Weak Form Efficiency in Asian Markets—The Case of China, India, Malaysia and South Korea
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Abstract. This paper examines the weak form market efficiency in a group of Asian equity markets. The sample encompasses four emerging markets comprising India, China, South Korea and Malaysia. Daily, weekly and monthly market returns are estimated for a runs test and variance ratio tests. The findings are contrary to some of the previous studies that are based only on unit root tests. This study sheds new lights on the extant literature on market efficiency and has important implications for investors who seek to identify mispriced assets in order to make abnormal profits.

1. Introduction
Market efficiency is considered to be one of the significant indicators used by investors who seek to identify assets to invest in capital markets. If the market is not efficient and stock prices are not characterized by a random walk, investors would be able to gain abnormal profits from purchasing undervalued or short inflated stocks which is nearly impossible in an efficient market. It has been proposed that the implications of the efficient market hypothesis (EMH) are twofold: first, as a predictive and theoretical model for the operation of financial markets; second, it can be an effective instrument for convincing more investors to invest in the equity markets \cite{17}. Therefore, tests of market efficiency and random walks reveal how efficient the equity market is in the real world and provide an important means of capital development.

This study is warranted in light of the changing regulatory and market structures in the studied markets, which may have resulted in changes in market efficiency. Latest data will be used to look at how the use of daily, weekly and monthly price information may produce different results, as the speed of information transmission in these markets is dramatically changed comparing to even one decade ago. The main research question of this paper is to detect the random walk behaviour in the representative Asian markets, encompassing Malaysia, China (SSE composite), South Korea and India, over the period 2004-2014.

Nowadays in developing economies, stock markets are gaining more momentum and investors are seeking more profitable investment opportunities. Therefore, it is imperative to know stock market efficiency as EMH is fundamental to investor’s decision making processes. The primary reason for choosing these four countries is due to that they constitute a significant proportion of the developing markets within Asia-Pacific region. Moreover, in the aftermath of the Asian crisis, the Malaysian and the Korean stock markets are now in a phase of readjustment. Thus, this paper aims to fill the research gap by examining market efficiency during the post crisis period from 2004 to 2014. The value of this research is that it renders information to investors and analysts who are concerned with market fluctuations during normal cycles as a benchmark to detect potential market failure. It also meets the needs of investors from markets which are undergoing recovery from a crisis to plan future investment strategies and to gain an understanding of stock price volatility.

Previous studies of market efficiency for Asian stock market are often focused on a single, developed market \cite{11}; while there are fewer studies for developing markets in the recent period, and the results of these studies are mixed. This paper therefore fills the research gap by selecting a number of countries to investigate violations of the random walk between four emerging Asian markets.
The remainder of the paper is divided into four sub-sections. Section 2 contains a review of empirical literature in the area of marketing efficiency in emerging markets, including Asian markets. Section 3 discusses the methodology. Section 4 deals with the data. The findings and a discussion are provided in Section 5, which is followed by the conclusions in Section 6.

2. Literature Review

The application of the random walk hypothesis (RWH) provides insight and an understanding of the efficient market hypothesis, and it targets to test this hypothesis. For instance, a variety of tests have been employed within the RWH framework to examine random walks in Asian markets. Chakraborty used variance ratio tests, run tests and serial correlation tests to demonstrate that Pakistani stock market does not follow the random walk hypothesis [4]. By using autocorrelation tests, a runs test, PP, ADF and KPSS unit root tests, Haque et al. indicated the evidence of rejection of the random walk hypothesis for the Pakistani stock market from 2000 to 2010 [9]. By applying Lo and MacKinlay’s variance ratio test, Chang and Ting (2000) found that the random walk hypothesis was rejected in the case of the Taiwanese stock market [5]. Similarly, Mobarek and Keasey (2000) and Mobarek et al. (2008) reached the same conclusion that Bangladeshi stock market was not efficient by different means [14,15]. While Chung (2006) used both non-parametric and parametric run tests and finds that the two Chinese stock markets are not weak form efficient [6]. Kim and Shamsuddin (2008) implemented multiple variance ratio tests to examine the stock market efficiency for nine stock markets in Asia, which were classified as frontier, emerging and developed markets [10]. They reported that emerging and developed markets show weak form efficiency while frontier markets were not efficient. Worthington and Higgs (2006) investigated fifteen equity markets (includes ten emerging markets and five developed markets) for random walk by using ADF, serial correlation, KPSS unit root tests, multiple variance ratio tests and runs tests [18]. They have mixed results from the four tests which claim the all markets tested are weak form efficient at best.

In developed countries, only the stock markets of New Zealand, Japan and Hong Kong are consistent with the random walk hypothesis. Suleman et al. used monthly prices from 2004 to 2009 to examine the weak form market efficiency for fourteen Asian markets [16]. They applied unit root, variance ratio, runs, autocorrelation and Ljung-Box Q-statistic tests and find that the monthly returns in none of these markets follow random walk. Lingaraja et al. studied the stock market volatility behaviour and efficiency of eight Asian emerging market indexes [12]. They found significant evidence of market efficiency in these emerging Asian markets. Outside Asia, Al-Khazali et al. (2008), Magnusson and Wydick (2000) and Gimba (2012) reported the market efficiency of various African economies, their conclusions are predominantly weak form efficient [2,8,13].

Reviewing of literature shows that results of market efficiency are mixed and methodologically dependent. This study aims to extend the evidence of market efficiency for Asian markets in a timely manner. The most recent data for four largest emerging Asian markets: India, South Korea and Malaysia are used which are collected during the latest time period from 2004 to 2014. The results of this study contribute to updating and expanding the existing empirical results on EMH in Asia’s emerging markets. These findings will have important implications for portfolio managers who seek to redefine assets that maximize risk-adjusted returns for their members. Findings are also important for the portfolio managers for the purpose to international diversification.

3. Methodology

The random walk model is used to investigate and explain market efficiency. It indicates that the historical price of a stock or a market index cannot be used to forecast future price trends, so a stock’s price changes are independent when the market is efficient [7]. In order to examine weak form market efficiency, two methods have been employed in this study: a runs test and variance ratio test.
3.1 Runs test

The runs test is used to measure the independence of a series price change which belongs to a non-parametric test. The non-parametric runs test is valid as a tool to measure the price returns randomness. The null hypothesis for a runs test is that the series of returns are temporal independent, which means weak form efficiency. Therefore, if this series of returns follows a random walk, the expected number of runs (m) should be close to the observed number of runs (R). The following equation is conducted to estimate the expected number of runs (m):

$$m = \frac{N(N+1)-\sum_{i=1}^{n}N_{i}^{2}}{N}$$  \hspace{1cm} (1)

Where $N$ represents the observations number, $i$ denotes the sign of plus, minus and no change, and $n_{i}$ is the total amount of changes for each kind of sign. If the number of observations is larger (>30), the expected number of runs will be normally distributed approximately with a standard deviation $\sigma_{m}$, which can be estimated as follows:

$$\sigma_{m} = \left[ \frac{\sum_{i=1}^{n}n_{i}^{2} + N(N+1) - 2N \sum_{i=1}^{n}n_{i}^{2} - N^{2}}{N^{2}(N-1)} \right]^{1/2}$$  \hspace{1cm} (2)

Then, a runs test can be conducted by using standard normal $Z$-statistic as follows:

$$Z = \frac{R - m \pm 0.5}{\sigma_{m}} \sim N(0,1)$$  \hspace{1cm} (3)

Where $R$ denotes the actual number of runs and 0.5 denotes the continuity adjustment. According to Abraham et al. (2002), a positive $Z$-value will be obtained if the actual number of runs is larger than the expected number of runs; contrarily, when the actual number is below the expected one, a negative $Z$-value will be obtained [1].

3.2 Variance-Ratio (VR) test

The VR test is a commonly used tool to examine the random walk. It is based on the assumption that there is a linear relationship between random walk terms and time. The VR test is shown below:

$$VR(q) = \frac{\sigma^{2}(q)}{\sigma^{2}(1)}$$  \hspace{1cm} (4)

Where $\sigma^{2}(q)$ is the unbiased estimator of $1/q$ of the variance of the $q$-th difference and $\sigma^{2}(q)$ is the variance of the first difference. Under the assumption of homoskedasticity increments, $z(q)$ is:

$$z(q) = \frac{VR(q) - 1}{\sqrt{v(q)}} \sim N(0,1)$$  \hspace{1cm} (5)

Where $v(q) = [2(2q - 1)(q - 1)]/3q(nq)$. Under the hypothesis of heteroscedasticity increments, there is another test statistics $z^{*}(q)$ which is:

$$z^{*}(q) = \frac{VR(q) - 1}{\sqrt{v^{*}(q)}} \sim N(0,1)$$  \hspace{1cm} (6)

where

$$v^{*}(q) = \sum_{k=1}^{q-1} \left[ \frac{2(q-k)}{q} \phi(k) \right]$$  \hspace{1cm} (7)

and

$$\phi(k) = \frac{\sum_{t=k+1}^{nq}(p_{t} - p_{t-1} - \bar{p})^2(p_{t-k} - p_{t-k-1} - \bar{p})^2}{\sum_{t=k+1}^{nq}(p_{t} - p_{t-1} - \bar{p})^2}$$  \hspace{1cm} (8)

The null hypothesis for the VR test thus is $VR(q) = 1$, that is, the studied index follows a random walk. If the $VR(q)$ is larger than 1, it indicates that returns are positively correlated and leads to a rejection of the random walk hypothesis.
4. Data Description

The dataset consists of stock market indices for India, China, Malaysia and Korea. The data are daily, covering the period from January 1, 2004 to January 1, 2014. All data are obtained fromDataStream.

Table 1 lists a summary of descriptive statistics of the returns for the four market indexes. The highest mean returns are in India for daily, weekly and monthly series and the lowest mean return is in China. The standard deviations of the Malaysian market are the lowest, meaning it has lower risk than the other markets. The weekly returns of China, the daily returns of India and the daily returns of Malaysia are positively skewed with all the other data are negatively skewed. All the market returns show positive kurtosis ranging from 0.9190 to 90.2589, indicating leptokurtic distributions with extreme observations.

5. Empirical Results and Discussion

The runs test aims to test whether successive price changes are independent. The results of the runs test for the normal returns on the studied market indexes are shown in Table 2. All the z-values for successive daily, weekly and monthly returns in the Chinese market are less than ±1.96, indicating that the daily returns are not independent at 5% significance level. The weekly and monthly returns of China, the daily returns of India and the daily returns of Malaysia are positively skewed with all the other data are negatively skewed. All the market returns show positive kurtosis ranging from 0.9190 to 90.2589, indicating leptokurtic distributions with extreme observations.
monthly returns are successfully proven to be independent, which means the weekly and monthly price movements for the Malaysian stock market follow a random walk.

<table>
<thead>
<tr>
<th>No. Obs</th>
<th>Returns &lt; mean</th>
<th>Returns &gt; mean</th>
<th>Number of Runs</th>
<th>Expected No. of Runs</th>
<th>Z-statistic</th>
<th>P-value</th>
</tr>
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<tbody>
<tr>
<td>China</td>
<td>Daily 2524</td>
<td>1282</td>
<td>1253</td>
<td>1223</td>
<td>1263.2</td>
<td>-1.6006</td>
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<tr>
<td></td>
<td>Weekly 512</td>
<td>261</td>
<td>251</td>
<td>235</td>
<td>256.9</td>
<td>-1.9385</td>
</tr>
<tr>
<td></td>
<td>Monthly 119</td>
<td>62</td>
<td>57</td>
<td>69</td>
<td>59.85</td>
<td>-0.3425</td>
</tr>
<tr>
<td>India</td>
<td>Daily 2473</td>
<td>1198</td>
<td>1275</td>
<td>1173</td>
<td>1234.34</td>
<td>-2.5488**</td>
</tr>
<tr>
<td></td>
<td>Weekly 521</td>
<td>242</td>
<td>279</td>
<td>239</td>
<td>260.19</td>
<td>1.8675</td>
</tr>
<tr>
<td></td>
<td>Monthly 119</td>
<td>48</td>
<td>71</td>
<td>59</td>
<td>60.4</td>
<td>0.1383</td>
</tr>
<tr>
<td>Korea</td>
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<td>1275</td>
<td>1238</td>
<td>1235.24</td>
<td>-3.8767**</td>
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<td></td>
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<td>232</td>
<td>289</td>
<td>255</td>
<td>258.38</td>
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<td></td>
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<td>58</td>
<td>61</td>
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<td>66</td>
<td>63</td>
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<td>0.7184</td>
</tr>
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</table>

Table 2. Results of Non-parametric Runs Test.

Table 3 shows the results of the variance ratio test. The sampling intervals are 4, 8, 12, 16 and 20 for daily returns; 4, 8 and 12 for weekly returns; and 4 and 8. It also shows the estimates of the variance ratio VR (q) and the test statistics of homoscedasticity Z (q) and heteroscedasticity. The critical value is 2.49 at 5% significance level for the test statistics.

Considering the results of the Chinese market, all the values of z (q) and z* (q) for daily and weekly data are larger than 2.49 for all intervals studied while these values for monthly returns exceed the critical value in interval 4 and are under the critical value in interval 8. It can be concluded that China’s stock market index does not follow a random walk and is therefore inefficient. Similarly for the Indian market, the random walk hypothesis is rejected for the daily and weekly returns as the value of z (q) and z* (q) exceed the critical value. The monthly return results from the Korean market show that these returns have homoscedasticity but do not have heteroscedasticity. The results of the daily and weekly returns indicate that they do not follow a random walk, as all the values of z(q) and z*(q) are larger than the critical value; the hypothesis of homoscedasticity and heteroscedasticity therefore fail to reject the null hypothesis. Similar results are shown for the Malaysian market. The aspect of monthly returns rejects the homoscedastic hypothesis and does not reject the heteroscedastic hypothesis. The daily returns and weekly returns of the Malaysian market do not follow a random walk based on the rejection of the hypothesis.

Table 3. Results of Variance Ratio test.
## 6. Conclusion

Motivated by the increasing economic strength, the rapid development of Asian countries and the mixed results of EMH for the Asian stock markets, this study examines the weak form market efficiency of four representative Asian stock markets. The runs test indicates that all four markets demonstrate the signs of random walk but this result is rejected by the variance ratio test, which suggests the stock markets of China, Indian, Korea and Malaysia are not efficient. This contradiction echoes the literature review and highlights the potential cause of the paradox.

There are a number of ways in which this research could be extended. For instance, one way is through the sample selection. It is generally known that weak form inefficiency is linked with small and newer capitalization markets. Stock level data may be able to shed some light on this issue by selecting small capitalization stocks and contrasting with large capitalization stocks. Andersen et al. (2001) indicated that a single variance ratio may be misleading in a high-frequency context [3]. Therefore, another extension could be using multiple variance ratio tests to replace the single variance ratio test.

### Reference


