Supply Chain Disruptions: Evidence from the Great East Japan Earthquake

Summary of Carvalho et al. (2021)

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The Quarterly Journal of Economics

February 3, 2026

1. Research Question(s) Addressed

- What role do input-output linkages play as a mechanism for the propagation and amplification of microeconomic shocks?
- How do disruptions spread both upstream (to suppliers) and downstream (to customers) along firm-level supply chains?
- What is the total macroeconomic impact of a localized natural disaster when accounting for these network-wide propagation effects?

2. Why it's Important

- **Aggregate Risk:** Intermediate goods transactions are massive (comparable to GDP), meaning supply chain failures are a primary source of national economic risk.
- **Policy Relevance:** International and national agencies (e.g., OECD, World Economic Forum) increasingly focus on supply chain security to prevent regional shocks from harming global growth.
- **Scientific Gap:** While theoretical models of production networks exist, systematic empirical evidence quantifying these effects at a national level was previously scarce.

3. Key Challenges

- **Identification:** Finding a truly exogenous micro shock that is not already correlated with broader industry or national trends.
- **Data Granularity:** Most datasets do not allow researchers to trace individual buyer-supplier links across hundreds of thousands of firms.
- **Traceability:** Measuring how a shock at Point A affects Point D through multiple indirect layers (e.g., a "supplier's supplier").

4. Data, Design, and Model

- **Data:** Uses a proprietary dataset from Tokyo Shoko Research covering roughly half of all Japanese firms, including binary identities of their suppliers and customers.
- **Design:** Leverages the 2011 Great East Japan Earthquake as a natural experiment. It compares firms in a "disaster area" (41 municipalities) with those outside, using their network distance as a treatment variable.
- **Model:** A general equilibrium model of production networks featuring nested Constant Elasticity of Substitution (CES) technology to capture substitution across inputs.

5. Contributions

- **Quantified Propagation:** Documented that hit suppliers caused a 3.8% sales decline for customers, and hit customers caused a 3.1% sales decline for suppliers.
- **Indirect Effects:** Proved that disruptions ripple to firms several steps removed from the earthquake zone, such as "customers' customers."
- **GDP Impact:** Estimated that the earthquake caused a 0.47 percentage point decline in Japan's real GDP growth, with network propagation doubling the impact relative to a world without linkages.

6. Caveats

- **Headquarters Location:** The data identifies firm headquarters, which may not always match the physical location of production plants (though robustness tests on single-plant firms support the findings).
- **Binary Linkages:** The dataset indicates the existence of a relationship but does not specify the exact Yen value or volume of transactions between firms.
- **Homogeneity:** The baseline model treats all suppliers as equally substitutable, which may overlook "bottleneck" firms that provide unique, non-substitutable parts.