

NETWORK FORMATION IN THE CHINA'S ENERGY STOCK MARKETS

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Overview

The energy industry index is a barometer of changes in the energy industry. Different industry indices differ in their methods of preparation, but they basically reflect the trends of the industry. As sources of energy industry indices compilation, listed energy companies play an important role in the energy financial market and commodity market. In addition, as owners of listed energy companies, shareholders can influence the transactions and decisions of listed energy, which in turn have impacts on the stability of the energy stock market. In order to study China's energy industry more comprehensively, we propose a layered approach based on complex network theory. We establish complex networks in order from the energy industry index, listed energy companies, and energy company shareholders. In the three-layers networks system, the first layer network takes the industry indices as nodes, and the second layer network takes the listed energy companies as nodes, as well the third layer network takes shareholders as nodes. In addition to the analysis of the topology of the layered networks, we have studied the clustering coefficient, modularity and evolutionary stability coefficient of networks. For the holding-based network, we find that when the economy is in a cyclical or rising state, the edges, averages degree and the stability coefficient of the nodes increase, but the modularity decreases. When the economy is in a recession, the changes in the structure of the holding-based network are reversed. Besides, the change of the weighted clustering coefficient is consistent with economic situation. This paper creates a new perspective to analyze the relationships in the energy stock market, helping us understand China's energy industry more comprehensively.

The paper is organised as follows: Section 2 introduces the data and methodologies used in this study. Section 3 presents results of the visualization of the three-layers networks, the properties of networks and the evolution of holding-based network. We discuss the relationship between network and stocks market in Section 4. Section 5 provides our conclusions.

Methods

Complex network method

Results

First, for the indices-based network, we find that although the indices are interrelated, some of them have higher impact values (degrees) than others.

Second, in the constituents-based network, all companies are linked by indices, but the weighted degree of different nodes varies greatly.

Third, for the holding-based network, the relationship between energy companies is closer (the edges and degree of the holding-based network increases), the degree of market segmentation declines (modularity declines), and the shareholding structure is more stable (stability coefficient increases) from 2009 to 2012. After 2012, the relationship between energy companies has begun to alienate (expressed as the decline in edge and degree), the degree of market segmentation increases (modularity increases), and the stability of the shareholding structure has declined (stability coefficient decreases). Until 2015, the stability coefficient of the holding-based network also rises rapidly.

Conclusions

In this paper, we study the network structure of the indices-based network, the constituents-based network and the holding-based network from the perspective of complex networks. The analysis of the indices-based network and the constituents-based network is to assist the research of the holding-based network. For the indices-based network, we find that although the indices are interrelated, some of them have higher impact values (degrees) than others. In the constituents-based network, all companies are linked by indices, but the weighted degree of different nodes varies greatly. We select the top 50 companies for equity research based on weighted degree. For

the holding-based network, we analyze the evolution of the networks structure from 2008 to 2017, and combine with the economic situation for discussion. When the economy is in a cyclical or rising state, the connections of nodes in the holding-based network gradually increase, the edges, averages degree and the stability coefficient of the nodes increase, but the modularity decreases. When the economy is in a recession, the changes in the structure of the holding-based network are reversed. Economic changes can be reflected in the properties of the network.

References

- Barrat, A., Barthlemy, M., Pastorsatorras, R., Vespignani, A., 2004. The architecture of complex weighted networks. *Proceedings of the National Academy of Sciences of the United States of America* 101 (11), 3747–3752.
- Newman, M. E. J., 2004. Analysis of weighted networks. *Physical Review E Statistical Nonlinear & Soft Matter Physics* 70 (5 Pt 2), 056131.
- Palla, G., Barabasi, A. L., Vicsek, T., 2007. Quantifying social group evolution. *Nature* 446 (7136), 664.
- Zhang, H. Y., Ji, Q., Fan, Y., 2014. Competition, transmission and pattern evolution: a network analysis of global oil trade. *Energy Policy*, 73(1), 312-322.
- Li, H., An, H., Huang, J., Huang, X., Mou, S., Shi, Y. , 2016. The evolutionary stability of shareholders' co-holding behavior for china's listed energy companies based on associated maximal connected sub-graphs of derivative holding-based networks. *Applied Energy*, 162, 1601-1607.