Time-varying long range dependence in market returns of FEAS members

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Abstract

We study the time-varying efficiency of nineteen members of the Federation of Euro-Asian Stock Exchanges (FEAS – an international organization comprising the main stock exchanges in Eastern Europe, the Middle East and Central Asia) by generalized Hurst exponent analysis of daily data with a rolling window technique. The study covers the six years of time period between January 2007 and December 2012. The results reveal that all FEAS members exhibit different degrees of long range dependence varying over time. We present an efficiency ranking of these members that provides guidance for investors and portfolio managers. Results show that the least inefficient market is Turkey followed by Romania while the most inefficient markets are Iran, Mongolia, Serbia and Macedonia. Throughout the considered time period, Turkey's stable Hurst exponent around 0.5 differs from others and shows characteristics of a developed financial market. For the federation members, strong positive relationship between efficiency and market liquidity is revealed. In the light of this fact, alternatives are suggested to improve market efficiency.

1. Introduction

Market efficiency simply states that the price in the stock market reflects all the available information. According to highly controversial efficient market hypothesis (EMH) of Fama [1], when all the information about the investments is known, it is not possible for anyone to beat the market and expect returns that are above average. EMH views market prices as random thus serial correlations between observations cannot exist. While short term serial correlation is accepted by supporters of EMH, long term serial correlation is generally rejected.

The long memory in asset returns has been an intriguing subject for a long time. Starting with the study of Mandelbrot [2], many others have supported the existence of long memory in asset returns (see [3] and the references therein). The presence of such memory brings out several problems in modern finance: (i) the investors’ preferred investment horizon becomes a factor in the investment risk [4], (ii) methods used to price financial derivatives may not be useful anymore, (iii) usual tests based on Capital Asset Pricing Model cannot be applied to series that have long term memory [5,6].

This study focuses on the efficiency of the markets in FEAS. Although there is a vast amount of literature on efficiency of developed markets [7–16], less is known for the emerging ones [5,6,17–20]. In particular, there is not a market efficiency analysis on FEAS in the literature. FEAS...
was established with its headquarters in Istanbul on 1995 with 12 founding members, and it has grown to 34 members and 15 affiliate members in 28 countries as a non-profit organization. The federation states its mission as to help create fair, efficient and transparent market environments among its members and in their operating regions. It also aims to minimize barriers to trade through the adoption of best practices for listing, trading and settlement besides promoting linkages among members for cross-border trading. Upon FEAS’ rising importance in the world financial system,
in June 2009, Dow Jones Indexes launched a series of benchmark indexes based on the performance of some FEAS equity markets.

We use the Hurst exponent to measure long range dependence in FEAS members. It uses a rolling sample approach that helps us to observe the time varying degree of the market efficiency. Instead of the popular R/S statistics [21] approach, this study uses the generalized Hurst exponent (GHE) introduced by Barabasi and Vicsek [22]. It combines sensitivity to any type of dependence in the...
data and simplicity. Furthermore, since it does not deal with max and min functions, it is less sensitive to outliers than the popular R/S statistics [23].

The rest of the paper is organized as follows: Section 2 explains the methodology for analysis of long range dependence and Section 3 describes the data. Section 4 presents the results and finally Section 5 offers a brief conclusion.

2. Methodology

Several methods have been proposed to analyze the long range dependence phenomenon. In this study, we are interested in the degree of long range dependence of a given stochastic process \( S(t) \) with \( \tau = 1,2,\ldots,N \) defined over a time window \( N \) with unitary time steps [7] and we use GHE as a measure of long range dependence. It is a generalization of the approach proposed in [21] and it may be evaluated using the qth-order moments of the distribution of increments, which is a good characterization of the statistical evolution of \( S(t) \) [7,8].

\[
K_q(t) = \frac{\langle |S(t + \tau) - S(t)|^q \rangle}{\langle |S(t)|^q \rangle}
\]

where \( \tau \) can vary between 1 and \( \tau_{max} \) and \( \langle \ldots \rangle \) denotes the sample average over the time window. GHE is then defined for each time scale \( \tau \) and each parameter \( q \) as

\[
K_q(t) \propto \tau^{qH(q)}
\]

The GHE is computed from an average over a set of values corresponding to different values of \( \tau_{max} \) in Eq. (1) [25,26]. For any value of \( q, H(q) = 0.5 \) means that \( S(t) \) does not exhibit long range dependence, while \( H(q) > 0.5 \) and \( H(q) < 0.5 \) implies that \( S(t) \) is persistent and anti-persistent respectively.

3. Data

We consider trading day closing values \( P(t) \) of 19 FEAS members i.e. Bahrain (Bahrain All Share Index), Bosnia and Herzegovina (SASE 10), Bulgaria (SOFIG), Croatia (CRO-BEX), Egypt (EGX 30), Georgia (GSX), Iran (TEPIX), Jordan (ASE General Index), Kazakhstan (KASE), Macedonia (MIB 10), Mongolia (MSE TOP 20), Montenegro (MONEX 20), Oman (MSM 30), Pakistan (Karachi 100), Palestine (Al Quds), Romania (BET), Serbia (BELEX 15), Turkey (BIST 100) and United Arab Emirates (ADX General Index). For comparison purposes, all stock market indexes were started and ended at 02/01/2007 and 26/12/2012 respectively. From daily closing values, daily log-prices \( \ln P(t) \) are obtained. We use a rolling window of \( \Delta t = 252 \) observations that shift one point at a time to calculate GHE. Note that for a given time-window \( t - \Delta t + 1, t \), the relation (2) leads to the following

\[
\ln K_q(t, \tau) = qH(q) \ln \tau + C
\]

From log-prices we compute GHE following the steps in [7,25,26]: we estimate \( H(q) \) as an average of several linear fits of Eq. (3) with \( \tau \in [1, \tau_{max}] \) and \( \tau_{max} \) varying between 5 and 19 days. We take the standard deviation of the \( H(q) \) over this range of \( \tau_{max} \) as proxy for standard error of the estimates.

4. Results

In Fig. 1, the time-varying GHE for \( q = 1 \) are presented. Fig. 1 also contains the standard errors of GHE (red curves) and the line \( H = 0.5 \) (blue line) to compare the results with a theoretical efficient market.

For almost all markets, \( H(1) \) displays mixed behavior in the considered time period (varying widely for some of the countries) but in general \( H(1) > 0.5 \) i.e. FEAS members exhibit persistent long range memory. In general, there is a tendency towards efficiency in eastern European members whereas most of the markets in the middle east displays divergence from efficiency especially after the beginning of the Arabian Spring. Turkey varies from others by its stable \( H(1) \) that takes values around 0.5 which is a characteristic of a developed financial market [25]. Table 1 presents the descriptive statistic for the time-varying \( H(1) \) for all FEAS members.

In order to check whether the time-varying Hurst exponents are due to noise, we performed several normality tests (see Table 1) and the results strongly suggest that these parameters are not normally distributed. Therefore,
Table 1
Descriptive statistics of the time-varying $H(1)$.  

<table>
<thead>
<tr>
<th>Market</th>
<th>Median (distance to 0.5)</th>
<th>Market</th>
<th>Mean (distance to 0.5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bahrain</td>
<td>0.5093 (0.0093)</td>
<td>Turkey</td>
<td>0.5096 (0.0096)</td>
</tr>
<tr>
<td>Bos. &amp; Herz.</td>
<td>0.5233 (0.0233)</td>
<td>Romania</td>
<td>0.5171 (0.0171)</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>0.5245 (0.0245)</td>
<td>Palestine</td>
<td>0.5191 (0.0191)</td>
</tr>
<tr>
<td>Croatia</td>
<td>0.5430 (0.0430)</td>
<td>Kazakhstan</td>
<td>0.5322 (0.0322)</td>
</tr>
<tr>
<td>Egypt</td>
<td>0.5572 (0.0572)</td>
<td>Jordan</td>
<td>0.5600 (0.0600)</td>
</tr>
<tr>
<td>Georgia</td>
<td>0.5744 (0.0744)</td>
<td>Pakistan</td>
<td>0.5694 (0.0694)</td>
</tr>
<tr>
<td>Gulf</td>
<td>0.5746 (0.0746)</td>
<td>Egypt</td>
<td>0.5782 (0.0782)</td>
</tr>
<tr>
<td>Israel</td>
<td>0.5799 (0.0799)</td>
<td>Pakistan</td>
<td>0.5799 (0.0799)</td>
</tr>
<tr>
<td>Iran</td>
<td>0.5871 (0.0871)</td>
<td>Oman</td>
<td>0.5884 (0.0884)</td>
</tr>
<tr>
<td>Jordan</td>
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<td>Montenegro</td>
<td>0.5915 (0.0915)</td>
</tr>
<tr>
<td>Jordan</td>
<td>0.5976 (0.0976)</td>
<td>UAE</td>
<td>0.5956 (0.0956)</td>
</tr>
<tr>
<td>Bos.&amp;Herz.</td>
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<td>Bosnia &amp; Herz.</td>
<td>0.5988 (0.0988)</td>
</tr>
<tr>
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<td>0.6126 (0.1126)</td>
<td>Bulgaria</td>
<td>0.6151 (0.1151)</td>
</tr>
<tr>
<td>Macedonia</td>
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<td>Macedonia</td>
<td>0.6316 (0.1316)</td>
</tr>
<tr>
<td>Serbia</td>
<td>0.6374 (0.1374)</td>
<td>Serbia</td>
<td>0.6379 (0.1379)</td>
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<tr>
<td>Mongolia</td>
<td>0.7227 (0.2227)</td>
<td>Mongolia</td>
<td>0.6948 (0.1948)</td>
</tr>
<tr>
<td>Iran</td>
<td>0.7550 (0.2550)</td>
<td>Iran</td>
<td>0.7656 (0.2656)</td>
</tr>
</tbody>
</table>

The scatter diagram in Fig. 3 and the simple regressions obtained from ordinary least-squares estimation clearly state that there exists a positive strong relationship between efficiency and liquidity. For example, Turkey and Romania, highest ranked members in efficiency, are also ranked highest in terms of daily average liquidity proxies per stock. Our findings are in parallel with the results of Cajueiro and Tabak [29–31]. Authors reveal that liquidity plays a significant role in explaining market efficiency in Brazilian stock market [31] and major stock markets of Asia [29,30]. Combining these facts suggests that for an improvement in a market's

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10 For these rankings to be meaningful, medians must be significantly different from each other. The Kruskal–Wallis test evaluates the hypothesis that all samples come from populations that have the same median, against the alternative that the medians are not all the same. In our case, we need to perform a test to determine which pairs are significantly different, and which are not with a multiple comparison approach. The results are given in Fig. 2 and it shows that most of the pairwise medians are significantly different.

11 Trade volume, turnover and market cap data for Iran, Georgia, Serbia and Palestine is not available so we remove these markets in this part of our analysis. Similarly, the market cap and turnover data is not available for Bosnia and Herzegovina so this member is omitted in the relevant analysis.

12 See the equations in Fig. 3.
efficiency, policy makers should focus on increasing the liquidity.

5. Conclusion

Market efficiency is not easy to test or measure empirically, however, it has vital implications: In an efficient market, there is no room for fooling investors. They can pursue a buy-and-hold strategy since this will lead to the same returns on average but the net profit will be higher due to fewer brokerage commissions. Considering the creditors, an efficient market can help determining whether a company is in the solvency condition or not and it assists them to decide the most potential company to join as the debenture holders due to the available information provided.

To observe the time-varying market efficiency in the Euro-Asian region, the concept of generalized Hurst exponents has been applied to FEAS members’ daily data between 2007 and 2012 by a rolling window approach. The results show that these markets display persistent long range memory in general. Through this time period, in general, eastern European markets evolves to a less inefficient state while middle eastern members diverge from efficiency. Moreover, divergence is observed around the beginning of Arabian Spring, which possibly has a partial responsibility in this artifact.

The markets have been ranked according to their efficiency and the least inefficient market is found to be Turkey, succeeded by Romania, while the most inefficient markets are Iran, Mongolia, Serbia and Macedonia. Furthermore, by its stable Hurst exponent around 0.5, Turkey differs from others and shows characteristics of a developed market throughout the considered time period.

For FEAS member, strong positive relationship between efficiency and market liquidity is revealed. In the light of this fact, the possible suggestions to improve market efficiency are the followings: Most of the members in FEAS do not have derivative markets. Literature shows that launch of derivative assets, in general, increases the underlying market’s liquidity [32,33], thus introducing a derivative market could increase efficiency. Similarly, recent studies [34,35] reveal that making short selling difficult has an adverse effect on liquidity. In that case, lowering short sale margin requirements or removing of the up-tick rule would possibly have a positive effect on efficiency. We hope our findings would be useful for investors, portfolio managers and policy makers.

Acknowledgments

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References


