Multi-factor Environmentally-extended Input-Output Analysis

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Summary of the Training Session:

The multi-factor modelling approach to environmentally-extended input-output analysis (EEIOA), developed by Guevara and Domingos (2017) [En. Econ. 61: 261-269], has the advantage of a more detailed and better analysis of environmental flows than other EEIOA approaches, as it considers the physical processes of conversion that environmental flows experience within the economy. It has been proven especially suitable in combination with structural decomposition analysis and scenarios analysis, through which it has been able to give insights about various type of economy-wide resource efficiency trends and about the relative roles of economic transitions on environmental trends and vice versa. It has also been used to provide more specification to multipliers, understand trade impacts, and evaluate policy decisions and futures.

In the theoretical part of the module, we review the fundamentals of the multi-factor EEIOA approach. I start with the conventional EEIOA models (the hybrid-unit energy input-output model and the direct environmental impact coefficient models). Then I introduce the construction and theory of multi-factor approaches (particularly focused on energy flows) and the more recent complex mixed-environmental-flows multi-factor models. I continue with lessons learned from multi-factor-approach-based studies to explore the area of application, limitations, and the whole range of advantages of this approach.

In the practical part of the module (i.e., MFEEIO Construction Toolbox), I explain in detail the methodology for the construction of multi-factor models from conventional, broadly available, environmental data. With available energy balances data and economic IO data, the participants will construct a country model for two years and perform a decomposition analysis. Finally, we discuss some methodological, interpretation, construction and data challenges of the multi-factor approach and its future research paths.

Outline:

First Session *EEIOA modeling approaches (hybrid-unit and direct impact coefficient models) and the fundamentals of the multi-factor approach*

Second Session *Applied studies and lessons learned from them, and MFEEIO Construction Toolbox (1st part)*

Third Session *MFEEIO Construction Toolbox (2nd part) and kick-off of participants' case study projects*

Fourth Session *MFEEIO Construction Toolbox (3rd part) and conclusion*

Prerequisites:

Participants must have a reasonable level in matrix algebra for IOA, and knowledge of the basic economic input-output model and the supply-and-use model in IOA. Also, it is desirable that they are familiar with environmental accounting methods.

Participants will bring with them their laptops for the exercises during the sessions. It is desirable that the participants have knowledge of data analysis software, for example, R, Python, Tableau, STATA. Most exercise will be given in python (though a R version will be also available). However, some exercises could be done with excel and by hand.

Suggested References:

Bagheri, M., Guevara, Z., Alikarami, M., Kennedy, C.A., Doluweera, G., 2018. Green growth planning: a multi-factor energy input-output analysis of the Canadian economy. Energy Economics, 74, 708-720. https://doi.org/10.1016/j.eneco.2018.07.015.

Guevara, Z., Córdoba, O., García, E.X.M., Bouchain, R., 2017. The status and evolution of energy supply and use in Mexico prior to the 2014 energy reform: An input-output approach. Economies, 5, 10-26. https://doi.org/10.3390/economies5010010.

Guevara, Z., Domingos, T., 2017a. The multi-factor energy input-output model. Energy Economics, 61, 261-269. http://dx.doi.org/10.1016/j.eneco.2016.11.020.

Guevara, Z., Domingos, T., 2017b. Three-level decoupling of energy use in Portugal 1995–2010. Energy Policy, 108, 134-142. https://doi.org/10.1016/j.enpol.2017.05.050.

Guevara, Z., Henriques, S., Sousa, T., 2021. Driving factors of differences in primary energy intensities of 14 European countries. Energy Policy, 149, 112090. https://doi.org/10.1016/j.enpol.2020.112090.

Guevara, Z., Molina-Peréz, E., García, E.X.M., Pérez-Cirera, V., 2019. Energy and CO2 emission relationships in the NAFTA trading bloc: A multi-regional multi-factor energy input-output approach. Economic Systems Research, 31, 178-205. https://doi.org/10.1080/09535314.2018.1528212.

Guevara, Z., Rodrigues, J.F.D., 2016. Structural transitions and energy use: A decomposition analysis of Portugal 1995-2010. Economic Systems Research, 28, 202-223. http://dx.doi.org/10.1080/09535314.2016.1157456.

Guevara, Z., Sebastian, A., Carranza Dumon, F., 2022. Economy-wide impact of conventional development policies in oil-exporting developing countries: The case of Mexico. Energy Policy, 161, 112679. https://doi.org/10.1016/j.enpol.2021.112679.

Heun, M.K., Owen, A., Brockway, P.E., 2018. A physical supply-use table framework for energy analysis on the energy conversion chain. Applied Energy, 226, 1134-1162. https://doi.org/10.1016/j.apenergy.2018.05.109.

Miller, R.E., Blair, P.D., 2009. Chapter 9 Energy Input–Output Analysis. In *Input-Output Analysis: Foundations and Extensions*, 2nd ed. Cambridge University Press, Cambridge, MA.

Rocco, M.V., Guevara, Z., Heun, M.K., 2020. Assessing energy and economic impacts of large-scale policy shocks based on Input-Output analysis: Application to Brexit. Applied Energy, 274, 115300. https://doi.org/10.1016/j.apenergy.2020.115300.