

## Do the metrics matter? Region-specific carbon footprints of Brazilian products

Topic: Input-Output Modelling: Sustainable Production and Consumption Policies - II

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Sustainable development has become a global commitment to ensure the continuity of future generations while allowing countries to develop without exceeding safe boundaries. Achieving sustainable production and consumption patterns involves adopting strategies to minimise environmental and social costs. From the production side, it implies decoupling economic growth from environmental degradation, increasing the efficiency of natural resources use. With regard to consumption, it is related to the process of purchasing, consuming, and disposing of products, including lifestyle changes to limit over-use. However, production and consumption sustainability can be assessed as long as environmental information is available, requiring better measurements and indicators.

This analysis represents a significant advancement in the quantification of carbon footprints in Brazil. By using an environmental extended input-output approach and incorporating detailed emission data, it links environmental issues and production and consumption. Unlike previous studies, this research provides country-specific carbon footprint information for each Brazilian state, accounting for emissions from all sources including agriculture, land use, energy use, industrial process, and waste. Most studies to date are limited to energy-based emissions or used life cycle databases that may not be nationally representative, and disregard emissions from land use and deforestation, resulting in underestimated carbon footprints. Including these emissions in the carbon footprint of Brazilian products is highly relevant given that they represent a large share of total national emissions but also because disregarding them may undermine efforts to meet the climate commitments.

To fill this gap, we adopted an empirical approach based on an estimated Multi-Regional Input-Output (MRIO) matrix for 2015 and emissions data from Mapbiomas and SEEG to develop a comprehensive understanding of the carbon intensity of 128 products across Brazilian states. To calculate the carbon intensity coefficient (tonnes of CO<sub>2</sub>e/US\$ million), we first created a correspondence between emissions sources and the MRIO products. Mapbiomas database captures the loss of natural area (in pixels) converted into carbon biomass while SEEG details emissions of other sources at disaggregated levels and for several Greenhouse Gases (GHGs).

Our evidence shows that the metrics matter when quantifying the carbon footprints of products in Brazil, particularly those food-related given the large economic and environmental heterogeneity across regions. This reflects the particularities of each state in terms of productive structure as well as socio-ecological system and emissions profile. For example, land use represents 50% of the nationwide carbon footprint of cattle and other live animals and animal products while in Pará it corresponds to 77% of its total carbon footprint. This is the major emissions-intensive MRIO product in Brazil.

The findings highlight the importance of considering region-specific carbon footprints rather than compiled databases in order to avoid misleading policy decisions aimed at promoting sustainability. To investigate the effects of implementing mitigation policies, the paper proceeds with an estimation of a Quadratic Almost Ideal Demand System (QUAIDS) from household expenditure data, the Brazilian Household Budget Survey (POF), reconciled with the MRIO products in the next stage. While improved supply-side production techniques have the potential to mitigate the environmental impact of production, there is also significant room for demand-side options, including shifts towards

more sustainable and healthier dietary choices. The next stage will consider policies to address these issues.