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TESTING THE RANDOM WALKS IN KOREA STOCK EXCHANGE

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ABSTRACT

The aim of this paper is to investigate random walk in Korea stock exchange. The results of unit root, autocorrelation and the variance ratio tests are applied, using daily data on returns of two indexes in the period 1997:7 to 2012:12. The null hypothesis of random walk is rejected for the two indexes and therefore the markets are no weak-form efficiency.

Keywords: Random walk hypothesis, Unit root test, Autocorrelation testr, Variance ratio Test, Korea stock exchange.

1. INTRODUCTION

One the most important conception in modern finance has been the Efficient Market Hypothesis associated to the random walk hypothesis that variation of prices is randomly in time and the excess returns is unpredictable. Fama (1970) summarizes that "a market which prices always fully reflect available information is called 'efficient'" (Fama, 1970). Market efficiency is categorized into three forms. In Weak- Form market Efficiency, the information set includes only historical prices of returns. In Semi-Strong market Efficiency; the information set includes all publicly available information. In Strong Form market Efficiency, the information set includes all privately available information. At the beginning the assumption of efficient capital markets has been associated with the theory of random walk to the possible variation of the price of the securities is completely random in time and therefore no abnormal profits or still unable to beat the market. However, several academic research conducted on various international markets have evidence that asset returns do not follow a random walk and hence called for more nuanced conclusions challenging the random walk markets and therefore the efficiency hypothesis . The attack of the wave theory of efficiency has been supported by numerous empirical studies , mainly the work of Summers (1986), Fama and French (1988) , Hoque *et al.* (2007) Lock (2008) and Charles and Darne (2013) , have provided evidence of what has been revealed as a major source of inefficiency , the autocorrelation of returns. The objective of the study is to check the efficiency in its weak form in Korea stock exchange and check whether KS11follow random walk or not. This article is organized follows: In the first section, we go through a literature review. In the second section, we developed the data and methodology. The empirical results are summarized in the third section

2. REVIEW OF LITTERATURE

The test of efficiency in its weak form been widely studied in financial literature namely the work of Felix Ayadi and Pyun (1994) apply the variance ratio test developed by Lo and Mackinlay (1988) to investigate the behaviour of prices of stock traded on the Korean stock market between January 1984 and December 1988. The results in this study have shown that the Korean stock market is a random walk market. For emerging markets, Kim (2004) reports the existence of a random walk for Hong Kong, Japon and Korea and rejections of random walk hypothesis for Taiwan and Thailand. The study of Hoque *et al.* (2007) examine the random walk hypothesis for eight emerging equity markets in Asia: Hong Kong, Indonesia, Korea, Malaysia, Philippines, Singapore, Taiwan and Thailand. They use weekly market prices and covered the period from April 1990 to February 2004. They found that the stock prices of the eight Asian countries do not follow random walk with the possible exceptions of Taiwan and Korea. The same results found by Lock (2008) using weekly data covers the period, 1990 through 2006 of Taiwan stock market. The study of Charles and Darne (2013) examines the random walk hypothesis for the Shanghai and Shenzhen indexes for Chinese stock exchanges using daily data over the period 1992-2007. He find that the earlier do not follow the random walk hypothesis but the first index seem more efficient. Segot and Lucey (2008) show the reject of null hypothesis of random walk for Egypt, Morocco and Lebanon, Jordan and Tunisia according to variance ratio test.

Omar *et al.* (2013) investigates the efficiency in its weak form in Karachi stock exchange. The data examined consists of daily, monthly and weekly returns for the period 1st Jan 1998 to Feb.29st 2012 to test random walk behavior. They used unit root test (ADF and PP tests), Run test and Kolmogrov Smirnov Normality test. The outcome of tests shows that KSE does not follow random walk and there are chances for the technical investors that they can earn the abnormal profit by identifying the trends in KSE. There test are used by Nawaz *et al.* (2013) to study the weak form efficiency to Karachi stock exchange of Pakistan. The purpose of study of Lim *et al.* (2013) is to test the efficiency of both Shangai and Shenzhen stock markets. This study utilizes different approaches, the serial correlation test, runs test and variance ratio test. They concluded that China's stock market has a weak form efficiency. Jain and Jain (2013) examined the weak form of efficiency in Indian stock exchange. The data used was consists of daily returns from April, 1993 to March 2013. The results of both non-parametric and parametric tests exposed that the theory of technical analysis does not hold and any investor can't make abnormal gains the patterns predicted by past prices. An empirical study of emerging Asian capital markets and some developed markets proved the similar results. The study of Worthington and Higgs (2006) used daily stock returns of China, Korea, Malaysia, Sri Lanka, Pakistan, Indonesia, India, Japan, Singapore, Hong Kong and New Zealand. By using unit root tests, run test, multiple variance ratio tests and auto-correlation function test. There results show that emerging markets and three developed markets of Japan, New Zealand and Hong Kong are not weak form efficient. On the other apart from Australia and Taiwan, unit root test represent these markets are weak form efficient. Sing and Sapna (2013) examined the weak form market efficiency in five stock exchanges of Asian countries. The data used in their study was consisting of daily, weekly and monthly

closing values. The run tests, autocorrelation and the Ljung-Box statistics has been applied. The results of the run test show that the Bombay stock exchange (BSE) and Singapore stock exchange (STI) do not followrandom behavior in case of daily prices. In case of monthly price, BSE has been found weak form efficient. Further, the results of autocorrelation and Ljung-Box test revealed that all stock exchanges under study follow random walk behavior in case of monthly and weekly prices except BSE. Vigg Kushwah *et al.* (2013) examines the weak form of market efficiency on Indian stock market (NSE) in the recent years from April , 1997 to March 2010. Using the run tests of daily stock prices shows the evidence of weak form of efficiency of NSE. Fahad (2013) investigates the random walk behaviour of CIVETS (Colombia, Indonesia, Vietnam, Egypt, Turkey and South Africa) foreign exchange rates against the US dollar using weekly data from February 2007 to April 2012. Using variance ratio tests, the results suggest that the nominal exchange rates of Vietnamese dong and Egyptian pounds violate the random walk hypothesis and do not follow a martingale process. However, the Colombian peso, Indonesian rupiah, Turkish lira and South African rand exchange rate markets are considered weak-form efficient.

3. DATA AND METHODOLOGY

The data used to test the weak form efficiency of Korea stock exchange has been take from the daily market closing prices of KOSPI (Korea Composite Stock Price Index) and KOSPI MIDCAP indexes. Data commence from July 1997 and ends at December 2012. This data has been taken from the web of Korea www.kse.or.kr. Three tests are used in this study: unit root test, autocorrelation test and variance ratio test.

a. Unit Root Test

Unit root tests are used to see that whether the financial time series is no-stationnary which is necessary condition for a random walk.

3.1. Augmented Dickey Fuller Test

Another statistical technique used to test the weak form efficiency of the stock market is the Augmented Dickey Fuller test (ADF), it tests if data is stationary. It is applied for analyzing the unit root in time series data. Data that has a unit root means it is non-stationary and it behaves according to the Random Walk theory. This method is mainly used for long term and complex time frames. To assess the market efficiency based on the ADF we apply the following formula:

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + \cdots + \delta_{p-1} \Delta y_{t-p+1} + \varepsilon_t, \quad (1.1)$$

3.2. Phillips-Perron Test

The Phillips-Perron test is another widely used unit root test for financial data in the time series. The PP test is based on the same null hypothesis formation as the ADF such as: H0: $\delta=0$. While the ADF test uses a parametric auto-regression to estimate the construction of the errors in the test regression, the Phillips-Perron unit root testing on the other hand tends to overlook

any form of serial correlation that exists in the test regression. The regression equation for this unit root test is:

$$\Delta y_t = \beta' \mathbf{D}_t + \pi y_{t-1} + u_t \quad (1.2)$$

3.3. Auto-Correlation Function Test

Auto-correlation function (ACF) test is also used as a measure of weak-form efficiency. It depicts the relationship of each value of the series with itself at different times t, t+1, t+2, t+3 so on and so forth. ACF is articulated as the function of time-groups

$$R(\tau) = \frac{\mathrm{E}[(X_t - \mu)(X_{t+\tau} - \mu)]}{\sigma^2} \quad (1.3)$$

3.4. Variance Ratio Test

Lo and Mackinlay (1988) presents a simple specification test aimed at testing the random walk hypothesis. That the random walk for a log stock price p_t can be written as:

$$p_t = \mu + p_{t-1} + \varepsilon_t \quad (1.4)$$

Where:

μ is the expected one period rate of return on the stock;

ε_t is a sequence of independently and identically residuals.

The principle of the test is that the variance of a q-th difference of the process (1-4) is equal to the sum of the corresponding q first difference variances. To refer to Lo and Mackinlay (1988), the q-th difference of (1-4) can be written as:

$$p_t - p_{t-q} = (p_t - p_{t-1}) + (p_{t-1} - p_{t-2}) + \ldots\ldots + (p_{t-q+1} - p_{t-q})$$

$$= \mu q + \sum_{i=t-q+1}^{t} \varepsilon_i$$

Thus the variance of $p_t - p_{t-q}$ is equal to: $\mathrm{Var}[p_t - p_{t-q}] = \sum_{i=t-q+1}^{t} \sigma_{\varepsilon i}^2 =$

$$\sum_{i=t-q+1}^{t} \mathrm{var}[p_i - p_{i-1}] \quad (1.5)$$

It follows that the ratio $\mathrm{Var}[p_t - p_{t-q}] \Big/ \sum_{i=t-q+1}^{t} \mathrm{Var}[p_i - p_{i-1}]$ must be equal to one under the null hypothesis of random walk and the test is called the variance ratio test.

4. EMPIRICAL RESULTS

The result of descriptive statistic shows that returns of both KOSPi and KOSPI MIDCAP index are not normally distributed since their mean do not exist at the some time. Moreover, both index returns have more negative skewness which means that both of them have more proportions on the left tail. The kurtosis values indicate that the series of both returns fall into the leptokurtic distribution. The fat-tail is examined by the values of the Jarque-Bera. Since the skewness and kurtosis values deviate from 0 and 3 as requirement for a perfectly normal distribution, both of the index are not yet efficient in a weak form.

4.1.Unit Root Tests

Table-1. Descriptive Sttatistics

VARIABLES	LK	LKM
MEAN	6.370	6.440
MAXIMUM	7.590	7.960
MINIMUM	7.796	6.703
STD.DEV	0.203	0.207
SKEWNESS	-2.433	-2.319
KURTOSIS	7.100	6.768
JARQUE-BERA	171.65	151.37

The random walk hypothesis is examined using unit root tests namely the Augmented Dickey and Fuller (1979) test and the Philips and Perron (1998) test. First, the study performs ADF test with intercept, with intercept and trend and without an intercept and trend. The results of ADF test of random walk model was presented in table 2. The ADF test result reveals that the null hypothesis of unit root (no stationary) of the stock market returns of two major indices Kospi and KospiMidcap is convincingly rejected, suggesting that the Korea stock market does not show characteristics of random walk and as such not efficient in the weak form implying that stock prices remain predictable.

Table-2. Results of Augmented Dickey Fuller Test

RETURNS	LK	LKM
Without Intercept And Trend	-25.144*	-25.027*
With Intercept	-25.168*	-25.052*
With Intercept And Trend	-25.109*	-25.120*
*Indicates Significance At One Per Cent Level		

The Phillips-Perron test conclude that both the return series rejects the null hypothesis of unit root. This result is consistent with the findings of ADF test suggesting the Korean stock market is not weak form efficient.

Table-3. Results of Philipps-Perron Test

Returns	Lk	Lkm
Without Intercept And Trend	-53.281*	-52.800*
With Intercept	-53.300*	-53.050*
With Intercept And Trend	-53.401*	-53.061*
*Indicates Significance At One Per Cent Level		

4.2. Autocorrelation Test

The results indicate a high degree of dependence on previous price when the lag is low. However, as the time lag increases the impact of past prices is found to be reducing. The standard error is relatively constant over different lags. This is confirming the non randomness of stock prices. This later, providing an opportunity for investors to exploit the market with the help of technical analysis.

Table-4. Autocorrelation Test

LK				LKM			
Lag	**Autocorr**	**Std Error**	**L Jung-Box Statistics**	**Lag**	**Autocorr**	**Std Error**	**L Jung-Box Statistics**
1	0.306	0.043	1111.301	1	0.674	0.030	11039.580
2	0.645	0.030	1111.350	2	0.318	0.030	11079.238
3	0.644	0.030	1106.870	3	0.275	0.030	11123.971
4	0.617	0.030	1113.941	4	0.220	0.030	11124.010
4	0.528	0.030	1114.097	4	0.186	0.031	11127.160
5	0.428	0.030	1114.884	5	0.152	0.031	11129.152
6	0.426	0.031	1115.670	6	0.142	0.031	11130.980
7	0.271	0.031	1115.770	7	0.105	0.030	11134.657
8	0.250	0.030	1116.309	8	0.056	0.030	11135.735
9	0.231	0.030	1118.400	9	0.045	0.030	11136.020
10	0.212	0.030	1118.921	10	0.033	0.030	11139.204

4.3. Variance Ratio Test

Table-5. RESULTS OF AUGMENTED DICKEY FULLER TEST

	Variance ratio test and Statistic test	**q=2**	**q=4**	**q=6**	**q=8**	**q=10**	**q=12**	**q=14**	**q=16**
KOSPI	$1+\hat{M}_r(q)$	0.796	1.032	1.255	1.052	1.112	1.297	1.201	1.120
	$z^*(q)$	-0.085	1.348	1.831	2.057	2.045	3.554	2.605	2.430
KOSPIMIDCAP	$1+\hat{M}_r(q)$	0.964	1.126	1.297	1.255	1.178	1.232	1.257	1.260
	$z^*(q)$	-0.523	1.203	1.451	1.721	2.203	2.451	2.721	2.102

Table 5 shows the results of the Lo-Mackinlay variance ratio test for several lags. The heteroscedasticity consistent variance ratio test are also performed by calculating the $z^*(q)$ for each lag. In the KOSPI index, variance ratios fluctuate as the length of interval q increases. More precise, the variance ratio of daily returns grows from 0.796 for interval of 2 to 1.255 for interval of 6 and then drops continuously to 1.297 for interval of 12. The variance ratio test of KOSPIMIDCAP index fluctuates from 0.964 for interval of 2 to 1.178 for interval of 10. In the interval of 16, the variance ratio becomes 1.260. According to the estimates of variance ratio, null hypothesis of random walk is rejected at any given ratio.

5. CONCLUSIONS

This paper examines the random walk in two of the Korea stock exchange (KOSPI and KOSPIMIDCAP). We employ four different tests ADF, PP, autocorrelation test and variance ratio test and find similar results. Data commence from July 1997 and ends at December 2012. These tests support the common results that the random walk is rejected for the two indexes then the Korea equity market is not efficient and investors cannot diversifying their investment into this market.

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