Is bioenergy trade good for the environment?

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Abstract

This paper analyzes the impacts of bioenergy trade on greenhouse gas emissions using a two-good, three-factor model. Bioenergy is an intermediate good produced by the agricultural sector and used by the industry as a substitute for fossil fuels. Countries impose Pigovian taxes on pollution emitted by both sectors without international coordination. We assume that Northern countries have a larger labor endowment than Southern ones and that agriculture is less pollution intensive than industry (after taxation). We show that compared to autarky, trade liberalization either increases or decreases worldwide emissions depending on regional comparative advantages.

Keywords: bioenergy; intermediate product ; North-South trade ; global pollution

JEL Classification: F18; H23; Q17

1 Introduction

The potential of bioenergy in mitigating greenhouse gas (GHG) emissions from fossil fuels has recently stimulated both the scientific and the political debate (von Lampe, 2006). On the one hand, fostering bioenergy, as well as other renewable energy sources, is justified by the environmental benefits arising from avoided GHG emissions; on the other hand, expanding bioenergy production may result in an increase in the burden on local ecosystems, e.g., by encouraging deforestation. Considerable arable land is necessary to meet the ambitious mandates set by governments, such as the US Energy

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Policy Act of 2005 or the EU target of 5.75 percent proportion of biofuels for transportation by 2010, particularly for Northern countries.[1] So far, bioenergy trade has been limited,[2] but these mandates and the comparative advantage of tropical countries, like Brazil or Indonesia, in producing ethanol from sugarcane or palm oil biodiesel (von Lampe, 2006; Kojima et al., 2007) will certainly induce an active and sizeable international trade in biofuels.

The objective of this paper is to appraise the potential impacts of bioenergy trade on the global economy, with a particular focus on the resulting level of GHG emissions. We adopt a theoretical approach in line with Copeland & Taylor (1994, 1995, 2003) to determine the trade equilibrium of a global economy with many countries belonging to two regions, North and South, and facing a global pollution with no international coordination. Governments set their environmental regulations independently, taking the other countries' emissions as given. The main source of differentiation across regions is a higher endowment in effective labor in Northern countries, the labor force being more productive in North than in South. Assuming homothetic production functions and consumer's preferences, autarky corresponds to the convenient benchmark case where emission levels of both sectors are identical in Northern and Southern countries, but as labor endowment are different, South is more pollution intensive than North. The effects of trade liberalization on the environment depend on the comparative advantages of each region. If North has a comparative advantage in industry, Northern emissions are increased while Southern ones are decreased, resulting in lower worldwide GHG emissions. Regional effects of trade are reversed when South has a comparative advantage in industry, but the global effect is also reversed since worldwide emissions increase. This asymmetry between these two situations comes from the fact that with an intermediary output like bioenergy, trade does not allow for an equalization of the input prices between countries. In particular, whatever the comparative advantages of each region, the environmental tax is always larger in North than in South. If North has a comparative advantage in industry, the increase in its GHG emissions are largely due to a scale effect: per product emissions are low (favorable

[1] For instance, to meet a 10 % share of biofuels in domestic transport fuel consumption, the U.S., Canada and the E.U need 30 %, 36 % and 72 % of their agricultural lands respectively, whereas only 3 % is needed in Brazil .(von Lampe, 2006)

[2] Of 2.8 billion liters of ethanol exports in 2008, Brazil exported 97 percent, primarily to Europe, Japan, India and the US. Net exports of biodiesel were 1.1 billion liters in 2007, the largest exporters being the US, Indonesia and Argentina, mainly to EU and Japan. (Source: 'World Biofuel Maritime Shipping Study', by IEA Bioenergy Task 40, April 2009. www.bioenergytrade.org).

technical effect compared to south) but many industries relocate from South to North, resulting in larger industrial emissions. Agricultural emissions of northern countries may also increase if South does not produce enough agricultural goods to satisfy the Northern demand of bioenergy. However, the decrease in industrial emissions of Southern countries is so large that it allows for a decrease in worldwide emissions. The scale effect is also at work when South is the industrial region, but per product emissions are large (unfavorable technical effect compared to North). Industrial emissions are reduced in North, but not sufficiently to overcome their increase in Southern countries.

Trade also has an impact on consumers' welfare which is different across regions: While Northern and Southern consumers benefit from the global reduction in emissions if North is the industrial region, Northern countries may enjoy an increase in their revenue whereas Southern countries' revenue decreases. This adverse impact of trade on Southern revenue makes a strong case against any involvement of Southern countries in international agreements that would result in more demanding environmental policy than the one freely decided in the absence of coordination.

Most of the literature on trade in bioenergy analyzes welfare effects of tariffs and subsidies on the ethanol market in a partial equilibrium framework, focusing on the U.S. and Brazilian markets (Elobeid & Tokgoz, 2008).[3] Here, we adopt a general equilibrium framework that allows to evaluate direct and indirect effects of environmental policies on the agricultural and the industrial sectors of countries involved in bioenergy trade. Several studies show that the trade of bioenergy could lead to an over-exploitation of the resource (deforestation) due to the lack of well-defined property rights in Southern countries (Chichilnisky, 1994). Here, there is no institutional failure since we assume that both regions are able to implement Pigovian tax on pollution coming from industrial emissions and from agricultural use of natural capital. The trade and environment literature has investigated the sectoral interaction between a "clean" activity (agriculture) and a Smokestack sector (industry) based upon a cross-sectoral externality, where industrial pollution reduces agriculture productivity or biodiversity, which makes spatial separation of activities a motive for international trade (Copeland & Taylor, 1999; Polasky et al., 2004). We depart from these external effects by assuming that GHG emissions only harms consumers through climate change.

[3] Recent studies also analyze the food versus fuel debate (Senauer, 2008) and the role of trade barriers in protecting inefficient corn-based ethanol production at the risk of deterring investment in the 'infant industry' producing cellulosic ethanol (Sheldon & Roberts, 2008).

Moreover, no sector can be considered as “carbon free": Although bioenergy use does not emit additional anthropogenic gases, production of bioenergy generates GHG emissions through the use of fertilizers or chemicals for an intensive type of agriculture or through the conversion of forested lands for an extensive type of agriculture.[4]

The remaining of the paper is organized as follows: Section 2 presents the model and Section 3 examines the autarky equilibrium. Section 4 considers the effects of trade on the environment and welfare of North and South. The last section contains some concluding remarks.

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[4]Highlighted by Fargione et al. (2008), converting land to some specific biofuel crops can generate 17 to 123 times more carbon than the annual savings of fossil fuel replacement (for instance, in the case of palm oil plantations in Indonesia and Malaysia).

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