Large-scale Structure of Nationwide Production Network in Japan: A brief review on stylized facts

Speaker:

Yoshi FUJIWARA

Graduate School of Information Science, University of Hyogo

Abstract:

Japan possesses enormous data that is exceptionally rare worldwide. This valuable data has been collected over many years by a private credit research companies which have been investigating and providing information on the creditworthiness of suppliers and customers from various perspectives. In particular, they have accumulated data on production networks at a nationwide scale with nodes representing firms and binary edges representing business relationships of suppliers and customers. The number of nodes exceeds a million and the number of links exceeds several millions. In addition, financial data such as industrial classification, geographical regions, firm size quantified by number of employees, sales, and profit are included as attributes, as well as bankruptcies including chained failures on the production network.

Completely recording enormous transactions between firms would be nearly impossible. However, to understand macro-level economic phenomena, data that are important to the firms, such as vital trading partners and the amounts of money being traded, is crucial. This is just like how understanding the relationships within an entire society requires research on the key friends and communications of each individual.

I would like to review stylized facts that have been uncovered by employing such data in Japan in collaboration with researchers, including the following:

- The production network, similar to many economic networks, exhibits a long-tailed distribution for the number of suppliers and/or customers of each firm, often characterized as "a few giants and many dwarfs", often leading to significant network effects.

- The network characteristics of each firm are closely related to the attributes of the economic entity, such as its size, industry, and region, leading to a heterogeneous network structure with clusters or communities.

- When the flow of goods and money is represented as a directed graph, a distinct bow-tie structure emerges, consisting of a giant core component and its upstream and downstream components. The Helmholtz-Hodge decomposition, a discrete mathematical technique, is useful for quantifying the position of a node within the

upstream or downstream components and extracting circular flows.

- Large-scale simulations are gradually revealing the role these structures play in the propagation of economic shocks, such as those caused by natural disasters and epidemics.

- It would be interesting to note that firms growth dynamics has two different regime; large firms (usually hubs in the network) obey the so-called Gibrat's law of proportionate effect, in other words, the growth rate is statistically independent of the firm size, while small firms (often suppliers common to hubs in the network) has growth, the variation of which becomes larger for smaller firms. The origin of this fact is an unresolved problem as far as I know.