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Summary

International trade negotiations have recently tackled the issue of possible free trade restrictions, justified - among others - on the basis of environmental concerns. Also, some analyses of international environmental agreements (especially in the field of climate change) have highlighted the key role played by changes in the terms of trade in determining the cost of environmental policies. Yet, secondary effects of international trade remain disregarded in many environmental policies, whereas the introduction of environmental trade barriers has been resisted, arguing that this may hide a Trojan horse of a renewed protectionism.

This paper reviews the debate on trade and the environment in the two fields of environmental and trade negotiations, highlighting the different and somewhat conflicting approach adopted in the two cases. A numerical general equilibrium model is used to illustrate how different "perceptions" (translated in terms of alternative model closures) affect the use of instruments, the distributional impact of the various policies, and the strategic interplay between negotiators in international agreements.

Keywords: Trade policy, environmental policy, climate change, general equilibrium models

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1. Introduction

In principle, the linkages between trade and environmental policies are widely recognised by both the economics literature and the policy practice.

Trade policies have an impact on the environment, because: (1) they stimulate economic growth, which induces a higher demand for polluting goods, but also for a cleaner environment (Antweiler et al., (2001)), (2) they reallocate production around the world, affecting the distribution of pollution sources and sinks (Lee and Roland-Holst (2000)). On the other hand, environmental policies also have an impact on trade patterns, because: (1) they alter domestic and international prices, which in turns affect the terms of trade (Bernstein et al. (1999)), (2) they create new markets (e.g., pollution permits), affecting the trade balance (Roson and Bosello (2002)), (3) they may induce dirty industries to relocate to countries with lax environmental regulation (Ulph (1994)).

Despite these obvious linkages, international trade bodies have been reluctant to link trade and environmental policy-making. Given the rising importance of non-tariff barriers as obstacles to free trade, there is a fear that environmental measures may become the Trojan horse of a renewed protectionism. Because of these and other reasons, some prominent economists have also argued against the linking of trade and environmental objectives (Bhagwati (2000) but, for a different opinion, see Repetto (2000)).

On the other hand, environmental organisations seem often to be unaware of the role played by changes in the terms of trades on the cost and effectiveness of environmental policies. Many sophisticated models used in this field simply disregard the existence of international trade. The text of many international environmental protocols, like the Kyoto protocol, makes hardly any reference to the consequences of these agreements on the world trade.

To understand these seeming inconsistencies, we think it is useful to start by bearing in mind that different people, having different cultural backgrounds, priorities and perspectives, conduct international negotiations. The technical functioning of the bodies involved, the transparency of the negotiation processes, the involvement of non-governmental organisations, etc., are also relevant disparities. In this respect, Esty (2001) notes: “one cannot blame all of the tensions at the trade-environment interface on linguistic differences, but these competing perspectives are emblematic of a deep clash of cultures, theories, and assumptions”.

The core objective of this paper is to formulate and analyse the conflicting perspectives which are prevailing in the context of trade and environmental negotiations. In particular, we shall adopt a modelling approach to highlight the following causal process:

PERCEPTIONS ⇒ INCENTIVES ⇒ INSTRUMENTS

By investigating this chain of reactions, we aim at providing three insights:

- (i) People's perceptions correspond to a model which they implicitly have in mind. We are not going to explain the underlying reasons for the different perspectives, but instead we will focus on the actual observed behaviour in the trade and the environment communities.
- (ii) If conception (i) is true, then people face incentives, which are motivated by the underlying models.
- (iii) Consequently, the instruments which are chosen, the sustainability of cooperative agreements, the inconsistency between different policies, can all be traced back to fundamental differences in the mental models.

The paper is structured as follows: we first review how international trade institutions, like the World Trade Organisation, have addressed the environmental problems, considering afterwards the symmetric problem of how environmental institutions have (or have not) taken into account the secondary effects of environmental policies on the world trade.

Subsequently, we introduce a very simple general equilibrium model, in which alternative model closures are used to mimic different "perceptions", possibly driving the strategies of international negotiators in the different contexts. A simple illustrative numerical model is used first, because the simplicity of its structure makes relatively easy the identification of the key factors shaping the results. To get a more realistic picture, however, the results are replicated using a variant of the GTAP model of the world economy, and the differences between the results obtained by the two models are briefly discussed.

A closing section summarises the main findings and draws some conclusions.

2. The treatment of environment in international trade negotiations: a policy analysis

Due to the growing concerns related to environmental quality, the debate on the linkages between environment and trade has intensified during the last decade. Arguably, trade itself is a contributing factor to environmental degradation through the pollutants emitted when goods are transported across different parts of the world. On the other hand, free traders often consider environmental actions as a threat since they fear protectionism under their cloak, which could pose new obstacles to the idea of liberalisation. Indeed, trade barriers and discriminating trade policies have already been justified on the basis of environmental protection and have been strongly criticised by

advocates of free trade since, by affecting the production and consumption of certain goods, they can induce a shift in the comparative advantage of certain industries and regions.

It is very important to analyse the interrelations between the two aspects, trade and environment, in order to prevent a misuse of environmental policies. A precondition for the implementation of such an effective policymaking requires a comprehensive understanding of the perspective supported by free traders. The next sections will therefore investigate the role of environmental concerns in the history of the trade negotiations and examine whether the defensive attitude of free trade advocates with respect to the environment translates into real policy strategies.

2.1 The evolution of environmental concerns in the WTO trade negotiations

The link between environmental and trade aspects has been discovered very early. In fact, questions regarding the interrelation of trade and the environment arose already in the early 1970s. As a response to the growing concern about the environmental impact of economic growth, the United Nations organised a Conference on the Human Environment in 1972 in Stockholm, which provided countries with an opportunity to address cross-boundary issues. Before this event, the Secretariat of the General Agreement on Tariffs and Trade (GATT) was invited to contribute, and produced a study dealing with the implications of environmental policies on the international trade. In this initial period, the possibility of a new “green” protectionism, justified by environmental policies, emerged as the principal concern of the trade officials, who consequently looked for ways to defend the idea of free trade. In the aftermath of the Stockholm Conference, the GATT set up the Group on Environmental Measures and International Trade, but this so-called EMIT group convened for the first time only in 1991, when several GATT members finally asked for its convocation¹.

At that point, environmental concerns could not be neglected any more. As a consequence of growing trade flows, the effects of trade on the environment became more obvious. At the same time, the number of environmental policies increased and started to have deeper impacts on trade. In particular, the increase in market-based policies – following the example of the United States – contributed to stronger and more evident interactions between the environment and the trade system. The most-cited event, which characterised a turning point in the intensity of the trade and environment debate is the Tuna-Dolphin trade dispute case. In 1991, the United States imposed an import ban on tuna from Mexico caught in nets, which caused the incidental killing of dolphins. Mexico complained to the GATT, emphasising that the embargo was inconsistent with the rules of

¹Due to a proposition, the assembly of this group has to be requested by the GATT members. In 1991, the urgent request was submitted by the members of the European Free Trade Association (EFTA).

international trade. The GATT ruled against the US and induced a public outcry, which implied a sudden prominence for trade as an environmental issue. However, at a closer look the GATT did not rule against the environment per se since it accepted the US target of protecting dolphins. The GATT decision reflects its objection to the use of discriminatory trade sanctions as a measure of achieving this aim (The Economist, Oct. 7th, 1999).

The popularity of the trade and environment argument has also been intensified by a larger research production on trade, social development and environment (e.g., special issues on some scientific journals: Ekins et al. (1994), Barrett (2000), Alpay (1999)). The activation of the EMIT group can therefore be seen as a result of all these developments and, even though several GATT members were initially against dealing with environmental questions, an agreement on the “structured” debate of the issue could be found.

Apart from the EMIT group’s activities, also other developments showed that the linkages between trade and environment started to play a larger role. A major event was the 1992 UN Conference on Environment and Development (UNCED), better known as the Rio “Earth Summit”, where the Agenda 21 has been adopted. This action programme aims at promoting sustainable development through various activities, including international trade.

A new era for the acknowledgement of the relationship between trade and environment started with the creation of the World Trade Organisation (WTO) in 1994. In the preamble of the new constitution, the Marrakech Agreement establishing the World Trade Organisation, an explicit link between the two issues has been made, stating sustainable development, environmental protection and conservation of scarce resources as explicit objectives and an integral part of the multilateral trading system. In addition to the founding charter, also a ministerial declaration dealing with the subject has been adopted, emphasising that “...(t)here should not be, nor need be, any policy contradiction between upholding and safeguarding an open, non-discriminatory and equitable multilateral trading system on the one hand, and acting for the protection of the environment, and the promotion of sustainable development on the other.” (Decision on Trade and Environment, 1994)

Through this last decision, the WTO’s Committee on Trade and Environment (CTE) has been established out of the previous EMIT group. The CTE’s establishment was intended to promote environmental and sustainable development issues by identifying the relationship between trade

measures and environmental measures². In its main outcome, a report to the WTO Ministerial Conference in Singapore in 1996, this interest in building a constructive relationship between trade and environmental concerns has been emphasised again, but without suggesting concrete actions. Since this time, the CTE met several times, but its focus has been narrow (above all on issues related to market access) and the overall effort has remained modest.

However, in the last decades the trade and environment debate has changed and intensified due to the emergence of other pressing environmental issues, as, e.g., climate change. The shift from the local to the global scale has rendered environmental problems more visible and demonstrates clearly that environment and trade are closely linked. Environmental concerns gained also more weight in the process of trade negotiations. At the Fourth Ministerial Conference, which took place in Doha, November 9th – 14th, 2001, ministers adopted a declaration that includes several aspects of trade and environment. The commitment to the objective of sustainable development has been reaffirmed, pointing at the requirement that “the protection of the environment and the promotion of sustainable development can and must be mutually supportive” (Doha Ministerial Declaration, Nov. 14th 2001). Also within the work programme identified at Doha, the mutual supportiveness of trade and environment is emphasised as a key target and the CTE is given the task of pursuing the necessary work in order to have sustainable development appropriately reflected. However, concrete actions still have to be negotiated.

2.2 An evaluation of the motivation behind the trade and environment debate

During the last decade, the WTO has tried to give to the environment a new higher profile. But, which reasons made the attitude of the trade community change in the beginning of the 1990s? Why did they deviate from the strategy they have been supporting up to that point?

Two main motives emerged, which can explain the sudden change: on one hand, the environmental problems shifted from a more local level, as e.g. smog, over a regional level, as e.g. acid rain, to a global scale, evidenced by the challenge of global warming. A second reason for the gain in visibility consists in the new culture of using more market-based policies also in the environmental context. This new strategy of market-based instruments has, clearly, closer links to trade issues.

However, even though the environment is often mentioned within the WTO, actually in practice there has not yet been major progress. For example, although the importance of the environment in

² However, a crucial statement guiding the CTE work emphasises that the WTO is not an environmental protection agency but focuses on trade, and therefore deals only with aspects of environmental policies which could have effects on trade or are somehow related to trade.

the trade context has been emphasised at the last WTO negotiations in Doha, only future negotiations will show if real changes will take place³. The environment and trade debate is still dominated by the attitude of several trade officials, who consider the environment as an obstacle to trade liberalisation.

In other words, the environment gained a lot of weight in the trade negotiations, but it still seems to remain more a rhetorical justification. Without any doubt, environment has become an important factor in the people's mind and the public opinion is crucial in order to base the WTO's work on sound foundations⁴. Indeed, the main implication observable from the activities undertaken by the WTO with respect to environment consists in the intense trade and environment debate, which makes the role of environment in trade better known.

Notwithstanding this important first step, the factor environment needs to be better incorporated into trade policies, and scientific models should hereby play a special role.

Several authors have already contributed to the trade policy debate with theories and models. Especially, Applied General Equilibrium models (AGE/CGE) have been extensively used in this field, which is a traditional application area for this class of models (Shoven e Whalley (1984)). However, environmental issues have been rarely explored and most of these models (as, e.g., McKibbin and Wilcoxon (1999)) concentrate on the effects of environmental measures on international trade, while conceding too little attention to the environmental externalities. One reason for this rather focussed approach consists in the use of the model results: in most cases the single parties involved in the trade negotiations ask for consultation by scientific advisers, making the scientific analysis rather a tool for single interest groups than an advice for the overall negotiation. In particular, economic modelling analysis has not been conducted systematically within the trade international organisations, like the WTO. The fact that environment still plays an insignificant role in these models seems to be one of the causes related to the absence of environmental considerations in trade measures.

³ In particular, the ministers agreed to negotiations on the relationship between existing WTO rules and specific trade obligations set out in multilateral environmental agreements (MEAs), procedures of exchange between MEA secretariats and the relevant WTO committees and on the reduction or as appropriate, elimination of tariff and non-tariff barrier on environmental goods.

⁴ For example, the WTO itself is under heavy criticism because it appears to have promoted globalisation at any price. Moreover, also its institutional design provokes criticism: it is said to be anti-democratic because of the organisation's new dispute-resolution procedures which enable the WTO's overruling of single governments (The Economist, Sept. 27th, 2001).

3. The role of trade issues in international environmental negotiations: the example of climate policy

By influencing the production and consumption of certain goods, environmental agreements have the potential to shift the comparative advantage of certain industries and regions. Environmental activities can thus have strong impacts on international trade. At the same time, trade and trade policies clearly exert an influence on the environment. These impacts have often induced a very negative attitude by environmentalists towards free trade, which is sometimes considered as the main evil responsible for environmental deterioration. Therefore, from the perspective of a “pure” environmentalist, protectionist measures, as e.g. trade barriers, appear to be a promising strategy in order to curb pollution.

The large gap between the free traders’ and the environmentalists’ perspectives explains why both of them still hesitate to seriously include both aspects in their strategies. Trade liberalisation and environmental protection appear sometimes to be unbridgeable, but only an integrated approach can effectively address the concerns in both fields. This section will verify whether this requirement is met in practice, by taking international climate policy as an example.

3.1 Are trade concerns taken into account in international climate negotiations?

In 1992, at the so-called "Earth Summit" in Rio de Janeiro, the United Nations Framework Convention on Climate Change sets an “ultimate objective” of stabilising atmospheric concentrations of greenhouse gases at “safe” levels.⁵ This target should allow ecosystems to adapt naturally to the climate change, while enabling the continuation of economic development in a sustainable way.

To achieve the objective of the Convention, the Kyoto Protocol was agreed to in 1997. For the first time in history, an agreement set binding emissions reduction targets for industrialised countries⁶ while the developing countries, including the large economies of India and China, were exempted from binding reduction targets, in the first commitment period. However, in the Kyoto Protocol only the targets, methods and timetables for global action were set, while specific rules and many of its operational details were missing and needed to be negotiated in the subsequent Conferences of

⁵ As of March 15th 2002, 186 governments and the European Community are Parties to the Convention.

⁶ In particular, the Kyoto Protocol requires that worldwide greenhouse gas emissions should decline to an average 5,2% below their 1990 levels by 2012.

the Parties (COP) and subsidiary bodies⁷. In order to advance on the operational details of the Kyoto Protocol, the so-called “Buenos Aires Plan of Action” has been decided at COP 4 in Buenos Aires, November 1998. However, only at the resumed COP 6 in Bonn, July 2001, Parties succeeded in reaching a political agreement on key issues under the Buenos Aires Plan of Action. On the basis of the Bonn Agreement, Parties at COP7 in Marrakech, November 2001, managed to finalise the operational details of the Kyoto Protocol after heavy concessions to certain key countries, as e.g., Russia.

The long series of negotiations related to the details of the Kyoto Protocol, including numerous concessions and an important withdrawal from the treaty (the US), lead to a drastic minimisation of the environmental efficiency of the agreement. Most of the modifications were based on the claim that the Kyoto Protocol would impose high costs on the countries’ economies. Since trade concerns were a strong motivation behind the criticism, we want to analyse whether the weight assigned to trade has changed since the Climate Convention and the Kyoto Protocol in its original form have been adopted.

Looking first at the Convention, already the Preamble affirms “that responses to climate change should be co-ordinated with social and economic development in an integrated manner with a view to avoiding adverse impacts on the latter”, emphasising thus the importance of adjusting climate change control to economic circumstances. In particular, the legitimate priority needs of developing countries for the achievement of sustained economic growth and the eradication of poverty are mentioned. In the context of this basic requirement, the linkages between trade and environment are acknowledged in Article 3.5 of the FCCC which defines its leading principles, stating that “...(m)asures taken to combat climate change, including unilateral ones, should not constitute a means of arbitrary or unjustifiable discrimination or a disguised restriction on international trade.”

The United Nations Framework Convention on Climate Change thus incorporates the interactions between economic and environmental system, but its reference to the implications on international trade are of limited nature.

Article 2.3 of the Kyoto Protocol refers explicitly to the UNFCCC’s Article 3, giving trade issues the same degree of importance as social, environmental and economic effects: “The Parties (...) shall strive to implement policies and measures (...) in such a way as to minimise adverse effects,

⁷ This is one of the reasons why the Protocol has not yet entered into force: many countries signed the Protocol, but only very few ratified it: The ratification status of the Kyoto Protocol as of March 6th, 2002: 84 countries signed the Kyoto Protocol (and accepted it in this way officially), but only 49 countries (mainly small island states) ratified it.

including the adverse effects of climate change, effects on international trade, and social, environmental and economic impacts on other Parties...”.

Notwithstanding the general commitment to take trade impacts into account when designing climate policies, no further references to the issue can be found throughout the Kyoto Protocol. Even though Article 3.14 of the protocol emphasises again that the emission reductions should be implemented in a way that minimises their adverse effects, the focus narrows to developing countries, leaving general issues related to international trade aside. In the subsequent negotiations, the issue of international trade has only marginally been touched, mostly in the context of dealing with the adverse effects on developing countries. Trade is mainly mentioned in the context of emissions trading, one of the market-based instruments foreseen by the agreement. Again, the debate about emissions trading demonstrates that the gap between the free traders’ and the environmentalists’ perceptions is still large: while free traders consider the instrument of emissions trading as one of the crucial provisions of the Kyoto Protocol, since it allows to reduce emissions when and where it is most cost-effective to do so, some environmentalists try to restrict emissions trading, since they accuse it of lowering the environmental effectiveness. Proposals to restrict the scope of emissions trading however seem to be in conflict with free trade and WTO provisions⁸.

In order to verify whether the situation related to the weight of trade issues has changed between the original version of the Kyoto Protocol and the final version, as determined at the COP 7 in Marrakech, we will now give a closer look to the outcomes of this last meeting. Even though not mentioned in the Marrakech Declaration itself, there are various references to trade issues in the Marrakech Accords. In particular, under the “key themes and areas for meaningful and effective action”, a so-called “enabling environments component” has been defined in order to improve the effectiveness of the transfer of environmentally sound technologies by -- among other provisions -- creating fair trade policies and removing potential barriers (Marrakech Accords, Article 12-14). More generally, the Marrakech Accords continue the tradition of provisions aimed at minimising adverse effects, including those on international trade. However, concrete actions have not yet been induced.

⁸ A special trade-related problem feared by environmentalists in climate policy consists in the so-called “carbon-leakage”. In order to prevent a relocation of energy-intensive industries to non-signatory countries and consequently a lower environmental effectiveness of the Kyoto Protocol, various measures regarding the energy content of non-signatories have been proposed, which could get into conflict with WTO rules if non-signatories would decide to use their WTO rights.

3.2 *Evaluating the role of trade issues in environmental policy*

Why are trade effects so marginally considered in climate change negotiations? We believe that one reason is given by the minor role played by trade in many scientific models used for policy evaluation in this field.

Scientific models have always supported environmental negotiations, especially in the case of climate change, and some supra-national institutions, like the Intergovernmental Panel of Climate Change (IPCC), have been specifically designed to this purpose⁹. From the beginning of the climate change debate, the use of models has been systematic and a strong link between the negotiations and the scientific community has been created, as shown by the direct involvement of the IPCC and similar bodies. This can be easily explained by the good amount of uncertainty (about causes and effects) surrounding many environmental problems. In the climate change case, in particular, it has been readily recognized that the problem does not merely involve natural sciences, but a contribution from the economic and social sciences is much needed.

The integration of socio-economic and natural modelling is witnessed by the birth of a new class of models, named Integrated Assessment Models. Simplifying somewhat, we can say that these models possess a hybrid nature of economic models (often the intertemporal general equilibrium type) and of climatology (modelling the “carbon cycle”, temperature variations, sea levels, etc.). Understandably, they can easily reach high degrees of complexity, making impossible a detailed representation of the economic linkages between countries. Among the most popular IAM models, some disregard the international trade altogether (Nordhaus and Yang (1996)), whereas some others consider trade in a very simplified way (Manne and Richels (1996)).

A relevant exception is given by some world economic models (normally, derived from existing CGE models), that have been adapted for environmental policy analysis. Generally speaking, these models suffer from serious deficiencies, like the absence of abatement technologies and of environmental impacts on economic activities in the model specification (Perroni and Wigle (1997)). However, they highlight the role played by the international trade in determining costs and effects of environmental policies. For example, Böhringer and Rutherford (1999) estimated that the cost of implementing the Kyoto protocol for the European Union is 54% lower, when the potential effects of the agreement on the terms of trade are properly taken into account.

⁹ As has been discussed in section 2.2, scientific consultations have operated on the level of single parties in trade negotiations.

4. Strategic modelling of trade and environment linkages

4.1 *The problem of incentives in international negotiations*

As seen in the last two sections, the perspectives of “free traders” and “environmentalists” are characterised by substantial differences: although both parties acknowledge the existence of mutual linkages between trade and environment, they reciprocally underestimate the importance of these effects and therefore have not yet implemented a really integrated approach.

Why are the general expressions of shared support not followed by specific actions? The previous sections already suggested some of the reasons, as e.g. self-interest behind the two types of policies. Trade and environmental policies can be compatible with each other (leading to “win-win” cases), or they can be in conflict with each other, but the exact outcomes – compatibilities or conflicts - are not obvious at first sight.

In an ideal world, an omniscient and benevolent planner could take the effects on trade and the environment simultaneously into account, and select the best course of action. But in the real world, actual policies spring from the interplay of actors, characterised by different perceptions and priorities. In this section, we show how general equilibrium modelling, when used in a strategic framework, can shed light on the negotiators’ incentives, driving their choices in the different contexts. In this way, also the “distance” of actual policies from the first-best solution can effectively be assessed.

4.2 *An Illustrative Numerical Model*

We introduce here a simple general equilibrium model, to highlight how different “perceptions” about trade and environmental issues may affect the strategic behaviour. To this end, we consider a conventional Heckscher-Ohlin-Samuelson type model, with the inclusion of an externality, and two alternative variants of the same model. In the first one, the externality is simply disregarded (thereby imposing in the model a standard GE structure) and, in the second one, the terms of trade are exogenously fixed (that is, the model has a partial equilibrium structure, with an externality). These alternative model versions are used to illustrate, in a very stylised way, the behaviour of agents who, on one hand, do not properly consider the environmental impact of trade measures or, on the other hand, disregard the impact of environmental policies on the international trade.

Two countries (A and B), two industries (1 and 2), one resource (in each country) are considered in the model. Production takes place with decreasing returns technologies, using the only production factor. Industry 1 is the “dirty” one, since it is assumed that higher production volumes for this

industry reduce the amount of resource endowments in *both* countries. This means that we are considering here a global externality (like carbon emissions in the climate change).

Utility for the two representative consumers is defined as an increasing function of consumption in the two goods, with standard properties. Environmental quality does not directly affect the consumers' welfare.

Countries are symmetrical and equal in terms of technologies, preferences, and initial endowments. The only difference regards a productivity factor, which is used to assign to country A a comparative advantage in the production of the industry 1. Therefore, in equilibrium, country A exports the dirty good to country B, which in turn exports the clean good 2 back to A.

Two policy instruments are taken into account: a unit production tax, applied only to the dirty industry, and an ad valorem tariff. Both instruments may be set autonomously or cooperatively in each country. We may think at environmental negotiations as dealing with the production tax (or equivalent measures), and at trade negotiations as dealing with the level of tariffs. The revenue of taxes and tariffs is rebated lump-sum and contributes to the income of each country (in addition to the value of the national resource).

The model has been specified using the set of equations and parameter values reported in the Appendix. Initially, a benchmark equilibrium has been computed. From this starting point, small variations for each of the four exogenous instruments (production taxes c_A and c_B , import tariffs t_A and t_B) have been considered in the three alternative model specifications ("Full", stands for the complete model with externality, "Trade", is the model without externality, "Env", is the model with externality and exogenously given world prices [implying disequilibrium in the world markets]). This gives rise to twelve simulation experiments.

The results are summarised in Table 1, in terms of Hicksian equivalent variation elasticities. Each number shows what percentage change is observed in the equivalent income of a country (values for country A to the left, values for country B to the right) when taxes, or tariffs, are raised by one percentage point. The sign of the elasticity reveals whether the welfare impact of a policy, at the country level, is positive or negative (at the margin). In other words, the elasticity values reveal whether a certain policy (e.g. increase in import tariffs) is beneficial to a country in terms of utility.

We have underlined the values for the countries that can directly act on the policy instrument. Therefore, we can imagine that, whenever the underlined number is positive, a country would like to raise the corresponding tax or tariff, or vice versa for a negative sign. If both countries have equal weight in international negotiations, the sign of the sum of the two elasticities determines whether a

certain policy is globally beneficial. In this case, the corresponding tax or tariff could be raised in the context of a cooperative agreement.

Tab. 1 – *Equivalent Variation Elasticities (x100)*

	FULL		TRADE		ENV	
	A	B	A	B	A	B
c_A	<u>0.87</u>	-0.40	<u>0.51</u>	-0.76	<u>0.29</u>	0.63
c_B	1.07	<u>-0.53</u>	0.76	<u>-0.85</u>	0.44	<u>0.33</u>
t_A	<u>0.90</u>	-0.98	<u>0.88</u>	-1.00	<u>0.03</u>	0.19
t_B	-0.97	<u>0.93</u>	-0.98	<u>0.92</u>	-0.16	<u>-0.17</u>

Consider first the elasticity values associated with the production taxes, in the model with fixed terms of trade (Env). This is the classic setting for environmental negotiations: increasing the externality tax has positive effects for both countries, but these are larger for the country not implementing the policy. Indeed, the latter benefits from the reduced externality, without bearing the distortionary cost of taxation. For higher initial values of the tax, we could well have that the welfare effects turn to be negative for the “active” country and positive for the “passive” one. International agreements could then be undertaken, to ensure that the two countries simultaneously adopt environmental policies.

Consider next the elasticity value associated with changes in tariffs, in the model without externality (Trade). This is the background of trade negotiations: each country would like to improve its terms of trade, through the imposition of an import tariff. However, this reduces the overall welfare. To solve this “prisoner dilemma” problem, mutual tariff reductions are negotiated in international agreements.

Suppose now that, because of these agreements, tariffs cannot be raised unilaterally. In this case, country A, which is the primary producer in the dirty industry, would like to impose a production tax, even when environmental effects are completely disregarded. Part of the tax burden would actually be shifted to the importing country (B), with terms of trade effects similar to those occurring through the imposition of a tariff. This is the case feared by some free-trade believers: green taxes could be used as pseudo-tariffs (Weber and Wiesmeth (2001)).

Clearly, the first-best solution would call for a comprehensive trade and environmental agreement, in which trade barriers are eliminated and externality taxes are introduced in all countries.

However, suppose that country A does not want to cooperate, and that country B could raise its import tariffs only in the context of an “environmental policy package”, in which taxes are jointly applied to domestic production and imports of the polluting industry. A simultaneous increase of c_B and t_B would then have a positive welfare impact on country B. In this case, it would also have a smaller but positive impact on the other country. Furthermore, environmental policy measures appear to be acceptable by B only when domestic taxes and tariffs are bundled. This is a situation somewhat similar to that emerging in the post-Kyoto stage, where the possibility of using compensatory tariffs by some signatory countries is being proposed.

4.3 *Replicating the Simulation Results with GTAP*

The model introduced in the previous section was useful in highlighting how different incentives may arise from different “mental models”. Yet, the earlier exercise suffers from one serious deficiency: all parameters values were set in an arbitrary way. It is then natural to ask whether the results can be replicated in a more realistic setting.

Here we present some findings obtained with a very aggregate version of GTAP. GTAP is an extensive data-base, as well as a general equilibrium model of the world economy (Hertel (1997)). Our aim is to provide an order of magnitude of the effects discussed above, but the reader is advised not to infer policy conclusions directly from the simulation results, because of a number of simplifying assumptions adopted:

- carbon emissions are assumed to be proportional to the production levels of a set of carbon-intensive industries, instead to the energy consumption at the intermediate and final stages;
- climate change is a dynamic phenomenon, which is poorly reproduced in a static framework. We simply assumed that the productivity of each country resource is inversely proportional to the world carbon emissions, which in turns are depending on the production levels of carbon intensive industries (with different carbon-content factors for the two regions);
- because of the Armington assumption adopted in the GTAP model (giving raise to “crosshauling” in international trade), the ENV scenario has been constructed by fixing the

international price of only carbon-intensive commodities, retaining also the original model assumption of imperfect international capital mobility¹⁰.

The model considers one national resource (aggregating labour, capital, and land), two countries (KYO = Kyoto signatory countries, excluding the US, NUS = Rest of the World), two industries (carbon intensive and all other goods and services – where the former group includes: carbon, oil, gas, minerals and metals, petroleum and coal products, chemicals, electricity and transport). The simulations are essentially the same as in the previous section¹¹, and the results in terms of income elasticities are reported in Table 2.

Tab. 2 – *Equivalent Variation Elasticities (x1000)*

	FULL		TRADE		ENV	
	NUS	KYO	NUS	KYO	NUS	KYO
C_{kyo}	-0,55	<u>-0,68</u>	-0,13	<u>-0,22</u>	-5,08	<u>-8,68</u>
C_{nus}	<u>3,33</u>	3,97	<u>-0,14</u>	0,15	<u>6,89</u>	10,81
T_{kyo}	0,49	<u>0,86</u>	-0,16	<u>0,14</u>	-0,09	<u>-0,22</u>
T_{nus}	<u>-0,44</u>	-0,80	<u>0,12</u>	-0,18	<u>0,24</u>	0,43

From a qualitative point of view, the main differences between the results produced here and those obtained with the illustrative model are:

- overall, the effects are smaller, because of the lower substitution elasticities (goods heterogeneity);

¹⁰ Because of the Armington assumption, both countries are exporter and importer of both goods. Since there is only one primary resource, only the price of one good can be fixed. When, for example, a tax on the production of carbon intensive goods is introduced, the market price of these goods cannot change and the result is a decline in the price of the national resource (necessary to absorb the cost shock). This implies that: the price of all other goods declines (triggering substitution) and there is some amount of capital outflow.

¹¹ Although it is technically possible to add one or more equations to account for the externality effects, we have adopted here a simpler, approximate solution method in two steps. First, we shocked one policy instrument to estimate the implied variation in production levels. The associated change in the resource productivity was then computed separately. A second simulation run was then carried out by simultaneously shocking the productivity parameter and the policy instrument.

- most results are driven by shifts in the location of carbon intensive productions. This is because 60% of world carbon emissions come from the NUS region, which has, nonetheless, production levels for carbon industries similar to those of the KYO region;
- the “tax exporting” effect, which could justify the use of carbon taxes as a protectionist weapon, is absent. This can be explained as follows. When a tax is introduced¹², there is a distortionary cost and a terms of trade benefit. In the GTAP model, the consumption patterns of the two countries are different, because each country relies relatively more on its own domestic products. Therefore, the domestic distortion outweighs the positive change in the terms of trade. This suggests that green taxes cannot be used as a substitute for import tariffs.

Notice that the Kyoto-countries could benefit from the introduction of “carbon-tariffs”, but only if these are applied worldwide (or just by the rest of the world). Relying only on domestic carbon taxes would be rather ineffective, because the polluting production would (partly) shift towards the less carbon-efficient NUS countries. In the same vein, KYO tariffs could act as substitutes for taxes on foreign dirty production.

5. Conclusion

Environmental and trade policies are obviously interdependent, and the linkages are especially strong when the environmental policy is conducted at the world scale. Not surprisingly, world trade organisations have started to consider environmental issues in their agendas, whereas impacts on international trade are often mentioned in environmental negotiations. However, this reciprocal recognition is still very much a rhetoric exercise: secondary costs and benefits induced by trade on environmental policies are not fully evaluated, whereas environmental objectives are only considered, by bodies like the WTO, in terms of exceptions to the general free trade rules. An integrated approach is still missing.

In this paper, we made an unconventional use of general equilibrium modelling, to highlight the strategic interplay in the different contexts. Aim of this analysis was to provide an explanation for the different approaches adopted by the trade and environment communities, as well as their consequences in terms of policy choices. Using alternative model closures, we estimated some EV elasticities, showing the incentives to cooperate or to free-ride in the various circumstances. A

simple illustrative model was used first to show: (a) that trade negotiators want to cooperatively set low tariffs and environmental negotiators want to cooperatively set green taxes, (b) that green taxes may act as substitutes for tariffs, (c) that unilateral environmental policies may be accompanied by compensatory tariffs.

When the exercise is replicated using data from the real economy, some additional findings are found, although these must be considered cautiously, because of the numerous simplifications. First, carbon taxes turn out to be ineffective as substitutes for tariffs (because of asymmetries in demand patterns). In addition, most results are driven by the degree of carbon efficiency (carbon intensity per unit of production) characterising the different industries and regions in the world.

Although the two models have a very simple structure, we believe that their main qualitative findings would be confirmed in more comprehensive studies (which are needed to draw valuable policy recommendations). Furthermore, the use of general equilibrium models for strategic analysis appears to be a promising approach for both a positive policy assessment (how actual policies are selected by people with different perceptions and objectives) and a normative policy assessment (in this case, the benefits of an integrated trade-environmental policy).

¹² In the GTAP data base the production taxes in the carbon intensive industries are, actually, subsidies. In principle, then, a carbon tax could reduce some initial distortions in the economy (on this issue, see Anderson and McKibbin (2000)).

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Appendix

Structure and parameters of the illustrative general equilibrium model

Production frontier, linking resource endowments r to production levels x :

$$r_a = \left(\frac{x_a^1}{\psi_a^1} \right)^2 + \left(\frac{x_a^2}{\psi_a^2} \right)^2 \quad (\text{A1})$$

The same relationship holds, symmetrically, for country b . Productivity parameter ψ set to 1.5 for sector 1 in country a and sector 2 in country b ; set to 0.5 for sector 2 in country a and sector 1 in country b .

Externality-sensitive endowments:

$$r_a = r_b = \frac{160}{x_a^1 + x_b^1} \quad (\text{A2})$$

Zero-profit condition, linking prices p to factor cost w and production tax c :

$$p_a^1 = w_a x_a^1 / (\psi_a^1)^2 + c_a \quad (\text{A3})$$

A similar relationship holds for all industries. However, production tax c is imposed only on industry 1. Its baseline value is one.

Demand definition (symmetric Cobb-Douglas):

$$d_a^1 = \frac{y_a}{2p_a^1} \quad (\text{A4})$$

A similar relationship holds for all industries.

Income definition:

$$y_a = w_a r_a + (d_a^2 - x_a^2) p_b^2 t_a + x_a^1 c_a \quad (\text{A5})$$

A symmetric condition holds for country b , where imports are expressed in terms of industry 1. Both ad-valorem tariffs are initially set to 5%.

Market equilibrium:

$$d_a^1 + d_b^1 = x_a^1 + x_b^1 \quad (\text{A6})$$

Analogously for industry 2.

Price equalization:

$$\begin{aligned} p_b^1 &= p_a^1 (1 + t_b) \\ p_a^2 &= p_b^2 (1 + t_a) \end{aligned} \quad (\text{A7})$$

In addition, the Walras law requires the choice of a numeraire. In this case, we set to one the value of the resource in country a .

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