Using network motif analysis to characterize the international trade network

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Countries build international relationships through economic activities. Recently, international trade between countries has been studied from complex network perspective [1,2]. Complex networks have numerous patterns of connections. Subgraphs that occur significantly more often in the real network than in randomized networks are referred to as motifs, while those occurring less frequently are anti-motifs. Network motifs have attracted attention as a tool for studying directed networks [3]. To identify characteristic patterns of interactions, motif analysis is applied to the international trade network of commodity-specific trade relations between countries for years 1962-2005. We use world trade data from MIT's Observatory of Economic Complexity. This data contains trading data about more than 200 countries and 700 commodities classified according to a 4-digit level SITC code. By dropping digit from the classification, we can reduce the number of different commodity categories: there are about 70 and 10 commodity categories at 2-digits and 1-digit level, respectively. To take into account the difference in sizes and total export of different countries, we use Revealed Comparative Advantage (RCA) which measures a country exports more of commodity than the average country. The commodity-specific trade network is constructed by connecting each pair of countries with RCA larger than 1. To detect significant three-node motifs, we calculate the number of appearances of these subgraphs in real and randomized networks. The randomized networks are generated from the real network by a series of edge rewiring operations. In the operation, we randomly choose two pairs of edges and exchange the destinations of the two edges between them, keeping the number of incoming edges, outgoing edges and mutual edges of each node unchanged. Because the number of appearances of two-node subgraphs is the same in both networks, the detected significant deviation is independent of significant subpatterns. For each commodity-specific trade network, we discover that particular motifs are significantly more abundant than expected by chance. The obtained motifs characterize the country and reflect particular economic functions. These findings provide a valuable insight into the relationship between the economic function and the network structure.

[l] Y. Ikeda et al., RIETI Discussion Pap **16-E-026**, 1 (2016).

[2] Y. Ikeda et al., Proceedings of SITIS, 456 (2014).

[3] T. Ohnishi et al., J. Eco. Inter. Coord. **5**, 171 (2010).