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ENVIRONMENTAL TAXES AND BORDER TAX ADJUSTMENT

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(preliminary version)

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 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.

[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].

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 have to make 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 incentive to reduce polluting emissions as much as possible otherwise they 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 problems 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, is a pure carbon tax as opposed to an energy tax. The reduction of CO_2 emissions can be reached through three channels:

- a reduction of energy services in households and firms, which is induced by the higher relative prices of energy;
- rising energy prices give an incentive to improve the efficiency of energy uses both in end-use sectors and in the production of secondary energies;
- fuel substitution leads 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 (3,087) 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 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 recently included, while 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

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

reduction of CO_2 emissions will certainly be more cost-effective than relying solely on regulatory measures.

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 of 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

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

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. But it would favour nuclear energy, 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 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 -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.

4.- *Energy taxes and competitiveness*

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[8], but with an equal unsuccessful outcome. When in the Gothenburg European Council it was identified as a priority the adoption of the Energy Products Tax Directive by 2002, immediately afterwards the Commission suggests an important caution saying that "the Union will insist that other major industrialised countries comply with their

[7] MAJOCCHI [1996]
[8] *Proposal for a Council Directive Introducing a Tax on Carbon Dioxide Emissions and Energy* (COM(95)172 final

Kyoto targets. This is an indispensable step in ensuring the broader international effort needed to limit global warming".

As a matter of fact, if global commons are at stake, attention should be given to the fact that states are interdependent. Hence, the effectiveness of the policy pursued by one state depends from what the other states do. This interdipendence is of two types. First, if one country curbs its emissions, this benefits other countries too. But the country implementing emissions control does not receive any compensation for these benefits and therefore does not take them into account when setting its own abatement level. There should be a presumption that "each group of countries will abate too little of its emissions relative to the amount that would be justified from a global perspective. Free-riding blocks the achievement of an effective environmental policy"[9].

Second, following the adoption of strict environmental rules the prices of traded goods would rise and, as a consequence, comparative advantage in the manufacture of these goods would shift abroad. As output of these goods rises abroad, emissions are likely to rise as well. These market effects are known as leakage that, provided it exists and is positive[10], undermines the environmental effectiveness of unilateral abatement policy.

In the literature "leakage" or "free-riding" problems are usually considered part of the general competitiveness issue. Two types of negative effects are usually claimed: eco-dumping and industrial migration to so called pollution havens. Those concerned about eco-dumping argue that industries in countries with lower or badly-enforced environmental standards have a competitive advantage, while pollution havens cause industrial migration, resulting in jobs and foreign direct investment being diverted from countries with high standards to countries with low ones. In

[9] BARRETT S. [1995].

[10] In the literature different quantitative estimates exist for leakage. See for instance, for high leakage rates: PEZZEY J. [1992], pp. 159-171; for low leakage estimates that do not render unilateral policy ineffective, see: OLIVEIRA-MARTINS J. *et al.*-[1992], pp. 123-140.

particular, the conventional wisdom is that environmental regulations impose significant costs, slow productivity growth and thereby hinder the ability of domestic firms to compete in international markets. This loss of competitiveness is believed to be reflected in declining exports, increasing imports and a long-term movement of manufacturing capacity abroad, particularly in pollution-intensive industries.

Evidence of countries deliberately resorting to low environmental standards to gain competitive advantage or to attract investments does not seem available. No systematic competitive impacts from disparate environmental regulations, no significant loss of markets, domestically or abroad, due to eco-dumping, nor industrial migration to countries with lower environmental standards has been documented. As far as the United States are concerned, a recent study shows that "there is relatively little evidence to support the hypothesis that environmental regulations have had a large adverse effect on competitiveness, however that elusive term is defined. Although the long-run social costs of environmental regulations 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"[11].

There are different reasons why the effects of environmental regulation on competitiveness are small. For all but the most heavily regulated industries the cost of complying with environmental regulation is a relatively small share of total cost of production. Even when there are substantial differences between environmental requirements within the internal market and abroad, domestic firms - and other multinationals as well - are reluctant to build less-than-state-of-the-art plants in foreign countries. Finally, even in developing countries where environmental standards - and certainly enforcement capabilities - are relatively weak, new plants normally embody more pollution control than is required. Therefore, "even significant *statutory* differences in pollution control requirements between countries may not result in significant effects on plant location or other manifestations of competitiveness”[12]. The main conclusion of this analysis is then that cost differentials stemming from divergent environmental regulations do not pose threats to industrial competitiveness sufficient to justify substantial cutbacks in domestic environmental constraints.

Recently, following the ideas put forward especially by Michael E. Porter[13], environmental regulations begin to be seen not only as benign in their impacts on international competitiveness, but actually as a net positive force driving private firms and the whole economy to become more competitive in international markets. The Porter’s argument is that strict environmental regulations can trigger innovation that may eventually raise a firm’s competitiveness outweighing the increased costs due to the complying with environmental rules. His argument has been supported by a large number of case studies showing examples of firms improving their economic performance following the implementation of tough environmental constraints[14].

The basic idea is that these “innovation offsets” will be widespread since reducing pollution is often coincident with improving the productivity with which resources are used; hence, the external shock through environmental regulation may reduce within the firm existing X-inefficiencies and organisational failures and may move the firm towards its production possibility frontier. In addition, Porter and van der Linde put forward the argument that firms may try to exploit a first-mover advantage by developing an environmental technology which can provide later a competitive advantage when other countries are induced to follow the same path of more stringent environmental regulations.

[11] JAFFE A.B. *et al.*-[1995], pp. 157-158.
[12] JAFFE A.B. *et al.* [1995], p. 158.
[13] PORTER M.E. [1990].
[14] PORTER M.-van der LINDE C. [1995], pp. 97-118.

For policymakers this idea of a possible “win-win” option has been appraised like a manna from heaven, because it relieved them of the difficult trade-off between environmental and other economic targets. But the economists remain largely sceptical about this assumption of a “free lunch” and support the need to implement a full cost-benefit analysis of environmental policy before reaching the conclusion that this policy is beneficial not only for the environment, but also for the economy as a whole. Two relevant assumptions underlying the Porter and van der Linde perspective have been particularly underlined: first, they see a private sector that systematically overlooks profitable opportunities for innovation; secondly, they envisage a regulatory authority that is in a position to correct this market failure. In the literature, using a neoclassical model of innovation in abatement technology, the conclusion has been reached[15] that an increase in the stringency of environmental regulations unambiguously makes the polluting firm worse off. Even if the firm can invest and adopt a new and more efficient abatement technology, if that technology was not worth investing in before, its benefits would not be enough to raise the company’s profits after the environmental standards are raised either.

In a recent paper[16] the validity of the Porter hypothesis is explored by considering firms’ reactions with respect to both the type and the quantity of equipment in which they invest in response to changes in the production costs, that trigger a restructuring of the capital stock in such a way that average productivity increases. If the firms invest in machines of different ages, younger machines are more productive and less polluting than older ones, but are more costly to buy and to install in the capital stock. Environmental regulation accelerates the removal of older machines from the capital stock which increases its productivity. “The implication for the debate on the Porter hypothesis is not that a win-win situation can be expected, but the trade-off between improving the environment and the competitiveness of the home industry is

[15] PALMER K. *et al.* [1995], pp. 119-132.
[16] XEPAPADEAS A.-de ZEEUW A. [1999], p. 165-182.

not as grim as it is sometimes suggested because of favourable changes in the composition of the capital stock"[17].

Hence, the prevailing view remains the current one, i.e. that competitiveness could be worsened by the implementation of stringent environmental policy and this widespread idea makes it more difficult to adopt new measures, especially when global -and not domestic- environmental goods are concerned by policy decisions.

5.- *Tax exemptions and border tax adjustments combined with the use of economic instruments*

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 thus 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[18], that "are seriously disadvantaged on account of an imbalance in trade from other Member States or an increase in imports

[17] XEPAPADEAS A.-de ZEEUW A. [1999]), p. 167.

[18] In the White Paper on Fiscal Reform, presented by the Italian government in December 1994, two alternative scenarios for the implementation of a carbon/energy tax have been sketched: the first considers a tax covering all the sectors -domestic, transport, industry- if a consensus is reached at the EU level to implement such a tax; the second considers an Italian unilateral initiative. In this case the industrial sector is excluded and the burden hitting the other sectors is parallelly raised. See MAJOCCHI A. [1997].

from third countries" (Article 9:2). Since there are a lot of reasons to question the rationale of this solution, it could be useful to explore the compatibility with the existing WTO rules of a policy setting up a system of border tax adjustments to balance the cost differentials between domestic and foreign production due to the environmental tax[19].

If the adoption of an environmental tax is constrained by a conditionality clause, that is by the adoption of similar measures by the other competing countries, this will imply that a decision to implement unilaterally the environmental policy is excluded and, furthermore, that it is more difficult to achieve a multilateral consensus for addressing global problems. Exemptions for energy intensive industries have been extensively adopted, but they largely impair the environmental result.

Border tax adjustments should be analysed further as a possible way out, keeping in mind that this solution seems to be easier to implement in the case of domestic environmental taxes rather than in the case of regulations. While in the case of energy products the possibility to levy a compensatory duty on the imports of fuels is clearly consistent with trade rules, some problems could arise when a border tax adjustment is envisaged on the imports of goods that use in the production process a considerable amount of energy[20].

It must be reminded that a negative conclusion has been reached on the point of border tax adjustments by the Dunkel Report on Trade and Environment, where the principle of a "level playing field" has been rejected suggesting that "there is no difference between the competitive implications of the type raised by different environmental standards and the competitive consequences of many other policy differences between countries". While this remark is generally correct as far as regulations are concerned, the possibility of border tax adjustments for environmental taxes levied on products, when these products are used as inputs in

[19] MAJOCCHI A. [1995].
[20] HOERNER [1998]

the production process of other products, has not been rejected by a GATT Panel when the EC -together with Canada - challenged the *United States Superfund Amendments and Reauthorization Act* of 1986.

The Superfund Act authorised a programme to clean up hazardous waste sites and deal with public health programmes caused by hazardous wastes. It imposed a tax on certain chemicals with effect from January 1, 1987 and further levied a new tax on certain imported substances, entering into effect on January 1, 1989. The taxable imported substances were derivatives of the chemicals subject to the domestic tax on certain chemicals.

The amount of the tax on any of the imported substances was equal in principle to the amount of the tax which would have been imposed under the Superfund Act on the chemicals used as materials in the manufacture or production of the imported substance if the taxable chemicals had been sold in the United States for use in the manufacture or production of the imported substances. Hence the Panel concluded that, to the extent that the tax on certain imported substances was equivalent to the tax borne by like domestic substances as a result of the tax on certain chemicals, the tax met the national treatment requirement of Article III:2, first sentence, of the GATT.

It remains to be checked if the ruling of the Superfund case could be applied when border tax adjustments are envisaged relating to products using large amount of energy not as a raw material, but as a combustion fuel consumed during the production process. In any case it should be proved that the tax is levied on a product (the fuel utilised during the production process) and not on the process as such -to avoid the ban of trade measures with extra-jurisdictional effects emphasised by the Tuna Panel Report.

The Superfund Act envisaged the possibility to implement border tax adjustments if the chemicals subject to the domestic tax on certain chemicals constituted more than

50% of the weight or the value of the materials used to produce such imported substances -determined on the basis of the predominant method of production. According to this provision -that has not been contested in the Panel Report- it seems conceivable to levy a border tax adjustment even if the energy -that is taxed domestically- does not appear in a measurable physical quantity within the imported product, provided the value of energy represents a certain percentage of the total value of the imported commodity.

In any case, it should be carefully considered that the widespread support of public opinion for tough environmental protection measures, especially in the most industrialised -and largely polluted- countries, should not conceal the risk that environmental standards could be used as new hidden trade barriers. It is quite clear that there are fully legitimate reasons for applying different domestic environmental policies, which reflect local conditions, preferences and levels of development. When environmental measures concern domestic goods, the argument for using trade restrictions can only be protectionist in nature and has to be firmly rejected.

When global environmental goods are at stake, the definition of international standards of environmental protection -as it has been the case for technical, sanitary, phytosanitary standards- seems to be an appropriate way out for coping with the needs of environmental protection, while limiting the negative impacts on trade. But as a general rule regulations do not represent the most cost-effective way for solving a global environmental problem. For instance, there is now a large consensus that one of the most cost-effective ways to address the global warming problem would be to implement a world-wide energy/carbon tax with an uniform rate since, in this case, the reduction of carbon dioxide emissions will take place where abatement costs are lower.

If this solution is not feasible in the short run, since some major countries cannot accept the same increase in energy taxation, unilateral actions are needed. But, in this case, new solutions –and border tax adjustments is probably the most effective- should be adopted to avoid that the protection of global commons will imply a worsening of competitive conditions for the most environment-friendly countries.

6 *A computable general equilibrium (CGE) assessment of border tax adjustment and other compensatory measures*

6.1 *General features of the model*. In the previous section we analysed the compatibility with the existing GATT/WTO rules of a system of border tax adjustment to balance the cost differentials between domestic and foreign production due to the environmental tax. Here, we want to propose a quantitative assessment of such a policy based on a very simple CGE model calibrated on EU-15 data[21]. The model is a very simple, standard neoclassical 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. 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 (excises and indirect taxes on energy inputs in the production processes) and consumption energy taxes (on energy final consumption). 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 changes responsive to unemployment rate change. Finally, the government recognises 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). As to foreign trade, goods classified in the same sector are different according to whether

[21] The database (benchmark) for the model is illustrated in the Appendix. The model is fully described in a related, forthcoming paper: "Tax Border Adjustment and Energy Taxation in the European Union: a CGE assessment" (Majocchi A. and M.Missaglia, forthcoming). The paper takes into consideration even much more sophisticated version of the model, with imperfect competition in some sectors, dynamics and a more realistic treatment of the "energy" sector, where different sources of energy (carbon and non-carbon) are taken into consideration.

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 common way of modelling the fact that we do not observe complete 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 a residual[22]. The government is subject to a balanced budget constraint and the same holds true for current account (the exchange rate with the Rest of the World is assumed to be variable) These assumptions deserve some comment. First, we are in a static framework and thus the best choice is to assume that there are a fixed budget deficit (surplus) and a fixed current account deficit (surplus). Indeed, variable budget and current account deficits (surpluses) would require to explicitly model the saving allocation behaviour of the consumer and international capital flows, which are, in essence, dynamic behaviours. Second, EU-15 data show that the balanced budget constraints are not far from reality[23]. Third, and maybe most importantly, our results would not change significantly had we assumed a non-zero fixed budget deficit (surplus) for both the government budget and the current account.

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. In the basic version of the model total CO_2 emissions are a fixed-coefficient-linear-combination of energy used as an intermediate input and energy used for final consumption. The fixed coefficient assumption amounts to assume that energy is a good obtained with a Leontief combination of different types of energy sources (coal, mineral oils, natural gas, renewable sources, etc.). In some of the more sophisticated version of the

[22] An alternative assumption is made in some of the more sophisticated versions of the model (Majocchi, A. and M.Missaglia, 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.

[23] Of course, this is not true for the *stocks* of public debt and external debt. But, again, this is a fact to be taken into account in the dynamic versions of the model.

model (Majocchi A. and M.Missaglia, forthcoming) we will remove this assumption and imagine some degree of substitutability among different energy sources, each of them with a different emission coefficient.

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, the only good reason for people to save is to invest.

6.2 *Energy taxation without any compensation*. Before illustrating the results of some interesting policy simulation, let us try to show what would happen should the EU increase energy tax rates by 10%. According to the benchmark data, this means increasing production energy tax rates:

a) from 9.9% to 19.9% for energy intensive sectors;

b) from 10.4% to 20.4% for non-energy intensive sectors;

c) from 35.6% to 45.6% for the energy sector (remember that mineral oil excise applies to this sector). Table 1 summarises the simulation results:

Table 1 An increase in energy taxation without any compensation (% changes)	
CO_2 Emissions	- 7.9%
Unemployment level	+ 7.85%
Energy intensive gross production (sec.1)	- 0.7%
Non-energy intensive gross prod. (sec.2)	- 0.14%
Energy production (sec.3)	- 8.4%
Tax revenue	+ 0.7%
Energy intensive competitiveness	- 0.78%
Non-Energy intensive competitiveness	- 0.15%
Energy competitiveness	-4.9%
Price index	+0.8%
Household utility	- 1.04%
Household income	- 0.045%

The results reported in Table 1 are not surprising at all. A substantive reduction in CO2 emissions costs a lot from an economic point of view. 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 sector and the energy intensive sector, both in terms of gross production and competitiveness. The latter is measured through terms-of-trade variations (domestic currency price of imports/foreign currency price of exports): a positive variation implies an improved competitiveness. Unemployment level (in the benchmark there is a 9% unemployment rate) worsens significantly as well. Can these economic costs be reduced without cutting environmental benefits too?

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). In all cases there is the same increase in energy taxes we illustrated in section 5.2. Scenarios are different as the to the way of compensating energy taxes' increase. More specifically:

A) 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[24]. The idea is to cut primarily the unemployment cost of energy taxation;

B) in Scenario B there is an equal-yield (in the same sense as before) 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 without any compensatory measures;

C) in Scenario C there is an equal-yield increase in export subsidies paid to the energy-intensive sector. Here, the idea is to help the most penalised sector, the energy-intensive one;

D) in Scenario D there is an equal-yield border tax adjustment. More specifically, the tariff rate increase for imports of energy-intensive goods (+4.5%) is higher than that for imports of non-energy intensive goods (+1%) which is in turn higher than the tariff rate increase for imports of energy (+0.5)[25].

[24] Remember that the balanced budget constraint is already part of the model, so we need not to impose this constraint again.

[25] Notice that in none of the four scenarios there is a "relevant" compensating measure in favour of the energy sector. Thic could seem a bit surprising, given the relevant losses suffered by the energy sector 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!

Table 2 summarises the results of the four policy scenarios:

Table 2 Energy taxation and policy compensation (% change for different scenarios)

	Scenario A	Scenario B	Scenario C	Scenario D
Emissions	-7.4%	-7.5%	-6.2%	-7.4%
Unemp.level	+1.07%	+0.73%	+6.3%	-0.7%
Energy-int. Gross prod.	0	-0.7%	+4.2%	0
Non-energy-int. Gross prod.	+0.5%	+0.6%	-1.1%	+0.4%
Energy gross prod.	-7.5%	-8.2%	-7.2%	-7.9%
Ener-int. Compet.	-1.4%	-2.5%	+12%	+1.7%
Non-energy-int. Compet.	-0.8%	+3.1%	-4.2%	-1.5%
Energy comp.	-4.7%	-7.5%	-7.9%	-5%
Price index	+0.12%	+0.8%	+0.7%	-0.015%
Utility level	-0.4%	-0.8%	-0.8%	-0.35%
Household income	-0.24%	+0.73%	-0.12%	-0.3%

However difficult, the ranking of scenarios seems in this case relatively simple. The tax border adjustment scenario (Scenario D) seems to guarantee the minimisation of the economic costs associated to the adoption of an increased energy tax, while at the same time maintaining the environmental benefit such an increase can assure. It is the only scenario associated with a reduction in the unemployment level; it minimises the loss of competitiveness of the energy sector[26] and the overall utility level, etc. The economics behind this result is not difficult. First, increasing the tariff rates creates room for labour taxes' reduction, which is not the case when export subsidies are increased to maintain competitiveness. Second, as in many other developed regions of the world, in the EU tariff rates are (on average) low, whilst export subsidies are not. Hence, room is created for augmenting the tariffs without prompting too many distorsions in the economy.

Of course, a word of caution is needed. These are very preliminary results, coming from a very simple, static and perfectly competitive model. Needless to say, the effects of a border tax adjustment should be checked in a fully multi-regional model, where the possibility of trade wars and strategic reactions cannot be ruled out. Still, these results point to a very interesting direction for future research and testing their robustness in more realistic and sophisticated frameworks is the first to pursue. Moreover, these preliminary results make it more urgent to understand whether the most environment-friendly countries are legally allowed to adopt a border tax adjustment while at the same time being reasonably sure not to bear the cost of less environment-friendly retaliations.

[26] Tariffs' increases could be designed to hold the non-energy-intensive sector's competitiveness constant. But this would be very costly for the economy as a whole, since this sector is much larger than the other ones and an increase in its tariff rate would substantially reduce consumer's welfare.

Appendix

	Sec1 (E.I.)	Sec2(N.E.I.)	Sec3 (E)	Govt	Cons	Inv	Exp	ExpSub
Sec1 (energy intensive)	427463	783077	29724	57886	901368	95120	201566	10406
Sec2(non energy intensive)	545376	3032732	72503	454609	2656066	896718	477188	72894
Sec3 (energy)	128326	97187	144568	23638	207249	1169	0	
Tax on Energy (production)	12658	10153	51509					
Capital services	359567	1357317	88617	126335				
Tax on capital	64527	211013	16496					
Labor services(gross wages)	618223	1616734	68267	759733				
Tax on labor	225466	632834	26116					
TOTAL	2381606	7741047	497799	1422202				
Import	112350	378986	104118					
Tariff	2247	15159	221					

Tax on consumption:	sec1	142309
	sec2	602038
	sec3	65715
Tax on capital	sec1	64527
	sec2	211013
	sec3	16496
Tax on labor	sec1	225466
	sec2	632834
	sec3	26116
Tax on energy	sec1	12658
	sec2	10153
	sec3	51509
Tariffs on imports	sec1	2247
	sec2	15159
	sec3	221
Export subsidies	sec1	10406
	sec2	72894
	sec3	
Income tax		2376690
TOTAL TA X REVENUE		4371851
Unemployment benefit		151464
Other transfer (TRO)		2798185

Source: authors' calculation based on EUROSTAT (2000) and WORLD BANK(2001).
We splitted the 25 sectors input-output table for EU-15 we received from EUROSTAT in three sectors: energy-intensive, non-energy intensive and energy. According to the energy intensity coefficient (energy input/total inputs), the energy-intensive sectors are: Ferrous and Non-Ferrous Ores and Metal; Non-metallic mineral products; Chemical products; Recovery, repair services, wholesale, retail; Inland transport services; Maritime and air transport services.

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