Research Statement

Integrating environmental and/or social indicators in a macroeconomic model

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As a research fellow at the Leeds University Business School (Leeds, UK), I worked in the EU-funded JUST2CE project to develop a SOCIO-ECO-MRIO stock-flow consistent ecological macroeconomic model with a complex input-output (54 sectors) and multi-regional structure (2 regions) and social extensions, empirically calibrated for the EU and the Rest of the World, in order to study the social and regional inequalities, economic and environmental impacts involved in the transition to a circular economy, featuring visuals that resembled the multi-dimensional analysis of doughnut economics.

SFC models provide a systematic framework for the dynamic analysis of the complex institutional structure of whole socio-economic systems (Caverzasi and Godin, 2015), making them particularly suitable to address income distribution, not only in terms of functional class, but also gender and race, as well as labor-market segmentation. In terms of class, following the earliest model of economic growth in history, including a landowner rentier class is essential in any macroeconomic model that attempts to describe a scenario of limited natural resources (Ricardo, 1971; Kaldor, 1955). In terms of labor-market segmentation, the most meaningful development for such sort of SFC models may be introducing data-driven, differential exploitation rates for different kinds of household classes (segmented by personal income, race and gender) following the setup of Dafermos and Papatheodorou (2015), that can be computed empirically as differential ratios between empirical use-time data and corresponding flows of wage payments that are required for the social reproduction of the household as a whole. Including the complexity of migration would also make the model more substantive, related to international wage differentials and the complex policy costs and benefits of immigration (such as the threat of deportation due to undocumented status and pressure on social services coupled with aggregate positive demand shocks).

In their consistent and comprehensive integration of the flows and stocks for both the real and financial sides of the economy, these models belong to and are compatible with the broader family of system dynamics, widely used in the natural sciences and engineering. In this direction, SFC models are particularly well-suited to capture the complex dynamic interactions between the environment and the economy (Dafermos et al., 2017, 2018). Following Briens (2015), input-output models are indispensable for investigating post-growth scenarios on a macroeconomic level (Hardt and O'Neill, 2017). This is an important ecological SFC models, as most ECO-SFC models today still aggregate the economy into one or very few sectors, particularly the energy sector

(Naqvi, 2014; Valdecantos and Valentini, 2017; Carnevali et al., 2020). Further, the sector-level composition of output does not often change over time due to technical change, sector-level changes in demand, or temporary/out-of-equilibrium imbalances between supply and demand and in profitability.

In my ecologically-extended dynamic models of multi-sector growth (Vallès Codina, 2023; Vallès Codina and Semmler, 2024), I already integrated ecological indicators to industry output, focusing on aggregated carbon emissions, land use, energy use, and water use. Once the macroeconomic model has an input-output structure, the integration of environmental indicators is relatively straightforward by computing their ecological intensities by output using international ecologically-extended input-output databases such as EORA or EXIOBASE, which provide a wealth of very precise ecological indicators. A critical contribution of this non-SFC model to the literature is its dynamic composition of output and prices (driven by the cross-dual interactions between price and quantity imbalances in profitability and between supply and demand) in contrast to being constant over time as it is *de facto* in SFC-IO models. Most significantly, this was achieved by not treating monetary flows (i.e. prices times quantities) in the aggregate, as it is most common in macroeconomic modeling, but by separating between prices and quantities, hence explicitly addressing physical flows as it is one of the core interests of any ecological macroeconomic model.

For instance, EORA offers 2,728 ecological indicators, such as nine sources of energy consumption, emissions of different greenhouse gases (among which fifty-five sources of I-GHG-CO2 emissions), air emissions, dozens of categories of raw material use, crop product use, total pasture area, crop and pasture land, and water footprint. However, there is a problem of dimensions by relating physical footprints to monetary flows, which my models also suffer. However, the high precision of such indicators still allows the use of specific functions of environmental and economic damage (e.g., not necessarily linear, as informed by environmental science), so that their impact on planetary boundaries and human well-being can be evaluated. Since these databases encompass a range of years, the time evolution of the ecological intensities can also be studied using machine-learning techniques, as they do not necessarily need to be constant but may vary over time. The main challenge we faced in our research did not lie in the integration of ecological or social indicators itself, but in the regional structure of the macroeconomic model that should be able to capture ecological unequal exchange in the context of core-periphery relations (Dorninger et al., 2021). While delinking from such unfair, uneven structures, many well-meaning degrowth policies exclusively focused on the Global North may negatively impact poverty, employment, and financial stability in the Global South, making compensatory policies with a global scope essential.

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