

MARIO: a versatile and user-friendly software for building Input-Output models

Topic: Advances in Open Source Software for Input-Output Compilation, Analysis and Quantitative Impact Assessment

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Input-Output models create comprehensive and coherent descriptions of the interdependencies between different sectors through a quantitative representation of the flows of goods and services in an economy. The formulation of Input-Output models allows a modeler to assess the effects of changes in the demand or supply of goods and services on the economy and to identify their key consequences on environmental, social, and economic aspects. Models such as these are essential for understanding the complex interactions within an economy and for planning and implementing policies. The development of a tool that can easily set the scope and detail of an IO model and automate the most common input-output modelling procedures would greatly simplify the rigorous application of these methods.

MARIO (Multi-Regional Analysis of Regions through Input-Output) is a framework to build Input-Output models, designed to evaluate the economic and environmental impacts of different scenarios with a scale and database agnostic approach where any kind of input-output tables ranging from a single region to multi-region, monetary, or hybrid, and input-output or supply and use can be adopted. MARIO key features include automatic parsing of different available databases, automatic calculation of different tables, intuitive Application Program Interface (API) for changing an existing database through adding a new flow or sector to the tables, database aggregation, and scenario creation through shock analysis. Through the separation of mathematical complexities of input-output models and databases, MARIO provides an efficient tool to input-output modelers to focus on their analysis (problem-specific) rather than performing recursive mathematical operations of input-output models. MARIO API is designed to be used by users with little experienced and knowledge of Python programming language as well as experienced Python users.

To build an input-output model using MARIO, an input-output database needs to be parsed at the first step. MARIO has different parsing functionalities where different available input-output tables like EXIOBASE (different versions such as monetary and hybrid and IO and SUT versions), EORA (single-region and multi-region), and EUROSTAT can be imported, and the missing table will be calculated in a one-line command. When dealing with non-structured tables, MARIO can read a specific table from excel, csv, or text files. Implementing any changes to an existing database, including aggregation, adding a new sector, flow, or satellite account, as well as building different scenarios through shock implementation, can be done through an automatically generated excel interface where the modeler needs to fill the necessary data for the change while, for more complex and programmatic uses, the Python interface of MARIO can be utilized. Moreover, MARIO's built-in functionalities allow interactive analysis of the model outcomes through some routine visualizations. The newly generated or updated input-output database in MARIO, can be saved in different formats (such as excel, csv, or text files) while generating a metadata file that is capable of tracking down all the operations and changes performed on the original database.

MARIO is an open-source software that can be freely accessed, used, modified, and distributed by anyone, taking the advantage of open-source scientific software philosophy of contributing to higher transparency and flexibility, while allowing researchers to collaborate and build upon existing work, resulting in faster and more efficient scientific progress.