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Trade from resource-rich countries avoids the existence of a global pollution haven hypothesis

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ABSTRACT

Free trade agreements are currently receiving much attention in the media and politics. One important question concerning free trade is its effect on the environment, for example in carbon dioxide emissions. The goal of this paper is to provide evidence on the validity of the pollution haven hypothesis using a multi-regional input-output approach for six regions and the rest of the world as a whole. Our findings indicate that in the period from 1995 to 2009, international trade has allowed the global economy to reduce its overall CO_2 emissions, compared to a hypothetical situation without international trade. The total amount of emissions saved was 15.06 Gt in the period under consideration. However, not all of the seven regions in our model have been able to reduce their CO_2 emissions through trade. Global value chains have led to China becoming a pollution haven for other regions and its exports have increased world emissions to 1.28 Gt CO_2 in 2008. However, what allows a net saving of emissions on a global scale is the supply of energy and natural resources from a set of peripheral economies, which in our geographical categorization are mostly integrated in the region of the rest of the world.

1. Introduction

Free trade of final goods, natural resources and parts and components is generally conducive to economic growth and welfare-enhancing, but it could be detrimental to the natural environment. Consumption in rich countries is responsible for the destruction of biodiversity in developing countries (Lenzen et al., 2012) or deforestation of the Amazon Rainforest (Karstensen et al., 2013). This trade involves the movement of raw materials from countries with natural resources to countries that use these resources in economic production (Wiedmann et al., 2013). In the particular case of petroleum this trade accounted for 37% of global emissions in 2007 (Davis et al., 2011). Emissions embodied in exports represented 20% of global CO_2 emissions in 1990 and in 2008 reached 26% of global emissions (Peters et al., 2011). This can be explained because firms have set up global value chains in search of comparative advantages at each stage of production such that, for example, emissions embodied in processing exports represent 35% of virtual carbon in Chinese exports in 2011 (Dietzenbacher et al., 2012; Su et al., 2013; Xia et al., 2015). At the same time we have witnessed a global GDP growth without precedents, which is multiplied by seven the last 50 years of the 20th century, associated with a further increase in the growth of international trade (WTO-UNEP, 2009), and associated demand for resources and environmental impacts. To the extent that international trade has accelerated global economic growth, it therefore has been a driver of environmental degradation.

The present paper contributes to the literature on the environmental effects of international trade by testing the validity of the pollution haven hypothesis (PHH). The PHH argues that international trade contributes to an increase in global GHG emissions, as companies locate production activities in countries with comparatively lax environmental regulation and high emission intensities (Copeland and Taylor, 2004). If this view is correct, globalization and the fragmentation of international supply chains lead to reductions of environmental pressures in high-income countries, but from a global point of view the total environmental pressure may increase. This may lead to “carbon leakage” — the relocation of emission-intensive activities to poorer countries (IPCC, 2007; Kuik

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and Hofkes, 2010; Monjon and Quirion, 2011; Peters and Hertwich, 2008).

The methodology used in this paper to evaluate the PHH represents a generalization of the Balance of Avoided Emissions (BAE), which was proposed in López et al. (2013) for a bi-regional input-output model (BRIO), to a global multi-regional input-output (MRIO) setting. The BAE differentiates between domestic CO_2 emissions embodied in exports (EEX) minus the emissions avoided by imports (EAM), the CO_2 emissions that would have been generated domestically if the imported products had been produced domestically. We compute the CO_2 emissions that would have taken place in a hypothetical situation without international trade, for six regions and the rest of the world as a single region on an annual basis from 1995 to 2009, and compare them to actual emissions.

In addition to the BAE, emissions incorporated in trade, exports and imports, and the consequent emissions balance has been used to identify countries with an "emission deficit" or an "emission surplus" (Andrew and Peters, 2013; Peters et al., 2012; Su and Ang, 2011), to identify the industries which are responsible along the global production chains (Davis and Caldeira, 2010; Davis et al., 2011) and analyzed how international trade affects the equity and effectiveness of climate change mitigation policies (Böhringer et al., 2012; Kanemoto et al., 2014; Steininger et al., 2014). However, not every reduction of emissions in high-income economies is associated with carbon leakage; the reduction of domestic emissions in advanced economies may be induced by an improvement in their energy efficiency and environmental technology rather than a reduction in the production level (Jakob and Marschinski, 2013; López et al., 2013). Assessing the contribution of international trade to the development of CO_2 emissions requires investigating whether trade leads countries to specialize in the production of goods with higher or lower pollution intensity (Copeland and Taylor, 2004). In the first case, the PHH would be confirmed, as trade allows firms to relocate emission-intensive industries from high to low-income countries, where social and environmental legislation, standards and overall costs are lower. In the second case, raw materials and final goods trade and the growing importance of global value chains would partially compensate the negative impacts associated with economic growth.

However, the fact that the emissions balance for the world economy sum up to zero (Kanemoto et al., 2012) and net balance between two regions also has the same balance, cannot help us answer the question of whether international trade is harmful to the environment. For this purpose we compute the BAE, which allows us to evaluate how the impact on carbon emissions from trade depends on comparative emission advantages of different countries and the sectoral composition of trade (Jakob and Marschinski, 2013). A positive sign of BAE indicates that international trade would have been a pollution haven for firms and a negative sign that the specialization of international trade has allowed emissions savings.

Regarding previous studies, one branch used bi-regional models to evaluate the balance of avoided emissions: Arto et al. (2014), Dietzenbacher and Mukhopadhyay (2007), Liu et al. (2016), López et al. (2013), Peters et al. (2007), Tan et al. (2013) and Zhang (2012). Although some of them only calculate emissions avoided by a country or region (Ackerman et al., 2007; Liu et al., 2016; Peters et al., 2007), but not emissions avoided by its trading partners, therefore, does not consider the net effect of this trade on the emissions. Nevertheless, the papers based on bi-regional models are adequate when we want to measure the impact of international trade between two regions, because they consider only emissions or any factor content between two countries but do not take into account the origin of imports and could be using more polluting suppliers (Ackerman et al., 2007).

The MRIO approach avoids the double counting of intermediate inputs and facilitates the appropriate identification of the factor content in international trade, e.g. value added, CO_2 emissions or soil (Johnson and Noguera, 2012; Trefler and Zhu, 2010) and assess the potential emissions leakage driven by international trade, which in a bi-regional model would be underestimated (Kanemoto et al., 2012; Turner et al., 2007). Some papers that have used a global MRIO output model to calculate the BAE are Chen and Chen (2011), representing the world in three regions; Zhang et al. (2014) for trade between Chinese regions, or Zhang et al. (2017) covering 40 countries and the region of rest of the world and distinguishing between the trade of final and intermediate goods. In Strømman et al. (2009), a world trade model with bilateral trade (WTMBT) is applied to evaluate if a shifting trade pattern means a reduction of global carbon emissions, which has the advantage of that the use of factors in each region does not exceed the region's factor endowments.

Other authors have used the concept of pollution in terms of trade (PTT within a global MRIO), the ratio of the average pollution content per dollar of value added, to evaluate if a country pays more environmental cost to obtain identical economic gains (Duan and Jiang, 2017; Grether and Mathys, 2013). This measure, in contrast to BAE, gives us a relative and not absolute view of the total emissions generated by international trade. Another significant branch in the literature is the use of econometric approximations to test the PHH; so far no conclusive evidence has been found (Antweiler et al., 2001; He, 2006; Javorcik and Wei, 2004). The main contribution of input-output analysis, compared to the econometric literature, methodology in this field is the ability to assess virtual carbon in trade, direct and indirect, taking into account the importance of linkage effects in a world where the indirect emissions (López et al., 2013) and trade of non-energy-intensive goods are the most important part of the growth in emissions embodied in international trade (Peters et al., 2011).

This paper is organized as follows: In section 2 we develop the methodology of the BAE and we comment on the databases that we used. Section 3 presents the main results and discusses them. Finally, in section 4 we conclude.

2. Methodology

2.1. Virtual carbon and embodied factor content

Let the world economy be described by a set of n_R world regions (countries or aggregates thereof), each in turn described by n_P industries (each producing a homogeneous good or service), and the flows occurring between them, primary production factors and final demand categories. That is, if $n_Z = n_R * n_P$ let Z be the $n_Z * n_Z$ matrix of inter-industry transactions, Y be $n_Z * n_R$ matrix of final consumption whose i-th column is the final demand of region i, let x be the n_Z column vector of total output and let V be the $n_R * n_Z$ matrix of primary inputs whose i-th row are the primary inputs of region i. Furthermore, let $\mathbf{r}$ be the n_Z row vector with GHG emissions (or some other primary factor) of every industry.

If $\mathbf{i}$ is a column vector of ones and ‘ denotes transpose the constraints of industry inputs and outputs reads:

$$x = Zi + Yi = Z'i + V'i \qquad [1]$$

According to the environmentally-extended Leontief quantity (backward demand-driven) model (Miller and Blair, 2009) the vector of upstream GHG emissions associated with consumption vector y which take place in every industry is $\mathbf{u}$ given by: