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Early warning model based on correlated networks in global crude oil markets

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Abstract

Applying network tools on predicting and warning the systemic risks provides a novel avenue to manage risks in financial markets. Here, we construct a series of global crude oil correlated networks based on the historical 57 oil prices covering a period from 1993 to 2012. Two systemic risk indicators are constructed based on the density and modularity of correlated networks. The local maximums of the risk indicators are found to have the ability to predict the trends of oil prices. In our sample periods, the indicator based on the network density sends five signals and the indicator based on the modularity index sends four signals. The four signals sent by both indicators are able to warn the drop of future oil prices and the signal only sent by the network density is followed by a huge rise of oil prices. Our results deepen the application of network measures on building early warning models of systemic risks and can be applied to predict the trends of future prices in financial markets.

Keywords: Systemic risk, Early warning model, Network density, Modularity

1. Introduction

Crude oil is a natural and non-renewable resource and plays a significant role in the development of the real economy and financial markets [1]. The collapse of the oil markets can greatly destabilize the world economy [2, 3]. Previous studies are focused on finding the endogenous and exogenous factors that affect the oil prices, such as investors' speculations and extreme events from other markets [4, 5]. For example, the recent 2008 financial crisis exhibits a great extreme risk spillover effect and leads to the crashes in oil markets. The closing price of West Texas Intermediate (WTI) crude oil price fell rapidly from \$145.31/barrel to \$41/barrel, dropped 72% within five months. This crisis has created renewed interest in systemic risk and forecasting the crisis.

Currently, few efforts have been put on proposing methods to measure systemic risk [6–10] and send the early warning signals of global crude oil markets based on correlated networks. On one hand, there is no specific definition of systemic risks, in which the contagion and destructive effect should be emphasized [9, 10]. On the other hand, systemic risks spread quickly in the global financial markets through the risk spreading channels and may result in the collapse of the financial system [11–18]. The risk spreading channels connect the financial markets or institutes and form a giant financial network. Through understanding the topological structures of financial networks, it is found that the enhancement of connectedness [11–14] or the changes of the topological structure [15–18] in correlated networks can be used to indicate the incoming financial crisis. In different financial markets, quite a few methods have been proposed to investigate the correlation-based network [19–23], such as the minimum spanning tree [24], the planar maximally-filtered graph [25], the correlation threshold or market graph method [26], and the partial minimum spanning tree and the partial planar maximally-filtered graph [27, 28].

The topological structures of correlated networks are usually associated with the co-movements of the oil prices, which could be originated from the hypothesis that the global crude oil markets are unified as “one great pool” [29] or that the crude oil markets are regionalized [30]. However, here we show that the co-movements of oil prices can be

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