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The game of trading jobs for emissions

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HIGHLIGHTS

- Employment and trade issues should be considered in GHG emission reduction policies.
- In 2008 24% of global GHG emissions and 20% of the employment are linked to trade.
- 43% of GHG and 45% of employment embedded in trade are due to EU and US imports.
- China exports 30% of the GHG and hosts 38% of the jobs generated by trade worldwide.

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ABSTRACT

Following the debate on the implications of international trade for global climate policy, this paper introduces the topic of the economic benefits from trade obtained by exporting countries in relation to the emissions generated in the production of exports. In 2008, 24% of global greenhouse gas (GHG) emissions and 20% of the employment around the world were linked to international trade. China "exported" 30% of emissions and hosted 37.5% of the jobs generated by trade worldwide. The European Union and the United States of America were the destination of 25% and 18.4% of the GHG emissions embodied in trade. The imports of these two regions contributed to the creation of 45% of the employment generated by international trade. This paper proposes the idea of including trade issues in international climate negotiations, taking into account not only the environmental burden generated by developed countries when displacing emissions to developing countries through their imports, but also the economic benefits of developing countries producing the goods exported to developed countries.

1. Introduction

In the last few decades world economies have experienced a rapid and profound process of globalization that has favored the flow of goods, services and production factors around the world. This phenomenon becomes clear when we look at the statistics of international trade. According to the World Trade Organization, between 1995 and 2011 world trade volume tripled in nominal terms to exceed $18 trillion (30% of world GDP).

The consequences of this growth in international trade can be observed in many dimensions of modern societies. For instance, by exporting goods and services countries can obtain economic benefits, such as the creation of new jobs (Rueda-Cantuche et al., 2013). On the other hand, exporting countries have to tackle the environmental consequences of producing these products (Muradian et al., 2002). This relationship between increasing trade flows, employment generation and environmental degradation is well known in the climate change literature (Weber et al., 2008).

This triangle formed by trade, employment and emissions connects with the outstanding political debate about how to define the responsibility of different countries to climate change. The Kyoto Protocol establishes that each country is responsible for the emissions generated within its national territory (i.e., the so-called producer responsibility principle) (Munksgaard and Pedersen, 2001; Peters, 2008; UNFCCC, 1997; IPCC, 2006). Because of the producer responsibility principle, larger imports of goods from countries without any climate commitment might result in an increase of the emissions undermining the overall climate

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mitigation effort. This question is closely linked to the problem of "carbon leakage" (Wyckoff and Roop, 1994) and the "pollution haven hypothesis" (Levinson and Taylor, 2008). These terms are used to describe a situation in which companies, in order to reduce costs, move their production to other countries which have a more lax climate policy.

During the last few years, emerging/developing countries have driven global emissions up by increasing significantly the release of greenhouse gases (GHG) to the atmosphere. At the same time, the emissions generated by developed countries have stabilized. It has been argued that these trends are related, among other factors, to the increasing exports of developing countries and to their growing market share in the final demand of developed economies (Raupach, 2007). In this context, the so-called consumer responsibility incorporates the emissions embodied in trade into an accounting framework, and postulates that each country should be responsible for all the emissions embodied in its final demand, regardless of where they have been generated (Peters, 2008; Hertwich and Peters, 2009). Following the consumer responsibility argument, developed countries should bear more responsibility for the emissions generated in emerging/developing economies from which they import.

In recent years, a growing number of studies have focused on quantifying these transfers of emissions between countries via international trade (Wiedmann, 2009; Davis and Caldeira, 2010; Peters et al., 2011). However, there has been little attention paid to the quantification of the related economic consequences for the exporting countries, which can be considered as part of a game in which one partner is willing to bear the costs of environmental degradation[1] in exchange for the inherent economic benefits of international trade, in terms of, for example, jobs creation. This issue is especially relevant for some emerging economies, for which exports are among the main drivers of national employment and economic growth.

The objective of this paper is twofold: firstly, it aims at describing the GHG emissions and the employment embodied in the exports of the world's main economies during 1995–2008; and secondly, it discusses the relevance of the employment benefits obtained by countries when producing exported goods.

The paper is structured as follows: Section 2 describes the database and the methodology used. Section 3 summarizes the main findings. Section 4 discusses the relevance of the results for policy making and Section 5 concludes.

2. Methodology and database

Multi-regional Input–Output (MRIO) models have been widely used to analyze the environmental consequences of trade (see Wiedmann, 2009 and Wiedmann et al., 2011 for a comprehensive revision of the literature and the existing databases). In this paper, a MRIO model will be used to calculate the emissions of GHGs and the employment embodied in international trade.

For the sake of simplicity, the methodology is described for the case of 3 regions with n sectors, but it can be applied to any number of regions and sectors.

The starting point of the model is a MRIO table. This table describes the flows of goods and services from every industry in a certain country to the intermediate and final users of other countries. We can distinguish 3 main components in a MRIO table,

[1] Note that for global pollutants such as GHGs, the environmental cost of the polluter is only relevant in terms of emissions accountancy and mitigation policy, since the environmental impact is global.

where superscripts indicate regions

$$\mathbf{Z}=\begin{bmatrix}\mathbf{Z}^{11} & \mathbf{Z}^{12} & \mathbf{Z}^{13}\\ \mathbf{Z}^{21} & \mathbf{Z}^{22} & \mathbf{Z}^{23}\\ \mathbf{Z}^{31} & \mathbf{Z}^{32} & \mathbf{Z}^{33}\end{bmatrix};$$

$$\mathbf{f}=\begin{bmatrix}\mathbf{f}^{1}\\ \mathbf{f}^{2}\\ \mathbf{f}^{3}\end{bmatrix}=\begin{bmatrix}\mathbf{f}^{11}+\mathbf{f}^{12}+\mathbf{f}^{13}\\ \mathbf{f}^{21}+\mathbf{f}^{22}+\mathbf{f}^{23}\\ \mathbf{f}^{31}+\mathbf{f}^{32}+\mathbf{f}^{33}\end{bmatrix};$$

$$\mathbf{x}=\begin{bmatrix}\mathbf{x}^{1}\\ \mathbf{x}^{2}\\ \mathbf{x}^{3}\end{bmatrix}$$

where $\mathbf{Z}^{rs}$ is the matrix of intermediate deliveries from country r to country s, and its element z_{ij}^{rs} denotes the sales of sector i in country r to sector j in country s; $\mathbf{f}^{rs}$ is a column vector with final demands (i.e., private consumption, government consumption and investments) and its element f_i^{rs} indicates the final demand in country s of commodities produced by sector i of country r; and $\mathbf{x}^r$ is the column vector of total industry outputs in country r. The relation between$\mathbf{x}$, $\mathbf{Z}$ and $\mathbf{f}$ is defined by the accounting equation as follows:

$$\mathbf{x}=\mathbf{Zi}+\mathbf{f} \quad (1)$$

where $\mathbf{i}$ is the column summation vector.

Furthermore, let us assume that the MRIO table is extended to include a vector of sectorial emissions of GHGs denoted by $\mathbf{g}$, a vector of direct emissions from households $\mathbf{h}$, and a vector of employment by sector $\mathbf{m}$

$$\mathbf{g}=\begin{bmatrix}\mathbf{g}^{1}\\ \mathbf{g}^{2}\\ \mathbf{g}^{3}\end{bmatrix};$$

$$\mathbf{h}=\begin{bmatrix}h^{1}\\ h^{2}\\ h^{3}\end{bmatrix};$$

$$\mathbf{m}=\begin{bmatrix}\mathbf{m}^{1}\\ \mathbf{m}^{2}\\ \mathbf{m}^{3}\end{bmatrix}$$

For each region, the *total emissions* would be given by the sum of sectorial emissions plus household emissions of the region analyzed, as reported in the following equation:

$$G^r=\mathbf{g}^{\mathbf{r}}\mathbf{i}+h^r \quad (2)$$

Similarly, the *total employment* of each region would be the sum of the employment in each sector of the region analyzed, as summarized in the following equation:

$$M^r=\mathbf{m}^{\mathbf{r}}\mathbf{i} \quad (3)$$

The input coefficients are obtained as follows:

$$\mathbf{A}^{rs}=\mathbf{Z}^{rs}(\hat{\mathbf{x}}^s)^{-1} \quad (4)$$

where $(\hat{\mathbf{x}}^s)^{-1}$ denotes the inverse of a diagonal matrix of total outputs in country s. Likewise, the emissions coefficients ($\mathbf{e}^r$) and employment coefficients ($\mathbf{d}^r$) are defined in the following equations for region r:

$$\mathbf{e}^r=(\hat{\mathbf{x}}^r)^{-1}\mathbf{g}^r \quad (5)$$

$$\mathbf{d}^r=(\hat{\mathbf{x}}^r)^{-1}\mathbf{m}^r \quad (6)$$

Eq. (1) can now be written as a standard input–output model as

$$\mathbf{x}=\mathbf{Ax}+\mathbf{f} \quad (7)$$

The solution to this model is given by $\mathbf{x}=\mathbf{Lf}$, where $\mathbf{L}\equiv(I–A)^{-1}$ denotes the so-called Leontief inverse. The total sectorial emissions