Research on energy stock market associated network structure based on financial indicators

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HIGHLIGHTS

• The structural similarity of stocks is described by multiple financial indicators.
• The stock associated network model based on financial indicators is created.
• Set threshold value and provide a detailed analysis of the topological features.

ABSTRACT

A financial market is a complex system consisting of many interacting units. In general, due to the various types of information exchange within the industry, there is a relationship between the stocks that can reveal their clear structural characteristics. Complex network methods are powerful tools for studying the internal structure and function of the stock market, which allows us to better understand the stock market. Applying complex network methodology, a stock associated network model based on financial indicators is created. Accordingly, we set threshold value and use modularity to detect the community network, and we analyze the network structure and community cluster characteristics of different threshold situations. The study finds that the threshold value of 0.7 is the abrupt change point of the network. At the same time, as the threshold value increases, the independence of the community strengthens. This study provides a method of researching stock market based on the financial indicators, exploring the structural similarity of financial indicators of stocks. Also, it provides guidance for investment and corporate financial management.

1. Introduction

Energy financial market is a complex system consisting of many interacting units. Energy is a core component of a country’s economic and social development [1], which is of great significance to the development of energy financial markets. In recent years, the energy stock market, which means the stocks belonging to energy industry sector in the stock market, has developed rapidly. Complex network theory is becoming a very popular theory and method to analyze the topological features and problems of stock markets [2]. In order to better promote the development of the stock market, the definition of the relationship between the stocks became a research focus point. Previous studies largely relied on the correlation [3,4], such as, Pearson and partial correlation [5–7], gray correlation [8] and price fluctuation correlation [9] between stock prices to
define the relationship between stocks. Also, some scholars paid attention to the impact of external economic and financial factors on the stock market. They discussed the government policy and monetary policy \([10,11]\), corporate performance \([12]\), stock index \([13]\) and financial indicators \([14]\) on the impact of stock prices to characterize the development of the stock market and to guide investment. What is more, some scholars studied the relationship between individual financial factors \([15,16]\) and stock prices to describe the relevance of the stock. However, the definitions of these relationships are all based on one single indicator, such as stock prices, yield or exchange rates. They are only indicative indicators of the company’s external financial performance. The value of a stock is not only indicated by the impact of stock prices, but also by many other factors, such as, co-attendance behavior of senior executive \([17]\), shareholder relations \([18]\), cross-holding relationships \([19]\), geographic locations \([20]\) and information networks \([21]\). These factors will have an impact on the capital structure of the stock market. Especially, financial indicators of listed companies can strongly prove the intrinsic value of the stock. If we depict the relationship between stocks through a series of financial indicators, we can understand the relationship of energy stock market in more detail.

The financial indicators are the relative indicators of the business summary and evaluation of financial status and operating results, which have a significant relationship with firm performance \([22]\). They can objectively and comprehensively reflect a company’s financial ability \([23]\). Financial indicators consist of a complex series of index factors, such as debt paying ability, operation ability, profitability, development capacity index \([24,25]\) and cash flow. The future profitability of the listed company is an important guarantee for the stock price rise, which represents the evaluation of the value of listed companies. However, profitability and other capabilities interact with each other to evaluate the potential benefits of Listed Companies in the future \([26]\). The previous study mainly focused on the correlation between the financial performance and stock price \([27]\), the individual financial indicator and the price \([28]\) and several financial indicators and stock return based on time scales \([29]\). Also, some scholars are concerned with the comparison of financial indicators of different enterprises, then they can observe differences in financial structure and detect financial risks or potential benefits planning \([30–32]\). The systematic analysis and evaluation of the financial indicators can help to fully understand the past and present operating results, financial conditions and changes of the enterprise \([33]\), and provide guidance to understand the present and future development of stocks and help stakeholders to make decisions. However, few studies have considered the structural differences and topological features of the stock market based on financial indicators from a holistic perspective.

The complex network has been widely and effectively used to present topological features in a holistic view. As a tool to analyze the entity structure and evolution from an overall perspective, complex network methodology is widely applied in the financial market. Furthermore, with respect to the energy market, there are many scholars focusing on the energy stock market \([37,38]\), energy trade \([39]\), listed companies \([40,41]\), etc. Also, some studied on the cross-correlations of 67 stock market indices \([42]\) and the partial correlation network \([43]\). However, stock markets and financial indicators are intricate, usually, in the analysis of complex network, the concept of threshold value was well used. The threshold value method can result in different structure of network and better detect the essence of the network. For instance, some scholars analyzed the network topology characteristics of the financial market based on the threshold method \([2,44]\), some researchers analyzed the global financial index correlation clustering network under different thresholds with stochastic matrix theory (RMT) \([45]\). Under different threshold, investors could make different investment options. And scholars have discussed portfolio choice based on the complex network and community structure \([46,47]\). In the face of a complex stock market and certain financial indicators, the threshold method eliminates the weak correlation, and the complex network better reflect the law of development of the stock market and community cluster characteristics from an overall perspective.

On the basis of the complex network research, we put forward the energy stock associated network model, whose foundation is the financial indicators of listed companies. We select financial indicator data from the financial sector of all energy companies in the Shanghai composite index of wind information. First, the data are collated and we normalize every financial indicator of each listed company to the same dimension for the empirical analysis. Second, using the formula of Pearson correlation coefficient, we calculate the structural similarity of financial indicators of every two listed company. Thus we get the structure similarity coefficient matrix. Finally, the threshold situation is set and combined with the complex network theory, the stock associated network model under different threshold values is established. By analyzing the topology of the network and the community cluster characteristics, we understand the characteristics of the current stock market and propose a quantitative approach to investment and enterprise financial management.

2. Data and methods

2.1. Data

The data used in this paper are mainly extracted from the Wind Information Database (http://www.wind.com.cn/). The selected data include the Listed Company List of all of the energy companies listed on the Shanghai composite index in 2014. The majority of the data used in this paper were collected on April 15, 2015. We select part of the financial analysis data in 2014 as sample data. Financial indicators include eight aspects, which are the share index (18 secondary indicators), profitability and earnings quality (35 secondary indicators), capital structure and debt paying ability (44 secondary indicators), operation ability (secondary indicators), growth ability (14 secondary indicators), cash flow (12 secondary indicators), DuPont analysis (9 secondary indicators) and warning Z values (7 secondary indicators).
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