The Entropy-based Chinese City-level MRIO Construction Framework

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Given the major part of the global population and economic activities in the city scale, understanding cityâ€™s impacts within and out of boundary (e.g. spatial interdependence or connectedness of cities) has been becoming vital in policymakers at multiple levels, however, it is impossible without the rapid development of city-level MRIO databases. Unfortunately, current MRIO databases focus more on the international level or subnational level. Lack of city-level MRIO databases has been compromising uprising city-level studies. Data availability is a key issue in city-level MRIO database construction, as city-level data are extremely scarce. Many efforts have been made to overcome the issue in city-level, in which IMPLAN and the Industrial Ecology Virtual Laboratory (IELab) technology are pioneers. The former is based on the double-constraint gravity model combined with data from the commodity flow survey by the US government. The latter overcomes these limitations and offers a flexible compilation structure for city-level MRIOs based on 11 non-survey methods and downscale from the superior table, such as the national IO table. Unfortunately, the former is still based on survey data that is not applicable in many other countries, while the latter largely follow a top-down philosophy with likely unrealistic assumption of homogeneity in technology and consumption between nations and regions. In this study, we propose a feasible bottom-up Chinese city-level MRIO construction framework, which is based on the entropy theory and publicly accessed data. It massively reduces the data requirement and can maintain data consistency without introducing uncertainty from balancing optimization.

We decompose the compilation processes into multiple layers. In the first step, the Provincial-level MRIO table would be constructed by using a total of 31 provinces official published single IOT, which would be served as a platform for the further city-level compilation. Cross-entropy is introduced in the trade data manipulation, as total domestic inflow and outflow for a sector are not the same when aggregating data from Province IO tables. Maximum-entropy is introduced in estimating interregional flows with survey-based transport data. In the second step, we begin city-level MRIO table construction by province with using adjusted province IO table (domestic trade adjusted in step 1). For a certain province, we first derive the cityâ€™s output and value added for each sector (its classification is as same as the province IOT) from cityâ€™s statistics yearbooks and international trade data from China customs database, which would be scaled to make sure the aggregated compatible with the accordingly data from province IOT. So, we are able to know the domestic supply for a sector for each city in the province. Then, the output of the key downstream sector and the cityâ€™s population are used to do the regressions to estimate the total demand for the upstream sector for each city. Afterward, for a certain sector, maximum entropy would be introduced to estimate the local supply and demand, supply to cities within the province, demand from cities with the province, supply to cities out of the province in China, and demand from cities out of the province in China, with constraint from province IOT. These data would be further used in estimating inter-city trade flow for each sector by maximum entropy, and regionalization matrix. With estimated city-level trade data, we use cross-entropy to regionalise city-level IO table from Province IO table and transform it into non-competitive ones. Given the estimated intercity trade flow and city-level IO table, we are able to connect each city in a province by assuming each sector following the trade pattern. Because all the data are controlled in the whole steps, and compatible with each, there is no error in the city-level MRIO table in the province, which avoid the uncertainty introduced by optimization processes (e.g. RAS). The city-level MRIO table in one province would be inserted into provincial level MRIO table to replace the according province. Following the steps above, all the cities in China can be linked together.

To test the reliability, we make a comparison between city-level MRIO table in Hebei province

compiled by this method and our city-level table in Hebei province complied previous based on the survey-based city IO table(only Hebei province have all cityâ€™s IO tables). We found the main differences between the city-level MRIO table are the inter-city trade, which is largely because the aggregated trade in survey-based city IO tables has an incredibly large gap between the trade in province IO table. This framework or some techniques in the framework have strong potentials in applying all other countries.