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Carbon emissions embodied in international trade: The post-China era

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HIGHLIGHTS

- China's trade with the rest of the world is replaced by the post-China countries.
- Under the best scenario, the CO_2 emissions in trade savings reach a peak of 18.2%.
- Non-traded goods and indirect emissions are driving the global emissions reduction.
- Trade diversion to less efficient countries could reduce the emissions only a 1.5%.
- If environmental variables are ignored, a chance to mitigate could be overlooked.

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ABSTRACT

The so-called post-China countries (PC-16́s), distinguished by low wages and high economic growth, will replace China as the "world's factory". The aim of this paper is to assess the effect of these changes on global CO_2 emissions pathways. To achieve this, a counterfactual is proposed wherein China's trade with the rest of the world is replaced by the PC-16's trade in a global multiregional input–output context. The emissions savings realized by trade replacement are significant in those scenarios where the current pattern of trade is maintained (−13% on emissions traded and −3.5% on global emissions) and in scenarios where enterprises relocate their production directly or indirectly to the most environmentally efficient countries (ranging from −15.2% to −18.2% on emissions embodied in trade). Nevertheless, the potential savings drop considerably (ranging from −1.5% to −7.1%) if companies and host countries take advantage of cheaper, but more polluting means of production and do not internalize the externalities. Through changes in international trade, there is a possibility of reducing emissions, which have to be included in international, multilateral and bilateral agreements to mitigate climate change if we do not want to lose the opportunities these changes present.

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1. Introduction

The composition of world trade is changing. China is currently the world's largest exporter—the "world's factory"—with its exports accounting for 10.4% of world trade in 2010 [1]. However, China is far from being specialized only in the trade of low-tech and labor-intensive goods. In 2005, most Chinese exports were in high-tech manufacturing [2], and in 2009, China became the largest exporter of tech-intensive goods, parts and components, ahead of the United States, Germany and Japan [3]. Although offshoring or processing exports play an important role in these sectors, China's processing exports as a percentage of its total exports decreased from the 1997–2006 period to 2012, falling from over 55% to below 45% [4]. Furthermore, China is not only the largest recipient of foreign investment, it is also among the world's top investors [5].

The economic strategy of China has changed. In recent years Chinese economy has moved from a system of growth based on exports, high investment strategies and energy-intensive manufacturing to a new growth model based on heavy-industrial investment and toward domestic consumption, particularly of services. These are important structural changes can achieve still-strong but lower economic growth, of a much better quality in terms of its social distribution and impact on the natural environment [6]. The improvement in the quality of life in China is changing the lifestyle of its population. Consumption patterns are shifting,

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becoming more similar to those of developed countries, and public spending on health and the development of a pension system is increasing [7]. After the 2007 crisis, China's growth cannot be explained by increasing exports, given that its trade surplus has shrunk from $261.8 billion in 2007 to $155.1 billion in 2011. Instead it can be explained by heavy investment in capital accumulation [8]. The end of cheap Chinese labor and China's development into a middle-wage country [9] is likely to change its role in the international sphere: it will cease to be the largest world export producer to instead become the largest global consumer of its own production and importer of final goods and services.

About half of cumulative anthropogenic CO_2 emissions between 1750 and 2010 have occurred in the past 40 years. Since 2001, coinciding with the entry of China into the World Trade Organization (WTO), total anthropogenic GHG emissions have increased on average 1 $GtCO_2eq$ per year [10]. In a globalization context, CO_2 emissions embodied in the production of internationally traded goods and services represent a large share of global CO_2 emissions (26% in 2008). This virtual carbon, moreover, and others factors embodied in international trade such as water and materials use, are growing faster than other economic indicators such as the GDP or population [11]. To date, China has played a major role in this emissions increase; in fact, it has emerged as the largest emitter of carbon dioxide in the world. According to Energy Information Administration, Chinese emissions increased by 170% between 2000 and 2009 [12]. This dramatic increase in CO_2 emissions can be explained by China's coal-based energy mix and the very high emissions intensity [13]. In 2009, approximately 82% of electricity generation in China was produced with conventional technologies, mainly coal [14]. China's increasing urbanization means that the construction industry, followed by electricity generation, represent the largest share of emissions associated with household consumption [15].

The affluence of rich countries is causing the international displacement of GHG emissions [16–18] land use [19], biodiversity [20], nitrogen [21], water [22] and energy [23]. This virtual trade is not only a question of extracting natural resources and exporting pollution from developing countries [24], the offshoring phenomenon has an important impact on the environment, also explained by emissions embodied by international transport [25] and processing exports [26]. As far as emissions are concerned, borders are meaningless. Their negative effects spread throughout the world, no matter where they occur, as evidenced in the case of China-US trade, where emissions avoided by offshoring to China were shown to be returning to the US by air [27].

The challenge of a transition from the current economic system toward a low-carbon economy to mitigate the climate change, has prompted the proliferation of several research on these topics. Some of these studies focus on assessing the improvement in the emissions intensity and the penetration of new technologies in the different countries of the world economy by the concept of 'stabilization wedges' [28]. Meanwhile, other studies highlight the importance of the reduction in energy intensity in different regions of China in the global context of reducing CO_2 emissions [29]. Other options proposed in the literature is the implementation of Pigouvanian tax to reduce the environmental externality of coal use in China [30] or [31] that propose 4 steps to China's carbon peak (set regional emissions targets, transparent emissions monitoring, expand carbon trading nationwide and advance green technology). However, the future implications in carbon emissions of the deviations of trade have been less analyzed due to the difficult to assume the direction (origin and destination) of these deviations.

Recent international experience where carbon leakage from developed to emerging countries has been very significant [11,32] and where there is a real risk that unless major economies recognize their imported carbon footprint even strong regulation on domestic emissions in major economies may not be effective in reducing total global emissions [33], it makes it interesting to study the potential trade deviations that could reduce the benefits of mitigation policies and the necessary penetration of cleaner energy. This trade diversion (or replacement) also could take a new direction, for some emerging countries (China, India, Mexico, etc.), which have substantially improved the living standards of their population, to other developing countries. This emissions leakage could reach a significant amount, since from 2005 emissions from developing countries are higher than the emissions of developed countries [34], because emerging countries have emissions intensities linked to the use of cheaper but more polluting [13]. Although they are incorporating in recent years mitigation policies to face of the demand that their citizens made to reduce local pollution and by international commitments adopted by these countries, such as Paris Agreement [35].

Replacing China as the world's factory is not simple, given its large size. It requires a set of countries with a large labor force and low wages. The PC-16́s, with a population of one billion, fulfills these criteria and will likely be assuming the role of being the world's factory in the next decades [36]. These countries are Mexico, the Dominican Republic, Nicaragua, Peru, Uganda, Ethiopia, Kenya, Tanzania, Sri Lanka, Bangladesh, Laos, Myanmar, Vietnam, Cambodia, the Philippines and Indonesia. Given this change in the "status quo" of international trade, this paper attempts to analyze the effects of these changes on the environment, and specifically on CO_2 emissions. Previous literature investigating the pollution haven hypothesis or the avoided emissions balance assesses the impact on GHG emissions of the substitution of international trade between countries that trade with each other, using the technological assumption to build a balance of avoided emissions [13,37–43]. Liu et al. [13] found if the emissions intensity of China's international exports were equal to the intensity of its imports, it would avoided emissions by 86% in 2007. However, these studies do not evaluate the impact of changing an international supplier due to possible environmental constraints or in pursuit of lower costs of production. In the context of criteria of responsibility, Kander et al. [44] proposed an improvement to consumption-based carbon accounting considered the different in technology by countrýs exports and the average carbon intensity for the relevant sector on the world market. They conduct an analysis making the assumption of the exports of a country rather than are produced with domestic technology are produced with the medium technology around the world. Other example where only accurate in trade can be seen in López et al. [45], but only for the case of the possible diversion of US imports from China to Mexico.

This paper proposes different scenarios wherein China's share of world trade is replaced by the PC-16́s trade. To illustrate this problem, a multiregional input-output (MRIO) model is developed to calculate the CO_2 emissions embodied in international trade in all scenarios proposed. Specifically, these scenarios are put forward that propose the replacement of China's trade based on PC-16́s trade patterns, their environmental efficiency (direct and total) and a combination of both assumptions. The significance of this work lies in measuring the impact and possible consequences of the changes anticipated in the global economic order and their implications on economic and environmental policy issues. The analysis draws on data from the Global Trade Analysis Project (GTAP) database (version 8.0) and is performed for 129 regions with a sectoral disaggregation of 57 industries.

This paper is structured as follows: Section 2 describes the methodology; Section 3 explains the main results; and Section 4 presents the conclusions and policy implications.

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