

## Is outsourcing decreasing gains in greenhouse gas efficiency in developed nations? A decomposition of energy and labor embodied in trade between 1995 and 2015

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In an ideal scenario, international trade could be capable of allocating production to the most appropriate locations in terms of the efficient use of capital, technology and resources, thus effectively reduce environmental impacts of production. This has not been the case and we might be far from the ideal scenario. The shift in production and the globalization of supply chains have not decreased global environmental pressures such as greenhouse gas (GHG) emissions so far. On the contrary, not only emissions have increased worldwide, but emissions embodied in trade have increased faster than global gross domestic product (GDP), mainly due to emissions embodied in traded products between developing and developed countries. This is especially the case for the years leading to the global financial crisis, when emissions from developing countries (especially China) grew rapidly between 2000 and 2007. Although the world economic recovery signalizes to a shift in the trade relations and in the carbon embodied in traded goods worldwide, with an increase in the South-South trade, the path for future emissions is still highly dependent on the policies adopted in the next years. One of the concerns with the growing emissions embodied in trade is that of carbon leakage. Although there hasn't been found much evidence of a strong carbon leakage i.e. increase of emissions in developing countries caused by the adoption of climate policies in developed countries the growth of emissions transfers between countries has been argued to be driven mainly by economic factors.

In the past decades, advances in information and communications technology, in transportation and growing trade openness have allowed for a strong rupture in the regional links between production and consumption. Although global supply chains have existed for centuries, it was in the past decades that the offshoring of manufacturing to resource-abundant countries have increased substantially. Today, finished and unfinished products are transported globally in unprecedented cost and speed. In this context, labor costs have been assumed to be an important driver to the migration of manufacturing stages, especially those characterized for high labor intensity such as textiles and clothing, from capital-abundant economies to labor-abundant regions. Nevertheless, labor-abundant regions tend to present lower energy productivity. The relocation of manufacturing stages can thus lead to an overall increase in energy consumption and, ultimately, trim down the impacts of GHG reductions in developed countries.

In this study we aim to quantify the relationship between labor costs, outsourcing and the further effects on environment. We look at the drivers for changes in total labor footprints and how labor and energy have been allocated between industries and countries between 1995 and 2015, as well as its relationship to the growth of GHG emissions embodied in trade, with special detail to industries that present higher shift in production location. We also perform a structural decomposition analysis (SDA) to understand the contribution of the shift in production between countries what we here call outsourcing to global relocation of labor, labor costs and energy and to the growth in carbon footprints. We used EXIOBASE, a high-resolution macroeconomic model which details the flows of products in the world economy, coupled with socioeconomic and environmental pressure indicators. In the recently developed version 3, EXIOBASE details the global monetary flows between the production of 200 goods and services in 44 countries and five Rest-of-the-World (RoW) regions for every year between 1995-2011 and nowcasted to 2015. The 44 countries in the model comprise, together, for 86% of global GDP in 2015 (91% in 1995). Preliminary results show that outsourcing is an important driver for the emission growth in developed regions, offsetting gains in technology efficiency, while increased affluence is the main

driver for emission growth in developing economies.