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# Assessing alternative solutions to carbon leakage

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ABSTRACT

A modified version of the computable general equilibrium GTAP-E model is developed in order to assess the economic and carbon emission effects of alternative trade policy measures aimed at reducing carbon leakage. We compare several unilateral policy measures implemented by countries subject to an emissions level cap. Results provide evidence of the scarce effectiveness of these policies in reducing the carbon leakage rate and, conversely, some of the trade measures that are discussed seem to be more consistent with the goal of protecting market shares of national firms in the domestic markets of abating countries. Assessing environmental and competitiveness outcomes jointly confirms that a global cooperative solution would be the most effective as well as an efficient policy option for reducing carbon leakage.



## 1. Introduction

In recent years, a large amount of the international literature as well as policy debate have expressed increasing interest in measures that mitigate the negative externalities of climate change policies. As a matter of fact, the imposition of stringent climate policies may produce substantially distortive effects in terms of displacement and re-allocation of carbon intensive production processes in unregulated countries where no climate policies are in force, a phenomenon also known as the carbon leakage effect (OECD, 2006). However, the extent of carbon leakage is controversial and there is considerable debate over the design of the correct policy mix to reduce it.

Generally speaking, the potential outcome of unilateral climate change policies may be a reduction in carbon emissions in abating countries, partially undermined by an increase in carbon emissions by unregulated countries. This negative outcome may be explained by relative changes in the comparative advantages between unregulated and abating countries, whose climate policies will reduce the competitiveness of domestic firms compared with foreign production. Losses in comparative advantages can be associated with increasing domestic production costs due to abatement efforts, thus changing the relative convenience of export flows from abating countries in the international markets, especially for carbon intensive sectors. As a result, unregulated countries may be encouraged to increase their carbon intensive production in order to gain export shares in the international market. Theory suggests that border measures, such as import tariffs and export subsidies on the carbon embodied in trade, can be used as a second-best instrument to improve the economic efficiency of unilateral emission pricing policies (Hoel, 1996). Consequently, some forms of border adjustments have been invoked with the aim of restoring a level playing field between domestic producers facing abatement policies (e.g., carbon tax or emission trading) and foreign exporters subject to a carbon tariff (Moore, 2010; Wooders and Cosbey, 2010).

The jury is still out on the exact design and practical implementation of these adjustments since there are several unresolved issues. In this respect, we will elaborate on the existing studies providing further evidence of the extent of carbon leakage and the impact of the different forms of carbon border tax (CBT). However, the major focus of the paper is on the ambiguities regarding the possible goal or goals to be achieved through a CBT. As a matter of fact, carbon tariffs are often justified as instruments for reducing the leakage rate and restoring the competitiveness of domestic firms: our results show that the two goals do not necessarily overlap.

Our goal is to assess the economic impacts of different forms of CBT to gain insights into the potential synergies and/or trade-offs between global goals in terms of carbon leakage reduction and more narrowly defined competitiveness gains. We use a computable general equilibrium (CGE) model to simulate policies based on embodied carbon tariffs. More specifically, we compare policies in which

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Annex 1 countries use carbon tariffs on imports from non-Annex 1 in order to meet alternative targets regarding carbon leakage or competitiveness. This allows the relative effectiveness and efficiency of trade policies in achieving various possible goals to be evaluated.

We refer to the Kyoto objectives as our climate policy framework in a world where two groups exist: abating and non-abating countries. In order to quantify how CBTs influence emission behaviors of the latter as well as international competitiveness of the former countries in a more realistic way, we develop a modified version of the computable general equilibrium GTAP-E model (Burniaux and Truong, 2002; McDougall and Golub, 2007).

In order to build a benchmark for investigating the effectiveness of alternative forms of CBT, we first assess carbon leakage implied by an international emission reduction agreement such as the Kyoto Protocol. We then implement a cooperative scenario featuring global emission trading where non-Annex[1] countries also play an active role in emission abatement by ensuring a zero leakage effect. In this case, multilateral climate policies are implemented and no unilateral trade adjustment policies are therefore necessary.[2] These scenarios may be interpreted as two opposite climate policy options according to a maximum (pure Kyoto Protocol framework) or a minimum (cooperative global emission trading) level of carbon leakage.

In between, we develop several approaches to dealing with the carbon leakage effect and introduce different carbon tariff schemes (hereafter referred to as non-cooperative scenarios). Carbon tariffs are either exogenously set according to the domestic carbon tax or endogenously computed as ad valorem equivalents.

In the former case, which is reasonably standard in the literature (e.g., Böhringer et al., 2011a; Mattoo et al., 2009), a specific carbon tariff is computed by multiplying the carbon tax either by the carbon content of imports or by the carbon content of the corresponding domestic good. In this case, exogenous tariffs are declared to be a policy instrument for ensuring a level playing field whereas outcomes in terms of leakage reduction or competitiveness enhancement are endogenously determined.

In the latter case, we develop an original modeling approach where the ad valorem tariff equivalent is set either with the aim of eliminating, or at least reducing, carbon leakage or with the aim of preserving the competitiveness of Annex I[3] countries with regard to their domestic demand. To this end, we start from a given goal, either in terms of carbon leakage reduction or competitiveness protection, and use the model to compute the sector-specific ad valorem tariffs that would allow these goals to be reached.

By applying the exogenously given CBT based on domestic carbon tax, we assess the economic impacts of the unilateral policies that are currently discussed in the political debate especially in the European Union. The effects produced by an exogenous carbon tariff on competitiveness, welfare changes and emission levels of non-Annex countries are compared with those produced by endogenous tariffs. The distance between the exogenous and the endogenous carbon tariffs gives an idea of the distance between the policy schemes currently discussed and the motivations put forward by their proponents and reveals if environmental or competitiveness concerns prevail in the current policy debate.

The economic and environmental effects resulting from alternative policies applied unilaterally by Annex I countries are also compared with the results from the cooperative, or zero-leakage, scenario. Such a comparison highlights the benefits for non-Annex countries of changing their conservative position in the climate negotiations, suggesting active participation as a possible strategy to avoid the unilateral countermeasures implemented by Annex I countries.

The rest of the paper is structured as follows. In Section 2 we provide a literature review on carbon leakage and border adjustments, in Section 3 we describe the computable general equilibrium model, the 2012 baseline and the non-cooperative and cooperative scenarios, in Section 4 we present the main simulation results and Section 5 provides some final remarks.

## 2. The carbon leakage issue

### 2.1. The measurement of carbon leakage

A global solution to climate change has not been implemented yet since the output of the Copenhagen meeting in 2009 was a non-binding agreement. Cancùn negotiations in 2010 and Durban COP17 in 2011 represented a step forward in reaching a cooperative solution, but global international cooperation to fight climate change still seems to be a difficult goal to achieve. Policy actions to reduce greenhouse gas (GHG) emissions remain unilateral and could be undermined by the presence of carbon leakage (Hamasaki, 2007).

The use of economic instruments for GHG emission reduction with a non-global approach is likely to have negative impacts on the competitiveness of some industrial sectors (Borghesi, 2011), for example, the steel and cement sectors (OECD, 2003, 2005). If only a few countries are involved in the implementation of climate change policies, non-abating countries may have comparative advantages in producing and exporting energy intensive goods and risking nullifying the efforts of abating countries. Veenendaal and Manders (2008), for instance, point out that if a coalition of countries committing themselves to reducing GHG emissions remains limited in its coverage, carbon leakage is likely to occur, partly offsetting the reduction efforts made by the coalition. The vast and growing literature on this issue distinguishes two typologies of leakage: the first one is caused by a shift in the location of production towards unregulated regions and the second one is related to an increase in energy consumption in non-abating regions due to the lower prices resulting from the reduced demand for fossil fuels on the international markets by abating countries (see Karp, 2010 for a literature review).

Imposing stringent climate policies in certain countries may produce substantially distortive effects in terms of displacement and development of carbon intensive production processes in countries where no climate policies are in action as pointed out in a well consolidated literature strand referring to the so-called pollution haven effect (Copeland and Taylor, 2004). According to the pollution haven hypothesis carbon leakage is due to production relocation related to the fact that leakage increases with the intensity of international competition in energy-intensive goods. If this competition is strong and energy intensive goods are perfectly substitutable in terms of production location, this will bring production of carbon intensive goods to countries with lower energy costs. In other words, when countries have different environmental regulatory stringency, production will be located where environmental costs are lower and carbon/energy intensive firms will move from abating countries to non-abating countries in order to exploit relative comparative advantages arising from heterogeneous environmental standards. As emphasized by Babiker (2005), in extreme situations where energy-intensive goods produced in different countries are perfectly homogeneous and substitutable, the relocation of the production of carbon intensive goods to non-abating countries is almost complete, leading to carbon leakage rates that can even exceed 100%. It is worth noting that the specialization process occurring in the domestic economy of unregulated countries, which react to unilateral climate policy by specializing and exporting those energy intensive goods subject to carbon tax in regulated countries, can also take place in the absence of international mobility of production factors. Such a case is the most widely explored in CGE and partial equilibrium models (Di

[1] We use the terms “unregulated”, “non-abating” and “non-Annex” countries interchangeably in the text.

[2] In the cooperative scenario, Annex I countries face their emission targets as defined in the Kyoto agreement whereas non-Annex countries are constrained to a zero-increase in domestic emissions, ensuring a zero leakage effect by definition.

[3] We use the terms regulated, abating and Annex I countries interchangeably in the text.