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Long-term correlations and cross-correlations in IBovespa and constituent companies

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HIGHLIGHTS

- Applications of DFA and DCCA analysis to the Brazilian stock market and its companies.
- The results found a long term correlation between the IBovespa and the its companies.
- The experimental results were divided by productive sectors of the Brazilian market.
- A comparison between the USA and Brazilian Markets was done.

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ABSTRACT

We study auto-correlations and cross-correlations of IBovespa index and its constituent companies. We use Detrended Fluctuation Analysis (DFA) to quantify auto-correlations and Detrended Cross-Correlation Analysis (DCCA) to quantify cross-correlations in absolute returns of daily closing prices of IBovespa and the individual companies. We find persistent long-term correlations and cross-correlations which are weaker than those found for USA market. Our results indicate that market indices of developing markets exhibit weaker coupling with its constituents than for mature developed markets.

1. Introduction

The IBovespa, the Bovespa's index is the main indicator of mean share prices in the Brazilian stock market. The method used for this index is based on the most traded financial assets in last months and current value represents the amount of cash on a theoretical portfolio. Currently, the IBovespa is comprised of fifty eight companies [1]. The behavior of IBovespa appears as a useful tool to check the level of economic stability. A volatile behavior of prices results in nervous investors, leading to slower economic growth and lower leaving standards.

Since the emerge of econophysics, the new subfield that uses methods of statistical physics to analyze financial indices [2], long-term correlations and cross-correlations in financial temporal series were extensively studied. The reported results include stock market indices, trade volume, prices of individual stocks, commodities, currency exchange rates and interest

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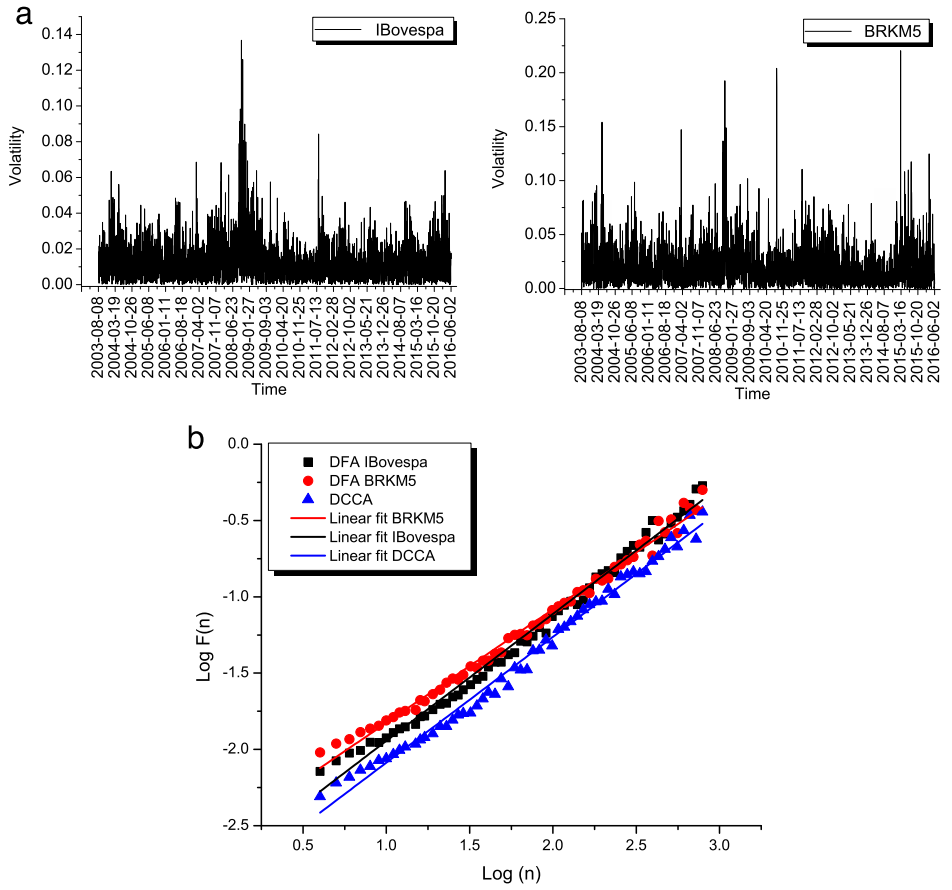

Fig. 1. DFA and DCCA analysis for Braskem (BRKM5) and Ibovespa: Temporal series of analyzed absolute returns (a) and the dependence on the window size n of the square root of detrended variance for the two series and the detrended co-variance among the series together with regression line slopes $\alpha_{BRKM5} = 0.75$, $\alpha_{Ibovespa} = 0.88$ and $\lambda = 0.83$ (b).

rates [3–12]. Cross-correlations between market indices as well as between individual stocks were studied on both the individual level (between each pair) [9,13], and on collective level considering stocks/market indices as unique complex systems [14–16].

However, much less is known about cross-correlations between a market index and its constituents. Gvozdanovic et al. [9], studied power-law cross-correlations between absolute returns of Dow Jones Industrial Average (DJIA) and each of its 30 constituent companies. They found strong persistent power-law cross-correlations with larger scaling exponents for the financial firms comprising the DJIA, than for non-financial firms. More recently da Silva et al. [17], investigated the influence of blue-chips (the top stocks, which have high liquidity, high reliability and a good reputation) on IBovespa index. They found (i) positive cross-correlation between IBovespa and these companies (ii) cross-correlations were stronger after the 2008 crisis. In order to contribute to a better understanding of relation between market index and individual stocks, in this study we extend the results of Silva et al. [17] by investigating cross-correlations between Ibovespa and 44 companies that make up this stock exchange in the period from August 08, 2003 to June 02, 2016. We use Detrended Fluctuation Analysis (DFA) method [18] to quantify the level of auto-correlations in IBovespa and in the individual stocks, and Detrended Cross-Correlation Analysis (DCCA) method [19] to quantify power-law cross-correlations between IBovespa and its constituent companies. We compare the level of cross-correlations among different sectors and draw parallel with US market [9].

The paper is organized as follows. In the following section we present the DFA and the DCCA methods, in the subsequent section we present data and the results of our analysis, and finally the conclusions are drawn.

2. Methodology

Detrended Fluctuation Analysis (DFA)

Detrended Fluctuation Analysis (DFA) was introduced by Peng et al. [18] as a method for quantification of correlations in non stationary time series [20]. Originally DFA was performed with linear detrending (DFA1), later it was extended to higher