

The Role of Supply Chains in the Propagation of Economic Shocks

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The Economy as a Fragile Production Network

*“Layman and professional economist alike, practical planner and the subjects of his regulative activities, all are equally aware of the **existence of some kind of interconnection between even the remotest parts of a national economy** [...] The presence of these invisible but nevertheless very real ties can be observed whenever expanded automobile sales in New York City increase the demand for groceries in Detroit, [...] when the sudden shutdown of the Pennsylvania coal mines paralyzes the textile mills in New England, and it reasserts itself with relentless regularity in alternative ups and downs of business cycles.”*

Wassily Leontief, *The Structure of the American Economy, 1919-1929*

The Economy as a Fragile Production Network

“We have seen that disruptions to supply chains caused by natural disasters and from criminal and terrorist networks seeking to exploit the system or use it as a means of attack can adversely impact global economic growth and productivity.”

U.S. National Strategy for Global Supply Chain Security (2012)

The Economy as a Fragile Production Network

Companies' supply chains vulnerable to coronavirus shocks

Shortages of components likely to be far worse than expected, warn experts



Experts say most US companies are unaware that they are exposed to Chinese factories idled by the coronavirus outbreak © Reuters

Patrick McGee in San Francisco and Andrew Edgecliffe-Johnson in New York MARCH 9 2020



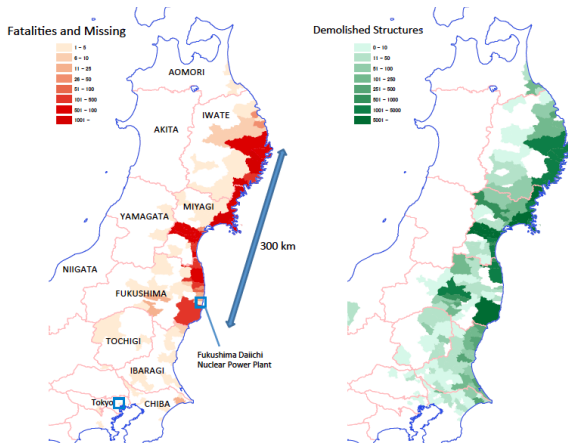
“... The presence of these invisible but nevertheless very real ties [...] reasserts itself with relentless regularity...”

Roadmap

- Lots of anecdotal evidence, but very little systematic evidence.
 - Two fundamental challenges:
 - Identifying plausible exogenous microeconomic shocks
 - Tracing the shock as it spreads over the production network
 - Today:
 - Present evidence in the context of Japan's 2011 Earthquake
 - *"Supply Chain Disruptions: Evidence from the Great East Japan Earthquake"* (with Nirei, Saito and Tahbaz-Salehi)

- Lessons (not) learned and challenges ahead
 - Private sector
 - Researchers
 - Policy makers

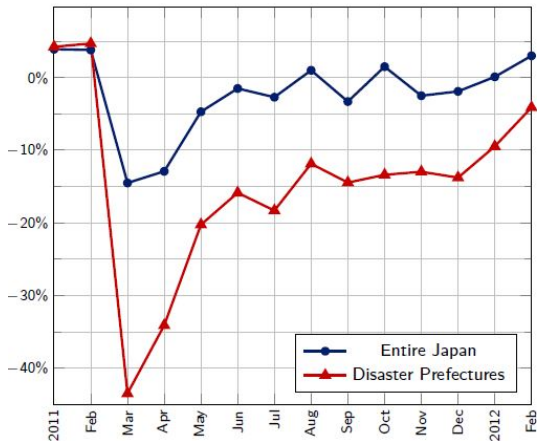
The Great East Japan Earthquake



Source: National Research Institute for Earth Science and Disaster Prevention of Japan

- March 11, 2011: Magnitude 9.0 earthquake off NE coast of Japan
- Exogenous, large and localized disruption to Japanese supply chains

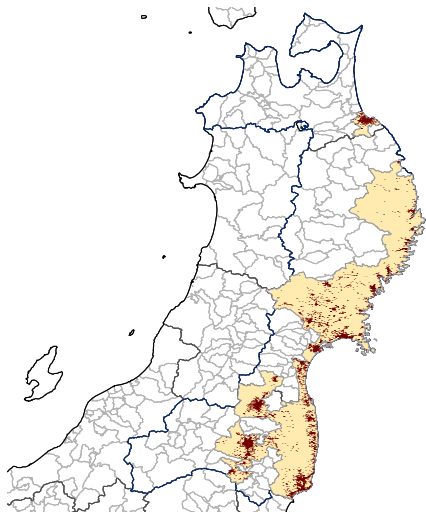
The Great East Japan Earthquake



Source: Ministry of Economy, Trade and Industry. Disaster-stricken prefectures are Aomori, Fukushima, Iwate, and Miyagi

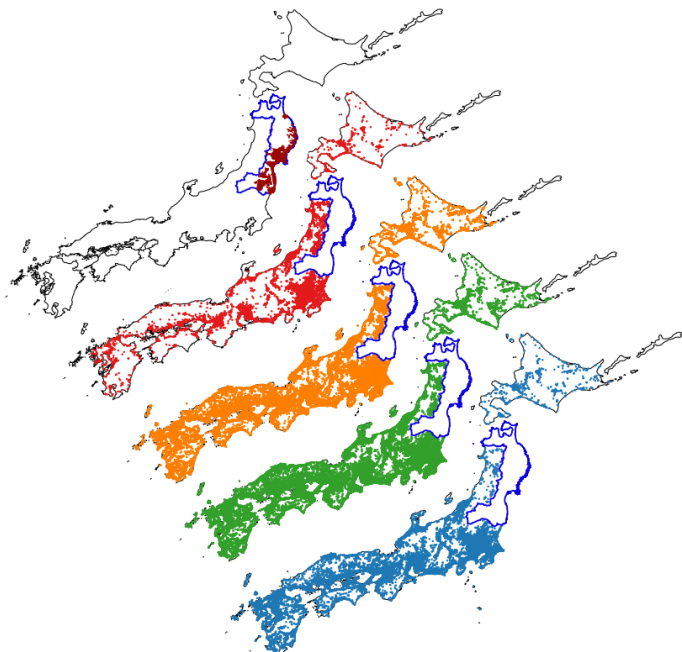
- Y-o-Y Growth rate of monthly Index of Industrial Production (IIP)
- Exogenous, large and localized disruption to Japanese supply chains

Disaster Area Firms



- Identify the “disaster area” by relying on three decrees issued by the gov.
 - ▶ the evacuation zone.
 - ▶ areas eligible for financial aid.
- Covers a total of 41 municipalities in four prefectures
- From large firm-level database, identify **Disaster area firms**:
 - ▶ firms with HQs located in this area
 - ▶ 18,728 firms
 - ▶ <3% of all firms in the sample

Four Degrees of Separation from Disaster Area Firms



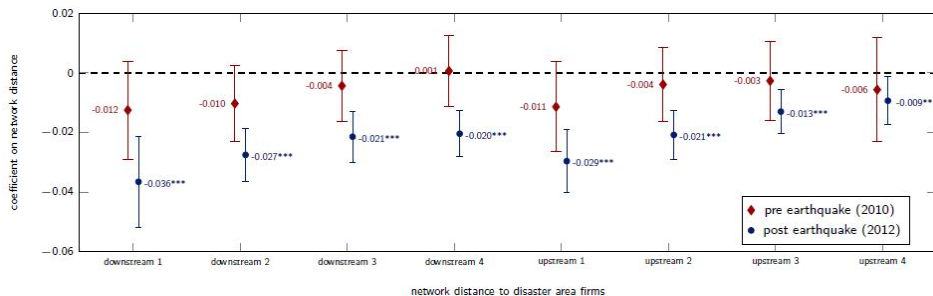
Empirical Specification

- Outcome of interest: impact of earthquake on *non-disaster area firms*, through supply chain linkages
- Construct four groups of upstream and downstream firms from disaster area firms

$$y_{ipst} = \alpha_i + \alpha_{pst} + \sum_{k=1}^4 \sum_{\tau \neq 2011} \beta_{k,\tau}^{\text{down}} \times_i^{(k)} \times \text{year}_\tau$$
$$+ \sum_{k=1}^4 \sum_{\tau \neq 2011} \beta_{k,\tau}^{\text{up}} \times_i^{(k)} \times \text{year}_\tau + \sum_{\tau \neq 2011} \gamma_\tau \times X_{isp,2010} \times \text{year}_\tau + \varepsilon_{ispt}$$

- $X_{isp,2010}$: a vector of firm-level controls

Propagation: Diff-in-Diff Coefficients



- Supply Chain Disruption: **Cascades through supply chain:**
 - Significant propagation of the shock both upstream and downstream
 - Effects decaying with network distance
- No evidence of pre-trend

Aggregation

- Earthquake effects for individual firms are *not* large.
- Effects maybe large in aggregate because it affects *many* firms
 - About 50% of firms in Japan are within 2 steps along the supply chain from disaster area firms.
 - This is a feature of production networks: they are *small worlds*.
- How large are the effects in the aggregate?
 - Japan lost 0.4% of GDP due to the earthquake.
 - This is a 3 fold magnification brought about supply chain linkages.
 - Japan historical growth rate for last 20 years: 1%.

Lessons (not) Learned: Firms

- How to build robustness in supply chains?
 - **Information** on supply chain risks
 - Who is my tier N+1 supplier?
 - **Diversification** of suppliers and production sites
 - Ensure short-run substitution possibilities.
 - **Standardization** of components
 - Reduce complexity and O-ring problems.
- Robustness comes at a cost:
 - Information gathering is costly
 - Diversification is costly and may destroy relation-specific investments
 - Standardization = less variety

Lessons (not) Learned: Research

- Production Networks literature expanded enormously *but*:
- Only recently started to consider **frictional environments**
 - Necessary to justify policy concerns about “systemic nodes” or “supply chain bottlenecks”.
 - Most of literature identifies supply chains as source of systemic risk but considers it efficient.
- Only recently started to consider **supply chain formation**
 - Theory of endogenous production networks needed to think through firms’ choices and possibly inefficiencies and externalities.
 - Necessary to understand how economy rewires after firms exit
- Extensive **Micro-data availability** still a bottleneck
 - Necessary to test and develop further theory

Lessons (not) Learned: Policy-Makers

- “We need ventilators; masks; tests... and we need them now”
- This requires policy-makers to know:
 - what are bottlenecks to the supply of individual goods?
 - i.e. production nodes that pose systemic risk, such that we cannot produce without them.
- And requires them to act. How?
 - ring-fence key supply chains?
 - ensure diversification and increased capacity?
- Problems abound:
 - **Information:** what firms are directly and *indirectly* necessary to produce good X?
 - **Policy-tools:** how exactly do we ring-fence?
 - **Justification:** what exactly are the externalities and market failures we are correcting for?