An analysis of interactions between polluting and non-polluting sectors for the Brazilian economy

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Abstract

Brazil is among the world's largest producers and exporters of agricultural commodities—such as soybeans, corn, cotton, coffee, sugar, orange juice, beef, and poultry—as well as forest products, especially pulp. (BRASIL, 2025). These activities are key drivers of economic and social development across multiple regions, and the sectors of Agriculture, Livestock, Forestry Production, Fishing, and Aquaculture are central to the Brazilian economy. They are estimated to contribute directly about 7% of Brazil's Gross Domestic Product (GDP) and to account for approximately R$72 billion in exports (IBGE, 2024; Brazil, MDIC, 2024). Despite their economic relevance, these sectors are also responsible for a substantial share of Brazil's greenhouse gas (GHG) emissions, largely due to deforestation, land conversion, and burning of native vegetation. In recent years, agricultural activities have accounted for around 30% of national GHG emissions, while land use, land-use change, and forestry (LULUCF) have represented roughly 40% of national emissions, much of which is associated with agriculture-related activities (SIRENE/MCTI, 2025).

Brazil's manufacturing industry also plays a pivotal role in the national economy, representing about 15.3% of GDP (CNI, 2024) and contributing 46% of Brazil's exports of goods and services. It is a major employer, accounting for approximately 14.7% of formal jobs (CNI, 2024), and is therefore critical both for job creation and for sustaining long-term economic growth. The diversity and complexity of Brazilian manufacturing strengthen Brazil's relevance in global supply chains. Activities classified under CNAE Section C have traditionally relied heavily on fossil fuels, implying substantial decarbonization potential. This potential can be realized through fuel switching toward

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renewable energy sources—such as bioenergy and biofuels—as well as through the adoption of new technologies and the electrification of production processes.

Drawing on the Green Taxonomy framework, which classifies Brazilian productive sectors according to climate vulnerability and adaptive capacity, this study combines the sectoral relevance of Brazil's economy with an input–output matrix calibrated to 2019 and emissions-intensity vectors for 68 productive sectors. This approach highlights the interdependence between high and low emitting sectors and enables an assessment, through intersectoral linkages, of the direct and indirect impacts, as well as external effects, associated with sectoral emissions in the Brazilian economy.

The Miyazawa method (1966, 1968, and 1971) and the method modified by Sonis and Hewings (1993) and Fritz, et al. (1998) were particularly relevant for measuring cross-impacts, allowing for a more detailed analysis of how shocks in the polluting sectors propagate to the rest of the economy. For this purpose, the economy was divided into non-polluting sectors (NP) and polluting sectors (P).

According to Hewings et al. (2001), the external and internal Miyazawa multipliers indicate the degree of economic interaction between two regions through the propagation of external and internal activities, respectively. In this paper, we adapt the Miyazawa multiplier to capture economic interaction between non-polluting sectors and polluting sectors. Accordingly, the exercise implemented allows us to assess the change in output generated in polluting sectors resulting from a one-monetary unit increase in final demand for non-polluting sectors. Put differently, the Miyazawa multiplier makes it possible to reveal the pressures that the non-polluting sector exerts on the polluting sector of the Brazilian economy.

In the classic input–output model, and thus in the Leontief inverse, only total final effects are identified, not separated partial multiplier effects. By contrast, the Miyazawa framework can capture both direct and indirect requirements, as well as internal and external propagation effects.

The results revealed the important role that structural interdependence will play in determining pollution levels in the region in the future. In addition, significant variations were noted across sectors in terms of the direct and indirect contributions to pollution. The analysis reveals that focusing attention only on polluting sectors in a regional economy may miss some of the more important interactions in the generation of pollution. The complex interplay between supply and demand among industries generates forces that are often significant contributors, through indirect pollution generation, in the volume

of pollution that is ultimately created in a region. Equally importantly, structural interdependence in the economy can play both a positive and negative role in pollution generation.

Keywords: input-output; emissions; Brazilian economy; climate change

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