Growth dynamics of complex business firms network

M. Takayasu

Advanced Data Analysis and Modeling Unit, Institute of Innovative Research, Tokyo Institute of Technology, Japan

In Japan there are about 1 million active business firms, and it is confirmed that the transac-tion relation network has a scale-free structure [1] and several non-trivial scaling relations are known to hold among quantities describing firm sizes such as annual sales, number of employ-ees and number of business partners [2]. In view of network growth we find that annihilation, creation and merger are the key processes with the clear tendency of preferential attachment with higher link nodes, and stochastic simulation of these processes produces a complex net-work structure which reproduces the basic prop-erties of real business network for the link number distribution [3]. We also show our new approaches to tune the frequency of 3-body motifs by revising the growth model [4]. Percolation properties [5] and anatomical decomposi-tion [6] are applied to quantitative description of network structure in view of rigidity by re-moval of links wither randomly or intentionally.

Money flow on the whole network is approximated by a set of equations [7] that is based on the so-called the gravity law [8]. This set of equations is already implemented in RESAS (Regional Economy Society Analyzing System) [9], which is a big-data analysis platform pro-vided by the government of Japan.

[1] T. Ohnishi, H. Takayasu and M. Takayasu, Progr. Theor. Phys. Suppl. **179**, 157 (2009).

[2] H. Watanabe, H. Takayasu, M. Takayasu, Physica A **392**, 741 (2013).

[3] W. Miura, H. Takayasu, and M. Takayasu, Phys. Rev. Lett. **108**, 168701 (2012).

[4] J. Maluck, R.V.Donner, H. Takayasu, M. Takayasu, JSTAT, to appear.

[5] H. Kawamoto, H. Takayasu, H.J. Jensen, M. Takayasu, PLoSONE, **10**, e0119979 (2015).

[6] H. Kawamoto, H. Takayasu, M. Takayasu, Sc. Rep. **7**, 163 (2017).

[7] K. Tamura, H. Takayasu, M. Takayasu, Phys. Rev. E **91**, 042815, (2015).

[8] K. Tamura, W. Miura, M. Takayasu, H. Takayasu, S. Kitajima, H. Goto, Int. J. Mod. Phys. **16**, 93 (2012).

[9] https://resas.go.jp/#/13/13101