Main drivers of changes in greenhouse gas emissions in Argentina: a structural decomposition analysis

Germán Augusto Zamorano, Federal University of Rio de Janeiro, germanzamorano@gmail.com; Kaio Glauber Vital da Costa, Federal University of Rio de Janeiro, kaioeconomia@gmail.com.

Overview

The challenges of reducing or controlling the increasing global temperatures require significant transformations in energy's, materials and food production and consumption systems, in addition to multilateral agreements in the area of international trade. The relationship between environmental degradation and income has been intensely debated in the last three decades. If the consequences of pollution and deterioration in ecological systems are currently being verified, in the coming years this pressure on the environment must continue, once, according to the OECD (2019), it is estimated that world GDP will double in the next 20 years. The critical limits of GHG emissions can be expressed in terms of a maximum rate in which the world economy can grow without placing the stability of the environmental ecosystems at risk, considering the evolution of GHG emissions per unit of GDP. In this sense, it highlights the importance of technological progress which allows production to be decoupled from GHG emissions and the consumption of natural resources, together with changes in the patterns of production and consumption, in order to maintain or increase growth rates in an environmentally sustainable way.

The objective of this paper is to analyze the main drivers of changes in GHG emissions in Argentina from 2000 to 2016. These determinants encompass alterations in final demand, shifts in energy and emission intensity related to production processes, and the sectoral composition of the economy. The identification of these key drivers during the specified period aims to enhance our understanding of achieving the decoupling of economic growth from GHG emissions. Given Argentina's varied economic circumstances during this period, ranging from one of its most severe crises to periods of robust growth, this study offers valuable insights into the intricate relationship between economic growth and GHG emissions in developing economies.

Methods

The method used to achieve this goal consists of a structural decomposition analysis (SDA) of environmentally extended input-output matrices (which incorporate satellite accounts of greenhouse gas emissions and energy consumption), provided by Eora MRIO database. Due to the outdated nature of the satellite accounts pertaining to energy consumption from Eora MRIO database, we augmented the energy consumption vectors by incorporating data sourced from the energy balances provided by the International Energy Agency (IEA).

SDA employs a comparative static analysis approach to dissect the historical changes of a variable, focusing on the determining factors behind those changes. Studies employing SDA encompass a wide range of variables, including product breakdown, value-added analysis, and labor demand. In the context of environmental research, SDA is commonly used to examine changes in physical flows such as energy consumption, CO2 emissions, and other resources and pollutants.

We consider the following equation, where the levels of GHG emissions and energy consumption are directly related to the value of production:

$$C = \frac{C}{EN}\,\frac{EN}{x}(I - A)^{-1} f = \hat{\mathbf{c}}\hat{\mathbf{e}}\mathbf{L}\boldsymbol{f} \quad \textbf{(2)}$$

Where ĉ is a diagonal matrix of dimension n x n representing emission intensity, ê is a diagonal matrix of dimension n x n representing energy intensity, L is then n x n Leontief inverse matrix, and represents the structure of intermediate consumption by each branch, the so called "recipe" each sector uses for its production process. Changes in this structure are mainly due to changes in production techniques and serves as a proxy of the technical change. Finally, *f* represents the final demand vector.

We further decompose the final demand vector f into foreign f_f and domestic demand f_d. This last one, we subdivide it into three drivers: *l* is a scalar representing the level (total amount) of total final demand expenditure over all sectors. *d* is the vector that indicates the distribution of the total amount of final demand across the different final-demand categories. Finally, the matrix B indicates the proportion of total expenditures by final-demand category that was spent on the product of each Argentinian sector in a determined year, resulting in

$$\mathbf{C = \hat{c}\hat{e}L}f_f l d\mathbf{B} \quad (4)$$

Results

Our findings reveal that the most influential factor affecting GHG emissions variation is the final demand, exhibiting an increase during economic growth and stagnation periods and a reduction during recessions. Concurrently, the energy intensity effect plays a pivotal role, comparable to that of final demand but exhibiting an inverse impact on emissions changes during economic downturns and growth phases. The alteration in the intermediate consumption structure marginally impacts periods of growth and stagnation, while it has a moderate effect during recessions. The emission intensity effect contributes to emissions growth during periods of growth acceleration and contributes to emissions reduction during growth and stagnation.

Conclusions

The results from this study reveal an interesting inverse relationship between the contributions of energy intensity and final demand to emission changes during the growth periods. These findings provide compelling evidence that promoting improved energy efficiency could prove highly effective in achieving significant reductions in emissions, even in a growing and affluent economy.

Moreover, the analysis identifies a handful of sectors responsible for the most substantial changes in emissions, with notable mentions being the commercial and public services, food, chemical and petrochemical industries, and other manufacturing sectors. Identifying the efficiency improvement potential within these specific sectors is of utmost importance, as well as providing both financial and technical support to enhance improvements in their energy and emission efficiency. By targeting these critical areas, the country can make significant strides in its efforts to mitigate climate change and foster sustainable development.

Considering the composition of Argentina's energy sources, a shift towards an energy mix characterized by a reduction in the use of oil and coal, and an increase in the utilization of natural gas as a primary energy source, can result in substantial emission reduction. This transformation was evident during the period from 2010 to 2016, where the increased imports of natural gas played a significant role in considerably lowering carbon emissions through the emission intensity driver.