Measuring the Multiple Layers of Greenhouse Gas Footprints in Global Production Networks: Emissions Embodied in Production Chains and Final Demand Patterns

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Input-Output Databases are useful tools that can be adapted to compare, evaluate and analyse carbon footprints of industries across countries. Their analytical power depending on the coverage of countries and industries. These measures complement the existing estimates of territorial-based and production-based emissions from official statistics, allowing analysis of the interconnected structure of the global economy by considering all the chains of production until the final demand.

Building on the previous work comparing production-based and demand-based (consumption-based) measures of CO2 emissions, this study introduces new analytical indicators of GHG footprints based on global production network structures. Notably, GHG emissions embedded in domestic and international production networks; and, GHG emissions footprints associated with final demand patterns from purchasersâ€™ price perspectives. Using OECDâ€™s recently updated â€œInter-Country Input-Output" (ICIO) database, the coverage of OECDâ€™s work on indicators related to greenhouse Gas (GHG) emissions embodied in international trade and final demand has recently been expanded to 76 countries (and the rest of the world) and the period of 1995 to 2020.

The new features include:
1) More use of emissions statistics compiled under the System of Environmental-Economic Accounting framework based on the resident principle. This allows calculation of production-based emissions that cover not only CO2 emissions from fuel combustion, but also non-fuel combustion emissions such as those from industrial processes and fugitive emissions from agricultural and mining activities.
2) The evaluation of the demand-based emissions by products from purchasersâ€™ perspectives. In fact, a common approach of carbon footprint studies has been to include emissions associated with distribution services accounting only for the intermediate transactions while this study explores the emissions from all intermediate, final consumption and capital formation expenditures.
3) The measure of the total direct and upstream emissions associated with production activities for both exported and domestic products.

These extended indicators create an opportunity to support policy decisions on decarbonisation of manufacturing processes, transitions towards renewable energy sources, and cross-border trade adjustments for high-carbon content products. They also provide new insights into the environmental impacts of the globalised world economy and, possible options for greenhouse gas mitigation to help governments design policies to reduce the ecological footprint.

The main data sources used for this analysis are OECDâ€™s ICIO database and GHG emissions statistics from Air Emissions Accounts (AEA) compiled by Eurostat and OECD. Going beyond analyses that only consider CO2 and energy consumption, and accounting also for non-fuel combustion emissions data for industries and households presents new methodological challenges, particularly related to filling gaps of missing data. The AEA GHG emissions statistics are only available for 42 countries with relatively weak coverage for earlier years (prior to the mid-2000s) for the majority of the covered economies and a considerable number of industries. These missing data are covered by adjusting information from other emissions data sources such as Fuel Combustion statistics and national inventories of GHG emissions.

The economies of many developing countries are dominated by agriculture and energy-related mining activities. In such cases, total GHG emissions are significantly higher than total CO2 emissions from fuel combustion activities. In developed economies, production-based emissions remain high for Electricity, Manufacture of basic metals and Household fuel combustion remain the highest activities of emission sources.

These changes in emissions production-based emissions result in both a smaller difference in the intensity of production-based emissions for developed countries and emerging economies compared to fuel combustion only indicators. When considering total GHG footprint indicators, we see an increase from 22 to 28 in the number of countries classified as net exporters of emissions when comparing with the same 66 target countries published in the 2021 edition of OECDâ€™s Trade in embodied CO2 database.

The direct and indirect emissions embodied in each product provides new insights of footprint measures from the viewpoints of purchasers and producers. The footprints of final expenditures of goods products become significantly higher than the emissions estimated by basic prices, as expected. The changes are evident for the sectors of products having important levels of trade and transport margins such as agriculture, food products and textile industries.