, the first dividend would be the environmental impact caused by the environmental taxes increases, which change consumption patterns and encourage energy efficiency. The second dividend would come from the revenue generated by the taxes, which can be used in public expenditures or compensating the reduction of other taxes in the economy.

There seems to be a consensus in the literature on the beneficial environmental effects of shifting the tax burden from labour to polluting outputs, but there is far from the consensus on the consequences of such a tax reform for non-environmental welfare. In addition, some authors (e.g. Schlegelmilch, 2002) argue that the macro-economic impacts of environmental taxes are often over-estimated since other factors such as exchange rates, labour market developments, tariff agreements, interest rates, demand, and so on, have a much larger influence on the economic performance in general and on employment in particular.

The connection between the double dividend and employment creation arises because one possible distortionary effect of taxation is the reduction of employment. Such a reduction in employment could result from taxes that are related to employment, such as income tax and social security taxes, but also from taxes that affect the real value of workers' wages, such as value added tax and excise duties. Thus, one aspect of the double dividend could be an increase in employment that follows from a reduction in one or more of these taxes.

Reductions in taxes may lead to increased employment, although the way in which this is achieved depends on the nature of the labour market. If there is involuntary unemployment, with the supply of labour being greater than the demand for labour, then an increase in labour demand may be achieved by reducing costs of employing labour, for example by reducing employers' social security taxes[4]. If there is no involuntary unemployment then an increase in employment requires an increase in labour supply. This could be achieved by increasing the returns to work, by reducing direct taxes on labour income or by reducing

[4] It is important to note that any increase in employment from this policy does not necessarily imply a reduction of unemployment by the same amount (or at all), because the increased availability of jobs may induce additional people to enter the labour force.

sales taxes on goods that workers wish to buy, provided that workers respond positively to such increased incentives.

Although the focus of the policy discussion has been mainly on employment, it is important to note that a double dividend could arise without any change in employment, simply by reducing the distortions in consumer choice that result from sales taxes. Indeed, a large part of the theoretical double dividend literature does not address issues of employment: it assumes that there is no involuntary unemployment and places no particular value on additional employment creation[5]. The theoretical literature that has dealt explicitly with employment has concentrated mainly on the case of involuntary unemployment, and the double dividend that is created in this case is often referred to as the "employment double dividend".

A distinction that has been drawn in the literature is that among the strong, intermediate and weak double dividend (Goulder, 1995). The weak double dividend is simply concerned with what is done with the revenue from environmental taxes, saying that it is better to use this revenue to reduce the rates of distortionary taxes than to provide lump-sum payments to citizens. The intermediate form states that it is possible to identify one or more distortionary taxes such that a revenue-neutral substitution of an environmental tax for this tax involves zero or negative gross welfare cost. The strong double dividend says that the replacement of some existing taxes with environmental taxes will reduce the distortionary cost of raising the current level of government revenue. In other words, the strong form of double dividend says that substitution of an environmental tax for a typical or representative distorting tax will necessarily improve gross welfare.

The weak double dividend has been shown to hold in almost all empirical models found in the literature. The most important exception is when the lump-sum payments are markedly better than tax reductions at raising the incomes of poor households[6]. However, the details of these results are not worth discussing here because the weak double dividend is simply about how to spend the environmental tax revenue. It says nothing to enhance the case for environmental taxation. It is the strong double dividend that needs to be true in order to claim that environmental taxes can contribute to the efficiency of the economy in other ways than improving the environment. Unfortunately, the conditions for the truth of the strong double dividend require more sophisticated analysis, and there is a wider range of disagreement.

Because the strong double dividend is concerned with reducing the distortionary cost of the tax system, the analysis can only be fully understood in the context of the theory of optimal taxation: a theory that deals with the problem of minimising the distortionary costs of a tax system that generates a given level of government revenue. The first important fact to be aware of is that the theory of optimal taxation typically does not concern itself with

[5] The idea is that there is very little gain in individual welfare in moving somebody from voluntary unemployment into employment, in contrast to the very substantial gains in moving somebody from involuntary unemployment into employment. Of course, both types of employment creation can improve tax revenue, and that effect is captured in the theoretical literature even when issues of employment are not addressed.

[6] As this sentence illustrates, the theory can also take account of the distributional effects of taxes. However, these have not been paid much attention in the double dividend literature and so will not be emphasised here. For a discussion about distributional effects of environmental taxes the reader can refer to Weir *et al.* (2005).

environmental issues. It is simply concerned with raising revenue efficiently, and so we can refer to such taxes as "revenue-optimal". Thus a revenue-optimal set of taxes is one that minimises its effect, as measured by a "distortionary cost", on the actions of market participants, without regard to their environmental effect[7]. If a country has adopted a revenue-optimal set of taxes, there is no possible change to those taxes that will raise the same revenue at a smaller distortionary cost. In particular, the imposition of a higher rate of tax on a good that damages the environment cannot reduce the distortionary cost of the tax system, and can generally be expected to increase it. This implies that the strong double dividend cannot be true in an economy where the taxes are revenue-optimal.

This does not mean that there is never a strong double dividend because it is unrealistic to suppose that countries currently have revenue-optimal taxes. What it does mean is that a strong double dividend exists when (and only when) the imposition of an environmental tax moves the tax structure closer to the revenue-optimum. Thus, those parts of the literature that claim to show the existence of a strong double dividend are based on situations in which the existing taxes are not revenue-optimal and environmental taxes produce a move towards the revenue-optimum. In contrast, the papers that show the absence of a strong double dividend assume either that taxes are already revenue-optimal or that the environmental tax does not move the system towards revenue-optimality. Which of these situations applies to any particular country is an empirical question and this is where the computer simulation models are useful. Nonetheless, the theory of optimal taxation can provide some general insight by indicating the likely structure of revenue-optimal taxes, and whether the introduction of environmental taxes is likely to reduce the distortionary effects of taxation in a typical EU country.

The **key determinants** of whether there may be a double dividend effect resulting from the introduction of a carbon tax are described below, along with the justification for their impact. The absolute **level of the revenues** that the environmental tax can raise is a determinant of the extent to which a double dividend can be obtained because it will determine how much other taxes can be reduced. In some cases in the past, revenues from environmental taxes have been overestimated, for example by not taking into account adaptive behaviour. The size of the potential revenues from the application of a carbon tax depends on the rate of the tax and the level of carbon being taxed. The relationship between revenues and the tax level is not linear – as higher levels of tax induce different behaviours on the part of producers.

The **use of the revenues** from the introduction of a carbon tax will impact on the extent to which an employment double dividend is experienced. The literature does not specifically deal with the practical question of which taxes on labour should be reduced to get the largest employment double dividend. Income tax or social security taxes could be reduced if employment increases are an objective of the policy, though smaller impacts may be felt through reducing other taxes such as value added tax on goods. Intuitively, it seems likely that it should be social security taxes because they are more closely linked to employment than income tax, which can cover non-labour incomes and is progressive (thus bearing less heavily on the incomes of lower-paid workers).

[7] This concept of revenue-optimal taxes takes account of all the effects of tax changes, including those that result from the shifting of the tax burden between different groups in society.

The extent to which there is distortion caused to the labour market by taxes (**the tax structure**) that may be reduced through the use of carbon taxes is clearly linked to the employment double dividend that may be anticipated. Thus, the level of taxes on labour will impact on the likelihood of a double dividend. Also, the **degree of substitutability** of labour for energy and the potential for substitution of capital and energy are important determinants of the potential for an employment double dividend. If the potential for substituting labour for energy is high then as the price of energy rises labour can be substituted for energy. The degree of substitution possible between capital and energy also impacts on the potential for a double dividend as energy prices rise, so capital is substituted for energy. The relationship between these two is crucial for an employment double dividend to exist.

Heady *et al.* (2000) note that the greater the elasticity of substitution between labour and energy, relative to the elasticity between capital and energy, the more likely it is that a double dividend will exist. The sensitivity of estimates of the double dividend to these parameters is shown in analysis contained in Heady *et al.* (2000). As expected, reducing the elasticity of substitution between capital and energy increases the employment double dividend, as the energy tax has a smaller distortionary effect on the quantity of capital used in production. In the extreme case of doubling the elasticity, the double dividend disappears. In general, the estimated elasticities of labour with respect to energy and that of capital with respect to energy favour a double dividend when taxes are shifted from labour to energy. Although the magnitude of this impact is still uncertain, the empirical evidence supports the case for an employment effect on these grounds.

Another relevant factor is the **mobility of capital**. Theoretically, if capital is relatively immobile internationally then it can absorb some of the carbon tax and less falls on factors such as labour, enhancing the double dividend effect. The impact of the potential to "tax shift" has been identified by a number of studies and Jansen and Klaasen (2000) suggest that the tax shifting effect is as important as the tax interaction effect in determining a double dividend.

In most European countries labour is taxed more heavily than other factors (**differential taxation between factors of production)**. If we rule out tax shifting by assuming that all inputs into production are elastically supplied at fixed cost (energy and capital because they are internationally mobile, and labour because the wage is fixed), it can be shown that minimisation of production costs requires that all factors are equally taxed. Thus a shift away from the taxation of labour to the taxation of other factors can be expected to reduce production costs. This will reduce the prices that workers face for the goods they wish to consume. In this case, the move from payroll taxes to taxes on other factors will not be offset by an increase in wages, and employment will increase.

This analysis looks as if it will lead to the existence of an employment double dividend for energy taxation, even without shifting the tax burden. However, the situation is not quite that simple, for two reasons. First, the argument in the previous paragraph was concerned with increasing the tax on all non-labour factors. An increase in energy taxation alone may improve the relative costs of labour and energy, but at the cost of possibly worsening the relative costs of capital and energy. Second, as energy is a produced good (although possibly imported) it may well have already been taxed, and so an additional tax on its use could lead to it being over-taxed. Thus, it is not clear that energy taxation will always lead to an employment double dividend. However, it is more likely to happen if energy is more substitutable with labour than with capital, as that would make the correction of the relative costs of labour and energy more important than the worsening of the relative costs of energy and capital.

Differences in estimates may arise from distinctions regarding whether the **labour market** is assumed to be in full employment or not and also the extent to which trade unions are considered in the models. Some studies have also examined the linkages between environmental improvement and labour supply. Assumptions made about the degree of clearing on the labour market will affect the impact of the introduction of a carbon tax on employment. The distinction has been drawn between the case of involuntary unemployment, whereby a double dividend may be achieved through reducing the costs of employing labour, and the case of full employment where an increase in employment requires an increase in the labour supply through e.g. reducing direct taxes on income.

The modelling of the labour market is divided into those models that assume full employment (or voluntary unemployment) and those that assume involuntary unemployment. The former may generate a 'double dividend' in the sense that employment increases as the incentives to supply labour become stronger. However, as the people who have moved into employment were previously voluntarily unemployed, the benefit to society is very different from the benefit created when involuntary unemployment is reduced. The two sets of employment effects are therefore not really comparable, although they are frequently compared.

The impact that **trade unions** may have on the long-run potential for an employment double dividend has been highlighted in the literature. Schöb (2003) presents a review of the issues involved. In summary, some authors suggest that in the presence of trade unions in the long run the net-of-tax wage is increased by the same amount as the labour tax rate is reduced, thus eliminating the short-run employment dividend. In other words, there is no long-run employment dividend (Brunello, 1996; Carraro *et al.*, 1996). However, Schöb (2003) shows that this result depends on a strict assumption of non-constant unemployment income (e.g. benefits), which does not always hold, especially for low-qualified workers. Schöb (2003) concludes that the long-run employment effect may still be positive.

Schwartz and Repetto (2000) examine the impact that the **quality of the environment** has on labour supply and consequently on the double dividend debate where there is an environmental improvement. They find that these impacts are likely to be small, though they may offset some of the impacts of higher prices from the introduction of carbon taxes on labour supply. For a carbon tax, however, this impact is likely to be small.

The degree to which **labour supply responds to changes in prices** has been investigated in a number of papers. Some argue that the tax-interaction effect cancels the double dividend, whereby higher prices for carbon-intensive goods may lead to reductions in labour supply. Goodstein (2002) argues, however, that price level increases in fact lead to positive impacts on labour supply through the lowering of disposable incomes and reducing wage substitution effects between married couples. Goodstein also suggests that the empirical literature shows there is a positive link between price level increases and labour supply. Hence, in the case of an economy under the assumption of full employment, there may be greater employment gains than is suggested to be the case in some of the estimates for the double dividend.

From the above discussion, we can conclude that there is a vast literature on the potential double dividend effects of the introduction of an energy/carbon tax. Furthermore we should note that the double dividend literature does not consider competitiveness impacts much in theoretical terms, though competitiveness will have a significant impact on the employment consequences of the introduction of an environmental tax.

Assessment methodologies for competitiveness, trade and employment impacts

Approaches to assessing economic effects

Alternative approaches can be used to measure changes in the economy induced by an environmental tax or policy. In addition to generating direct effects, environmental taxes can result in indirect or induced economic effects across the economy as a whole or in related sectors of the economy. From the industry perspective, when the policy has significant impacts on the costs of producing a particular good this may affect the demand for substitute and complementary goods and services produced by other sectors. When the change in demand for the substitute goods is followed by a change in their prices, this may lead to indirect effects on producers and consumers of the substitute good or service. These indirect effects may be either negative or positive, depending on the supply and demand relationships that are affected by the environmental policy. A policy that leads to significant direct compliance costs for one sector may nevertheless generate net gains for the economy as a whole, as a result of changes in the demand for different goods and services. Alternatively, it may create net losses to the economy as a result of investments being diverted from activities that would increase output. Table 1 summarises these general approaches.

Economic models focussing on the **supply-side** of the economy use supply data (e.g. labour supply or energy supply) to generate estimates of the impact that might occur from changes in policy measures on the level of economic activities. The obvious failing of such models is the lack of any consideration of demand effects. This approach also fails to capture policy-induced effects properly because new policies may be implemented in a different manner than previous policies, meaning that data for the actual context is invalid in another context. The use of supply-side data may be useful in providing order-of-magnitude estimates of the indirect effects arising from a change in the environmental policy when the use of more sophisticated methods is constrained.

The **demand-side approach** assesses the economic impacts of an environmental policy through a range of different models, for example, input-output models; Keynesian multiplier-based models; and econometric analysis for estimating the impacts that expenditure or compliance costs have on the economic variables. At the macroeconomic level the demand-side approach recognises that the implementation of the environmental tax by individual users of energy and energy-consuming products is influenced by a number of policy parameters, especially ones that influence the price of energy and that of energy-using products. At the industry level, the macroeconomic modelling approach assumes that environmental taxes affect companies' behaviour as both buyers and sellers, affecting interactions at inter- and intra-sectoral levels. This is the only approach capable to predict the full net effects generated by a change in the environmental policy. Two types of models are used for analysing effects at the macroeconomic level, (a) econometric models and (b) general equilibrium models.

Table 1: Approaches to assessing wider economic effects

Approach	Scope of Analysis	Methodology	Data Sources
Expanded CBA	Wider effects but variable, depending on the positive identification of linkages.	Analysis of microeconomic data; partial equilibrium analysis	Survey data and statistics
Supply-side approaches	Direct positive or negative employment effects	Analysis of microeconomic data and job losses surveys	Survey data
Demand-side approaches	Direct positive employment effects	Calculation of manpower per unit of expenditure	Statistics on jobs per unit of expenditure
	Direct and indirect positive employment effects	Input-output and multiplier based calculations using changes in final demand	Statistics on environmental expenditures and input-output tables
	Direct and indirect positive or negative economic growth effects	Analysis of microeconomic data, investment and growth surveys	Survey data
Econometric and Macroeconomic models	Net employment and GDP effects of environmental expenditures	Behaviour equations used to link changes in expenditure to changes in inter-sectoral supply and demand	Econometric models and input-output equations
Computable General Equilibrium models	Net employment and GDP effects of environmental measures	Modelling of long-run changes in supply and demand equations until all markets reach equilibrium	Detailed data on inter-sectoral linkages, including input-output data

Source: RPA Limited (2001) "Employment Effects of Waste Management Policies" a report prepared for EC-DG Environment.

Econometric models statistically relate a variable of interest (dependent variable) to several macroeconomic and policy variables in order to investigate which of these variables impact the dependent variable. The estimated coefficients of the policy variables indicate the significance and magnitude of the impact of the policy variable(s) over the relevant variable or indicator. A common use of econometric models in policy analysis is the estimation of the demand function for specific goods or services in order to observe how this demand is affected by important policy variables. For example, economists may estimate the demand for energy and, consequently, the price-elasticity and/or income-elasticity of the demand for energy consumption. These statistics are important to foresee how policies that affect energy prices will impact the consumption of energy. This type of analysis is also very useful at the microeconomic level, when individual (household or firm) data are available.

Both the demand and supply side effects can be evaluated through the use of **Computable general equilibrium** (CGE) models. Such models are the most sophisticated type of top-down approach and are used to evaluate the benefits and costs of implementing a proposed environmental policy. They are able to quantify direct and indirect effects of environmental taxes on many aspects of the economy, like its structure and predicted growth, and the allocation of resources. CGE models take into consideration both demand and supply interactions, being able to deal with longer planning horizons, which allow analysts to examine long-term movements in a wide range of economic variables. Essentially, these models simulate markets with systems of equations specifying supply and demand behaviour across the investigated markets.

According to the pertinent literature, a reasonable general equilibrium model is supposed to have the following elements: (i) a description of the utility functions and budget constraints of each household in the economy; (ii) a description of the production functions of each company in the economy; (iii) the government's budget constraint; (iv) a description of the resource constraints of the economy; and (v) assumptions relating to the behaviour of households and companies in the economy.

General equilibrium models compare two distinct states of the economy, before and after the implementation or consideration of the policy. The difference between the two states represents the net economic benefit or cost of implementing the environmental policy in question. In general, CGE involve the following steps:

(i) the baseline or pre-policy implementation world is represented by a system of empirical equations describing demand and supply in all relevant markets. The solution to this system yields a pre-policy vector of production and consumption prices;

(ii) the proposed policy change is then modelled by shifting the supply and demand curves appropriately;

(iii) the model is re-solved, yielding a new vector of production and consumption prices;

(iv) the overall net benefit or cost of the proposed policy is determined by examining the difference pre-policy and post-policy vectors of prices.

The Main Models Used in Europe[8]

The ***HERMES*** model (European Commission, 1993) is an econometric model, with a fairly complex specification of macroeconomic relationships. However, it has some characteristics of a general equilibrium model in that the specifications of production, consumption and labour supply are consistent with the CGE models that are typically used in analysing optimal tax and double dividend issues. It does not assume perfect competition in the product market (while most theoretical models do) and has a real wage determined by productivity growth and unemployment. The production function incorporates capital, energy, labour and intermediate goods in a nested CES form, with capital nested with energy and labour with intermediate goods.

[8] Based on Heady *et al.*, (2000).

The ***EUROGEM*** model is from the same stable as *HERMES,* but is an integrated Europe-wide model. The production structure is similar to *HERMES*. The labour market is not assumed to clear, and its analysis is extended to include a union bargaining objective function, which is a function of the level of employment and the difference between the wage rate and the level of real income for an unemployed person. Union policy thus determines the real wage rate and the effective level of unemployment. This feature, along with the integrated EU-wide modelling, distinguishes it from *HERMES.*

The ***GEM-E3*** model (Capros *et al.*, 1996) is a more classical computable general equilibrium model, with more emphasis on consistency with general equilibrium theory than detailed estimation of a macroeconomic model. The production function structure is similar to that of *HERMES*, but a bit more complicated. The most important difference is that it assumes perfect competition in all markets, including the labour market. This means, strictly, that there is no unemployment.

The ***E3ME*** model is an econometric model, but is different from *HERMES* in having less concern for the structures of economic theory. It is similar to *HERMES* in having imperfect competition and a wage determination equation that incorporates productivity growth and unemployment. From the point of view of this study, it is difficult to compare with the other two models because it does not estimate a production function, only input demand functions. In some cases, production functions can be inferred from input demand functions, but this is not the case for *E3ME* as the input demand functions are not consistent with the constant returns to scale assumption that is made in general equilibrium models.

Table 2: Main features of empirical models used in the European environmental tax literature

Model	Key Economic Assumptions	Special Points
Hermes	CGE model with unemployment. Uses nested CES production functions. National and EU applications.	Detailed development at national level in EU. Structure is transparent. Real wages determined by productivity growth and unemployment.
EUROGEM	Similar to HERMES. National and EU applications.	U-wide model. Real wages now also depend on trade union bargaining objectives, which are a function of employment and real income differentials between workers and the unemployed.
GEM-E3	Classical CGE model with full employment. Run at EU-12 and EU-15 level	Structure has more emphasis on consistency with general equilibrium theory than with detailed estimation of structural equations. Information on model structure is cursory.
E3ME	Econometric model with less basis in economic theory. Assumes unemployment.	No production functions specified; only input demand functions with increasing returns. Cannot derive underlying productions functions from them.
HONKATUKIA	Model for Finland only. Dynamic CGE model with	Firms are imperfectly competitive, which allows some of the tax to be passed on in

	relatively simple structure and full employment.	higher prices. Implications of environmental for overall efficiency of economy remain unclear.
LEAN-TCM	Similar structure to HERMES with unemployment.	Real wage depends on tightness of labour market

Source: Heady *et al.,* (2000).

The ***HONKATUKIA*** model (Honkatukia, 1997) is a full employment, dynamic CGE model with a relatively simple production structure. Its novel feature is the treatment of firms as imperfectly competitive. With free entry and exit, firms' profits are driven to zero. It is not entirely clear what the implications of this structure are for the double dividend. The author notes that, with imperfect competition, the increase in consumer prices following tax changes will be greater, as prices are based on a mark-up on costs. Furthermore, since mark-up pricing implies inefficiency, the tax policies may reduce or exaggerate these inefficiencies. In practical terms, however, we cannot say what overall impact imperfect competition will have, unless the degree of competition is specifically modelled as a sensitivity parameter. The author has not done this.

The ***LEAN-TCM*** model also has some features that are similar to *HERMES.* The production structure is a nested one, with labour and an 'energy-capital' aggregate. The labour market again does not clear. Unlike the *EUROGEM* model, the real wage is not determined by a specific union bargaining objective function but by an equation in which the real wage increases as a function of the tightness in the labour market (difference between the actual and full employment levels of labour supply). Table 2 summarises the main features of the models described above.

Empirical assessments of competitiveness, trade and employment impacts

- Competitiveness and trade assessments

Nicoletti and Oliveira-Martins (1992) used GREEN, a global dynamic applied general equilibrium model, to study the economic effects of policies aiming to reduce carbon dioxide emission in Europe. Particularly, they were concerned with the implications of the European Commission (EC) proposal to impose a mixed energy/carbon tax for the world distribution of emissions and the competitiveness of the EC economy. GREEN incorporates full bilateral trade linkages between all regions of the world, and allows for a large and flexible regional disaggregation, while at the same time preserving sufficient sectoral detail. These characteristics make GREEN particularly well suited for the analysis of international competitiveness issues and the simulation of different kinds of regional and global agreements to reduce carbon emissions.

OECD (1997) argued that computable general equilibrium models show the existence of a wide range of potential leakages[9] due to the implementation of unilateral carbon taxation. However, a review of critical assumptions shows that results should be considered with great caution, as the treatment of intra industry trade, exchange rates adjustments and

[9] The term 'carbon leakage' refers to the relocation and shifting of production to lower carbon regulated countries.

capital mobility, let alone technology, is often inappropriate. Macroeconomic models based on econometric analysis generally find lower effects on competitiveness, or even negligible when energy/carbon tax revenues are recycled in the economy through a reduction of existing distortionary taxes.

OECD (1997) presented a number of studies that empirically tested the hypotheses that the expenditures for pollution abatement and control have caused a loss in competitiveness. For example, using a model of international trade which assumes trade flows are determined by comparative advantage, Tobey (in Adams, 1997) looked at the evolution of trade of industrial products generally considered as pollution-intensive – mining sector, primary metals, paper and pulp, and chemicals – and concluded that the important and consistent finding of the empirical tests was to show that the hypothesis that environmental regulations alter patterns of world trade is not supported empirically. Grossman and Krueger (in Adams, 1997) examined whether pollution abatement costs influenced the patterns of bilateral trade and investment with Mexico, concluding that Mexican exports to the US are determined largely by the factor uses of the industries. A variable reflecting pollution abatement costs in the US industry adds nothing to the explanation of the sectoral pattern of bilateral trade.

Jaffe *et al.* (1995) reviewed and analysed over one hundred studies that looked at the potential effects of environmental regulation on US competitiveness and concluded that there is relatively little evidence to support the hypothesis that environmental regulations have had a large adverse effect on competitiveness. Although the long-run social costs of environmental regulation may be significant, including adverse effects on productivity, studies attempting to measure the effect of environmental regulation on net exports, overall trade flows, and plant location decisions have produced estimates that are either small, statistically insignificant or not robust to tests of model specification. The authors' rationale for this conclusion is, however, qualified by noting:

a) Existing data is severely limited and the difficulty of measuring the stringency of environmental regulation makes it difficult to determine statistical significance between regressions on regulation and economic performance;

b) Except for the most heavily regulated industries the cost of compliance is not high enough to affect competitiveness;

c) The stringency of regulation among the major western industrial democracies are roughly equivalent and do not alter trade patterns;

d) In those cases where there are substantial differences between domestic regulatory regimes, multinational investors do not substantially alter the environmental performance of their investment;

e) In countries with lower environmental regulation, investments by domestic companies are often built to higher environmental standards, thus mitigating the difference in statutory standards.

According to OECD (1997), Barker and Johnstone (1997) reviewed several model-based analyses looking at carbon abatement policies in OECD and Annex I countries, as part of a study on competitiveness and taxation, concluding that estimates of carbon leakage can vary from –45 to 80 percent. It is noted that leakage increases sharply with the carbon/energy tax, and the highest leakage occurs in models based on trade theory with homogeneous products, undifferentiated by region of origin. The last point illustrates the importance of the elasticities of substitution between domestic and traded goods. The authors concluded that if one assumes that such elasticities are high, competitive losses and leakage would be correspondingly high. However, the energy-intensive sectors are not particularly elastic and those studies that draw on econometric evidence find that these elasticities are low and the competitiveness and leakage effects are small. Two other important factors in the analysis of leakage are:

a) The treatment of exchange rates – if exchange rates are assumed to adjust to new price levels, they will compensate losses in price competitiveness caused by the tax;

b) Capital mobility – if full capital mobility is assumed, for example, to equalise rates of return across all activities worldwide, a common assumption in global CGE models, the risks of relocation are completely obviated. In that respect, it should be noted that foreign direct investment from OECD countries goes mostly to other industrialised countries (Annex I).

Recently, Dresner *et al.* (2006) described results obtained in an EU project (PETRAS – Policies for Ecological Tax Reform: assessment of social responses) that aimed to address the question of how to make ETR policies more acceptable among the general public, industry included. The authors claimed that perceived impacts on competitiveness and low-income groups is an important political barrier to the introduction of environmental taxes, particularly energy taxes. In this regard, Dresner *et al.* (2006) mentioned a Danish study of corporate stakeholders' responses to applied energy taxes. "Aiming at developing a better understanding of how companies decide to respond to energy taxes, an investigation of the decision-making processes showed that they depend on a complex set of variables of which environmental taxes are only one…companies do not behave like the rational economic actors assumed in the econometric models, a finding which can explain the well-known 'energy efficiency gap'. Instead, the culture of the business and the surrounding society played a very significant role" (Dresner *et al.*, 2006).

- Employment assessments

Some economists have argued that substituting environmental taxes for pre-existing distortionary taxes on income may yield the double dividend, but others suggest that environmental taxes typically exacerbate, rather than alleviate, pre-existing tax distortions. For example, Mooji and Bovenberg (1998) explored how inefficiencies in the initial tax system affect the potential for a double dividend. They concluded that, in a model for a small open economy with only labour and a polluting input as factor of production, non-environmental welfare[10] declines, suggesting that there is a trade-off between environmental quality and private incomes. That is, an increase in the supply of the public good of the environment is associated with a higher tax burden that reduces private incomes. However, other factors of production, such as capital, are important for the non-environmental consequences of environmental tax reforms. Mooji and Bovenberg, (1998) showed that incorporating capital creates the potential for a double dividend by inducing a so-called tax shifting effect, which means that an environmental tax reform may move the tax system closer towards its non-environmental optimum if the tax system is sub-optimal initially.

[10] Those related to the labour and capital markets.

Ziesemer (1995) argued that a conventional double dividend policy – defined as reduction of greenhouse gas emissions and unemployment through taxation of energy and carbon dioxide emissions and subsidisation of wage costs – and the aim of keeping international competitiveness intact are mutually exclusive concepts. It is suggested that a double dividend policy that aims reducing greenhouse gases emissions and unemployment without violation of international competitiveness has to tax energy use and carbon dioxide emissions of households and should use the revenues to subsidise investment in energy saving technologies to reduce costs to firms. Reduction of energy coefficients lowers marginal costs and prices and therefore increases competitiveness and employment in an environmentally friendly way and may encourage other parts of the world to participate in greenhouse gas emission reduction policies. In summary, subsidies on investment in energy-saving technologies paid out of carbon and energy taxes are a better way to stimulate competitiveness and employment and achieve emission reductions than wage subsidies are, if policy makers want to safeguard energy-intensive sectors.

Honkatukia (1997) reports on a model for Finland. The model was run for a base case where taxes on carbon equivalent to about $13/tonne. The model then looked at further increases of 50-200% with different ways of revenue recycling: through lump-sum transfers, through social security payment reductions and through social security payment reductions applied selectively to labour intensive sectors. The simulations also looked at two cases of overall investment; one where it was fixed in each sector and the other where it was fixed in aggregate.

The results show that the base case generates virtually no double dividend. Although it is not explained, this is possibly due to the fact that the revenues are not recycled. In the other simulations, where revenues are recycled, some employment increases are generated relative to the baseline. With aggregate investment fixed and tax increases of 50% on carbon, the employment increase is 0.05%, a figure that is much lower than those predicted in the Europe-wide studies. While the tax increases are not comparable, it is instructive that the impacts are smaller. This may be the result of elasticities of substitution between labour and capital/energy being the same as those between capital and energy. The model shows that constraining capital movements makes the employment effects smaller; when each sector has to keep retain its overall capital level constant, the employment effect is only 60 percent of the above. The model also shows that a discriminatory way of recycling the tax revenues is not desirable. The employment effect is smaller than when all sectors are treated equally. Finally the environmental benefits in all cases are very small; carbon emissions changes are negligible. Another study was conducted for Finland by Alatalo (1998). Using a general tax of $35 per tonne of carbon dioxide, and reducing social security contributions, both production and employment would rise by between 0.2-0.4 per cent.

Heady *et al.*, (2000) presented some conclusions that might be drawn from the double-dividend literature, paying particular attention to factors that could be relevant to the construction of empirical models. The authors concluded that international co-operation might be useful in minimizing the loss of international competitiveness that could result from introducing environmental taxes. International competitiveness is not considered in the theoretical literature on the double dividend, which assumes that exchange rates adjust to maintain equilibrium in the balance of payments. However, it is captured in the empirical literature.

Parry and Bento (2000) explained the different components of the welfare effects of alternative environmental policies in the presence of labour taxation, providing a conceptual framework for interpreting their numerical results. The authors extended previous models by incorporating taxfavoured consumption goods. In this setting, the efficiency gains from recycling environmental tax revenues are larger because pre-existing taxes distort the consumption bundle, besides distorting factor markets. They concluded that revenue neutral emission tax can produce a significant double dividend, and that the efficiency gains from emissions taxes over grand fathered permits are also larger than previously recognised in the literature.

Hoerner and Bosquet (2001) reviewed 44 studies containing 104 distinct simulations of environmental tax reform in Europe and found that when tax revenues are used to reduce other distorting taxes, the economic outcome is better than if those revenues are not so distributed (the weak double dividend), in terms of both employment and GDP. In the studies reviewed by Hoerner and Bosquet (2001), 74% of the simulations predicted that environmental tax reform (revenue neutral) will create jobs on net and an additional 4% show no change in employment. The authors concluded that the results suggested a positive employment dividend is possible in certain circumstances when revenue recycling occurs through cuts in social security contributions, which directly influence the price of labour.

As can be seen in Table 3, as many as 86% of the simulations that recycled tax revenue through reductions in social security contributions resulted in net employment increases, the largest percentage of any tax recycling option. This result is magnified when reductions in employers' social security contributions are targeted at low-income workers. The authors claim that European unemployment consists to a large extent of low-income and low-productivity unemployed, who face technological change that has reduced the demand for low-skill labour. In addition, low-income workers in general have higher elasticity of labour supply than that of other workers; and low-income labour tends to be a good substitute for energy and capital, which suggests that reducing social security contributions encourages a shift to a more labour-intensive economy (Hoerner and Bosquet, 2001).

Table 3: Predicted employment and GDP impact of ETR by tax revenue recycling mode

Recycling	Impact	Employment		GDP	
		Nr. of simulations	%	Nr. of simulations	%
Cuts in social security	Positive	64	86	52	67
	Negative	10	14	26	33
	Total	74	100	78	100
Cuts in personal income tax	Positive	15	54	7	25
	Negative	13	46	21	75
	Total	28	100	28	100
Cuts in value added tax	Positive	7	78	4	44
	Negative	2	22	5	56
	Total	9	100	9	100
Cuts in corporate profits tax	Positive	1	50	0	0
	Negative	1	50	2	100
	Total	2	100	2	100
Lump sum transfers to households	Positive	4	80	4	50
	Negative	1	20	4	50
	Total	5	100	8	100
Financial incentives for energy efficiency	Positive	5	100	4	80
	Negative	0	0	1	20
	Total	5	100	5	100

Source: Hoerner and Bosquet (2001)

Bohringer, Conrad and Loschel (2003) build on a CGE model to estimate the impacts of carbon taxes and joint implementation (JI) on the German economy. They make a rather unlikely scenario of Germany using carbon taxes alone to meet their emissions reductions target and find that unemployment in Germany would rise by 0.22%. Because of the large reduction in emissions that they require (25%), even with a carbon tax that is recycled there is a small increase in unemployment. This is an important lesson in the double dividend literature, which has typically looked at lower rates of tax and reductions in emissions. The comparison with JI is stark, where Germany combined a carbon tax with ‘purchase’ of carbon reductions outside the country. In this case it achieves the same ‘reduction’ in emissions but now unemployment falls by 0.49%. The underlying model is broadly similar to the GEM-E3 model in its specification of elasticities. These results reinforce the need for the consideration of a broad spectrum of policy measures to reduce emissions, as carbon taxes and JI (and presumably CDM) working together reduce the costs of reducing emissions and hence any negative effects are mitigated and any possible employment double dividend may be reinforced.

Environmental taxes in Europe

The EU has encouraged the use of market-based instruments across the Union and in member states. Of all economic instruments, environmental taxes and charges are the most frequently used in Europe (Dresner *et al.*, 2006). The Scandinavian countries pioneered in implementing environmental taxes and tax reforms since the early nineties. Finland was the first country to implement a carbon tax, which was soon followed by the Netherlands, Sweden, Norway and Denmark (e.g. Vehmas, 2005; Wier *et al.*, 2005; Klok *et al.*, 2006).

Dresner *et al.* (2006) summarised the European experience with environmental tax reform, understood as a revenue neutral tax shift from taxes on labour to environmental taxes (According to EEA (2000), the Czech Republic has a comprehensive system of environmental charges, both on emissions to air and water and on some products such as CFCs. There is also a charge on the conversion of agricultural and forest land to other purposes. Several products are subject to reduced VAT (5%, while the standard rate is 22%) targeting energy conservation and/or environmental protection. A noise pollution tax is also in place in the Prague airport, differentiated according to four noise levels. The environmental charge revenues are transferred to the State Environmental Fund since 1992. Its annual revenue is around US$167.2 millions and expenditures are approximately US$104.0 millions (Bluffstone, 2003)

Table 4). However, several environmental taxes implemented in Europe did not fit the definition of ETR in a sense that they were not followed by tax cuts elsewhere. We present in

Table 5 and Table 6 (Eastern European countries) an attempt to indicate some environmental taxes implemented in Europe.

Table 5 has to be seen as indicative of some of the environmental taxes in place, not as a summary of all environmental taxes implemented in Western Europe.

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Table 4: Implemented and proposed tax shifts in European countries

Country	Tax shift		Environmental tax revenue collected (% of total tax revenue)
	From	To	
Finland 1990	Partly taxes on labour	CO_2 emissions	
Sweden 1991	Reduction of labour taxes of around 4.3% points; and social security contributions.	Environmental and energy taxes including CO_2 tax and SO_2 tax.	1.9% (environmental and energy taxes 18 bil SEK; 2 bil Euros)
Denmark 1992/3; 1995; 1998[(a)]	Personal income, employers' social security contributions, investments incentives.	Various (electricity, water, waste, cars), CO_2 and SO_2.	2.5% (2.5bil DKK; 340 mil Euros 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 Euro in 1998).
UK 1996	Employers' social security contributions.	Landfill	0.2% (450 mil UKL; 640 mil Euros in 1996).
Finland 1997	Personal income, employers' social security contributions.	CO_2 and landfill	0.5%
Italy 1998/9	Reduction of employment charges.	CO_2 on mineral fuels	0.15 – 0.2 %[(b)] (around 600 mil Euros)
Germany 1999	Social security contributions (pension insurance) paid by employers and 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 Euros in 1999).
France 1999	Plans to reduce taxes on labour and employment.	Generalised pollution tax (known as TGAP) [(c)]	NA
Austria 1999	Employers' social security contributions.	Energy and vehicle taxation.	Up to 4.8% (up to50 bil ATS; 3.6 bil Euros).
UK 2001	Employers' national insurance contributions.	Energy / CO_2 emissions under the change levy.	0.3% in employers' NICs (L1bil/yr).
UK 2002	National insurance contributions.	Aggregates tax (sand, gravel, crushed rock).	Expected to raise 609MEUR in 2002.

Notes: (a) The reform in 1993 primarily concerned households, the reform in 1995 concerned industries and the latest reform in 1998 concerned both households and industries.

(b) The reduction of 0.2% is based on total tax revenue of around 339 billion Euros in 1995.

(c) The French generalised pollution tax was created in 1999 grouping 17 environmental taxes on waste, water and air pollution together. The ETR was regarded as 'unconstitutional' in 2001. Future developments are unclear.

NA = not available

Source: Dresner *et al.* (2006).

Table 5: Overview of economic instruments for environmental policy use in Western Europe, 2000

	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Iceland	Ireland	Italy	Luxembourg	Netherland	Norway	Portugal	Spain	Sweden	United Kingdom
Motor fuel taxes / charges																	
Excise tax	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
CO_2 tax			x	x	x	x				x		x	x			x	x
VAT	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Other energy products																	
Excise tax	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
CO_2 tax			x	x	x	x				x		x	x			x	x
VAT	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Air emissions – pollution charges																	
NOx					x					x						x	
SOx			x		x					x						x	
Emission non-compliance fee																	
Transport related taxation																	
Vehicle tax	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Highway toll																	
Road tax																	
Sales tax																x	
Import duty																	
Registration charge	x	x	x	x			x	x	x	x		x	x	x	x	x	
Company car tax																	
Air transport																	
Noise tax / charges etc.												x					
Agricultural inputs																	
Fertilisers	x	x		x									x			x	
Soil protection charge																	
Waste related product charges																	
Ozone depleting substances	x	x	x					x									
Batteries / accumulators	x	x	x							x						x	
Carrier bags			x					x		x							
Disposable containers / packaging	x	x		x						x			x				
Tires	x		x	x								x					
Light bulbs			x														
Lubricants				x						x			x				
Refrigerators																	
Waste	x		x	x	x		x			x		x	x			x	x
Water effluent charge / tax	x	x	x	x	x	x			x	x		x	x			x	

Source: Authors' elaboration from EEA (2000) and Schlegelmilch (2002).

Table 6: Overview of economic instruments for environmental policy use in CEEC, 1999

	Bulgaria	Croatia	**Czech Rep**	Estonia	Hungary	Latvia	Lithuania	Poland	Romania	Slovakia	Slovenia
Motor fuel taxes / charges											
Excise tax	x	x	**x**	x	x	x	x	x	x	x	x
CO_2 tax											x
VAT	x	x	**x**	x	x	x	x	x	x	x	x
Other energy products											
Excise tax	x	x	**x**		x	x	x	x		x	x
CO_2 tax											x
VAT	x	x	**x**	x	x	x	x	x	x	x	x
Air emissions – pollution charges											
NOx			**x**	x		x	x	x		x	
SOx			**x**	x		x	x	x		x	
Emission non-compliance fee	x		**x**	x	x	x	x	x	x	x	
Transport related taxation											
Vehicle tax	x	x	**x**		x		x	x	x		
Highway toll			**x**		x					x	
Road tax		x	**x**				x		x		
Sales tax	x							x			
Import duty	x	x		x	x		x	x	x	x	
Registration charge	x			x			x	x		x	
Company car tax	x										
Air transport											
Noise tax / charges etc.			**x**								
Agricultural inputs											
Fertilisers								x			
Soil protection charge					x						
Waste related product charges											
Ozone depleting substances			**x**			x				x	
Batteries / accumulators					x	x					
Carrier bags											
Disposable containers / packaging				x	x	x					
Tires					x	x					
Light bulbs						x					
Lubricants						x					
Refrigerators					x						
Waste											
Municipal waste user charges	x	x	**x**	x	x		x	x	x	x	x
Waste disposal charge / tax			**x**	x	x	x		x		x	
Waste non-compliance fees		x		x	x	x	x	x		x	
Deposit refund schemes			**x**		x		x			x	
Levy on nuclear account	x		**x**		x	x				x	
Instruments for managing water quality											
Water consumption charge	x	x		x	x		x	x	x	x	x
Sewage treatment charge	x	x	**x**	x	x		x	x	x	x	x
Water effluent charge / tax		x	**x**	x		x	x	x	x	x	x
Water pollution non-compliance fee	x	x		x	x	x	x	x	x	x	
Water extraction charge / tax		x	**x**	x	x	x	x	x	x	x	
Natural resource mining											
Mining charges / taxes	x	x	**x**	x	x	x	x	x		x	
Instruments for biodiversity and nature protection											
Charges for conversion of agri and forest land			**x**							x	
Hunting charges	x			x			x				x
Natural park entrance charges								x			
Nature protection non-compliance	x			x	x		x	x		x	
Tree cutting charges / taxes	x					x	x	x			

Source: EEA (2000).

Determinants of competitiveness and trade impacts

Energy/carbon taxation aims to increase energy prices so that users would save it and invest in energy efficient technologies. The main argument of industry against implementing energy/carbon taxation is the loss of international competitiveness because of the extra costs of both higher energy prices and new technology investments. It is argued that additional energy taxes would damage the competitiveness of the energy intensive sectors exposed to high international competition. As examples, the steel, cement and chemistry sectors may face particular pressures of this type.

Competitiveness is essentially related to the ability of a productive sector or industry to sell its goods and services in both local and international markets. Environmental regulation or policies tend to raise industry's production costs and affect its competitiveness in both internal and external markets. In some cases, the regulations may lower industry's long-term costs through energy savings, in-plant resource recovery, and accelerated investment in more productive equipment. The extra production cost represented by the expenses incurred by each company to comply with the legislation can affect the industry size in a way that with higher production costs some companies are no longer competitive and, therefore, cause bankruptcies and job losses in those sectors. On the other hand, some authors (e.g. Clinch *et al.*, 2006) argue that firms' competitiveness is influenced by micro factors such as cost structure, product quality, trademark, service and logistical networks; and macro factors such as exchange rates and trade regimes. The impact of an energy tax is reflected in a firm's cost structure, and is thus only one factor influencing firms' competitiveness.

Environmental regulation may also adversely affect the competitiveness of certain sectors, depending on the severity of the effect. If the affected sectors are major export earners, and imports remain constant, then exchange rate depreciation may occur – assuming a floating exchange rate regime. In addition, import-inflation may occur with further indirect negative macroeconomic effects, which can be interpreted as a decline in national competitiveness.

It is important to estimate, if not accurate values, at least the magnitude of the quantitative importance of the effects of environmental regulation on the level and pattern of production. Assuming that being competitive is important because it enables goods and services to be produced and sold, contributing to sector output and income increases, the competitiveness indicators should be analysed. Some examples of competitiveness indicators can be the balance of trade, market share, trade intensity of exports, among others.

Effects on competitiveness should only be important if environmental policy in different countries imposes different levels of costs on competing companies. Pearson (2000) argues that the international competitive effects of the increase in costs may be modest to the point that they pose no policy concern, and this is more likely when

a) foreign competitors are also undertaking pollution-abatement expenditures,

b) the financing of abatement expenditures is internationally harmonised under the Polluter Pays Principle;

c) environmental costs are passed backward to factor returns rather than forward in prices; and

d) the environmental protection costs are small relative to other production costs such as wages, raw materials, transport *etc*.

In order to estimate the impact of environmental regulation in a given industry, an important usual assumption is that countries or industries within countries when facing strict environmental regulations and high costs of compliance to the legislation may be placed at an international competitive disadvantage. In the international trade context, to what extent differential environmental regulations among countries had a measurable impact on the level and pattern of trade and direct investments is difficult to ascertain. Some studies have attempted to analyse *ex-post* whether existing environmental regulations have had effects on international trade, and others are *ex-ante* analyses that attempt to estimate the trade effects if prospective environmental regulations are effective. Usually, these studies have concentrated on industrial pollution and industrial pollution control costs, which neglect the trade consequences of protecting against broader environmental effects such as soil erosion, overfishing, and disruption of ecosystems. According to Pearson (2000), it would be interesting to know the international trade consequences of a comprehensive environmental protection program that deals not only with industrial pollution, but also with these broader environmental effects.

The data on costs of environmental protection are then important to the empirical estimation of the trade competitiveness question. In general, the studies that aim to estimate the impact of environmental regulation on trade competitiveness use estimates of expenditures for end-of-pipe treatment or costs of process changing. This approach, according to Pearson (2000), tends to neglect the real costs of the control measures taken (e.g. delays and uncertainties in the permitting process, and the administrative costs of identifying and complying with environmental regulations), which can also affect competitive performance. In general, if firms within the sector respond to the additional compliance costs by attempting to raise prices, they run the risk of reduced sales, both in terms of the domestic and international markets. On the other hand, if firms within the sector absorb the compliance costs, that is, they do not attempt to pass the burden of the compliance costs onto consumers in the form of higher prices, the profitability of the sector will remain unchanged.

OECD (1997) analysed statistics related to the magnitude of trade in energy-intensive products from and to Annex I countries, focusing on the three OECD regions – Europe, Pacific, and North America. The study provides an analysis of static cost increases caused by a US$100 tax per tonne of carbon for the main energy-intensive industries, in a selection of OECD member countries. The authors concluded that the magnitude of the competitiveness effects of co-ordinated energy/carbon taxation in Annex I countries depends, among other things, on (i) the contribution of trade in carbon/energy-intensive products to gross domestic product (GDP); and (ii) the proportion of trade in carbon/energy-intensive products with non-Annex I countries in total trade, and the extent of competition from non-Annex I country exports.

However, the following notes are provided regarding the above results:

a) Situation of individual countries within the three OECD regions differs significantly from aggregate regional observations;

b) It does not account for the full pass-through of the tax in the economy, which would result in somewhat higher prices for other intermediary inputs to these sectors;

c) It does not capture possible macro-economic effects of the tax such as inflation, its effect on the economy as a whole and on energy-intensive sectors in particular;

d) It does not allow for adjustments of production processes, in response to the new price levels, nor does it incorporate real-world elements of such a tax;

e) It does not render the various levels of possible energy efficiency improvements, likely to differ within the same industrial sector across countries, since their prevailing industrial energy prices are quite disparate;

f) It does not indicate whether or not the position of industries/countries with respect to their price competitiveness would be altered by such a tax;

g) The comparison of static cost increases for energy-intensive industries across countries does not give a full picture of the competitiveness impact at the firm level, as profit margins differ, allowing for more or less costly adjustments in output prices.

A recent study carried out by the World Bank looked at the competitiveness effects of a carbon tax (World Bank, 2008). It looked at trade data between OECD countries from 1998 to 2005 and used a gravity model in which trade flows are a function of the relative size of two countries and the distance between them. In addition it tested the hypothesis that the trade flows would be affected by the presence of a carbon tax in the importing and/or exporting country. The results show that a carbon tax imposed by the importing country has a small negative affect on trade flows, while a tax imposed by the exporting country has no effect on trade flows. As a comparison the study also looked at the impact of imposing stricter energy standards for energy using appliances. In this case the imposition of energy standards during the period of the analysis results in a decline in trade of about 10 percent in all three case: when the standards were imposed by the importing countries, when they were imposed by the exporting countries and when they were imposed by both. Thus it appears that energy standards have a larger effect on trade flows than do carbon taxes. One explanation could be that carbon taxes allow for many exemptions for energy intensive industries, thus reducing any trade impacts, while energy standards raise costs that cannot be avoided by exporters and that have to be met by importers.

The study also examined the evidence for carbon 'leakage' – i.e. the moving of carbon intensive industries out of countries that impose restrictions on carbon emissions to countries that do not have restrictions (i.e. developing countries). Previous studies had indicated that about 20% of reductions from a country with carbon limits are leaked – for every 5 tons of reductions in such countries 1 ton reappears in a country with no constraints. In this study they looked at the ratio of imports to exports of energy intensive products in developing countries, that ratio is declining and that in developed countries is increasing since 1990, indicating some shift of energy intensive production to the developing countries. On the other hand if we look at trade between the EU and US the ratio of imports to exports for energy intensive products is increasing for the US. Since the US had less restrictions on carbon (there is no emissions trading scheme for example) this result is puzzling. It is possible that intra-EU shifts (from countries with more stringent carbon limits to ones with less stringent limits) are the dominant movement and the EU-US trade data is masking those shifts.

The study looks further at Import-Export ratios to see if there is relocation of industries from US to China and other Asian countries? It finds that the ratio of imports to exports of energy intensive products are declining in all these Asian countries, suggesting that there is some increase in carbon intensive exports or carbon leakage. For other developing countries there is not discernible trend.

Identifying sectoral competitiveness and trade impacts in the Czech Republic

This section aims to provide preliminary statistics on the magnitude of trade in energy-intensive sectors/products from and to the Czech Republic, with the objective of identifying possible trade impacts of eventual carbon taxes given the issues discussed in the previous sections. It must be highlighted that these are only conjectures and possible effects will be better identified with the analysis using a general equilibrium model for Czech Republic and a wide consultation among key stakeholders in the country.

According to OECD (1997), the magnitude of the competitiveness effects of energy taxation in a country will depend, among other things, on (i) the contribution of trade in carbon intensive products to GDP; and (ii) the proportion of trade in carbon intensive products with countries where environmental taxes are not in place. With these in mind, we summarise some trade statistics of energy intensive goods (e.g. paper and pulp, chemicals, basic metals, machinery). The Czech Statistical Office[11] provides the statistics on external trade, industrial production and energy intensity of production (Table 7 and Table 8).

Table 7: Share of countries in Czech Republic's external trade: Jan – Feb 2008; CZK million FOB (current prices)

Country	Exports			Imports		
	Feb	Jan + Feb	% of total value	Feb	Jan + Feb	% of total value
Germany	65,744	130,916	30.8	57,634	111,460	28.0
Slovakia	18,647	36,085	8.5	11,166	21,118	5.3
Poland	13,319	25,753	6.1	11,321	22,437	5.6
France	11,457	22,937	5.4	8,411	16,441	4.1
Italy	11,582	22,414	5.3	9,537	17,828	4.5
United Kingdom	11,105	21,799	5.1	5,205	10,262	2.6
Austria	10,092	19,299	4.5	7,238	14,176	3.6
Netherla	7,90	16,8	4.	6,92	13,4	3.

[11] http://www.czso.cz/eng/redakce.nsf/i/home.

nds	9	72	0	4	49	4
Belgium	6,248	12,131	2.9	3,883	7,435	1.9
Spain	5,910	11,812	2.8	4,097	8,091	2.0
Russian Federation	5,156	9,862	2.3	11,848	24,306	6.1
Sweden	3,929	7,922	1.9	1,959	3,997	1.0
United States	3,719	7,186	1.7	3,199	7,880	2.0
Romania	3,219	6,266	1.5	893	1,588	0.4
Switzerland	3,231	6,139	1.4	2,116	4,041	1.0
Total			84.2			71.5

Note: China (8.1%); Japan (3.3%); Hungary (2.7%); South Korea (1.5%); Thailand (1.1%) and Taiwan (1.0%) account for other 17.7% of imports in Czech Republic.

It can be observed in Table 7 that the main commercial partners of Czech Republic are also those countries close to Czech Republic (geographically), especially Germany, Slovakia and Poland. Almost half of the Czech exports, in financial terms, are directed to those countries. Regarding the possibility of relocation of Czech firms, one possible effect of an increase of production costs due to the carbon tax, it can be said that the relocation of firms in the neighbour countries is improbable, since those countries already implemented energy/carbon taxes. For example, Poland has a comprehensive system of air pollution charges, with relatively high rates. Slovakia has charges on several air pollutants, on substances and products damaging the ozone layer and on the conversion of agricultural and forest land to other purposes (EEA, 2000). Finally, as discussed earlier in this report, Germany has implemented its environmental tax reform since 1999. The extent to which new energy/carbon taxes in Czech Republic would affect its competitiveness and trade level with its main partners would depend on the magnitude of the new tax, relating to the tax level observed in other countries. The tax structure already in place in Czech Republic, how far it is from the revenue optimal state, will also determine how new environmental taxes will affect the economy, including employment and competitiveness.

Table 8: Exports by commodities and regions from Czech Republic – 2007

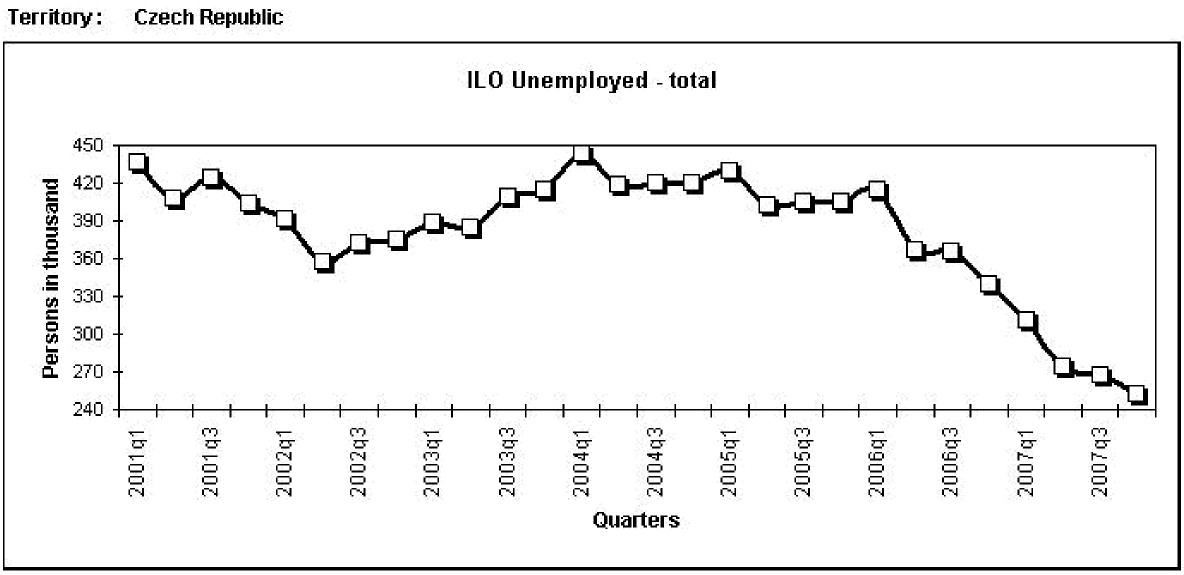
Commodity	Partner country	Stat. value EUR (ths.)	Stat. value EUR (%)
Chemicals and related products	EU15	2,409,393	2.5
	OECD	4,542,583	4.7
	Countries of former Soviet Union	532,984	0.5
	EU27	4,538,179	4.7
Manufactured	EU15	11,858,868	12.2

goods classified chiefly by material	OECD	17,193,761	17.7
	Countries of former Soviet Union	802,054	0.8
	EU27	16,791,111	17.3
Machinery and transport equipment	EU15	36,895,860	38.0
	OECD	46,415,953	47.7
	Countries of former Soviet Union	2,376,562	2.4
	EU27	44,714,082	46.0
Total		**189,071,391**	

Source: Czech Republic Statistical Office (http://www.czso.cz).

The energy-intensive sectors are supposed to be those sectors more affected by increasing costs generated by energy/carbon taxes. For example, the electricity supply industry (ESI), iron and steel sector, the chemical industry (excluding refining), and paper and pulp. It can be observed in Table 8 that machinery and equipments exports to OECD countries represent around 48% of Czech Republic's exports in that group of products. Given the magnitude of the sector exports to countries where environmental taxes are already in place, it can be said that energy/carbon taxes might not affect the sector's competitiveness. Again, analyses of general equilibrium models are necessary to confirm (or not) this statement. In addition, a qualitative analysis of interviews with selected expert stakeholders in Czech Republic may provide us with more insights about the potential competitiveness impact of environmental taxes in Czech Republic.

Figure 1: Unemployment rate in Czech Republic



Source: Czech Republic Statistical Office (http://www.czso.cz/csu/2007edicniplan.nsf/engp/3101-07)

As discussed earlier in this report, the impact of environmental taxes on employment depends, among other things, on the current level of unemployment. The energy-intensive sectors are supposed to be those sectors more affected by increasing costs generated by energy/carbon taxes. For example, the electricity supply industry (ESI), iron and steel sector, the chemical industry (excluding refining), and paper and pulp. It can be observed in Table 8 that machinery and equipments exports to OECD countries represent around 48% of Czech Republic's exports in that group of products. Given the magnitude of the sector exports to countries where environmental taxes are already in place, it can be said that energy/carbon taxes might not affect the sector's competitiveness. Again, analyses of general equilibrium models are necessary to confirm (or not) this statement. In addition, a qualitative analysis of interviews with selected expert stakeholders in Czech Republic may provide us with more insights about the potential competitiveness impact of environmental taxes in Czech Republic.

Figure 1 shows that the unemployment rate in Czech Republic has been falling steadily since 2006, which suggests that a gradual implementation of environmental taxes in the country would have a small impact on employment. However, a detailed analysis of the Czech labour market is required for more substantial forecasts. The analysis using the CGE model will give us more insights on this issue as well.

Potential mitigation measures

Some compensatory measures are identified as possible mitigation measures that can be taken by governments to address potential competitiveness losses for energy intensive industries. These measures intend to accommodate competitiveness concerns of energy-intensive industries, which argue that they would suffer competition from similar industries operating in countries without the same tax levels. Some measures are listed below[12]:

a) Rebates and refunds – it must be considered a differentiated rate structure with a lower tax rate for the sectors more exposed to international competition. However, refunds or any other tax exemption increases administrative costs and undermine the environmental purpose of the energy/carbon tax. Thus, it is recommended that rebates and refund must be regarded as a temporary and limited measure, with a clear objective of easing the transition for firms towards cleaner technologies investment;

b) Gradual implementation – this is necessary to allow firms to adapt and invest in cleaner technologies according to a feasible planning;

c) Regional aid policies – can help regions where energy intensive industries are concentrated. For example, fiscal incentives for research and development can assist energy intensive industries in investing in cleaner technologies;

d) Co-ordinated implementation – the harmonisation of tax rates in international or regional levels in order to avoid the delocalisation of firms to less environmentally friendly countries or region.

OECD (1997) referred to tax exemptions, arguing that the principle of uniform taxation is to apply the same marginal cost to the use of a certain resource, so that the economy as a whole can mobilise the cheapest options to reduce emissions. Lowering the tax on certain sectors of the economy requires increasing this cost on other sectors, if the same environmental goal is to be met. In theory, this results in an increase in cost from the uniform taxation option. In a context where other countries tax all activities equally, a country that would systematically exempt certain industries from a tax for competitiveness reasons would attract investment in such activities, leading to an increase in their emissions. In order to maintain emissions at some pre-agreed level, increasing taxation would have to be applied on the rest of the economy. The authors concluded that exemptions would neither benefit the environment through reduced emission leakage, nor the economy as a whole, nor those activities they aim to protect. While this is not definitive evidence on the effects of exemptions, it points towards their implications for the economy as a whole.

OECD (1997) also discussed other compensatory measures that have been discussed to alleviate the negative impact on competitiveness of environmental taxation, while minimising the negative effect from the standpoint of the environment. They are (i) recycling tax revenues or rebates; (ii) conditional exemptions, ceilings, and adjusted rates; and (iii) border tax adjustments.

According to OECD (1997), modelling results show that recycling tax revenues through lower payroll taxes can help reducing overall GDP costs and minimise competitiveness effects.

[12] Environmental Fiscal Reform Campaign – http://www.antaisce.org/campaigns/intersting_articles/ETRcomp.pdf.

Since an energy/carbon tax would be raised on all energy uses – industries and households -, but rebated entirely to the productive sector through lower payroll taxes, this sector would record a net reduction in its overall tax burden. Another way of recycling tax revenues to minimise the cost impacts of most energy-intensive industries is to offer tax credits for investments in more energy efficient processes. This would require establishing a set of criteria to determine which investments are eligible for such credits. Danish experience shows that this necessitates some trial and error, as applicants can and do try to manipulate these criteria, but that such systems are feasible and useful over a transitional period.

An example of conditional exemption was provided by the Swiss government when helping to reduce the negative economic impact of carbon taxes, while trying to preserve their role as an incentive for lower emissions. The government would introduce a carbon dioxide tax if other measures have failed to set the country on track for its 2010 target. Certain companies would still be eligible for exemption, provided they sign a legally binding agreement with the government to achieve the emission targets. Once the companies do not meet the emission target, the exemption is cancelled and the carbon tax is to be paid for emissions that occurred over the period. Such a mechanism would provide a strong incentive for reaching the agreed emission target.

Other alternative compensatory measures refer to applying a ceiling on total energy/carbon tax payments and introducing a set of tax rates – decreasing as tax payments increase – so as to reduce the average cost for large emitters, while providing a permanent incentive for reducing emissions. This latter system consists in a tax rebate system applied to industries in energy-intensive sectors, and which can prove that their energy costs – for the part of energy that would be subject to the tax – represent at least 3% of their gross output. From that level on, increasing tax rebates are applied to activities depending on their energy intensity. The tax rates are designed to provide a permanent incentive for companies with high energy intensity to reduce their energy intensity in order to lower their overall tax burden. This is an example of a targeted tax system that would maintain an economic incentive to abate emissions (OECD, 1997).

Border tax adjustment is the remission of taxes on exported products and the imposition of taxes on imported products, which intends to ensure that internal taxes on products are trade neutral. There is no agreement as to whether border tax adjustments could be used to offset energy/carbon taxes. The practicality and the legal requirement of such measure is under discussion and study by the OECD and World Trade Organisation (OECD, 1997).

Finally, Dresner *et al.* (2006) argue that the potential negative impacts of environmental taxes on competitiveness, employment (particularly on specific sectors or regions) and low income groups can be overcome by (i) careful design; (ii) the use of environmental taxes and respective revenues as part of policy packages and green tax reforms; (iii) gradual implementation; and (iv) extensive information and consultation with all parties concerned.

Summary and conclusions

Environmental taxes may increase costs of affected industries and reduce their economic performance, including international competitiveness. The loss of international competitiveness is related to a decline in net exports and, in the extreme case, the relocation of industries, which introduces a negative impact on GDP and employment.

On the other hand, the tax revenue generated by the environmental tax allows a reduction in other distortionary taxes in the economy, which could have a positive impact on GDP and employment (double dividend). Actually, since environmental taxes can be used to reduce other taxes, competitiveness can actually increase for that reason. As a result, the net effect of environmental taxes on competitiveness is not clear. Very energy intensive industries might suffer, labour intensive sectors might benefit. This report identified different definitions and the different levels that competitiveness can be analysed, and discussed some issues involving the double dividend literature.

It seems that there is a consensus on the literature on the beneficial environmental effects of energy/carbon taxation and shifting the tax burden from labour to polluting outputs. However, there is far from the consensus on the consequences of such a tax reform for non-environmental welfare declines. The empirical tests are not conclusive and their results are dependant of particular specifications of the models used.

This report also reviewed some general equilibrium models used to analyse competitiveness effects related to energy/carbon taxation, their main features and potential. These possible competitiveness effects of energy/carbon taxation are determined, among other things, by the magnitude of the tax related to other production costs in energy-intensive industries; the share of trade of energy-intensive sectors compared to total trade and the harmonisation of the tax rates along the main competitor countries. However, the studies reviewed that analyse the competitiveness issues related to energy/carbon taxation produce limited findings. Those analyses deal only with the price element of competitiveness, neglecting non-price elements of competitiveness, such as companies' choices on production methods, mix of products, and investment decisions. Within the EU, competitiveness effects of environmental measures have generally been small, since a great deal of trade is done between countries affected by the same environmental measures. In addition, relocation of industry to lower level environmental standard countries has been relatively rare (OECD, 1997). In the US, Jaffe *et al.* (1995) found no evidence to support the hypothesis that regulations had an adverse effect on US competitiveness.

A recent World Bank study suggests that carbon taxes, where they have been imposed, have not had an impact on trade flows between OECD countries. On the other hand energy efficiency standards have had some impact on trade flows. There is also some evidence for carbon 'leakage' – the shifting of carbon intensive industries out of the EU and other countries with carbon limits to countries with no limits – i.e. developing countries.

Regarding potential competitiveness impact of environmental taxes in Czech Republic, from the limited data available we infer that the impacts would be small, since the main trading partners of Czech Republic have already implemented environmental taxes (e.g. Germany and other EU countries). However, we recognize that the energy intensive sectors that will be affected may need some special treatment, although we stress that this issue has to be substantiated with the results obtained with the CGE model and the stakeholders' analysis.

In any case, the following measures could help to mitigate competitiveness effects that may occur (i) introduce the tax gradually; (ii) rebates may be needed for sectors most exposed to competition for a limited period of time, although a better option is to provide regional aid policies to help areas where the impact are greatest; (iii) coordinate the implementation with trading partners (e.g. via the energy directive).

Environmental taxes can create employment when firms switch away from energy to labour, and effect is greater when elasticity of substitution between energy and labour is high, and when elasticity of substitution between energy and capital is low. The effect is greater when present taxes are distorted; when the recycling is via reductions in high labour taxes; the economy has high unemployment (not the Czech case) and there are no offset by increased wage demands; capital is not very mobile internationally (if it is, carbon tax cannot be absorbed by capital and has to be borne by labour, reducing employment effect); and the country has enough international market power to raise prices of carbon intensive goods without causing a fall in production and therefore a fall in labour demand. All these suggest that the employment effect of higher environmental taxes in the Czech Republic will tend to be small, if any. Again, this statement has to be confirmed (or not) using the results of the CGE model and the stakeholders' consultation.

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