

Where is the choke point? Supply chain vulnerability in firm-to-firm transaction networks

Topic: Input-Output Modelling: Trade and Global Value Chains policies (1)

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<Motivation/research question>

With today's elevating geopolitical tension, supply chain vulnerabilities may be deliberately targeted through economic statecraft by political adversaries.

This paper proposes a novel approach to quantify supply chain exposure to network concentration risk, by combining the information from input-output tables (IOTs) and firm-level transaction data.

<Novelty>

The principal contribution of this study is that the proposed metric is specifically designed for the analysis of economic security issues with a particular focus on firms' activities. Until recently, attempts to analyze supply chain vulnerability primarily centered on the use of IOTs. However, the input-output approach faces a major limitation when it comes to the issues of economic security. This is because its unit of analysis is either 'industry' or 'product' while it does not contain information about economic entities; notably, firms. For example, IOTs alone cannot serve to analyze the economic impact of the Entity List issued by the U.S. Department of Commerce, which specifies entities subject to trade restrictions. While the input-output analysis works well for economic security on products, a different approach is required for the analysis on entities.

<Data and analytical method>

Our novel risk indicator, Risk Exposure Mapping (REM), addresses this issue by combining the information from IOTs, on one hand, and the firm-level transaction data of FactSet Research Systems, on the other.

FactSet's database is composed of several data packages prepared for various analytical purposes. As of October 2025, these packages together cover 617,245 firms globally and contain more than 2.3 million transactional relationships. By cross-referring to business activities of each firm, production relationships can be mapped from IOTs to FactSet's firm networks.

Firm-to-firm dependency is calculated by multiplying the weights (given by corresponding input coefficients) along all production pathways.

<Analytical results>

We analyzed a recent case of supply chain disruption in automobile industry caused by China's export control of Nexperia's semiconductors. Nexperia is a Dutch company specializing in the production of semiconductors specific to the uses in automobiles.

Comparing the degree of dependence of major automakers on Nexperia's semiconductors, Volkswagen, which is well known for its highly modularized product architecture and global outsourcing strategy, shows the highest dependence on the product.

Also, through detailed anatomy of production paths of Volkswagen's US affiliate, it is seen that over 98% of the entire exposure score is accounted for by only two production paths (out of the entire 104,303 paths), suggesting that the supply chain of Volkswagen-US is characterized by high degree of path concentration for critical supply dependence on Nexperia. This was further confirmed by comparison to the supply chain of Toyota Motors' US affiliate, which shows much more dispersed path dependence on Nexperia.