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ENVIRONMENTAL TAXES AND BORDER TAX ADJUSTMENTS AN ECONOMIC ASSESSMENT

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1.- *The rationale behind energy taxation*

In the Communication presented to the Gothenburg European Council[1] the Commission clearly states that "the EU will meet its Kyoto commitments. However, Kyoto is but the first step. Thereafter, the EU should aim to reduce atmospheric greenhouse gas emissions to an average of 1% per year over 1990 levels up to 2020". Among the measures to be taken at the EU level, the Commission identifies as a priority the "adoption of the Energy Products Tax Directive[2] by 2002. Within two years of this, the Commission will propose more ambitious environmental targets for energy taxation aiming at the full internalisation of external costs, as well as indexation of minimum levels of excise duties to at least the inflation rate". Hence, in Europe the idea of using energy taxation to comply with the constraints defined in the Kyoto Protocol is still considered an useful complement of regulatory measures.

In the past, environmental policies have largely relied on command-and-control measures[3]. These generally identify maximum emissions levels or minimum efficiency standards that apply equally to every economic agent through all the economic sectors. Regulatory measures have as the main advantage the possibility to ensure that – as far as controls are effective and not too expensive and, therefore, the constraints are really complied with - the environmental targets are indeed met. Especially in cases where the achievement of the target is of crucial importance, they may be preferable to alternative instruments.

There are, however, many drawbacks associated with these regulatory instruments:

- from the point of view of static efficiency, if a standard for emission reduction is set, every firm will be obliged to carry on equal abatement efforts, regardless of the fact that marginal abatement costs could differ among polluters. It would be cheaper for the economy as a whole if firms with relatively low marginal abatement costs were forced to reduce emissions more than firms with high costs, because total costs in this case will be minimised;

- from the point of view of dynamic efficiency, with direct regulations a firm is not penalised for emitting a residual amount of pollution as long as the firm complies with the standard. Therefore, the firm has no incentive to use new technologies to reduce emissions below the norm set by the regulatory authority. Under a tax regime polluting firms have to pay taxes on the remaining amount of pollution. This will force them to look for and to adopt new abatement technologies thereby reducing the tax burden, since firms have a cost

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[1] *A Sustainable Europe for a Better World: A European Union Strategy for Sustainable Development*, Commission Proposal to the Gothenburg European Council, COM(2001)264final, Brussels, 15 May 2001.
[2] *Proposal for a Council Directive Restructuring the Community Framework for the Taxation of Energy Products*, COM(97)30.
[3] For a recent comparison between taxes and command-and-control measures see BOVENBERG, A.L.-GOULDER, L.H. [2001].

incentive to reduce polluting emissions as much as possible otherwise they will face higher tax payments.

If these are some basic reasons for adopting tax measures for environmental purposes, it is important to identify on what specific grounds it is possible to support the adoption of an energy tax. It is well known that in this field an instrument that traditionally has been implemented in many different countries is the excise on mineral oils, whose main purpose is to raise revenue given the low demand elasticity for this kind of commodity. Only recently the excise on mineral oils has been considered also as an instrument of environmental policy, especially with regard to transport.

Recently, the debate on the use of an energy tax has been revamped with the growing awareness of the problem of global warming. If the aim of the envisaged policy is exclusively to reduce emissions of carbon dioxide the first best instrument, from an economic point of view, seem to be a pure carbon tax as opposed to an energy tax. As a matter of fact, the curbing of CO_2 emissions can be reached through three channels:
- a reduction of energy services used in households and firms, which is induced by the higher relative prices of energy;
- rising energy prices that provide an incentive to improve the efficiency of energy uses both in end-use sectors and in the production of secondary energies;
- fuel substitution leading to replacement of carbon-intensive fuels by low or no-carbon intensive alternatives. Especially in electricity production significant possibilities exist. However, this option is also available in end-use sectors (e.g. substitution of coal for heating by natural gas).

A pure carbon tax perfectly links the tax burden on various energy products to their carbon content and uses all the three options described above. An energy tax does lead to little fuel substitution. Hence, compared to an energy tax, a carbon tax needs a lower tax rate to reach the same target of reduction of carbon dioxide emissions because carbon-intensive fuels are made relatively more expensive. But an energy tax would also reduce many other environmental damages. In a world without externalities it would make no sense to tax energy as such as this would only distort the optimal allocation of resources. However, an energy tax might be strongly advocated as energy consumption is, in fact, related to a number of important externalities such as acid rain, transport related externalities (e.g. congestion) and externalities related with the use of nuclear energy. Even if the energy tax is not a first-best instrument since the link between the externality and the energy use is not perfect, it seems to be in any case an attractive second-best solution.

Furthermore, the energy tax, while contributing to solve the problem of the security of supply, will reduce the differences in the impact of taxation that a carbon tax would bring about since CO_2 intensities differ more strongly across countries than energy use. In conclusion, even if a pure carbon tax has a major impact on the reduction of CO_2 emissions, energy taxation could be supported by considerations related to the overall impact on total welfare, which is largely influenced by side effects on other variables too (e.g. other environmental externalities, income distribution, etc.). Hence, it does not seem unexpected that the countries implementing energy taxation for environmental purposes have adopted in some cases a combination of a pure energy and carbon taxes, trying to achieve many environmental targets with the same instrument.

2.- *Global warming and the carbon/energy tax*

The problem of global warming represents currently one of the main areas of concern for all the mankind. CO_2 emissions are considered as being the main contributory factor to the greenhouse effect (its share on total GHGs amounts to 65% according to recent estimates), while the atmospheric concentration of carbon dioxide is largely of anthropogenic origin, primarily caused by the burning of fossil fuels. The depletion of tropical rain forests has become as well a major source of the atmospheric concentration of carbon dioxide in the last thirty years, and it is now estimated to be responsible for one third of the emissions caused by the combustion of fossil fuels.

While global warming is a world-wide problem, the main responsibility lies with the industrialised countries. The world emissions of carbon dioxide is equivalent to 22,854 million tonnes. In the United States emissions reach 5,565 million tonnes, while in Europe emissions are equivalent to 3,102 and in Japan to 1,144 million tonnes, but it is important to remark that emissions in China are already larger than in Europe (3,187) and in India reach 881 million tonnes, but with a rate of increase of 4.4% and 5.8% respectively. In the near future the policy measures needed for limiting carbon dioxide emissions should be implemented especially in the Northern industrialised countries; but, with the expected economic growth of the developing countries, their CO_2 emissions could increase dramatically, since energy efficiency is significantly at very low level. An effective policy for addressing the global warming problem should therefore provide the right economic incentives to the industrialised countries for increasing energy efficiency and limiting carbon dioxide emissions, but in the same time it should warrant adequate incentives for raising energy efficiency also in less developed countries.

The European Community contribution to global CO_2 emissions is only 13.7%, compared to 24.6% for the US, 5.1% for Japan, 6.3% for Russia, 13.8% for China and 3.9% for India. An unilateral action by the EC would not solve the greenhouse problem, whose nature is global. But with the adoption of the Convention on Climate Change at the UNCED Earth Summit held in Rio in June 1992 and, afterwards, with the approval of the Kyoto Protocol, a world-wide commitment to cope with the problem of global warming has been taken. It is within this framework that the best instruments to achieve the goal in the most cost-effective way should be chosen.

In the case of climate change there is no clear-cut trade-off between regulations and taxation. A comprehensive strategy must give space both to command-and-control and to economic instruments, relying on a mutually reinforcing set of regulatory, voluntary and fiscal measures. Energy efficiency could be promoted through higher energy prices and the imposition of technical standards, while fuel-switching towards the use of less-polluting energy sources could be favoured by an increase of energy prices according to the carbon content. In the industrial sector a large space remains for voluntary agreements targeted to a reduction of CO_2 emissions.

Within the European Community, as a first step to limiting greenhouse gases, the joint Energy-Environment Council of 29.10.1990 decided to stabilise CO_2 emissions in the Community in the year 2000 at 1990 level. The strategy initially proposed by the Commission involved a wide set of different measures and aimed at reaching the target of stabilising CO_2 emissions balancing the competitive needs of the European economy with the environmental requirements.

First of all, possibilities to improve energy efficiency appear to exist in all sectors and for all energy sources. This "no-regret policy" will increase energy security, improve the transport system, limit energy-related air emissions other than CO_2 and strengthen the industrial structure. But also fuel switching has a major role to play, especially in the medium and long term, with a much more substantial share of natural gas to the detriment of coal and possibly oil. Finally, the contribution to achieving the stabilisation target through an increased use of renewable energy sources should be promoted, by overcoming technical obstacles with R&D programmes and by improving the economic position of these energies.

Hence, regulatory measures are needed to exploit the possible gains in energy efficiency, while R&D programmes should be supported to keep up minimum-emissions power production from fossil sources -including the development of carbon abatement technologies-, renewable energy sources and efficient energy utilisation and conservation, including energy-efficient transports. In a recent revision of the policy strategy to curb global warming[4] a list of more than 40 measures has been included; but these measures have to be complemented by an efficient system of emissions trading within the EU, which implies an overall saving that has been estimated equal to one third compared to the total cost of the reference case[5].

In 1992 the EC Commission has proposed to supplement this set of regulatory measures with a fiscal levy on the use of all non-renewable energies (including large scale hydro-electric), thus providing a signal to the market that the trend of energy prices is on the upward direction, and influencing in this way the behaviours of firms and individuals. This tax has been considered to be consistent with the "polluter pays principle" and has been advocated in many resolutions by the European Parliament. Furthermore, it is a well-known conclusion of the existing literature on environmental taxation that, since CO_2 emissions are related to very different uses of fossil fuels by a very large number of consumers and business, the use of policy instruments based on market mechanism to provide incentives for the reduction of CO_2 emissions will certainly be more cost-effective than relying solely on regulatory measures.

[4] *The European Climate Change Programme (Report 2001)*, European Commission, Brussels, 2001.
[5] CAPROS, P. [2000]

3.- *The design of a carbon/energy tax*

In designing its carbon-energy tax proposal[6] the EC Commission has been confronted with some basic options:

a) a production tax or an excise. Since the production (or import) of fossil fuels is unequally spread over the territory of the Member States, a genuine production/import tax will not reflect the consumption of energy products and the amount of CO_2 emissions in each Member State. Excises are a consumption tax which could be levied with the domestic producers (or importers) of the energy products as well as with the final or intermediate energy consumers. It seems the most convenient system for taxing energy. The early application in the production process combines the advantage that the number of economic agents performing the taxable transactions is small and easily checkable and that the burden of the tax is immediately shifted on all energy consumers, thereby directly affecting their behaviours. The revenue should be credited to the Member States where consumption takes place. Thus, for intra-Community transactions, the levy has to be postponed until the goods have reached the Member State of destination and are released for consumption, requiring a system of administrative follow-up of the goods - also for the products currently not submitted to excises - from the production (or import) site to the Member State of consumption.

b) taxable products. For gas and liquid fuels the tax base and the corresponding rates should be related to individual products as defined in the Combined Nomenclature. For coal different categories have to be defined, each with a specific emission factor. The introduction of an average rate for coal would favour the most polluting coal qualities and lead to serious distortions in competition, since the quality of coal is often linked with geographical factors. Taxable products should include brown coal (lignite) and peat.

c) carbon/energy share of the tax. The tax could have an energy component - to be applied to all energies - and a component based on carbon content of each fossil fuel. The energy tax will be more effective in promoting energy efficiency. The carbon tax would provide more specific incentives to reduce CO_2 emissions, but would put a relatively higher burden on coal, which is the most secure energy supply. It would favour nuclear energy as well, which has advantages in terms of CO_2 reduction, even if it leads to its own particular problems (security, wastes disposal). Furthermore, the impact of the carbon tax on the industrial competitive position of the Member States would be different according to their energy structure.

d) tax base. The tax base must be defined in the stage where the various products acquire their definitive characteristics - from the point of view of CO_2 emissions and energy

[6] *Proposal for as Council Directive Introducing a Tax on Carbon Dioxide Emissions and Energy* (COM(92)226 final).

content. This is a technical requirement - otherwise downstream differentiation would have to be introduced - and in the same time guarantees a clear link between the tax base and the environmental/energy targets. Accordingly, the tax base should be defined in a way as to include fossil fuels used for combustion, considering that:

- petroleum products acquire their definitive attributes when processed into various types of mineral oils;
- natural gas and coal broadly when extracted - even if they could be further processed.

e) tax rates. If the main goal of the tax is to stabilise CO_2 emissions, the target rate should be established in real terms, combined with a minimum initial rate indexed to the consumer price level. This tax rate should be additional to existing taxes that now are levied on some products - e.g. the excise on mineral oil.

f) exemptions. A zero rate should be established for energy sources used as raw materials and for the renewable energies (with the further provision that electricity produced by large hydro-plants should be subject to the energy tax). A special fiscal treatment should be provided in favour of energy intensive industrial sectors largely open to international trade, that accept to limit CO_2 emissions through voluntary agreements.

g) ad hoc system for electricity. Different options are open for taxing electricity:

- a pure input tax. Fossil fuels supplied to power stations are submitted to the excise taxation, while an analogous tax is levied on nuclear heat and hydraulic force. The main advantage of this option is that it promotes energy efficiency through a complete taxation of conversion losses, which are considerable (about 2/3 of primary energy is lost during the transformation, in particular in nuclear plants). This option, however, does not comply with the destination principle and requires a system of rebates for exempted sectors or firms.

- an output tax. Fossil fuels supplied to power stations are exempted from the excise and electricity is taxed on its own as an energy product. There is perfect compliance of the destination principle, but there is no (positive) incentive to improve energy efficiency in power generation plants, whereas a (negative) incentive is provided for a substitution of other fuels with electricity. In addition, there remains the problem how to assess the carbon tax, since the electricity supplied is made out of different fuels.

- a combined solution. Electricity is taxed on its own on the basis of the energy content, taking into account conversion losses, and the price charged to the consumers includes - besides the energy tax - also the carbon tax paid according to the carbon content of the fossil fuels supplied to the power stations. This option - that lies behind the solution that was adopted in the Commission's 1992 proposal - could easily comply with the destination principle. Furthermore, while the carbon tax provides an incentive to enhance efficiency in the production of electricity and to reduce CO_2 emissions, the energy tax, being immediately charged on prices paid by consumers, affects their behaviours towards more energy-saving and allows for a zero or reduced rate to be charged to energy-intensive sectors, without having to implement a system of rebates.

The Commission's proposal has chosen in favour of a balanced solution, 50% of the tax being modulated according to the energy content and the other 50% being modulated according to the carbon content of each type of fossil fuel. The Commission estimated that a rate of the tax equivalent to $10 per barrel of oil could be sufficient - when supported by other regulatory measures and by complementary national programmes - to achieve the stabilisation target. This tax rate had to be progressively reached in the year 2000, starting with a rate of $3 and increasing it each year by $1. This provision seemed relevant to promote a gradual adaptation of the European economy to the new conditions of the energy market. Accordingly, in the first year of implementation, the tax rate should be €2.81 per tonne of carbon dioxide emitted on combustion in the presence of excess oxygen and €0.21 per gigajoule of energy content. However, electricity should be charged by the energy tax at the rate of €2.1 per Mw/h, with the exception of electricity generated by hydroelectric installations, that will be taxed at the rate of €0.76 per Mw/h.

The new tax had to be eventually decided at the Community level and introduced by the Member States, the revenue accruing to their Exchequers. In this case, the principle of subsidiarity will be correctly applied, while avoiding any risk of trade distortions within the internal market, since the legislation will be implemented at the national level according to a Community Directive. A key characteristic of the tax should be its revenue neutrality. This means that it should not result in any increase in total tax burden and the resulting revenue needs to be offset by fiscal incentives and by tax reductions. This shift of the burden of taxation away from distortionary taxes on companies and individuals and towards taxes on exhaustible resources, that in addition produce heavy damages to the environment when used for combustion, will represent a first step for shaping a taxation system more efficient (with less deadweight-loss) and in the same time more friendly towards the environment and a sustainable development[7].

It was explicitly stated in the Proposal that the tax should be implemented by the Community only when measures with an analogous financial impact will be introduced by the other OECD countries. This conditionality clause could be spelt out as a way for putting pressure on the main countries competing in trade with the Community firms and especially on US and Japan, so that similar policies for limiting carbon dioxide emissions are carried out at least at the level of the industrialised world. In the Commission view it was also considered essential to avoid any deterioration of the competitive position[8] - and the following delocation of the European firms - towards countries outside the OECD area implementing less stringent environmental standards, in particular for those industrial sectors employing energy intensive production processes and with a large involvement in international trade (steel, chemicals, non-ferrous, cement, glass, pulp and paper). Hence, a special fiscal treatment had to be provided, but the affected industries would be obliged to assume an engagement to reduce voluntarily CO_2 emissions.

[7] MAJOCCHI, A. [1996]
[8] MAJOCCHI, A. [2002]

4.- *Economic effects of energy taxes*

This carbon/energy tax Proposal has never been adopted by the Council. A new Draft Proposal has been put on the table by the Commission in 1995[9], but with an equal unsuccessful outcome. Then, in March 1997 the European Commission adopted a Proposal for a Directive restructuring the Community framework for taxation of energy products[10]. This proposal updates an older Directive (92/82/EEC) which sets minimum excise rates for mineral oils, that are now only a fraction of the lowest actual rates, and includes innovative features differentiating the new scheme from the older one.

First, the scope of the tax is extended and includes a larger number of products, and not only mineral oils. Second, the proposal contains a three steps phase-in of increased rates. Third, the proposal foresees that firms whose non-transport energy costs constitute more than 20% of production costs are to be exempted from taxes paid on energy consumption beyond 10 percent of their production costs. However, in any case total taxes paid must be at least equal to 1 percent of sales value. In addition, feedstocks, inputs for electricity production and commercial aviation will not be taxed. Furthermore, the proposal permits Member States to reimburse completely or partially taxes paid for energy consumption exceeding 10 percent of production costs. Exemptions or lower rates are also possible for renewable energies (such as hydropower, solar, wind, biomass), environmentally benign transport (rail, inland shipping) and for investment in energy saving technologies.

The economic foreseeable impact of the proposal has been analysed in a recent paper[11] using three different macroeconomic models: HERMES (Harmonised European Research for Macrosectoral and Energy Systems), GEM-E3 (General Equilibrium Model for Economy-Energy-Environment) and E3ME (Energy-Environment-Economy Model for Europe). All the three models contain detailed modules for the energy sector and are macroeconomic models covering a number of EU countries. The simulation of the effects of the new tax proposal has been carried out by making assumptions in three key areas: size of the tax shock, way of using revenues and the handling of tax exemptions.

The first assumption is that Member States implement only what is strictly required by the new minimum rates, i.e. only tax increases that are compulsory take place since any further tax increases cannot be directly attributed to the proposed directive and fall within the realm of Member States' sovereignty. The second assumption is that the revenues are used to decrease social security contributions paid by employers since the proposed Directive clearly suggests fiscal neutrality and the use of the revenue to reduce labour costs. The third assumption is that tax exemptions for energy intensive industries apply disregarding the fact that sectors encompass a large number of very heterogeneous enterprises, some of which might qualify for a derogation while others do not. The main results of the

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[9] *Proposal for a Council Directive Introducing a Tax on Carbon Dioxide Emissions and Energy* (COM(95)172 final.

[10] *Proposal for a Council Directive Restructuring the Community Framework for Taxation of Energy Products* (COM(97)30 final.

[11] JANSEN, H.-KLASSEN, G. [2000]

simulation are shown in Table 1: all the figures presented are in comparison with a baseline scenario where current tax levels change with the level of inflation over the period of analysis.

In spite of the similarities in results significant differences emerge between GEM-E3 on the one hand and both Hermes and E3ME on the other hand. The differences in results between HERMES and E3ME are mainly caused by the fact covers only 6 countries excluding Spain and Ireland that would face high energy tax increases under the proposal. The main difference between GEM-E3 and the other two models lies in the higher substitution possibilities and the weaker feedbacks between output, consumption and investment that it assumes, so that increase in GDP – and consequently in employment – in E3ME is more significant.

Table 1 - ***EU-wide model results in the year 2005***
(with recycling to reduce social security contributions)

	HERMES	GEM-E3	E3ME
GDP	+ 0.06	+ 0.02	+ 0.20
Consumer prices	+ 0.04	+ 0.08	+ 0.10
Employment	+ 146,000	+ 155,000	+ 335,000
Real wages	+ 0.12	+ 0.40	+ 0.10
Energy consumption	- 0.52	- 0.89	- 0.70
CO_2	- 1.6	- 1.47	- 0.87

Source: Jansen, H. – Klaassen, G. [2000], p. 188

In absolute terms, all the impacts are relatively small, but the effect of the proposal on GDP results positive and lies between 0.02 and 0.20 percentage points. The inflationary shock - measured in terms of consumer price changes - is small as well and the proposal has a limited but positive impact on employment: estimates vary between 146,000 and 335,000 jobs created. Finally, the relative increase in energy taxes leads to an EU-wide reduction of CO_2 emissions of 0.9 to 1.6 percent compared to the baseline. The emissions of a number of other pollutants - such as sulphur dioxide, nitrogen oxides and particulate matter - will also decrease, so that secondary benefits can be expected.

These results point to an improvement in Europe's economic performance - GDP -, while contributing to a mitigation of two important problems: unemployment and environmental degradation. A double dividend seem to emerge[12]. Two key factors can be distinguished to explain these achievements. As the tax makes energy consumption relatively more expensive and the employment of labour cheaper through the reduction in social contributions, the economy as a whole becomes more labour intensive and less energy intensive, with a consequent decrease in energy consumption and in CO_2 emissions. As far

[12] MAJOCCHI, A. [2000]

as economic growth is concerned, two factors work in opposite direction. The increased energy costs reduce households' disposable income and the competitiveness of the firms; but the use of the revenue to cut down social security contributions counteracts this negative impact re-injecting income into the economy. As a result production costs diminish in the economy as a whole since only a minor part of the increased tax burden falls on the industry and more than two thirds of the tax revenue arises from taxation of products used by households, while the revenue recycling benefits mostly industry, which now enjoys lower wages gross of taxes. The conclusion is that "on average, the reduced wage bill more than compensates the increased energy taxes. These reduced production costs imply that the proposal (including recycling) poses no threat to international competitiveness of the European economy as a whole, although some sectors face a small loss in competitiveness"[13]. It should also be stressed that, notwithstanding the foreseen positive effects of the Proposal on GDP, export shrink while imports decrease only slightly. The result is a worsening of the trade balance, even if lower than the positive impact on domestic demand.

5. – Competitiveness and the use of border tax adjustments

The idea that energy taxes do not have a strong impact on external competitiveness is not supported by other researchers that reach more negative conclusions regarding the competitive position of a country hit by high energy taxes. This point has been already addressed in a previous paper[14]. But fresh evidence has now emerged that seems to confirm the idea that strict environmental regulations could worsen the competitive stance of domestic firms.

In particular, a recent research[15] has tried to estimate the effects of industrial regulations on industrial activity using data available on both regulations from the Clean Air Act Amendments' division of counties into pollutant-specific nonattainment and attainment categories and manufacturing activity from 1.75 million plant observations that comprise the 1967-87 Censuses of Manufacturers. The conclusion of this research is that environmental regulations retard industrial activity since " in the first 15 years after the CAAAs became law (1972-1987), nonattainment counties (relative to attainment ones) lost approximately 590,000 jobs, $37 billion in capital stock, and $75 billion (1987$) of output in polluting industries. Although these estimates are not derived from a randomized experiment and therefore cannot meet a strict definition of causality, they provide robust evidence that these regulations deter the growth of polluters"[16].

Although the evidence on the impact of environmental levies on competitiveness does not seem conclusive[17], the worsening of the competitive position of domestic firms is considered as self-evident either by public opinion or decision makers. Hence, when in the

[13] JANSEN, H. -,-KLAASSEN, G. [2000], p. 189.
[14] MAJOCCHI, A. [2002]
[15] GREENSTONE, M. [2001]
[16] GREENSTONE, M. [2001], p. 28.
[17] BARKER, T.-KÖHLER, J. [1998]

Gothenburg European Council it was identified as a priority the adoption of the Energy Products Tax Directive by 2002, immediately afterwards the Commission suggested an important caution saying that "the Union will insist that other major industrialised countries comply with their Kyoto targets. This is an indispensable step in ensuring the broader international effort needed to limit global warming". As a matter of fact, the trade-off that seems to exist between environmental protection and external competitiveness is effectively one of the main hurdles to be overcome so that a political agreement could be achieved for implementing unilaterally domestic environment protection measures, when global commons are at stake. Even if, in the long-run, a sound environmental policy could improve the domestic industrial structure, and hence also the competitive position of the country concerned, when in the short run external competitiveness seems to be impaired, it is much more difficult to get an advanced environmental legislation adopted throughout the political process.

The way-out from the dilemma between environmental effectiveness and external competitiveness suggested in the original Proposal for a carbon/energy tax presented by the EU Commission has been the provision of tax exemptions to energy-intensive industries largely open to international trade, that "are seriously disadvantaged on account of an imbalance in trade from other Member States or an increase in imports from third countries" (Article 9:2); and similar provisions are provided for in the 1997 Proposal, as it has been previously seen. But the use of tax exemptions for energy-intensive sectors is widespread in all the countries where an energy tax has been implemented to curb carbon dioxide emissions.

In Sweden, manufacturing industry and horticulture are completely exempt from the energy tax and are only liable for a reduced rate of the carbon dioxide tax. Energy-intensive industries, such as steel industry, can receive a further tax exemption. There are sectors completely exempted from the energy tax – such as agriculture – or subject to preferential treatment with regard to the emissions of greenhouse gases, such as the cement or steel sectors. According to recent estimates[18] effective tax rates represent a share of nominal tax rates that can vary from 19.4% to 44.2% for different fuels subject to the tax. A similar situation exists in Denmark where the tax rate for energy intensive sectors is equal to 25% of the general rate. The high nominal tax rates on coal are not really effective because power stations (electricity and gas production) are completely exempted from coal taxes. Yet 95% of electricity generated in Denmark is coal based and around 90% of total coal inland deliveries are consumed by power stations. In Norway[19], exemptions are so widespread that only 38% of greenhouse gases emissions are subject to some kind of environmental taxation.

Another recent paper[20] has pointed its attention on the differences between environmental taxes paid by households and respectively by firms. The average rate of the carbon tax has been estimated for five countries: Norway, Sweden, Denmark, Finland and Netherlands.

[18] EKINS, P.-SPECK, S. [1999]
[19] GODAL, T.-HOLTSMARK, B. [2001]
[20] SVENDSEN, G.T. *et al.* [2001]

The ratio between the rate applied on households and that levied on the firms is equal to 1.1 in the Netherlands, 1.2 in Finland and Norway, 1.4 in Sweden and 1.9 in Denmark.

The introduction of tax exemptions for energy intensive industrial sectors is therefore a widespread device targeted to avoiding a negative impact on external competitiveness of domestic firm. But this solution appears as largely ineffective both from the point of view of efficiency and equity. New solutions – and border tax adjustments (BTA) is probably the most valuable - should be adopted to avoid that the protection of global commons will imply a worsening of competitive conditions for the most environment-friendly countries.

It has been shown[21] that with a tax whose base is consumption, collected on manufacturers, if a BTA is adopted where a countervailing duty is levied on imports and a rebate given to exports, "there is no impact at all on domestic producers. Production remains at the [same] level and producers continue to receive an after-tax price equal to [the previous one]. The reduction in the quantity demanded domestically is fully offset through an equal reduction in imports. We conclude that BTAs of the consumption-tax type result in reduced consumption, just as intended. Move now to the case of a production tax, where imports are untaxed and there is no remission of tax when taxed goods are exported. Here the result is quite different. Here, the quantity demanded remains unchanged; however, the quantity supplied domestically has now fallen. Thus, where BTAs implement a domestic production tax, production is reduced, again as intended".

While the rationale for border tax adjustments for environmental excise taxes is clear cut, the case where the environmental excise tax is applied to an intermediate good, but it is the final good that is imported is a less straight-forward case[22]. If both the intermediate and final sectors were perfectly competitive, an import tax on the final good equal to the level of the environmental excise tax times the extent to which the intermediate good enter the domestic downstream firm's cost function, would raise marginal costs for the importer by the same amount, and consequently will have a neutral effect on imports[23].

In the United States, when in 1993 President Clinton's Btu tax proposal was considered in the House of Representatives, its legislation included an "imputed Btu tax on imported products identified by the Treasury Department as having direct energy inputs that would have been taxed if produced in the United States in excess of 2% of value of the final product". The tax on toxic chemicals treats imports in a similar fashion. The tax rate on imported products that embody 50 percent or more of taxable chemicals, measured either by weight or value, is set equal to the tax that would have been collected if the taxable chemicals used in production had been sold in the United States. In the absence of any information regarding the content of non-ozone depleting taxable chemicals, the Secretary of the Treasury may impose a tax rate based on the use of taxable substances in the predominant method of production for the imported product or the Secretary may impose a 5 percent ad valorem tax on imported chemical products.

[21] HOERNER, J.A. [1998]
[22] McCORRISTON, S.-SHELDON, I.M. [2002]
[23] POTERBA, J.M.-ROTEMBERG, J.M. [1995]

In a previous paper[24] we have tried to assess the compatibility with WTO provisions of a BTA system in the case of an energy tax[25]. In the following paragraph we will try to estimate the economic impact of an energy tax, levied also on embodied inputs and supported by the levy of a countervailing duty on imports and by the granting of a rebate on exports. In this way we will try to check the validity of the conclusions previously reported, stating that BTA are really effective in safeguarding the competitiveness of the domestic firms - affected by the unilateral levy of an energy tax – vis-à-vis foreign competitors whose costs are not raised by a similar tax.

6. - A computable general equilibrium (CGE) assessment of border tax adjustments and other compensatory measures

6.1. - Background and general features of the model

After having recalled the need of a system of border tax adjustments, here we propose a quantitative assessment of such a policy based on a very simple CGE model calibrated on EU-15 data (1995)[26]. This is a relatively new task in the literature. Indeed, till now CGE models have been extensively used to understand whether environmental (Pigouvian) taxation could lead to a "double dividend"[27]. The basic idea is that environmental taxes not only produce a better environment, but also generate positive economic payoffs, as they allow to cut other taxes (for instance employers' social security and income taxes) that are generally regarded as distorsionary[28]. When, as is the case in the EU, there is disequilibrium in the labour market and involuntary unemployment prevails, the double dividend that could be created through environmental taxes is often referred to as "employment double dividend".

The issue we are mainly interested in is somewhat different. It can be the case that the employment double dividend does not materialise because, though the extra government revenue (generated by environmental taxes) is actually utilised to reduce other distorsionary taxes, this is not enough to offset the loss of competitiveness domestic firms suffer vis-à-vis their foreign counterparts. In this case, one can imagine two possible ways out: either the government further goes on in substituting distorsionary taxes with environmental taxes, or it faces more directly the issue of domestic firms' competitiveness by giving them some form of compensatory protection (through border tax adjustments)[29].

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[24] MAJOCCHI, A. [2002]
[25] DEMARET, P.-STEWARDSON, R. [1994]
[26] The model's database (benchmark) and equations are fully described in a related, forthcoming paper (MISSAGLIA, M. [2002]) where much more sophisticated versions of the model are taken into consideration, with imperfect competition in some sectors, intertemporal dynamics and a more realistic treatment of the "energy" sector, where different sources of energy (carbon and non-carbon) with different emission coefficients can partially substitute each other.
[27] MAJOCCHI [2000]
[28] For an excellent survey on these topics see HEADY *et.al.* (2000).
[29] Of course a third solution could be envisaged: a further reduction of distorsionary taxes without any further increase in environmental taxes. This would imply a cut in government's expenditure level and welfare state provisions. Whilst some author could look at this solution with some enthusiasm, this is not our case. And,

The former solution is hardly applicable: first, the substitution of distorsionary taxes with environmental taxes is likely to decrease the overall degree of distorsion the tax system imposes to the economy up to a certain point. Beyond that point, environmental taxes become distorsionary themselves, as they push the polluting goods' production below the optimal level. Second, efficiency is not the only requirement of a well-designed tax system; equity matters as well. Pigouvian taxes are by definition regressive, as their burden is in any case passed on to the consumer. Hence, substituting the income tax (or even payroll taxes, that are paid by all sectors of the economy and not just by the polluting ones) with still higher environmental taxes is likely to undermine social cohesion. We are left with the second solution – the border tax adjustments – and the model we are going to describe is a way to assess its economic impact.

The model is a very simple, standard neo-classical formalisation of the EU economy. In a static framework, production is organised around three sectors: energy intensive production, non-energy intensive production and energy production[30]. Perfect competition prevails in each sector and all income accrues to a single, representative consumer (distributive issues are not analysed) who holds two productive assets, capital and labour. The government collects income taxes, consumption taxes, labour and capital taxes, tariffs on imported goods and services, and energy taxes. There are two types of energy taxes: production energy taxes (taxes on energy inputs in the production processes) and consumption energy taxes (taxes on final consumption of energy)[31]. On the expenditure side, the government buys goods, services, labour and capital to produce a public good; moreover, it provides unemployment benefits and pays "other transfers" (pensions and so on) to the households. In the model, unemployment is endogenous: a Phillips curve is introduced to make real wage's changes responsive to unemployment rate's variations.

Finally, the government pays export subsidies to help domestic firms penetrate foreign markets (in such a simple and aggregate version of the model, any public expenditure designed to favour the export sector is classified as "export subsidy" even if, properly speaking, this is not necessarily true). Government budget is balanced, which is not only consistent with EU-15 aggregate data, but also with the Stability and Growth Pact most of the fifteen have agreed upon. As to foreign trade, goods classified in the same sector are

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irrespective of any value judgement, you cannot ask EU people to buy a better environment (for all) with less social security (for them). It would not be politically feasible.

[30] The only available Input-Output Table (IOT) for the aggregation EU-15 is the version R25 (25 branches). Eurostat will begin to receive from the Member States, starting from December 2002, much more detailed (60 products and 60 activities) supply and use tables as well as symmetric IOTs established on an harmonised basis and thus easy to aggregate. In the R25 version, however, the energy sector is not sub-divided into its components (coal, oil, gas, etc.), but it is treated as a single, aggregated sector. In our model, the energy sector fully corresponds to that of the R25 IOT; the other 24 sectors of the R25 IOT are divided into energy intensive and non-energy intensive sectors according to the importance of the energy input in the production process.

[31] Of course, the energy tax could be alternatively modelled as an excise paid to the Government by the energy sector and whose economic burden is then passed on to the users, be them final users ("consumption energy tax") or intermediate users ("production energy tax"). However, this way of modelling energy taxes makes more difficult to capture the fact that in some countries some users are subject to a reduced tax rate. In general, the effects of differentiated tax rates, exemptions, refunds, etc. on different industries and final demand categories are better captured by explicitly modelling two different taxes for intermediate and final uses.

different according to whether they are produced domestically or imported (this is the well-known Armington assumption). The degree of substitutability between domestic and imported goods is assumed to be the same across economic agents (firms, consumer, government). This is a very strong assumption, but it reduces tremendously the dimensionality of the model. However imperfect, the Armington assumption is one very common way of modelling the fact that we do not observe complete (Ricardian) specialisation in real economies. In the simplest version of the model the economy is considered to be small (small country assumption) and it takes as given the world prices of all traded goods. On the export side, domestic producers are assumed to be completely indifferent between selling at home and selling abroad, so that the quantities exported are completely determined by foreign demand, whilst domestic production delivered to the domestic market is determined as a residual[32]. The current account must be balanced and the exchange rate with the rest of the world is determined endogenously. The balanced current account assumption, which is very common in static CGE models, is also very close to the EU-15 data and therefore the benchmark database has been only very slightly adjusted to be fully consistent with such an assumption[33].

The model attempts to capture some of the key features relating to CO_2 emissions. These include: a) linking emissions to the consumption of polluting inputs (energy), as opposed to output; b) including emissions generated by final demand consumption; c) integrating substitutability between polluting (energy) and non-polluting inputs. Total CO_2 emissions are a fixed-coefficient-linear-combination of energy used as an intermediate input and energy used for final consumption. The reason why we assume different emission coefficients for intermediate and final uses of "energy" has to be found in the different composition of this aggregated good when used for final or intermediate purposes (in other words: coal, natural gas, fuel oil, biofuels, unleaded petrol, leaded petrol, diesel, etc., are combined in different ways to produce energy as an intermediate rather than energy as a final good). Emission coefficients are also fixed, which amounts to assume that in our model neither intermediate nor final users can substitute among different energy sources. This is not a realistic assumption, but no alternative is available with a R25 IOT (see footnote 27) and, most importantly, our purpose is to assess the economic impact of a border tax adjustment rather than the environmental consequences of differently designed energy/CO_2 taxes.

Finally, the model equates investment to saving. This particular closure rule implies that investment is driven by saving. In a real model (money does not matter at all) with no uncertainty, there are no reason for people to save but investing.

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[32] An alternative assumption is made in some of the more sophisticated versions of the model (Missaglia, M. [2002], forthcoming), where domestic producers are assumed to differentiate the domestic market and the export market using a Constant-Elasticity-of-Transformation (CET) production possibility frontier.

[33] In CGE models the initial database is assumed to be an equilibrium. This implies that benchmark data must be consistent with each equation of the model.

6.2. - Energy taxation without any compensation

Before illustrating the results of some interesting policy simulations, let us show what would happen should the EU increase all the energy tax rates by 10% without implementing any compensatory measure[34].

The model has been run for three possible cases; the benchmark (B), where all parameters and elasticities are those calibrated or estimated econometrically, and two sets of alternative values for some key elasticities (this is the so called sensitivity analysis, where the robustness of the main results is checked against different values of some elasticity and structural parameter). In the "environment-friendly" (EF) scenario it is assumed that: foreign demand for energy-intensive exports is more rigid (wrt the benchmark); imports of energy-intensive goods are more easily substitutable with domestic production; finally, energy is more easily substitutable with other intermediates inputs in each sector. In the "environmental-enemy" (EE) scenario the opposite assumptions are made.

Table 1 summarises some of the main results.

Table 2 – An increase in energy taxation without any compensation
(% change)

	Benchmark (B)	EF	EE
CO_2 emissions	- 7.90	- 8.85	- 6.1
Unemployment level	+ 7.65	+ 7.42	+ 7.84
Energy intensive gross production	- 0.70	- 0.56	- 0.82
Non-energy intensive gross production	- 0.12	- 0.10	- 0.19
Energy gross production	- 8.40	- 9.10	- 6.90
Tax revenue	+ 0.70	+ 0.73	+ 0.80
Energy intensive competitiveness	- 0.83	- 1.20	- 0.65
Non energy intensive competitiveness	- 0.23	- 0.60	0.00
Energy competitiveness	- 3.45	- 4.50	- 3.95
Price index	+ 0.86	+ 0.84	+ 0.88
Utility level	- 1.03	- 1.05	- 1.05
Household income	- 0.05	- 0.06	- 0.05

[34] The 10% increase in the energy tax rates is what is needed in our model to reduce emissions by about 6% to 9% (depending on the value of the relevant elasticities, see Table 2 below). Given that according to the Kyoto Protocol the EU should cut emissions by 8% compared to the 1990 level, the 10% increase we postulated has to be considered a realistic starting point to discuss the economic impact of a tax border adjustment. It is worth

These results are as expected. A substantive reduction in CO_2 emissions costs a lot from an economic point of view. Under each scenario, the only “plus” is in government tax revenue, due to the energy taxes’ increase needed to cut emissions. The highest price, of course, is paid by the energy and the energy intensive sectors, in terms of both gross production and competitiveness. The latter has been measured using the terms of trade’s variations (domestic currency price of imports/foreign currency price of exports) and of course a positive variation implies an improved competitiveness. Unemployment *level* rises quite dramatically and the corresponding unemployment *rate* jumps from 9 to 9.7%, as a result of two combined effects: a lower gross production in each sector and labour-capital *substitution*. The latter occurs because in each scenario the relative price of capital falls due to the huge reduction in capital demand prompted by the collapse of energy production, which is the most capital intensive of the economy.

In the environment friendly scenario (EF) the key assumption is the higher (wrt the benchmark) elasticity of substitution in each sector between energy and the other intermediate inputs. It implies that the same increase in energy taxation prompts a still more accentuated decline of the domestic production of energy (-9.1% against –8.4%). Symmetrically, the domestic production of the other goods falls less markedly than under scenario B (and so the unemployment level) because such goods are demanded as intermediates in substitution of the energy input. Obviously, all these changes favour a particularly pronounced reduction in emissions’ levels, and this is why we have labelled this scenario as “environment-friendly”. One should also remark that under this scenario the loss of competitiveness of each sector is higher than under scenario B since the competitiveness is proxied by the terms of trade and, given the world (foreign currency) price of imports and the trade policy parameters, they are ultimately determined in each sector by the domestic price and the exchange rate.

In our model, the accentuated loss of competitiveness under scenario EF is mainly explained by the rise in *each* domestic price, which in turn can be attributed to the sharper (wrt the benchmark) increase in the production costs. In other words: under both scenarios the energy price – following the increase in tax rates - jumps to much higher levels, but under scenario EF, when the other intermediates are more pronouncedly demanded to substitute for energy inputs in the production processes, their price jumps as well. Hence, the sharp increase in the production costs and the grave loss of competitiveness.

Mutatis mutandis, the same observations applies to the EE scenario. Can these economic costs be reduced without cutting environmental benefits too? What is the best compensatory policy EU’s public authorities can envisage?

6.3. - Energy taxation and policy compensation

Here we want to compare four different “compensating” policy scenarios (let us call them A, B, C and D), and each of them will be combined with the different assumptions about

recalling (footnote 30) that a distinction between a pure carbon tax and an energy tax is impossible to introduce within the framework of a R25 IOT.

elasticities we have just described under labels EF and EE. In all these combined scenarios we will impose the same increase in energy taxes as before (+10%). But every single scenario differs from the others as to the compensatory policy implemented by the government. More specifically:

in Scenario A there is an "equal-yield" decrease in labour taxes (essentially, social security contributions). In CGE modelling literature "equal-yield" can mean several different things. Here (in the basic version of the model), we adopt the most popular meaning: labour taxes are reduced so as to leave unchanged total government's tax revenue[35]. The main objective of this compensatory policy is to alleviate the unemployment cost imposed by energy taxation;

in Scenario B there is an equal-yield increase in export subsidies paid by the government to energy- and non-energy-intensive sectors. The idea is to protect productive sectors from the loss of competitiveness they would suffer in the absence of any compensatory measures;

in Scenario C, only the energy intensive sector gets some subsidy from the government (and the equal-yield constraint is still there). Here, the idea is to channel government's help in favour of the most penalised sectors;

Table3–Energy taxation with different compensating measures

(% change)

	A-B	A-EF	A-EE	B-B	B-EF	B-EE	C-B	C-EF	C-EE	D-B	D-EF	D-EE
CO_2 emissions	-7.4	-8.45	-5.60	-7.55	-8.75	-5.60	-6.25	-8.30	-3.80	-7.30	-8.25	-5.60
Unemployment level	+1.06	+1.11	+0.80	+9.22	+9.50	+9.00	+5.60	+8.55	+3.6	-0.04	-0.02	-0.20
Energy intensive gross production	-0.18	-0.10	-0.24	+0.11	-0.15	+0.35	+3.70	+1.22	+5.30	-0.15	+0.10	-0.45
Non-energy intensive gross production	+0.46	+0.47	+0.41	+0.31	+0.45	+0.16	-0.90	-0.12	-1.50	+0.47	+0.62	+0.50
Energy gross production	-7.80	-8.30	-6.40	-8.20	-9.10	-6.75	-7.20	-8.75	-5.35	-7.80	-8.10	-6.40
Energy intensive competitiveness	-0.35	-1.60	-1.15	+1.60	+2.12	+1.22	+10.40	+17.20	+5.30	+0.90	+0.10	+1.70
Non energy intensive competitiveness	-0.75	-1.00	-0.55	+8.50	+8.90	+8.55	-5.50	-0.40	-8.80	-2.25	-3.00	-1.50
Energy competitiveness	-4.70	-4.90	-4.55	-4.20	-3.65	-4.70	-9.10	-4.30	-12.00	-6.10	-6.85	-5.50
Utility level	-0.40	-0.40	-0.38	-1.05	-1.10	-1.04	-0.75	-1.04	-0.55	-0.30	-0.35	-0.32

in Scenario D there is an equal-yield border tax adjustment. This means that a reduction in labour taxes is allowed to exactly compensate the higher tax revenue accruing to the government from two sources: higher energy taxes (as in the other scenarios) and the border tax adjustment. More specifically, the tariff rate increase for imports of energy-intensive goods is supposed to be higher than those for imports of non-energy intensive goods and energy [36]. Table 3 summarises simulations' results.

In general it is pretty difficult to compare so many figures and build an appropriate ranking of different scenarios[37]. In this case, however, it does not seem that difficult. First, note that scenarios B and C are very costly in terms of unemployment increase. The government's choice of using the extra revenue coming from energy taxation to subsidise domestic producers of both energy-intensive and non-energy intensive goods (scenario B) or just the former group (scenario C) without cutting labour taxes makes them more competitive but further lowers energy domestic production (since it is a basic principle of economics that there is no free lunch and a subsidy given to someone is a tax imposed on someone else). But energy production is capital intensive, which causes a fall in the relative price of capital and thus a strong labour/capital substitution effect throughout the whole economy. We are left with scenarios A and D. Scenario A corresponds to the traditional idea behind the double dividend literature (take the energy tax revenue and use it to reduce social security contributions and you will get a better environment and less unemployed people).

Scenario D illustrates the tax border adjustment. First of all, from an environmental point of view they are substantially equivalent. But the double dividend – better environment, less unemployed – is actually produced by the border tax adjustments. We find here an empirical confirmation of the hypothesis sketched in Section 5. Despite in Scenario A the extra government revenue (generated by environmental taxes) is actually used to reduce labour distorsionary taxes, this is not enough to offset the loss of competitiveness domestic firms suffer vis-à-vis their foreign counterparts. The negative effect on employment prompted by the collapse of energy-intensive and energy domestic production more than offset the incentives to labour hiring coming from labour taxes' decrease. In the border tax adjustments scenario, the positive (however very weak) incentive given to the domestic production is enough to reverse the result and produce a double dividend.

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[35] Remember that the balanced budget constraint is (implicitly) already part of the model, so we do not have to impose it again. It is automatically met.

[36] Notice that in none of the four scenarios there is a significant compensating measure in favour of the energy sector. This could seem a bit surprising, given the relevant losses it suffers due to the energy taxes' increase. However, as is clear from the benchmark data, the EU is an energy importer: tariff's increases would simply make the consumers worse off, whilst export subsidies, that are very costly for the government, could not turn the EU in an energy exporter.

[37] According to the usual welfare criteria we should compare the utility levels and calculate such items as equivalent variation or equivalent compensation. But here this would not make a lot of sense. First, the environmental benefit coming from emissions' reduction does not enter the utility function. Second, the public good produced by the government does not appear in the utility function as well. We could do it, but we are still evaluating how to do so in a non-trivial way.

7. - Conclusions

In this paper we have tried to understand whether the EU could comply with the Kyoto commitment concerning the reduction of carbon dioxide emissions using, in the framework of a policy design exploiting a set of different tools, an energy tax implemented unilaterally, even if the main competitors, and especially the US, will not do the same. Our provisional conclusion is that it is possible for the EU to comply with the Kyoto targets, but this will require the adoption of a compensatory border tax adjustment, which seems compatible with existing WTO/GATT rules (and its earlier jurisprudence). We have shown, with the help of a simple CGE model calibrated on EU-15 official data[38], that border tax adjustments are more likely to produce a double dividend (better environment, less unemployed) than other compensatory policies.

Of course, a word of caution is needed. These are very preliminary results, emerging from a very simple, static and perfectly competitive model. Needless to say, the effects of a border tax adjustment should be studied in a fully dynamic, multi-regional model, where the possibility of strategic reactions cannot be ruled out.

[38] EUROSTAT [2000]

References

BARKER, T.-KÖHLER, J. [1998], *International Competitiveness and Environmental Policies*, Cheltenham, Edward Elgar

BOVENBERG, A.L.-GOULDER, L.H. [2001], *Environmental Taxation and Regulation*, NBER Working Paper 8458, Cambridge MA, September

CAPROS, P. [2000], *The Economic Effects of EU-Wide Industry-Level Emission Trading to Reduce Greenhouse Gases. Results from PRIMES Energy Systems Model*, National Technical University of Athens

DEMARET, P.-STEWARDSON, R. [1994], *Border Tax Adjustments under GATT and EC Law and General Implications for Environmental Taxes*, "Journal of World Trade", pp. 5-65

EKINS, P.-SPECK, S. [1999], *Competitiveness and Exemptions from Environmental Taxes in Europe*, "Environmental and Resource Economics", pp. 369-396

EUROSTAT [2000], *Annuaire Eurostat, 1998-1999*

GODAL, O.-HOLTSMARK, B. [2001], *Greenhouse Gas Taxation and Distribution of Cost and Benefits: The Case of Norway*, "Energy Policy", 29, pp. 653-662

GREENSTONE, M. [2001], *The Impacts of Environmental Regulations on Industrial Activity: Evidence from the 1970 and 1977 Clean Air Act Amendments and the Census of Manufactures*, NBER Working Paper 8484, Cambridge MA, September

HEADY, C.J.-MARKANDYA, A.-BLYTH, W.-COLLINGWOOD, J.-TAYLOR, P.G. [2000], *The Relationship Between Environmental/Energy Taxation and Employment Creation*, Univ. of Bath

HOERNER, J.A. [1998], *The Role of Border Tax Adjustments in Environmental Taxation: Theory and U.S. Experience*, paper presented at the Workshop on "*Market-Based Instruments and International Trade*", Institute for Environmental Studies, Amsterdam

JANSEN H.-KLASSEN G. [2000], *Economic Impacts of the 1997 EU Energy Tax: Simulations with Three EU-Wide Models*, "Environmental and Resource Economics", pp. 179-197

MAJOCCHI, A. [1996], *Green Fiscal Reform and Employment: A Survey*, "Environmental and Resource Economics", No. 4, December, pp. 375-397

MAJOCCHI, A. [2000], *Greening Tax Mixes in Oecd Countries: A Preliminary Assessment*, "Rivista di Diritto Finanziario e Scienza delle Finanze", pp. 361-395

MAJOCCHI [2002], *The Trade-Off Between Environmental Taxes and External Competitiveness: A Way-Out*, in L.A. Kreiser (ed.), *Critical Issues in International Environmental Taxation*, CCH, Chicago, pp. 357-379

McCORRISTON, S.-SHELDON, I.M. [2002], *The Non-Neutrality of WTO Border Tax Adjustments for Environmental Excise Taxes Under Imperfect Competition*, forthcoming

MISSAGLIA, M.[2002], *Border Tax Adjustment and Energy Taxation in the European Union: a CGE assessment*, forthcoming

POTERBA, J.M.-ROTEMBERG, M. [1995], *Environmental Taxes on Intermediate and Final Goods When Both Can Be Imported*, "International Tax and Public Finance", pp. 221-228

SVENSEN, G.T.-DAUGBJERG, C.-HJOLLUND, L.-PEDERSEN, A.B. [2001], *Consumers, Industrialists and the Political Economy of Green Taxation: CO_2 Taxation in OECD*, “Energy Policy”, 29, pp. 489-497