

From exposure to fragility: A composite MRIO metric of global supply chain disruption risk and country typologies

Topic: Input-output Modelling and Supply Chain Resilience (I)

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This abstract is submitted to the Special Session "Input-output Modelling and Supply Chain Resilience".

Since the beginning of the last unbundling of globalization, countries have been more connected each time, leading to the so-called global supply chains or global value chains. As previous literature has shown, globalization has had positive effects on the different economies, allowing its upgrading into more sophisticated tasks. However, natural disasters such as the earthquake and tsunami in Japan in 2011 or more recently, the COVID-19 pandemic, and the current international tensions have evidenced the potential risks associated to global supply chains in case of disruption. This has renewed interest in measuring and comparing countries' vulnerability and resilience to supply-chain disruptions, beyond single-shock case studies.

Previous literature in this framework has commonly focused on risks models and inoperability input-output models. With them, they often estimate the impacts of different possible shocks at multisectoral level. More recently, some works have gone further and proposed different metrics to measure either dependence (Inomata & Hanaka, 2024) or exposure (Baldwin et al., 2025). Building on this literature and acknowledging that the concept of risk of disruption of a supply chain is multidimensional, the main aim of this work is to move beyond single notions such as dependence or exposure and integrate several complementary risk channels in MRIO-based indicators. This allows to perform different cross-country and cross-sector comparisons, defining combined country typologies.

More specifically, this study will work in Multiregional Input-Output framework (MRIO) to derive the different factors affecting risk of disruption. Particularly, we consider different dimensions related to the following. First, we will work with the interdependency matrix A^* often used in the inoperability input-output models. The elements of a particular row of an interdependency matrix give information about the additional inoperability added by each column (e.g., country-sector). Therefore, the average of each row can be interpreted as an aggregate measure of the supply chain's dependence, capturing its overall interdependence intensity or "strength".

On the other hand, business and management literature claim that, in the last decade, there was a tendency towards concentration of supply, increasing the vulnerability of the chains. In a MRIO framework different forms of concentration can be derived, such as sectoral and geographical, therefore, both will be computed. Moreover, concentration can be computed in terms of volume, but also of frequency. In this sense, the metric proposed by Inomata & Hanaka, (2024) will be also considered.

We also construct additional indicators based on key global value chains measures, such as position (upstreamness/downstreamness). Disruption risk is not symmetric along the chains, being typically higher for more upstream positions, where production is more intensive in inputs and the shocks can propagate downstream. External backward and forward indicators for specific sectors will be also calculated as proxies of exposure both to demand and supply, and those will be complemented with the metrics recently proposed by Baldwin et al., (2025). Additionally, the ratio of domestic production respect exports will be also computed. The more outward-oriented a country is, the more dependent it may become. Finally, the length of the chain and the proportion of inputs coming from non-neighbors will be also important factors. Additionally, under the current uncertain context with international political tensions, strong trade with "non-friends" countries could also strengthen the risk of disruption of production (as an example the international tariffs imposed

by the US). This dependence on non-aligned suppliers will be also the basis of other indexes reflecting this geostrategic dimension.

Once all factors are computed within the MRIO framework, a Principal Component Analysis (PCA) will be run to obtain a single indicator as combination of all the previous dimensions. Based on these econometric results, some scenarios will be designed in a MRIO framework to test the resilience of countries to unexpected shocks. Empirically, we will use ICIO database (OECD (Organisation for Economic Co-operation and Development), 2023), which covers the period 1995-2022 and it is constituted by 80 countries and 50 sectors. The first results show a general increase in backward linkages, therefore of exposure to supply, and an increasing tendency of geographical concentration, while at the beginning risk was mainly driven by a deep exposure to demand.