An input-output analysis of CO2 emissions from a regional income perspective: an application to the Brazilian economy

Topic: Environmental Input-Output Modelling (3)
Author: Guilherme Perobelli Salgueiro
Co-Authors: Fernando Salgueiro Perobelli, Geoffrey J.D. HEWINGS, Eduardo Amaral Haddad, Edson Paulo Domingues

Using data from SEEG, the climate observatory, Brazil emitted 2.3 billion gross tons of greenhouse gases in 2022, representing an 8% drop compared to the previous year, when 2.5 billion tons were emitted. However, it is a high level of pollution. Deforestation is the main source of greenhouse gas emissions in Brazil; in 2022, the destruction of forests resulted in the emission of 1.12 billion gross tons of carbon dioxide, corresponding to 48% of Brazilian emissions. In the same year, 2022, the amount of greenhouse gases from agriculture grew to 617.2 million tons, an increase of 3.2% compared to 2021 and accounting 27% of the countryâ€™s total.

While the imbalances in Brazilian regional dependencies in terms of production and income have been documented, little research has been directed to the impact on emissions; are there similar imbalances? To address this question, we develop a multiregional economic network model that integrates spatial (nation, region) and sectoral (industries) dimensions to assess how income variations influence COâ‚‚ emissions. This is achieved by modifying an interregional input-output matrix covering Brazilâ€™s 27 states and 68 productive sectors for the base year 2019. Emissions data are sourced from the Greenhouse Gas Emissions and Removals Estimation System (SEEG).

The study explores the spatial, sectoral, and institutional drivers of emissions by analyzing the structure of production, trade, and income formation. A key contribution of this research is its focus on a middle-income country, employing a systemic approach to identify the supply-side impacts, classify sectors and regions, and analyze interregional interdependencies. Through this framework, we aim to identify the key agents responsible for COâ‚‚ emissions, leveraging the concept of embodied emissions to better understand their drivers.

Additionally, a panel data model with fixed effects were estimated, to evaluate the relationship between COâ‚‚ emissions (dependent variable) and national income across major economic sectors (agriculture, agriculture for exportation, industry, services, trade, and extractive industry). Our findings reveal a trade-off between emissions mitigation and economic growth, as key sectors driving Brazilâ€™s development are also major sources of emissions.

The input-output analysis further highlights the role of each sector in COâ‚‚ emissions by categorizing them into quartiles based on their direct and total impacts, establishing a hierarchy for sectoral mitigation strategies. Our results indicate a high degree of heterogeneity in sectoral elasticities, both in direct and total effects.
Dividing the elasticities in two measures (e.g. total and direct) may contribute to a better design of the potential mitigation policies both in spatial and sectorial terms. The spatially aggregate results help to better understand which are the main driver of the emissions, if local â€“ when the direct impact is higher than the total impact or if it is in the rest of the economy â€“ when the total impact is higher than the direct impact.

Spatially aggregated results reveal whether emissions are primarily local (when direct impact exceeds total impact) or driven by interregional linkages (when total impact surpasses direct impact). State of SÃ£o Paulo, for instance, exhibits a local emissions driver, meaning an increase in its value-added affects emissions nationwide. In contrast, the State of ParÃ¡ emissions are more

sensitive to value-added variations in other states, emphasizing interregional dependencies. Sectoral analysis also shows that emissions from agriculture and livestock are locally driven, whereas wholesale and retail trade emissions are largely influenced by the broader economy.

The results in this paper reinforce the tradeoff between income growth and emissions, the heterogeneity of the results both in sectorial and spatial terms and the necessity to customize the mitigation policies in a country with a spatial production structure with high degree of specialization like Brazil.