

Modeling Chained Failures on Large-scale Economic Networks in Japan

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Abstract

We will talk about recent studies based on real data of propagation of financial failures in the past financial crises and the present one due to the earthquake at nation-wide scales in Japan. The Bank of Japan and several leading credit research agencies in Tokyo have accumulated a huge amount of data regarding interbank, banks-firms, supplier-customer and so on for two decades or more. By using such large-scale data, we will measure the actually occurred propagation of financial distress on the real data of large-scale economic networks comprising of firms, banks, and their relationships at the order of millions and even more.

Keyword: economic networks, graph algorithm, debtrank, super-computer

Background and Summary

Recent availability of big data on economic systems gives us to quantify and model previously unknown aspects how economic agents are depending on each other in complex networks at a nation-wide or global scale. Without proper knowledge on such dependencies, it is impossible to understand financial instability and systemic risk that had brought and will potentially cause disastrous influences on societies.

Crucial aspect of economic network is creditor-debtor relationships among banks, firms, household and the government. There are different layers in the network. One layer of the network is an arena of real economy, namely supplier-customer links among firms as nodes[1]. The firms activities are financed from financial institutions as well as directly from financial markets. The layer of supplier-customer network is thus linked to another layer of financial network between firms and banks[2]. Furthermore, the banks are also creditors and debtors of themselves comprising another layer of inter-banks network.

In this talk, we shall study chained failures on such networks by using exhaustive list of bankruptcies and defaults of firms and banks on the networks. Focused is how one can measure and model chained failures, as endogenous propagation on the economic networks, which were caused by exogenous shocks such as the Lehman shock and the natural disaster of the Earthquake in Japan.

For the measurement of chained failures on the supplier-customer network, we find that there is a long-time relaxation process which is similar to what is know by modified Omori law in statistical seismology.

We also perform the simulation of financial stress on the large-scale network by using a graph-search-like methodology of DebtRank and employing super-computer resources of our Graduate School and the Discrete-Event Simulation Research Team, RIKEN AICS.

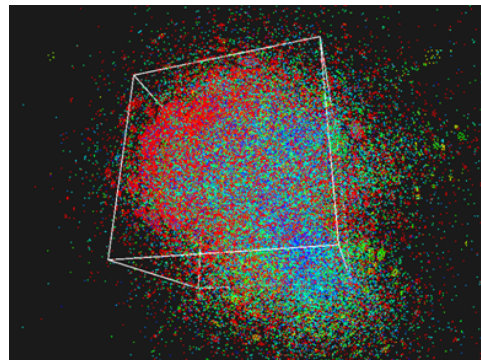


Figure1: DebtRank calculation for manufacturing sector (0.12 million firms). Different colors indicate how much each node's failure causes financial stress in the system.

References

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