The mutual causality analysis between the stock and futures markets

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HIGHLIGHTS

• Conditional Granger causality performs better in revealing asymmetric correlation.
• Direct information flows from stocks to futures are significantly greater.
• Conditional Granger causality could be used to detect the important events.
• Direct information flows are significantly less than the information flows.

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ABSTRACT

In this paper we employ the conditional Granger causality model to estimate the information flow, and find that the improved model outperforms the Granger causality model in revealing the asymmetric correlation between stocks and futures in the Chinese market.

First, we find that information flows estimated by Granger causality tests from futures to stocks are greater than those from stocks to futures. Additionally, average correlation coefficients capture some important characteristics between stock prices and information flows over time.

Further, we find that direct information flows estimated by conditional Granger causality tests from stocks to futures are greater than those from futures to stocks. Besides, the substantial increases of information flows and direct information flows exhibit a certain degree of synchronism with the occurrences of important events.

Finally, the comparative analysis with the asymmetric ratio and the bootstrap technique demonstrates the slight asymmetry of information flows and the significant asymmetry of direct information flows. It reveals that the information flows from futures to stocks are slightly greater than those in the reverse direction, while the direct information flows from stocks to futures are significantly greater than those in the reverse direction.

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1. Introduction

Information flow is a hot topic for theoretical researches and practical applications in complex systems. By definition, information flow is characterized by interaction among different objects. Previous studies proposed numerous methodologies to estimate information flows. Haythornthwaite [1] estimated the information flows by resource exchanges

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and revealed the directions in which information or resources flowed. Those types of social networks intuitively exhibit the information delivery, whereas they are challenged for the interaction among different objects in deeper levels.

Alternatives were proposed by scholars to estimate information flows. Cheung et al. [2] estimated information flows by Granger causality tests to analyze patterns of information flows between Eurodollar spot and futures markets, and finally uncovered the impact of information conveyed by futures data on market price movement. Gabjin et al. [3] investigated the information flows among industrial sectors in the Korean stock market by symbolic transfer entropy (STE) methods, and found that the information flows during the financial crisis were greater than those in pre-crisis and post-crisis periods. The above-mentioned two methods, the Granger causality test and the transfer entropy, both have their limitation as they are applicable to pairwise causality, and were proved equivalent by Barnett et al. [4] under Gaussian situation. Yao et al. [5] studied the industrial energy transferring paths by minimal spanning trees in pre-crisis and post-crisis periods, potentially revealing how the information flows influenced the industrial risk contagion on industrial upgrading and transformation. However, the scope of above studies is in one complex system.

In the field of finance, the price discovery between stock markets and futures markets is the stepping stone for securities investment [6,7]. In reality, the presence of futures accelerates arbitrage trading, and thereby reduces the volatility of the stock market. The high leverage of stock index futures increases the participation of funds, and boosts the liquidity of the stock market. The presences of hedging tools provided by stock index futures push agents to invest, and increase the volume of the stock market. The futures price movement is closely bound up with spot stock prices, as the agreed price of a stock index futures contract is based on the price of underlying asset. Thus it is worthwhile to study the relationship and information flows between stock markets and futures markets.

Based on the inefficiency of capital markets, many works have interpreted how stock index futures and spot goods influence each other in global markets. Chan [8] and Tse [9] successively investigated S&P 500 index and futures, and both found the leading trend of futures. Ding et al. [10] made theoretical analysis on the influence of the launch of stock index futures on stock prices in American, European, Chinese and Japanese markets. Comparably, Zakaria et al. [11] investigated the daily data of the Malaysian stock market and showed the unidirectional causal relationship from the cash market to futures market. Similar results were obtained in the studies of FTSE 100 and Nasdaq 100 [12–15]. The literatures above explored the lead–lag relationship between spots and futures from global markets, whereas they excessively focused on overall influence without considering time scales. Thus further studies set out to investigate how the lead–lag relationship between spot markets and futures markets evolved over time. Fang et al. [16] analyzed the short-term and long-term influence from stock index futures to stock market volatility. Furthermore, Gong et al. [17] used both parametric and non-parametric methods to study the relationship among China Securities Index 300 (CSI 300), Hang Seng Index (HSI), Standard and Poor 500 (S&P 500) Index and their associated futures. Their findings quantitatively supported the leading trend of index futures. In their studies, the non-parametric method showed how the lead–lag relationship changed over time. Illuminated by their works, we take time scales into consideration.

To quantify the degree of market imperfection, some scholars highlighted the concepts of information flows. Several studies focused on bidirectional mutual information flows between two objects. Based on the Granger causality test, Bose [18] discovered the information flows from the Indian futures market to stock market were slightly greater than the information flows from the spot market to futures market. Kwon [19] also found the asymmetric information flows between the stock indexes and component stocks in Australia, Canada and China markets. Despite burgeoning literatures about information flows, still few works focus on the correlation among several complex systems, in which each complex system has many objects. Thus considering different complex systems, Kim et al. [20] showed that the information flows between some fund performance indicators (FPI) and the Korean stock market increased sharply when great events happened. And information flows between the Korean fund market and the Korean stock market were significantly positively correlated with the market volatility. However, these studies were mostly based on the Granger causality test.

Motivated by these previous studies, we follow the thoughts of the information flow and causal relationship to study the interaction between the Chinese stock market and futures market. Unlike previous studies on information flows among financial objects, we employ the conditional Granger causality model to study the information flow between the stock and futures markets, and compare it to the Granger causality model [21]. Since the Granger causality model cannot detect whether the interaction is direct or mediated by other objects, the conditional Granger model serves as the supplement of the Granger causality model to distinguish the direct causality from the indirect, and hence it has been widely used in the field of neuroscience [22–24]. Concerning few applications of the conditional Granger causality model in the financial field, we think it meaningful to reveal the direct causal relationship of financial objects. As an extension of the Granger causality model, the conditional Granger causality model can serve as a benchmark to investigate their difference in relationship mining. We also try to adopt dynamic thinking to study the evolution of the causality between the stock and index futures markets. Based on Granger and conditional Granger causality models, the information flows are subdivided into direct information flows and indirect information flows.

The rest of this paper is organized as below. In the next section, we describe the time series data used in the models. In Section 3, we describe the models used in this paper. In Section 4, we present the empirical results obtained with different models. Finally, we provide conclusion of this paper.
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