Basin structures of a complex network with strongly biased nonlinear flow

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Abstract

Flow networks in society and in economics tend to obey gravity-type nonlinear interaction which causes strong inequality as a result. We focus on dominant flows and define main streams and basins. For given directed complex network structure we propose a simple method to extract dominant flow and drainage basin structure, and we show some analytical evaluation relating to this new method.

Keyword: Econophysics, Complex Network, Nonlinear Science, Modelling

1. Introduction

Physical view of studies on flow networks have provided universal insights to related phenomena of river dynamics, blood vessels and leaf veins. Recently, researchers extend their focus on flow in social phenomena. As a result of big data analysis of international trades[1], traffic between cities[2] and transaction between firms[3], the interaction called gravity-type interaction has been observed. The interaction is expected to be a universal rule of social network interaction.

The nonlinear relation caused by the gravity type interaction brings strong inequality among links in the network. For example, Fig.1 shows the share of transaction volume involving about 50,000 firms in the business firm data in 2011 in descending order. As known from this figure, the transaction of highest share is likely to be extremely dominant. Considering this fact, only one dominant link is essential for understanding the flow but the other small ones can be ignored.

2. Flow Analysis

We consider the fact that the link of the largest amount flow plays an important role to know the flow dynamics, and we proposed a method to extract underlying important structure

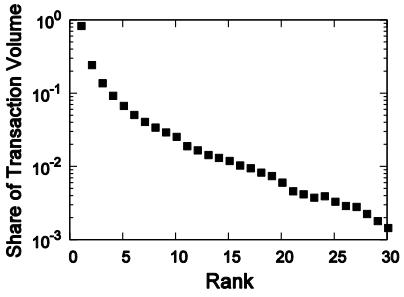

Figure 1 : The rank of share of transaction volume in 2011.

of flow on a complex network by removing small-flow-rate links.

In this study, we focus on statistical properties of extracted network structure. We show the ratio that the number of links surviving after the above removing process is important and derived the value analytically. We apply this method to a real inter-firm trading network data.

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