Methodological Framework for Evaluating Risk levels of Cascading Failures of the Global Network and Innovation of the Industry Structure of Countries

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Abstract

The recent economic crisis has shown that different economic sectors are interconnected. The importance of evaluating potential risk levels of the crisis has been increasing but the methods quantifying vulnerabilities of complex systems have not been developed. Using worldwide Input-Output table during the period 1995-2011, we simulate a collapse of an industry in a given country. The discontinued cash flow from the collapsed industry causes other industries' failures when the cash inputs are under a tolerance level. The critical tolerance levels at the cascading failure sensitively describe the status of the industry network. Using these measures, we show the evolution of the importance of the countries and mention innovation of the industry structure of countries.

Keyword: Global Industry Networks, Risk, Cascading Failures, Industry Structure

1. Methodological Framework

Using the Input-Output table of N industries (nodes), it is possible to construct a directed product supply network. We simulate a collapse of an industry as follows.

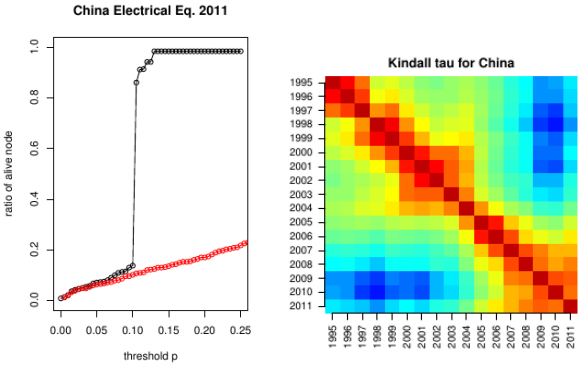
$$n_i(s+1) = \theta\left(\sum_{j=1,N} x_{i,j} n_j(s) + d_i n_i(s) - (1-p)\right)$$

Here, $x_{i,j}$ and d_i are scaled elements of the table, between industries and of demand parts. $n_i(s) \in \{0,1\}$ describes the state {died,alive} of an industry at s step. $p \in [0,1]$ is the tolerance parameter and θ is the step function. This equation has two trivial solutions, 1. $n_i(s)=0$ $(\forall i)$ 2. $n_i(s)=1$ $(\forall i)$. From the initial condition $n_k(0)=0$, $n_i(0)=1$ $(i \neq k)$, the number of the alive industries $\sum_i n_i(\infty)$ shows cascading failure $p<p_c(k)$.

We use the critical tolerance threshold $p_c(k)$ to measure the importance of each industry in the global economic network.

2. Innovation of the Industry Structure

This worldwide IO table is combined by N_i industries of N_c countries ($N=N_i \times N_c$). By comparing industry order rankings of $p_c(k)$ in each country for different years, we calculate the Kendall coefficients and study the industry structure change for 17 years.



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