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Efficiency and cross-correlation in equity market during global financial crisis: Evidence from China

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HIGHLIGHTS

- We examine market efficiency and cross-correlation of Chinese equity markets during crisis.
- We detect time-varying market efficiency of equity markets.
- Long-term dependence between equity markets varies with time scale.
- We find existence of contagion and absence of interdependence during crisis.

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ABSTRACT

Using one minute high-frequency data of the Shanghai Composite Index (SHCI) and the Shenzhen Composite Index (SZCI) (2007–2008), we employ the detrended fluctuation analysis (DFA) and the detrended cross correlation analysis (DCCA) with rolling window approach to observe the evolution of market efficiency and cross-correlation in pre-crisis and crisis period. Considering the fat-tail distribution of return time series, statistical test based on shuffling method is conducted to verify the null hypothesis of no long-term dependence. Our empirical research displays three main findings. First Shanghai equity market efficiency deteriorated while Shenzhen equity market efficiency improved with the advent of financial crisis. Second the highly positive dependence between SHCI and SZCI varies with time scale. Third financial crisis saw a significant increase of dependence between SHCI and SZCI at shorter time scales but a lack of significant change at longer time scales, providing evidence of contagion and absence of interdependence during crisis.

1. Introduction

Since the establishment of Chinese equity market in the 1990s, it has developed rapidly and overtook Japan to become the world's second largest equity market in 2014. Despite an astonishing spike of the stock index, Chinese equity market is still not mature and not completely open to foreign investors. Unique features of Chinese equity market include non-tradable shares of state-owned enterprises, lack of short-selling mechanism and majority of individual investors [1–4]. In consideration of its unique features, it is meaningful to explore the microstructures of Chinese equity market, which concerns how prices either diverge from, or converge to long-term equilibrium. We seek to investigate the market efficiency and cross-correlation between Shanghai and Shenzhen equity market before and during financial crisis. In this paper, we adopt the framework of the Fractal Market Hypothesis (FMH) [5] and the tool of Hurst exponent to capture the properties of Chinese equity market.

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Chinese incredible economic growth has aroused attention from all over the world, however, its equity market is still unable to serve as the sound and well-functioning financial system, thus many empirical literatures are devoted to investigating its market efficiency [6–10]. According to FMH, Hurst exponent as a measure of long-term dependence is used to evaluate the market efficiency. An inefficient market demonstrates long-term dependence, which can be proved by Hurst exponent diverging from 0.5. Hurst exponent has been widely applied to undeveloped financial markets in emerging economies, including stock indices, exchange rate, interest rate and bond indices [11–14]. In consideration of Hurst exponent, fractal dimension and entropy, Efficiency Index is introduced to comment on market efficiency after controlling of different inefficiency sources [15–17]. Moreover, FMH is constructed on the general characteristics of market turbulence, discontinuity and non-periodicity [18]. FMH associates market stability with liquidity, which provides smooth pricing process in the market [19]. A stable market provides liquidity by matching investors at different investment horizons [20]. If market loses its fractal structure and specific investment horizon dominates, extreme events may happen [21,22]. Therefore FMH possesses advantages on analyzing equity market efficiency during turbulent periods, which is ignored by the Efficient Market Hypothesis (EMH) [23].

Using Hurst exponent, empirical literatures have investigated equity market efficiency in the context of market crash. Grech and Mazur [24] investigated the Dow Jones Industrial Average (DJIA) index during 1929 and 1987 crashes and found local Hurst exponent of DJIA dropped significantly before any crash. Similar conclusions were reached by Grech and Pamuła [24]; Kristoufek [25]; Domino [26] on Warsaw Stock Exchange Index and Prague Stock Exchange Index. Cajueiro et al. [27] found that the collapse of Greek equity market in turbulent periods was accompanied by an increasing local Hurst exponent to value above 0.5. Kumar and Deo [28] confirmed these findings via investigating 20 global financial indices during 2008 global financial crisis. In contrast to Cajueiro, Kristoufek [19] detected a declining trend of the local Hurst exponent of the DJIA, NASDAQ and S&P500 returns during the Subprime crisis, namely lower than 0.5. Kristoufek [19] explained that investors at shorter investment horizons traded more frequently than those at longer investment horizons during crisis, which led to a lack of liquidity. Horta et al. [29] analyzed the dynamics of Hurst exponent of equity market in Belgium, France, etc. in the context of the Subprime and the European debt crisis. After a statistical test based on standard Gaussian distribution, they identified a significant increase in correlation between the local Hurst exponents during 2008 crisis, while the increase in correlations during 2010 crisis period was less intense.

Based on Hurst exponent, empirical researches have examined the market dynamics of equity markets during financial crisis. Different methods were employed for calculating Hurst exponent: the rescaled range (R/S) analysis [30], the fluctuation analysis (FA) [31], the detrended fluctuation analysis (DFA) [32], the detrended moving average analysis (DMA) [33], the generalized Hurst exponent approach (GHE) [34] and their variants. In this paper, we adopt not only DFA but also the detrended cross correlation analysis (DCCA) [35] to investigate market efficiency between equity markets. Methods proposed by econophysicists will provide extra insights into Chinese equity market in the context of market crash. In addition, majority of empirical literatures conduct a statistical test based on Gaussian process [36]; however, it may miss the properties of original time series because the returns series is not normally distributed. Barunik and Kristoufek [37] concluded that the degree of fat-tail and length of time series determine confidence interval of estimated Hurst exponent. Therefore we carry out the statistical test via shuffling method [37], which keeps the fat-tail distribution of original return series.

There are two major stock exchanges in China: the Shanghai Stock Exchange, established on December 19, 1990; the Shenzhen Stock Exchange, established on April 3, 1991. Some empirical literatures have investigated reciprocal influences between the Shanghai Composite Index (SHCI) and the Shenzhen Composite Index (SZCI). Using the bivariate GARCH model, Tsui and Yu [38] demonstrated that conditional correlation between SHCI and SZCI was not constant. In order to find the influence of the Asian crisis on SHCI and SZCI, Groenewold et al. [39] carried out the Granger test in two sub-periods and showed existence of two-way causality in the pre-crisis period while lack of causation in either direction in the crisis period. Considering the cluster around the tail of time series, Wen and Liu [40] introduced a new correlation coefficient Co based on geometrical derivation of copula function and reported a highly positive interdependence between SHCI and SZCI. Using cointegration analysis, Lin et al. [41] reported that SHCI and SZCI were cointegrated and the integration between Shanghai market and Shenzhen market tended to get closer both in the short term and in the long term.

Although previous empirical researches have examined the cross-correlation between SHCI and SZCI for one or at most two time scales (the short term and the long term) and employing different econometric methods (e.g. Pearson cross-correlation coefficient, cointegration theory or the vector autoregressive model), little is known about how Shanghai and Shenzhen equity market co-move over time scale, especially in turbulent periods such as financial crisis. We re-examine the cross-correlation between SHCI and SZCI at different time scales based on the detrended cross correlation coefficient proposed by Zebende [42]. It will make a complementary contribution to the current empirical researches on cross-correlation between Chinese equity markets.

Our empirical analysis endeavors to answer the following questions: (a) Did the efficiency of SHCI and SZCI change with the advent of financial crisis? (b) Did the interdependence of SHCI and SZCI change over time scale? (c) Did the cross-correlation between SHCI and SZCI change with the onset of financial crisis?

Using the one minute high-frequency data of SHCI and SZCI from January 1, 2007 to December 31, 2008, empirical evidences revealed three findings. First we detected a time-varying market efficiency of SHCI and SZCI. Second the long-term dependence between SHCI and SZCI varies over time scale. Third positive cross-correlation increased significantly at shorter time scales with onset of financial crisis, while no significant change was found at longer time scales.