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The influence of trading volume on market efficiency: The DCCA approach

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HIGHLIGHTS

- Investigation of cross-correlation between market efficiency and trading volume.
- DCCA coefficient is applied to analyse degree of correlation.
- Weak cross-correlation between market efficiency and trading volume is found.

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ABSTRACT

For a single market, the cross-correlation between market efficiency and trading volume, which is an indicator of market liquidity, is attentively analysed. The study begins with creating time series of market efficiency by applying time-varying Hurst exponent with one year sliding window to daily closing prices. The time series of trading volume corresponding to the same time period used for the market efficiency is derived from one year moving average of daily trading volume. Subsequently, the detrended cross-correlation coefficient is employed to quantify the degree of cross-correlation between the two time series. It was found that values of cross-correlation coefficient of all considered stock markets are close to 0 and are clearly out of range in which correlation being considered significant in almost every time scale. Obtained results show that the market liquidity in term of trading volume hardly has effect on the market efficiency.

1. Introduction

Informational efficiency of financial markets or, as usually referred, just market efficiency emphasises the role of information on setting prices [1,2]. More specifically, the efficient market hypothesis (EMH) states that the information arriving to the market is quickly incorporated and correctly reflected in the security prices. This implies that the existence of autocorrelation between distant observations is not allowed as it would violate the assumption and past prices could be used to predict future prices. The existence or non-existence of long-distance correlation has been a topic of debates among academicians and financial professionals especially by portfolio managers and analysts who try to generate higher returns [3]. By now, there is a large amount of work in the literature testing for long-range dependence and the global and local (time-varying) Hurst exponents are by far the most widely used parameter characterising the long-term memory and have been calculated by several different methods [4]. Recently, Barkoulas and Baum [5], using the spectral regression method, found some evidence of long-term memory for returns of five US stocks while Carbone et al. [6], using the detrending

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moving average (DMA) technique, found long-term memory in German stock and sovereign bond market. Podobnik et al. [7] showed that financial time series of index returns and their magnitude of 10 European transition economies exhibit long-range auto-correlation. Cajueiro and Tabak [8,9] employed a rolling sample approach to estimate median Hurst exponents and ranked efficiency for emerging markets. Moreover, they found that long-range dependence for stock returns of emerging markets is time-varying and the efficiency of nearly all emerging markets seems to get higher and higher on average, [10]. In addition, Cajueiro et al. [11] reported that financial market liberalisation could increase market efficiency of the Athens stock exchange. Likewise, Alvarez-Ramirez et al. [12] used detrended fluctuation analysis to investigate the time variation of the efficiency of US stock markets and found that they have become more efficient after the end of the Bretton Woods system. Furthermore, Bariviera et al. [3] examined sovereign and corporate bond indices of European Union countries and found that the financial crisis had a larger effect on the market efficiency of the corporate than the sovereign bond markets. They also found that the financial crisis has uneven effects on the market efficiency of all corporate bond sectors [13].

Noticeable developments in related directions should also be mentioned here. First, a generalised Hurst exponent approach has been used by Di Matteo and co-workers [14–16] to study scaling properties of developed and emerging markets. They argued that deviations from efficiency are associated with the degree of development. On the other hand, Zunino et al. [17] demonstrated that, using the multifractal detrended fluctuation analysis (MF-DFA), the multifractal degree may be employed to characterise the stage of market development. MF-DFA has also been applied to study the efficiency of the stock market efficiency by Rizvi et al., [18] and, based on the empirical results, the impact of the stage of market development has been pointed out. In a recent series of papers, Kristoufek and Vosvrda [4,19,20] introduced a new measure, the Efficiency Index (EI), for capital market efficiency by utilising long-term memory, fractal dimension and approximate entropy as input variables and applied it to 38 stock market indices across the world with the conclusion that the most efficient markets are in the Eurozone. In addition, they applied the method to 25 commodity futures and found that energy commodities are the most efficient while the last are about livestock [20].

Another issue of importance in relation to the market efficiency is the role of liquidity. This issue has been received more attention recently and is arguably unsettled [21–24]. Although enough liquidity might be an important condition supporting the EMH but it is not even part of the hypothesis by itself. Contrarily, liquidity is essential for the account of market stability in the fractal market hypothesis (FMH) [25,26]. Cajueiro and Tabak [8] noted the positive relationship between market efficiency and liquidity. They further examined the Chinese stock markets and suggested that liquidity may have an influence on the evolution of the Hurst exponent [21]. Oh et al. [22] analysed foreign exchange of 17 countries and suggested that the markets with a large liquidity have higher market efficiency. Recently, Sensoy [23] determined market efficiency of 19 members of the Federation of Euro-Asian Stock Exchanges (FEAS) and found strong positive relationship between efficiency and market liquidity. However, Bariviera [24] indicated that the correlation between the market efficiency and liquidity in case of the Stock Exchange of Thailand (SET) is weak which seems to be in disagreement with the others. This controversy leads us to be interested in finding out whether the liquidity actually affects the market efficiency or not.

In this work, we employ the detrended cross-correlation coefficient ρ_{DCCA}, which was first proposed by G.F. Zebende [27], to test the relevance of the liquidity and market efficiency. The ρ_{DCCA} is defined in terms of the Detrended Cross-Correlation Analysis (DCCA) [28,29], which is based on Detrended Fluctuation Analysis (DFA) [30], to quantify the level of cross-correlation between two non-stationary time series. It has been widely used in recent years [31–34] and has been applied to meteorology [35] as well as to economy [36–39]. It has also been compared to the Pearson correlation coefficient and has been found that, for non-stationary time series, it is superior [40]. Alternatively, the ρ_{DCCA} may be analysed by the DCCA method based on DMA [41]. Moreover, Horvatic et al. [34] have improved the DCCA method by using polynomial of varying order instead.

Of interest and in relation to this work, several multifractal analyses of the cross-correlation have been introduced. First, Zhou [33] generalised DCCA to study multifractal properties and termed the multifractal detrended cross-correlation analysis (MF-X-DFA). Then, Jian and Zhou [42] adapted detrended moving average (DMA) [43] and multifractal detrended moving average (MF-DMA) [44] to create a variant of MF-X-DFA, called multifractal detrended moving average cross-correlation analysis (MF-X-DMA). On the other hand, Kristoufek [45] introduced multifractal high cross-correlation analysis (MF-HXA) which is a generalisation of the high–high correlation of Barabasi et al. [46]. Based on joint multifractal analysis (see Meneveau et al. [47]), multifractal cross-correlation analysis using the partition function approach (MF-X-PF) was proposed by Wang et al. [48] and further generalised by Xie et al. [49]. Recently, Qian et al. [50] proposed detrended partial cross-correlation analysis (DPXA) and its families (DPXA coefficient and multifractal DPXA) in order to improve the efficiency of the DCCA method when the time series are influenced by common external forces.

The main point of this article which contributes to the literature on EMH is the study of the cross-correlation of the market efficiency and its liquidity for a single market using the detrended cross-correlation coefficient. As the market efficiency and liquidity actually evolve over time, we focus our attention on a single market to study level of cross-correlation between time series of market efficiency and liquidity. Focusing on a single market makes the degree of correlation show up much clearer than working with the market efficiency and liquidity of many markets. To do this, we apply time-varying Hurst exponent method to study the index of the market in order to obtain the time series of market efficiency. We use the moving average of trading volume as a liquidity proxy. The ρ_{DCCA} is then performed to quantify the correlation between market efficiency and liquidity. The samples employed in this study consist of closing prices and trade volumes of the 3 world leading stock markets; US, Japan, Hong Kong and also of 3 emerging markets; India, Korea and Thailand. Note that the Hurst exponent (H) is calculated from DFA method.