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How does the coal stock market, carbon market and coal price co-movement with each other in China: A co-movement matrix transmission network perspective

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Abstract

As the global warm problem becomes more and more serious, many countries try hard to develop a low carbon economy and build a low carbon society. Along with low carbon development, the carbon market has grown up around the world. Meanwhile, as the key body of the coal industry, coal listed companies suffered a lot due to the low carbon development. As many countries, China also pay lots of effort to cut down the consumption of coal products, so as to realize the restructuring of energy industry. In this paper, we try to find out whether the China's coal stock market, carbon market and coal price co-movement with each other in a certain way. First, we defined the co-movement matrix of the coal stock market, carbon market and coal price (three indices for short) in each trading day which can show the co-movement patterns between any of the two indices. Then, based on complex network method, we took the co-movement matrices as nodes, the time adjacent relations as edges to construct the co-movement matrix transmission network, and the role of each co-movement matrix, the relations between any of the two co-movement matrices, as well as the important group of the co-movement matrix transmission network were analyzed based on different topological features. Finally, based on the results, we analyzed the co-movement relations of carbon-related markets. The method proposed in this manuscript is helpful for the researchers to find out how the low carbon development affects different markets, and it is also helpful for the investors to analyze what the co-movement patterns of different markets in a holistic perspective.

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Keywords: Co-movement matrix; Transmission network; Coal stock market; Carbon market; Coal price

1. Introduction

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As the global warm problem becomes more and more serious, many countries try hard to develop a low carbon economy and build a low carbon society. Along with low carbon development, the carbon market has grown up around the world [1]. In China, 7 Carbon emissions trading pilots had been constructed gradually since 2011[2]. Due to the low carbon revolution, the coal industry faces up to a serious situation now, and as the as the key body of the coal industry, coal listed companies suffered a lot due to the low carbon development. Meanwhile, as the most index of coal industry, coal price can show what the situation of the coal industry is obviously. So, the question is “Is there a certain way or ways that coal stock market, carbon market and coal price co-movement with each other?”

For analyzing the co-movement relations of different time series, it is common to calculate the correlation coefficients based on different methods, such as Pearson Coefficient, Granger, GARCH, etc. However, it can only shows the relations in a certain periods without presenting its inner co-movement patterns and transmission relations. The co-movement matrix transmission network is a better way to show not only the co-movement patterns of multi time series in a short term, but also the transmission features and the roles of co-movement patterns from a holistic perspective [3].

In this paper, we take China as case, try to find out the relations among China’s coal stock market, carbon market and coal price co-movement with each other. First, we defined the co-movement matrix of the coal stock market, carbon market and coal price in each trading day which can show the co-movement patterns between any of the two indices (CMM for short). Then, based on complex network method, we took the co-movement matrices as nodes, the time adjacent relations as edges to construct the co-movement matrix transmission network (CMM-TN for short) which can show both the long period relations and short term co-movement patterns [3]. Based on the CMM-TN and the topological features, we analyzed the role of each co-movement matrix, the relations between any of the two co-movement matrices, and the important group of the co-movement matrix transmission network. Finally, based on the results, we analyzed the co-movement relations of carbon-related markets, so as to find out how the low carbon development affects different markets.

2. Data and Methods

2.1. Data

There are three different series of data used in this paper, the coal price, the coal stocks price, the carbon price. Here, we used thermal coal daily future close price as coal price, which was downloaded from Wind database. Meanwhile, we used 23 coal stocks (whose data have no more than ten consecutive days absence) close price from Wind database. Besides, we chose the daily traded price of Beijing carbon market as sample data about the carbon price (<http://www.bjets.com.cn/article/jyxx/>), which is one of the earliest carbon market and with well disclosed of daily carbon price. Here, we selected the daily data from January 2014 to December 2015. Then based on Formula 1, we calculated the daily movement rate ($f_{i,t}$) of each indices price ($p_{i,t}$) (see Fig 1 to Fig 3).

$$f_{i,t} = \ln(p_{i,t}) - \ln(p_{i,t-1}) \quad (1)$$

2.1. Methods

According to Fig.1 to Fig.3, we can find that the movement features of different carbon-related indices are totally different. In order to show the daily co-movement patterns, here we defined the co-movement matrix M_t , which is a 3*3 symmetric matrix, the value of the matrix at trading day t is calculated by Formula 2. Due to the carbon market daily traded price is not available on some trading days, here, we chose the trading days according to the carbon market. Then we take each M_t as node, the time adjacent relations as edges to construct the CMM-TN. Then we take each M_t as node, the time adjacent relations as edges to construct the CMM-TN.

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