Growth of what? An exploration of pathways for global economic demand with low fossil fuel use and high employment

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This paper is motivated by the search for economic pathways which are simultaneously environmentally and socially sustainable. One aspect of such a pathway is the relative composition of economic demand. Different sectors have very different environmental and social footprints. While much attention is paid to aggregate growth rates of economic activity, the composition of growth is crucial to understanding the actual social and environmental effects of growth. In short, to know the impact of a 2 percent growth rate, one must know which 2 percent is growing.

The research question of this paper is to identify pathways for the evolution of global economic demand which simultaneously reduce the use of fossil fuels and maintain a sufficiently high level of employment to enable social stability. To do so, the paper will use an input-output database to create a systems dynamics model which will show the energy and employment requirements of various sets of growth rates for sectoral final demand for the global economy. These sets of sectoral growth rates will represent different plausible scenarios, or pathways, which can be used as inputs in further climate-economy modeling work.

The model is based on a dataset created for the MEDEAS World integrated assessment model. MEDEAS is a large-scale systems dynamics model which combines a demand-led economic system with a representation of the bio-physical limits to growth in the shape of an energy availability feedback which constrains economic activity to the amount of energy produced within the model. At the core of the MEDEAS economic system is a 35-sector input-output framework, adapted from the World Input Output Database, with global data running from 1995 to 2009.

The paper will present a concentrated model built with the MEDEAS database. The model will include a Leontief inverse of technical coefficients, a set of sectoral energy intensities by five types of energy carriers (electricity, heat, solids, liquids, gases) and a set of sectoral labor intensities at the global level. The energy intensities include both energy used in the process of production, with data taken from the World Input Output Database, and for energy used in household consumption, with coefficients calculated separately within the MEDEAS database. Labor intensities will be adapted from the World Input Output Database.

The model will run to 2050, with energy and labor intensities evolving exogenously based on pathways taken from the literature. The technical coefficient matrix will evolve with respect to changes in the energy intensities according to the method proposed in Nieto et al. 2023. These evolutions will provide ongoing plausible background assumptions regarding the productive structure of the economy over the next thirty years. This will allow us to exogenously set differentiated rates of growth for sectoral levels of demand, and receive approximate estimations of the total energy and labor requirements of those growth paths.

To create these sets of differentiated growth rates, we will categorize sectors based on 1) the relative intensity of their use of solid, liquid and gas energy, 2) their relative labor intensity, and 3) their importance in the deployment of renewable energy. By focusing only on energy in the form of

solids, liquids and gas and not of electricity and heat, we hope to directly identify reductions in the use of fossil fuels. In doing so, we assume that the rebalancing of sectoral demand will be done in the context of an energy transition, where electricity generation becomes increasingly provided by renewable sources. This also provides justification for the third consideration, as we do not want to project substantial declines in sectors which will be critical in the energy transition.

We believe that this paper will be a novel application of input-output analysis to the topic of the sectoral composition of the economy with respect to social and environmental limits. The primary output of the model will be sets of sectoral growth rates which achieve both reductions in fossil energy use and a stable level of employment. These sets will provide coherent scenarios of different economic pathways which would aid policymakers in respecting the limits set in the Paris Agreement. These demand scenarios would be fully compatible with the larger MEDEAS model, and could serve as the starting point for building more complete techno-economic scenarios.

References

Nieto, Jaime, Pedro B. Moyano, Diego Moyano, and Luis Javier Miguel. 2023. â€œIs Energy Intensity a Driver of Structural Change? Empirical Evidence from the Global Economy.â€• Journal of Industrial Ecology 27 (1): 283â€“96. https://doi.org/10.1111/jiec.13352.