Chain-reaction bankruptcies on Multilayered complex networks

Hayato GOTO[*1], Hideki TAKAYASU[2,3], and Misako TAKAYASU[2]

[1] Department of Computational Intelligence and Systems Science, Interdisciplinary Graduate School of Science and Engineering, Tokyo Institute of Technology, 4259, Nagatsuta-cho, Yokohama 226-8502, Japan
[2] Institute of Innovative Research, Tokyo Institute of Technology, 4259, Nagatsuta-cho, Yokohama 226-8502, Japan
[3] Sony Computer Science Laboratories, 3-14-13, Higashi-Gotanda, Shinagawa-ku, Tokyo 141-0022, Japan

E-mail: [*]goto.h.ac@m.titech.ac.jp

The bankruptcy of Lehman Brothers in 2008 triggered off a big confusion in the worldwide economy. For example, Japan also faced one of the worst economic crises after WWII and at least 45 public firms went bankrupt caused by this collapse of a firm in the United States[1].

As for firm size distributions such as sales and number of employees, they follow power-law[1][2]; that is, firms have characteristics of complex system meaning that majority of firms are categorized as small firms. It is rare for small firms to exploit overseas markets because of lack of funds compared with big firms, they are not affected other nations' impact directly. Instead, they are considered to be influenced by local economy condition and by interaction with other local firms. In fact, the report by credit research firm in Japan says that one of the main reasons of bankruptcies is a trend of customers and investees[3].

Here, we focus on chain-reaction bankruptcies in view of complex system by analyzing the big data of Japanese business firms provided by Teikoku Databank, Ltd. As for the study of chain-reaction bankruptcies in Japan, Fujiwara et al.[4] found the heavy tail of size distribution of chain-bankruptcies was caused by non-random event. We also investigate it empirically from the viewpoint of multilayered complex networks that are consisted of inter-firm trade network and a network of firms defined by investment relation which is considered to be a key factor of robustness of network of firms.

References

[1] Hideki Takayasu, and Kenji Okuyama, "Country dependence on company size distributions and a numerical model based on competition and cooperation", Fractals 6(01), 67-79 (1998).

[2] Robert L Axtell, "Zipf distribution of US firm sizes", Science 293(5536), 1818-1820 (2001).

[3] Yoshi Fujiwara, "CHAIN OF FIRMS'BANKRUPTCY: A MACROSCOPIC STUDY OF LINK EFFECT IN A PRODUCTION NETWORK", Adv. Complex Syst. 11(05), 703-717 (2008).

[4] Yoshi Fujiwara, and Hideaki Aoyama, "Large-scale structure of a nation-wide production network", Eur. Phys. J. B 77(4), 565-580 (2010).

---

[1]http://www.tdb.co.jp/report/watching/press/pdf/p090401.pdf