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Asymmetric MF-DCCA method based on risk conduction and its application in the Chinese and foreign stock markets

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HIGHLIGHTS

- Asymmetric MF-DCCA method based on different directions of transmission is proposed.
- The simulation results of DMF-ADCCA method are discussed.
- Asymmetric DMF-DCCA method is applied to the analysis of the stock markets.
- Nonlinear Granger causality test is employed to Chinese and foreign stock markets.

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ABSTRACT

The acceleration of economic globalization gradually shows the linkage of the stock markets in various counties and produces a risk conduction effect. An asymmetric MF-DCCA method is conducted based on the different directions of risk conduction (DMF-ADCCA) and by using the traditional MF-DCCA. To ensure that the empirical results are more objective and robust, this study selects the stock index data of China, the US, Germany, India, and Brazil from January 2011 to September 2014 using the asymmetric MF-DCCA method based on different risk conduction effects and nonlinear Granger causality tests to study the asymmetric cross-correlation between domestic and foreign stock markets. Empirical results indicate the existence of a bidirectional conduction effect between domestic and foreign stock markets, and the greater influence degree from foreign countries to domestic market compared with that from the domestic market to foreign countries.

1. Introduction

In recent years, the economic exchanges between countries have become frequent and close because of the acceleration of finance unity accompanied by the economic globalization. As a barometer of the national economy, the stock index has gradually presented the linkage. Although a certain gap between developed countries and financial system needs to be addressed, the influence of China, India, and Brazil as representatives of the emerging countries has been increasing and their stock markets have been presenting certain linkage characteristics with developed countries. However, economic linkage

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will also lead to financial risk. Boyer et al. [1] concluded that local financial risks can be expanded or diffused because of the existence of the risk conduction phenomenon. Moreover, the risk of transmission exists not only in each financial market in one country, but also in the markets of different countries. The Asian financial crisis of 1997 and the 2008 subprime mortgage crisis are two typical examples. Another fact that cannot be ignored is the absence of a unified paradigm for the mutual effects of the financial markets that reflect economic development. For example, affected by many factors, such as economic and political positions, the financial impact of the US on the Chinese financial markets is obviously bigger than its impact on the US financial markets. Furthermore, market movements are often stronger during the rise and fall associated with global financial turmoil, and the stock market of developing countries appear relatively independent of the developed countries during generally stable periods. This phenomenon has something to do with the rapid economic development of developing countries. Therefore, the risk transmission of domestic and foreign financial markets may have asymmetric characteristics.

The study of risk conduction between the stock markets at home and abroad started early. The results and methods of research have been relatively rich. Scholars in the early times mainly used the calculation of the linear correlation coefficient of the stock markets to analyze the risk of conduction effect. When using linear correlation to study the risk of transmission relationship between the markets, the changes in different periods are analyzed. For example, Baig and Goldfajn [2] studied the risk conduction effect on the stock markets of Thailand, Malaysia, Indonesia, South Korea, and the Philippines. The empirical results show the significant correlation among national stock markets during an economic crisis. However, the correlation among the stock markets is not static and the method used to depict the correlation gradually developed from static correlation coefficient into time-varying correlation coefficient. Examples of the correlations are the dynamic conditional correlation (multivariate) GARCH (DCC-MGARCH) [3,4]; the long memory VAR-DCC-GARCH model [5], and multivariate fractionally integrated asymmetric power ARCH (FIAPARCH) dynamic conditional correlation (DCC) approach [6]. The Granger causality test method proposed by Granger et al. [7] is another approach that has been widely used to analyze the risk conduction effect [8–10]. The traditional methods, such as the GARCH model, VAR model, and Granger causality test, can detect the asymmetric correlation. However, most of them depend on a specific model form or the threshold value. In recent years, some scholars have proposed the nonlinear Granger causality test method [11] based on the linear Granger causality test method, which compensates for the limitation of the linear Granger causality test method. Alzahrani, Masih, and Al-Titi [12] attempted to investigate the non-linear Granger causality between the wavelet transformed spot and futures oil prices. Their findings consistently indicate the bidirectional causality between the spot and futures oil markets at different time scales and under non-linear causality assumptions. Fernandez [13] applied the nonlinear Granger causality test to examine the spillovers of the US subprime crisis to Asian and European economies and to determine the extent of the effect of the crisis on the currency and stock markets. The empirical results indicate that volatility effects partly induce nonlinear causality.

In addition, a large number of studies on the financial market exist, particularly empirical analyses of the long-range autocorrelation between stock [14,15] and exchange markets [16,17]. The results demonstrate that the stock markets and other financial markets have the nonlinear characteristics of the multifractal. Hurst index is one of the commonly used methods to measure the long-range correlation of the financial time series. Numerous methods to estimate the Hurst value of the time series are available as long as the fractal exists. The rescaled range Hurst analysis (R/S) introduced by Hurst [18] in 1951 is an early scaling method used to estimate the power-law correlation exponents from random signals. However, the R/S statistic is sensitive to short-range correlations and presents a biased evaluation of the Hurst exponent if the time series is short [19,20]. Peng et al. [21] proposed the detrended fluctuation analysis (DFA) when they studied the correlation of molecular chains in deoxyribonucleic acid (DNA). The DFA method avoids the spurious detection of apparent long-range correlations that are artifacts of patchiness. The DFA method has been proven to more advantageous than R/S statistics in terms of estimating the Hurst exponent, especially for short time series [22]. However, one Hurst exponent, that is, monofractal, can hardly describe the multi-scale and complex structure of fractals in the financial time series. As an extension of the DFA, Kantelhardt et al. [23] proposed a multifractal DFA, which can be used to investigate the multifractality in nonstationary time series. Since then, the DFA and multifractal DFA methods have been extensively used in the measurement of long-range correlation of financial markets [24,25]. Moreover, Podobnik and Stanley [26] introduced the DFA method in the analysis of two non-stationary time series and called it the detrended cross-correlation analysis (DCCA). In addition, Zhou [27] proposed the multifractal detrended cross-correlation analysis (MF-DCCA or MF-DXA) to reveal the multifractal characteristics of two cross correlations of non-stationary time series. Concerning MF-DCCA, there are also several versions including the MF-X-DFA [27] based on the DCCA [26], the MF-X-DMA [28] based on MF-DMA [29] and DMA [30], MF-HXA [31], MF-XPF [32–34], MF-CCA [35,36], and MF-DPXA [37]. Besides MFDFA or MF-DCCA, there are other tools such as wavelet transform modulus maxima (WTMM) and maximum overlap wavelet transform (MODWT) that can be applied in the multifractal analysis of time series [38,39]. Since then, these methods have been widely utilized in the analysis of the cross correlation of time series, including stock and future markets [40–44].

Alvarez-Ramirez, Rodriguez, and Echeverria [45] proposed the asymmetric detrended fluctuation analysis (A-DFA) as an extension of the DFA method to detect the asymmetry scaling behavior of time series. Cao et al. [17] employed the A-DFA method to explore the asymmetric multiple scaling behavior of the Chinese stock market, and the empirical results show that the degree of multifractality of the rising trend in the Chinese stock market is stronger than the downward trend. Moreover, the correlation of the asymmetry is obvious in the large fluctuation and the occurrence of major events will increase the asymmetry of the stock market. Subsequently, the MF-ADCCA method was proposed by Cao et al. [41]