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An Empirical Study on Weak-Form of Market Efficiency of Selected Asian Stock Markets

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Abstract

The purpose of this research is to investigate the weak form of market efficiency of Asian four selected stock markets. We have taken a daily closing price of stock markets under the study from the 1st January 2000 to 31st March 2011 and also divided full sample in three interval periods, and have applied various test like Runs Test, Unit Root Test, Variance Ratio, Auto Correlation and other test. BSE Sensex has given the highest mean returns to the investor followed by SSE Composite and HANGSENG. BSE Sensex could be considered as high risk markets as it has reported the highest Standard Deviation. During the period BSE Sensex, HANGSENG and SSE Composite markets showed positive average daily returns except NIKKEI. The Runs Test indicated BSE Sensex and NIKKEI markets are weak form inefficient whereas HANSENG and SSE Composite hold weak form of efficiency. The time series for the full as well as sample period did

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not have a presence of unit root in the markets understudy. According to Auto correlation test it is inferred that the equity markets of the Asian region under the study remained inefficient for some lag whereas they were efficient for the other lag.

JEL classification numbers: C12, C14, D53, G14, G15
Keywords: Weak form Market Efficiency, Autocorrelation test, Runs test

1 Introduction of Markets Indices Understudy

1.1 BSE SENSEX

The **Bombay Stock Exchange SENSEX** (acronym of **Sens**itive Ind**ex**) more commonly referred to as **SENSEX** or **BSE 30** is a free-float market capitalization-weighted index of 30 well-established and financially sound companies listed on Bombay Stock Exchange. The 30 component companies which are some of the largest and most actively traded stocks are representative of various industrial sectors of the Indian economy. Published since January 1, 1986, the SENSEX is regarded as the pulse of the domestic stock markets in India. The base value of the SENSEX is taken as 100 on April 1, 1979, and its base year as 1978-79. BSE launched a dollar-linked version of SENSEX, called **Dollex-30** on 25 July, 2001. As of 21 April 2011, the market capitalization of SENSEX was about 29,733 billion (US$660 billion) (42.34% of market capitalization of BSE), while its free-float market capitalization was 15,690 billion (US$348 billion).[4]

[4] http://en.wikipedia.org/wiki/BSE_SENSEX_dated_19-03-2001/2:40 pm.

1.2 HANGSENG Index

The **Hang Seng Index** (abbreviated: **HSI**) is a free float-adjusted market capitalization-weighted stock market index in Hong Kong. It is used to record and monitor daily changes of the largest companies of the Hong Kong stock market and is the main indicator of the overall market performance in Hong Kong. These 45 constituent companies represent about 60% of capitalization of the Hong Kong Stock Exchange. Starting from 7th March, 2011, the HKEX will extend their trading hours. In the first stage, (opening value will be at 09:20) 09.30-12.00 and 13.30-16.00. In the second stage, from 5th March 2012, the afternoon trade will change to 13.00-16.00, that's mark with the mainland trading hours. HSI was started on November 24, 1969, and is currently compiled and maintained by Hang Seng Index's Company Limited, which is a wholly owned subsidiary of Hang Seng Bank, one of the largest banks registered and listed in Hong Kong in terms of market capitalization. It is responsible for compiling, publishing and managing the Hang Seng Index and a range of other stock indexes, such as Hang Seng China Enterprises Index, Hang Seng China AH Index Series, Hang Seng China H-Financials Index, Hang Seng Composite Index Series, Hang Seng China A Industry Top Index, Hang Seng Corporate Sustainability Index Series and Hang Seng Total Return Index Series.[5]

1.3 NIKKEI 225 Index

The **Nikkei 225** (more commonly called the ***Nikkei***, the ***Nikkei index***, or the ***Nikkei Stock Average*** is a stock market index for the Tokyo Stock Exchange (TSE). It has been calculated daily by the Nihon Keizai Shimbun (Nikkei) newspaper since 1950. It is a price-weighted average (the unit is yen), and the

[5] http://en.wikipedia.org/wiki/Hang_Seng_Index_dated_19-03-2011/2:45 pm.

components are reviewed once a year. Currently, the Nikkei is the most widely quoted average of Japanese equities, similar to the Dow Jones Industrial Average. In fact, it was known as the "Nikkei Dow Jones Stock Average" from 1975 to 1985. The Nikkei 225 began to be calculated on September 7, 1950, retroactively calculated back to May 16, 1949.Since January 2010 the index is updated every 15 seconds during trading sessions. The Nikkei 225 Futures, introduced at Singapore Exchange (SGX) in 1986, the Osaka Securities Exchange (OSE) in 1988, Chicago Mercantile Exchange (CME) in 1990, is now an internationally recognized futures index. The Nikkei average has deviated sharply from the textbook model of stock averages which grow at a steady exponential rate. The average hit its all-time high on December 29, 1989, during the peak of the Japanese asset price bubble, when it reached an intra-day high of 38,957.44 before closing at 38,915.87, having grown six fold during the decade. Subsequently it lost nearly all these gains, closing at 7,054.98 on March 10, 2009—81.9% below its peak twenty years earlier.[6]

1.4 SSE Composite

The **SSE Composite Index** is an index of all stocks (A shares and B shares) that are traded at the Shanghai Stock Exchange. SSE Indices are all calculated using a Paasche weighted composite price index formula. This means that the index is based on a base period on a specific base day for its calculation. The base day for SSE Composite Index is December 19, 1990, and the base period is the total market capitalization of all stocks of that day. The Base Value is 100. The index was launched on July 15, 1991.[7]

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[6] http://en.wikipedia.org/wiki/Nikkei_225_dated_19-05-2011/2:55 pm

[7] http://en.wikipedia.org/wiki/SSE_Composite_Index_dated_19-05-2011/3:10pm

Table 1: Summary of Markets under study

Particulars	BSE	HKEX	SSE	TSE
Type	Stock Exchange	Stock Exchange	Stock Exchange	Stock Exchange
Location	Mumbai, India	Hong Kong, China	Shanghai, China	Tokyo, Japan
Founded	1875	1891	1891	Tokyo Stock Exchange Group, Inc
Key People	Madhu Kanan (CEO and MD)	_____	Geng Liang (Chairman) Zhang Yujun (President)	Taizo Nishimuro, Chairman Atsushi Saito, President & CEO Yasuo Tobiyama, MD, COO & CFO
Currency	Indian Rupee	Hong Kong Dollar	RMB	Japanese yen
No. of listings	5034	1413	900 (Feb 2011)	2292
Volume	US$231 billion (Nov 2010)	_____	US$0.5 trillion (Dec 2009)	US$3.7 trillion (Dec 2009)
Market Cap	US$1.63 trillion (Dec 2010)	US$2.7 trillion (Dec 2010)	US$2.7 trillion (Dec 2010)	US$3.8 trillion (Dec 2010)
Website	www.bseindia.com	hkex.com.hk	www.sse.com.cn	www.tse.or.jp
Logos	Bombay Stock Exchange Limited BSE The edge is efficiency	HKEx 香港交易所	TOKYO STOCK EXCHANGE	Shanghai Stock Exchange

Source: Websites of respective stock exchanges

Figure 1: Trend of Markets under study

The above Figure 1 shows the trend of Asian selected markets under study. The data comprises of daily closing values of stock markets indexes for India (BSE Sensex 30), Hong Kong (HANGSENG), Japan (NIKKEI 225) and China (SSE Composite). The data includes daily closing observation from 1st January 2000 to 31st March, 2011, during which some of markets remained volatile, especially India, Hong Kong, and Japan whereas China (SSE Composite) remains same from full period. Trend shows that the prices are moving cumulatively in systematic manner.

Market efficiency refers to a condition, in which current prices reflect all the publicly available information about a security so that there is no scope for the abnormal return by an individual investor. The basic idea underlying market efficiency is that competition will drive all information into the price quickly. Due to immediate transformation of information, prices are quickly influenced. Under the Market Efficiency, current market price reflects all available information so

that any financial market could be the best unbiased estimate of an investment. Fama (1970) gave Efficient Market Hypothesis into three forms of hypothesis based on information flow. The weak form EMH stipulates that current prices already reflected past price, trades and volume information that means technical analysis cannot be used to predict the market sentiments for the next period.

2 Review of Literature on Weak-Form of Market Efficiency

The literature review is summarized in the following table.

Table: 2 Literature Review

Sr. No.	Study	Markets Under Study	Period of Study	Methodology Used	Results Found
1	S. K. Chaudhuri (1991)	India	1988-1990	Serial Correlation, Run test.	Study indicates that market does not seem to be efficient even in its weak form.
2	Sunil Poshakwale (1996)	India	1987-1994	Serial Correlation, Run test, KS test.	Evidence concentrating on the weak form efficiency and the mean returns except for the Monday and Wednesday are positive.
3	Martin Laurence, Francisc Cai and sun Quin (1997)	China	1993-1996	Unit Root test, Serial Correlation, Co- integration test, Granger Causality test.	Results of both tests conclude weak form market efficiency and all markets are gradually being in global economy.
4	Asma Mobarek and Keavin Keasey (2000)	Bangladesh	1988-1997	Auto-correlation test, Auto-regression, ARIMA model.	Indicates that the daily share return of market is not Random and Market is not weak form efficient.

Table continuous

5	Bhanu Pant and T. R. Bishnoi	India	1996-2000	Unit Root test, Autocorrelation, Variance Ratio.	The random walk hypothesis for daily and weekly market indices returns was not accepted.
6	Claire G. Gilmore and Ginette M. McManus (2001)	Czech Republic, Hungary, and Poland	1995-2000	Autocorrelation, Variance Ratio test, Co-integration and Granger Causality test.	Evidence behavior of random walk in all markets and indicate dependency with Czech and Hungarian markets to the Polish exchange.
7	Natalia Abrosimova, Gishan Dissanaike and Dirk Linowski (2002)	Russia	1995-2001	ARIMA and GARCH model, Unit root, Autocorrelation and Variance ratio tests.	Found that random walk could not be rejected for the monthly data, yet it could be rejected for daily data.
8	Bin Liu (2003)	China	1996-2002	Fama-MacBeth regressions, Autocorrelation	Evidence that is not favoring the weak-from EMH. Evidence does not provide any support for the proposition that the SSE is a weak-form.
9	Helen K. Simon (2005)	USA	1995-2004	MLR Model, ANN Model.	The findings supposition that market is Weak form Efficient.
10	Ashutosh Verma (2005)	India	1996-2001	Serial Correlation	Over all the market is weak form efficient.
11	Arusha Cooray and Guneratne Wickremasinghe	India, Sri Lanka, Bangladesh and Pakistan	1996-2005	Pair-wise Correlation, Autocorrelation, Cointegration test, Granger Causality test.	Unit Root test Weak From efficiency for all markets while DF-GLS and ERS test not support. Hence, the post-deregulation stock markets of South Asia appear in general to be efficient except in the case of Bangladesh.

					Table continuous
12	Mohammed Omran and Suzanne V. Farrar (2006)	Egypt, Jordan, Morocco, Turkey and Israel	1996-2000	Variance Ratio, Auto-correlation.	The limited support for weak form efficiency in Middle Eastern emerging markets implies a degree of predictability of returns.
13	Collins Gyakari Ntim, Kwaku K. Opong, and Jo Danbolt (2007)	Africa	1990-2005	Variance Ratio	The market stock returns are conclusively not efficient in the weak form, neither from the perspective of the strict random walk nor in the relaxed martingale difference sequence sense.
14	Rakesh Gupta and Parikshit K. Basu (2007)	India	1991-2006	Phillips-Perron tests, augmented Dickey-Fuller (ADF) and KPSS.	The results of these tests found that this market is not weak form efficient.
15	Rengasamy Elango, Mohammed Ibrahim Hussein (2007)	Dubai ,Saudi Arabia, Abu Dhabi, Qatar, Kuwait, Oman, Bahrain.	2001-2006	Run test, KS test. Auto-Correlation	Analysis of the daily stock index returns of markets indicates that there are larger variations in returns during the study period and the markets are not efficient in the weak-form.
16	Batool Asiri (2008)	India	1990-2000	ARIMA, Autocorrelation, Unit Root test.	The results suggest that current prices in the BSE reflect the true picture of the companies and which is follow random walk.
17	Asma Mobarek, A.Sabur Mohllaha and Rafiqual Bhuyan (2008)	Bangladesh	1988-2000	Runs test, K-S test, Auto-correlation,	Study provides evidence that security of DSE does not follow random walk and remains inefficient.

Table continuous

18	P K Mishra and B B Pradhan (2009)	India	2001-2009	Unit Root Test, Phillips-Perron tests augmented Dickey-Fuller(ADF)	The study provides the evidence of weak form inefficiency of Indian capital market.
19	Francesco Guidi, Rakesh Gupta and Suneel Maheshwari, (2010)	Poland, Hungary, the Czech Republic, Slovakia, Romania, Bulgaria, and Slovenia	1999-2009	Autocorrelation, Runs Test, Variance Ratio, GARCH-M.	Overall results indicate that some of these markets are not weak form efficient.
20	Saif Sadiqui and P.K.Gupta (2010)	India	2000-2008	Runs test, K-S test Autocorrelation, Auto -regression ARIMA	The results of both indices suggest do not exhibit weak form efficiency.
21	P K Mishra (2010)	India	1991-2009	Unit Root test, GARCH Model.	It represents inefficiency of Indian capital market.
22	Kashif Hamid, Muhammad T.S., Syad Z.A., Rana S., (2010)	Pakistan, India, Sri Lanka, China, Korea, Hong Kong, Indonesia, Malaysia	2004-2009	Auto-correlation, Runs Test, Unit Root Test and Variance Ratio.	Study indicates that no market is weak form efficient among all markets.

3 Objectives of the Study and Limitations

3.1 Research Objectives

3.1.1 Main Objective

The aim of this study is to verify weak form of market efficiency of selected stock markets under study.

3.1.2 Other Objectives

1. To study pattern in return among the four stock markets.
2. To investigate whether the four stock markets follow the Random Walk.
3. To study series is stationary or not.
4. To know whether markets follow normal distribution.

3.2 Hypothesis of the Study

We have developed following hypothesis (null hypothesis) for our study.

1. H_0 : Daily distribution of stock markets returns is normally distributed (DS)
2. H_0 : The succeeding price changes are not dependent and move randomly (Runs Test)
3. H_0 : Series contains a unit root (Unit Root test)
4. H_0 : The stock returns of the markets under the study follow normal distribution (K-S test)
5. H_0 : There is no autocorrelation (Auto-correlation test)
6. H_0 : VR (q) = 1 or Markets under the study are efficient in Weak-Form (VR test)

3.3 Scope of the Study

The purpose of our research is to investigate the weak form of market efficiency of Asian four selected stock markets (namely Bombay Stock Exchange, Hong Kong Stock Exchange, Tokyo Stock Exchange and Shanghai Stock Exchange) which are actively traded. For our study we took a daily closing price of stock markets under the study from the 1st January 2000 to 31st March 2011 and also divide full sample as in three interval periods, and have applied various test like Runs Test, Unit Root Test, Variance Ratio, Auto Correlation and other test and developed hypothesis that stock markets under study are weak form efficient or not.

3.4 Sample

For studying the objectives sample which consists of the daily closing prices of the selected markets of Asian countries: India (Bombay Stock Exchange), Hong Kong (Hong Kong Stock Exchange), Japan (Tokyo Stock Exchange), China (Shanghai Stock Exchange).

3.5 Sample Period

We have taken a closing price of selected stock markets under study from the 1st Jan. 2000 to 31st March. 2011.

3.6 Sample Size

The Sample size varies from market to market. Following table 3 shows the details of sample size in each market. The data are synchronized. The sample includes observations of daily closing price of individual indices for 11 years and

3 months. In addition, the study also considers the four selected stock market; which are actively traded.

Table 3: Summary of Sample of the Markets under study

No.	Markets	Country	Index	Period From	Period To	Total No. of Observa-tions
1	BSE	India	BSE Sensex 30	01-01-2000	31-03-2011	2786
2	HKEx	Hong Kong	Hang Seng	01-01-2000	31-03-2011	2804
3	TSE	Japan	Nikkie225	01-01-2000	31-03-2011	2759
4	SSE	China	SSE Composite	01-01-2000	31-03-2011	2881

The observations are daily closing values of selected stock market indices have been taken and market returns are computed as follows.

$$R_t = \ln(P_t / P_{t-1})$$

t = Market Price at time 't'

P_{t-1} = Market Price at time 't-1'

3.7 Statistical Test used

3.7.1 Runs Test

We applied runs test to find out the serial independence in return series which will find out the trend in the succeeding price variations. The efficiency in the market indicates the succeeding price variation should be autonomous to each other. For greater sample size the test statistic is just about normally distributed:

$$Z = \frac{\bar{\omega} - \mu_{\omega}}{\sigma_{\omega}} \approx N(0,1)$$

where

$$\mu_{\omega} = \frac{2m + m_{-}}{m} + 1, \quad \text{and} \quad \sigma_{\omega} = \sqrt{\frac{2m + m\_\left(2m + m\_ - m\right)}{m^2\left(m-1\right)}}$$

3.7.2 Unit Root Tests

Augmented Dickey-Fuller (ADF) test is applied to assay the existence of unit root in the time series of stock price return in the indices. Majorly it is used to test the stationarity of the time series.

$$\Delta R_t = b_0 + b_1 + \pi_0 R_{t-1} + \sum_{t=1}^{j} \psi_i \Delta R_{it\text{-}1} + \varepsilon_t$$

3.7.3 Kolmogorov-Smirnov (KS) Test

KS Test is a widely used goodness-of-fit test. It compares the observed cumulative distribution function for a variable with a specified theoretical distribution which may be normal, uniform, Poisson, or exponential. It checks whether the observations have come from the specified distribution.

3.7.4 Auto Correlation

The autocorrelation test is used to test the relationship between the time series and its own values at different lags. If the autocorrelation is negative it means it is mean reversal and accepts the null hypothesis and if the result is positive coefficients then it cannot accept the null hypothesis.

$$Q_{Ljung\text{-}Box} = n(n+2)\sum_{t=1}^{k} \frac{\psi^2(t)}{n-t}$$

3.7.5 Variance Ratio Tests

A significance assumption of the random walk theory is investigated through variance ratio test. If R_t is a random walk then the ratio of the variance of the j^{th} difference scaled by "J" to the Variance (σ^2) of the first difference have a probability equal to one, that is why the Variance (σ^2) of the j-difference boosts linearly in the surveillance interval,

$$VR(j) = \frac{\sigma^2(j)}{\sigma^2(j)}$$

where,

$\sigma^2(j) = 1/j^{th}$ variance

$\sigma(1) =$ is the variance of the first differences

For that null hypothesis;

H_0: VR (q) = 1 means Markets under the study are weak-form efficient

Ha: VR (q) ≠ 1 means Markets under the study are not Weak-form efficient

3.8 Expected Contribution of the Study

In our study, we intend to contribute to the empirical literature on tests of Efficient Market Hypothesis by employing various statistical tests to investigate weak form EMH for various exchanges of Asian countries using daily frequencies of data set. A comparison of the results for Indian Stock Market with the results for other countries' share markets would provide additional understanding of the relative market efficiency of Indian Stock Markets. We also propose to use Chinese Stock Market data set to compare our results with them. The comparison would provide gainful insight in understanding efficiencies in the stock markets. The findings of this study will be useful to those involved in investment decision-making in the stock market of India, as it will increase their understanding of the pricing process prevailing in the stock market.

3.9 Scope for the Future Research

In our study, only the weak-form EMH is considered while the semi-strong and Strong form EMH would be the concern of future research. Also, instead of index returns, individual share price data of the markets might turn better results in terms of market efficiency with weekly data or monthly data. For further research sample of one country indexes can be taken and various tests can be applied to know its impact on each other which is not applied in our research.

4 Data Analysis of Weak-Form Market Efficiency

4.1 Analysis of Descriptive Statistics

One of the assumptions of the random walk model is that the distribution of the return series should be normal. In order to test the distribution of the series, the descriptive statistics of the log of market returns are calculated and presented in the below Table 4.

During the period from 1st Jan 2000 to 31st March 2011 BSE Sensex, HANGSENG and SSE Composite markets showed positive average daily returns except NIKKEI, the highest daily return came from the BSE Sensex (India) at 0.05% followed by SSE Composite 0.03% HANGSENG 0.01%. The lowest daily return is witnessed by the 0.01%. At the same time BSE Sensex is showing 0.14% median which is moving in positively and showing good sign for return whereas NIKKEI did not indicate and shows 1.76% volatility which is less than the other markets where BSE Sensex shows 1.88% volatility, SSE Composite at 1.82% and HANGSENG at 1.80%. The markets can also be compared on the basis of Average Daily Return to S.D. Ratio. The highest ratio indicates the best Risk Return craving because this indicates average daily return per unit of S.D. The BSE Sensex showed highest ratio of 2.79% followed by SSE COMPOSITE and

HANGSENG 1.68% and 0.74% when NIKKEI are on negative side at -0.74%.

Table 4: Results Descriptive Statistics for the selected Markets Returns (Full Sample)

	BSE SENSEX	HANGSENG	NIKKEI	SSE COMPOSITE
Mean	0.05%	0.01%	-0.03%	0.03%
Median	0.14%	0.04%	0.00%	0.05%
Maximum	15.99%	16.80%	13.23%	9.03%
Minimum	-11.81%	-13.58%	-12.92%	-9.26%
Std. Dev.	1.88%	1.80%	1.76%	1.82%
Average daily Return to S.D. Ratio	2.79%	0.74%	-1.58%	1.68%
Skewness	-0.101	0.307	-0.597	0.040
Kurtosis	9.245925	13.36848	10.70208	6.459555
Jarque-Bera	3910.14	10801.65	6082.465	1199.002
Probability	0.0000	0.0000	0.0000	0.0000
Sum	1.264489	0.320683	-0.6668	0.733345
Sum Sq. Dev.	0.850982	0.78199	0.741568	0.796129
No. of observation	2403	2403	2403	2403

The Values for Skewness 0 and kurtosis 3 represents that the observed distribution is perfectly normally distributed. Here the value of skewness and kurtosis of stock return series of the four selected Asian stock markets are not equal to 0 and 3 respectively, which is (negative skewed for BSE Sensex -0.101 and NIKKEI -0.597 and Positive for HANGSENG 0.307 and SSE composite 0.040), and the value of all markets of Kurtosis is positive, thereby indicating mesokurtic distribution. The evidence of negative skewness for returns series in two markets BSE Sensex and NIKKEI indices returns are similar to findings of

Kashif Hamid, et al (2010) in fourteen stock markets, Guidi Francesco, Rakesh and Suneel (2010) for seven European markets, Rakesh Gupta and Parikshit K. Bashu (2007) in Indian two stock markets BSE Sensex and NSE 50.

The calculated Jarque-Bera statistics and p-values in the table 4 are used to test null hypothesis for normal distribution (H_0: Daily distribution of stock markets returns is normally distributed). All p-values are less than (0.01) at 1% level of significance suggest that the null hypothesis cannot be accepted. Therefore, none of these returns series is then well approximated by normal distribution. It means the non-normal frequency distributions of the stock returns deviate from the prior condition of random walk model.

Table 5 presents the descriptive statistics of period wise returns of four stock markets. From Table 5, we can see the daily returns are negative in all the markets except SSE Composite. The standard deviation is also similar for the BSE Sensex, HANGSEN, NIKKEI around (0.017) whereas for SSE Composite is less as compare to that markets which represents lower risk in SSE composite with S.D ratio (0.024). Likewise in period 2 the returns are positively and higher for BSE Sensex and SSE composite (BSE: 0.0014) with higher risk (0.0156) and lower returns in NIKKEI and HANGSENG (NEKKEI: 0.0006) with lower standard deviation. And period 3 the return in BSE Sensex is also higher as compare to others, negative for the NIKKEI and SSE Composite with average risk which indicate that BSE Sensex has higher positive return in Period 2 and 3 with higher risk.

The skewness is negative in all period except in period 3 for BSE Sensex and HANGSENG. This results of skewed and kurtosis is as compare to for Full periods returns or skewed results are similar or near to similar. The calculated Jarque-Bera statistics and p-value are used to determine or testing null hypothesis that the daily distribution of market indices is normally distributed. In that all period p-values are smaller than 1% level of significance, suggest the null hypothesis cannot be accepted. So, none of the markets are normally distributed in

the period 1, 2 and 3. From this analysis we can say that the investment in the period of 2 and 3 in BSE Sensex and HANGSENG is better because Average daily returns to standard deviation ratio is positive and higher.

Table 5: Results Descriptive Statistics for the selected Markets Returns (Period wise)

	Sample: 05/01/2000 to 20/10/2003				Sample: 21/10/2003 to 29/06/2007			
	BSE	HANG SENG	NIKKEI	SSE	BSE	HANG SENG	NIKKEI	SSE
Mean	-0.0002	-0.0004	-0.0007	0.0000	0.0014	0.0007	0.0006	0.0013
Median	0.0009	-0.0010	-0.0012	0.0001	0.0022	0.0009	0.0007	0.0012
Maximum	0.1046	0.0760	0.0722	0.0885	0.0793	0.0377	0.0677	0.0790
Minimum	-0.0821	-0.1023	-0.0901	-0.0654	-0.1181	-0.0537	-0.0775	-0.0926
Std. Dev.	0.0175	0.0169	0.0172	0.0144	0.0156	0.0102	0.0122	0.0165
Avg. daily returns to S.D. Ratio	-0.0088	-0.0251	-0.0385	-0.0029	0.0882	0.0712	0.0498	0.0781
Skewness	-0.1637	-0.1849	-0.0532	0.7127	-0.8606	-0.4737	-0.4018	-0.2099
Kurtosis	6.5061	6.8200	4.9156	9.5363	9.8569	5.7400	6.7471	6.7871
Jarque-Bera	413.85	491.58	122.85	1493.69	1668.1	280.54	490.16	484.54
Probability	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*
Sum Sq. Dev.	0.2457	0.2286	0.2374	0.1654	0.1958	0.0837	0.1183	0.2183
Observations	801	801	801	801	801	801	801	801

	Sample: 03/07/2007 31/03/2011			
	BSE SENSEX	HANGSENG	NIKKEI	SSE COMPOSITE
Mean	0.0004	0.0001	-0.0008	-0.0003
Median	0.0011	0.0007	-0.0001	0.0009
Maximum	0.1599	0.1680	0.1323	0.0903

Minimum	-0.1160	-0.1358	-0.1292	-0.0804
Std. Dev.	0.0226	0.0242	0.0219	0.0227
Avg. daily returns to S.D. Ratio	0.0156	0.0040	-0.0353	-0.0146
Skewness	0.2090	0.5047	-0.7645	-0.0042
Kurtosis	8.7873	10.5754	10.6680	4.6285
Jarque-Bera	1123.64	1949.29	2040.43	88.51
Probability	0.000*	0.000*	0.000*	0.000*
Sum Sq. Dev.	0.4086	0.4692	0.3849	0.4112
Observations	801	801	801	801

*indicate 1 % level of significance

4.2 Runs Test

Runs test is a non-parametric test that is designed to examine whether successive price changes are independent. The non-parametric runs test is applicable as a test of randomness for the sequence of returns. Accordingly, it tests whether returns in emerging market indices are predictable. The null hypothesis for this test is for temporal independence in the series (or weak-form efficiency): in this perspective this hypothesis is tested by observation the number of runs or the sequence of successive price changes with the same sign i.e. positive, zero or negative. Each change in return is classified according to its position with respect to the mean return. Hereby, it is a positive change when return is greater than the mean, a negative change when the return is less than the mean and zero when the return equals to the mean (Gupta, Rakesh and Maheshwari, 2010)). To perform the runs test, the runs can be carried out by comparing the actual runs R to the expected number of runs.

Table 6: Results of the Runs Test (Full Sample)

	BSE SENSEX	HANGSENG	NIKKEI	SSE COMPOSITE
K=Mean	.00052621	.00013345	-.00027749	.00030518
Cases < K	1127	1183	1186	1176
Cases >= K	1276	1220	1217	1227
Total Cases	2403	2403	2403	2403
Number of Runs	1128	1206	1264	1206
Z- Statistic	-2.863	0.154	2.518	0.165
p-value	0.004*	0.877	0.012**	0.869

Notes: if the Z-statistic is greater than or equal to ± 1.96, then we cannot be accepted null hypothesis at 5% level of significance.

* Indicates non acceptance of the null hypothesis that successive price changes are independent.

* indicate 1 % level of significance,

**indicate 5 % level of significance

As pointed out by Guidi, Rakesh and Maheshwari (2010), when actual number of runs exceed (fall below) the expected runs, a positive (negative) Z values is obtained. A negative Z value indicates a positive serial correlation, whereas a positive Z value indicates a negative serial correlation. The positive serial correlation implies that there is a positive dependence of stock prices, therefore indicating a violation of random walk. Since the distribution Z is N (0,1), the critical value of Z at the five percent significance level is ±1.96 .

The results of Runs test for the returns on markets under the study are indicating in the above table 6. For the full period, the runs test clearly shows that the successive returns for all indices except the HANGSENG and SSE composite, are not independent at 1% and 5% level of significance (significance value of ±1.96) and the null hypothesis of return independence because our p-value is less

than 0.05 at 5% level of significance.(H0: *The succeeding price changes are not dependent and move randomly*) which indicate null hypothesis cannot be accepted in BSE Sensex and NIKKEI which indicated that both markets are inefficient, means not weak form efficient for whole period so investor can predict the markets returns. This result for the full sample period is consistent with Rakesh Gupta and Parikshit K. Basu (2007). And HANGSENG and SSE Composite, we cannot reject null hypothesis, concluded that both markets are efficient and follow random walk so investor cannot predicted the market returns for whole period.

From the Table 7 indicate period wise analysis in three interval period, In the first period we can interpret that the markets under the study shows Weak-Form efficiency except BSE Sensex in all three period. All the estimated Z-values are insignificance at the 1% and 5% level of significance except BSE Sensex which indicates inefficiency on period-1 in BSE Sensex and p-value is significance at 5% level of significance, the null hypothesis the succeeding price changes are not dependent and move randomly cannot be accepted. Where in other three markets, HANGSENG, NIKKEI and SSE Composite our null hypothesis accepted which indicate markets are efficient in weak-form.

The results of Runs test of the second period on the markets under the study are reported in above table. For that period, the runs test clearly shows that markets under the study are Weak-Form efficient and so the null hypothesis of the return independence is accepted in second period which indicate means the markets under the study follow random walk and so we cannot predict the behavior markets returns during second interval period.

And the above table for the third period null hypothesis accepted at 5% level of significance elucidates that succeeding price changes are not dependent and follow random walk. So we can conclude that a return of markets under the study is clearly shows Weak-Form efficient and not easily predictable. This finding is also similar of Kashif Hamid et al (2010).

Table 7: Results of the Runs Test (Period wise)

Sample:05/01/2000 to 20/10/2003							
	Mean= k	**Cases < K**	**Cases >= K**	**Total Cases**	**Number of Runs**	**Z-statistic**	**p-value**
BSE	-0.0002	375	426	801	365	-2.476	0.013**
HANGSENG	-0.0004	418	383	801	398	-0.194	0.846
NIKKEI	-0.0007	413	388	801	398	-0.220	0.826
SSE	0.0000	395	406	801	394	-0.525	0.600
Sample: 21/10/2003 to 29/06/2007							
BSE	0.0014	372	429	801	386	-0.957	0.338
HANGSENG	0.0007	390	411	801	420	1.329	0.184
NIKKEI	0.0006	397	404	801	426	1.735	0.083***
SSE	0.0013	401	400	801	390	-0.813	0.416
Sample: 03/7/2007 to 31/3/2011							
BSE	0.0004	383	418	801	395	-0.406	0.685
HANGSENG	0.0001	394	407	801	395	-0.452	0.651
NIKKEI	-0.0008	380	421	801	427	1.882	0.060***
SSE	-0.0003	382	419	801	408	0.521	0.602

Notes: if the Z-statistic is greater than or equal to ± 1.96, then we cannot be accepted null hypothesis at 5% level of significance.

* Indicates rejection of the null hypothesis that successive price changes are independent.
* Indicates 1% level of Significance

** Indicates 5% level of Significance

*** Indicates 10 % level of Significance

4.3 Unit Root Test

Since unit root is necessary condition for a random walk, the Augmented Dickey-Fuller test is used to test the null hypothesis of a unit root. The results of Augmented Dickey-Fuller for the unit root of all the markets under study are

presented in the following Table 8. ADF unit root was performed for the whole sample period Jan 2000 to March 2011 for the maximum lag period of 36.

Table 8: Results of Augmented Dickey-fuller for the markets under study (Full Sample).

	BSE SENSEX	HANGSENG	NIKKEI	SSE COMPOSITE
ADF	-46.6777	-48.5725	-48.5901	-48.5967
p-value	0.0001*	0.0001*	0.0001*	0.0001*

*indicate 1% level of significance

The t- statistics critical value at 1%, 5% and 10% are -3.43288, -2.86254, and -2.56735 respectively and it clearly showed stationary because the null hypothesis of unit root (H_0: Series contains a unit root) is convincingly cannot be accepted, suggesting that these market show the existence of random walk which is similar to the findings of Rakesh Gupta and Parikshit K. Basu (2007).

The Table 9 presents the unit root test analysis in different intervals e.g., Sample: 05/01/2000 to 20/10/2003, Sample: 10/21/2003 6/29/2007, Sample: 7/03/2007 3/31/2011. In above table the t-statistics at 1%, 5% and 10 % are -3.4383, -2.86494 and -2.568634 respectively and it clearly showed stationery in all sub period as the p-value<0.05 which does not accept null hypothesis (H_0: Series contains unit root). Therefore null hypothesis cannot be accepted at 1%, 2% and 10% level of significance which shows that series is stationery. The results therefore indicate that there exists of some evidences of random walk in all the selected Stock markets for that periods.

Unit root test alone cannot be used to conclude that markets under study are weak form efficient as it does not detect the predictability of return. So there is a need to apply other tests as well.

Table 9: Results of the Augmented Dickey-Fuller and Unit Root Test for the selected markets (Period wise)

Sample:05/01/2000 to 20/10/2003				
	BSE SENSEX	HANGSENG	NIKKIE	SSE COMPOSITE
ADF	-26.3982	-27.5017	-28.7646	-27.4932
p-value	0.0000*	0.0000*	0.0000*	0.0000*
Sample: 10/21/2003 6/29/2007				
	BSE SENSEX	HANGSENG	NIKKIE	SSE COMPOSITE
ADF	-27.1059	-27.8532	-28.8502	-28.6794
p-value	0.0000*	0.0000*	0.0000*	0.0000*
Sample: 7/03/2007 3/31/2011				
	BSE SENSEX	HANGSENG	NIKKIE	SSE COMPOSITE
ADF	-27.2349	-28.3174	-27.3743	-27.9313
p-value	0.0000*	0.0000*	0.0000*	0.0000*

*indicate 1% level of significance

4.4 Kolmogorov-Smirnov Test:

The non-parametric, Kolmogorov Smirnov Goodness of Fitness Test (KS) test whether the observed distribution fit theoretical normal or uniform distribution. Kolmogorov Smirnov Goodness of Fitness Test (KS) is used to determine how well a random sample of data fits a particular distribution (uniform, normal, poisson). It is based on comparison of the sample's cumulative distribution against the standard cumulative function for each distribution. The Kolmogorov- Smirnov

one sample goodness of fit test compares the cumulative distribution function for a variable with a uniform or normal distributions and tests whether the distributions are homogeneous. We use both normal and uniform parameters to test distribution.

Table 10: Results of K-S Goodness of fit test (Full Sample: Normal Distribution)

	Absolute	Positive	Negative	K-S-Z	P-value
BSE SENSEX	0.076	0.074	-0.076	3.736	0.000*
HANGSENG	0.083	0.077	-0.083	4.048	0.000*
NIKKEI	0.061	0.049	-0.061	3.007	0.000*
SSE COMPOSITE	0.075	0.07	-0.075	3.673	0.000*

*indicate 1% level of significance

The Kolmogorov Smirnov Goodness of Fit Test (KS) shows p-value < 0.05 at the 1%, 5% and 10% level of significance, in case of normal distribution. The results clearly indicate that the frequency distribution of the daily values of the markets under the study does not fit normal distribution. The above table 10 indicates the null hypothesis cannot be accepted which means the all markets under the study does not follow normal distributed because it provide p-value which is insignificance at the 1% level of significance the evidence of all the markets under study are similar to findings of Sunil Poshakwale (1996) of Indian stock markets, Rengasamy Elango, and Mohammed Ibrahim Hussein(1996) of GGC markets. (Significance at 0.05) these results are also similar finding with descriptive statistics which also indicate markets under the study does not follow normal distribution. (H_0: The stock returns of the markets under the study follow normal distribution).

Table 11: Results of K-S Goodness of fit test (Period wise)

Period:05/01/2000 to 20/10/2003					
	Absolute	Positive	Negative	K-S-Z	P-value
BSE SENSEX	0.062	0.054	-0.062	1.759	0.004*
HANGSENG	0.052	0.052	-0.052	1.479	0.025**
NIKKEI	0.029	0.029	-0.026	0.814	0.521
SSE COMPOSITE	0.09	0.09	-0.075	2.543	0.000*
Sample: 10/21/2003 6/29/2007					
	Absolute	Positive	Negative	K-S-Z	P-value
BSE SENSEX	0.086	0.075	-0.086	2.427	0.000*
HANGSENG	0.072	0.048	-0.072	2.032	0.001*
NIKKEI	0.057	0.038	-0.057	1.626	0.010**
SSE COMPOSITE	0.059	0.059	-0.057	1.669	0.008*
Sample: 7/03/2007 3/31/2011					
	Absolute	Positive	Negative	K-S-Z	P-value
BSE SENSEX	0.079	0.079	-0.075	2.239	0.000*
HANGSENG	0.082	0.082	-0.077	2.332	0.000*
NIKKEI	0.078	0.062	-0.078	2.195	0.000*
SSE COMPOSITE	0.076	0.058	-0.076	2.161	0.000*

*indicate 1% level of significance

**indicate 5% level of significance

From the above Table 11 analyze daily returns of the markets under the study in different period i.e. Period: 05/01/2000 to 20/10/2003, Sample: 10/21/2003 6/29/2007 and Sample: 7/03/2007 3/31/2011. In the first period, concluded that at 1%, 5% and 10% level of significance all the markets under the study follow normal distribution except NIKKEI in the period 1 as compared to whole period, null hypothesis cannot be accepted in the BSE Sensex, HANGSENG and SSE Composite it means those markets returns are not follow normal distribution.

Where NIKKEI indices null hypothesis can be accept at 10% level of significance.

The second interval period indicate from the table 11 that all the markets under the study shows patterns of normal distribution as compared to whole period and period one, we can conclude that at 1%, 5% and 10% level of significance all the markets under the study follow normal distribution, null hypothesis cannot be accepted in the BSE Sensex, HANGSENG, NIKKEI and SSE Composite it shows that the markets returns are not follow normal distribution. And for the third period interval, concluded that at 1%, 5% and 10% level of significance all the markets under the study follow normal distribution, null hypothesis cannot be accepted in the BSE Sensex, HANGSENG, NIKKEI and SSE Composite it shows that the markets returns are not follow normal distribution.

4.5 Auto-Correlation Test

Our literatures provide evidence that Auto-correlation test used to test weak form market efficiency. Auto-correlation test is a reliable measure for testing of either dependence or independence of random variables in a series. Kendall (1948, p. 412) compute the price changes at different lagged 1,2,3,4 time periods. Later the test is used very popularly (e.g., Laurence, 1986; Claessens, Dasgupta and Glen, 1995; Poshokwale, S. 1996; Nicolas, 1997; Nourredine Khaba, 1998). The serial correlation coefficient measures the relationship between the values of a random variable at time t and its value in the previous period. Auto correlation test evidences whether the correlation coefficients are significantly different from zero. The auto-correlation coefficients have been computed for the log of the market return series that shows significant auto-correlation at different lags for the whole sample period.

In Appendix, Table 12 provides the results of the sample autocorrelation coefficients and the Ljung-box statistics for the daily returns on the indices for

BSE Sensex, HANGSENG, NIKKEI and SSE composite markets for the full sample period 5/1/2000- 31/03/2011. To test the Random walk hypothesis for the selected markets under study, autocorrelation tests up to 36 lags were performed for daily stock returns.

Positive autocorrelation indicates predictability of returns in short period, which is general evidence against market efficiency, whereas negative autocorrelation indicate mean reversion in returns. BSE Sensex appears the significant negative correlation at lag 2, 3, 5, 6, 10, 13, 14, 17, 18, 20, 22, 23, 24, 29, 32 and 34. HANGSENG also shows significant negative autocorrelation at lag 2, 3, 5, 9, 14, 17, 18, 20, 23, 25, 29, 31, 32and 36. Nikkei shows negative autocorrelation at lag 2 to 8, 13 to 16, 18 to 20, 24, 28 to 31. And SSE composite shows negative autocorrelation at lag 2, 5, 6, 8, 12, 17 to 23, 26, 29, 30, 34. Thus, it shows that at the above lags the returns cannot be predicted and weak form of efficiency holds.

Ljunj-Box statistics also provide evidence of possible dependence. The Ljunj- Box Q- statistics shows that the null hypothesis is of no autocorrelation (H_0: There is no autocorrelation) if p-value is significant at 1 % and 5% (p-value<0.05). So in BSE the null hypothesis cannot be accepted for all lags except lag 2 to 6 and 34 to 36. It means that returns are auto correlated from lag 2 to6 and 34 to 36 in BSE Sensex. Similarly the returns are not auto correlated in the HANGSENG except for lag 1 to 4. The returns for Nikkei market are not auto correlated except for lag 1 to 20.And the returns of SSE composite are not auto correlated except for lag 1 to 5 and 8, 9.

According to Auto correlation test it is inferred that the equity markets of the Asian region under the study remained inefficient for some period whereas they were efficient for the other period. After whole discussion it is worth nothing that the acceptance or rejection of the null hypothesis does not entails that the equity markets are efficient or inefficient respectively, because of conclusion of this research are based on samples.

Table 13: Results of Auto-correlation test and Q-Statistics for Returns (Period wise)

	Sample: 05/01/2000 to 20/10/2003				Sample: 21/10/2003 to 29/06/2007				Sample: 30/07/2007 to 31/03/2011			
	BSE	**HANG SENG**	**NIKKEI**	**SSE**	**BSE**	**HANG SENG**	**NIKKEI**	**SSE**	**BSE**	**HANG SENG**	**NIKKEI**	**SSE**
p1	0.068	0.039	-0.017	0.027	0.042	0.014	-0.021	-0.017	0.037	-0.002	0.031	0.012
p2	0.026	-0.037	-0.007	0.002	-0.081	-0.028	-0.023	0.021	0.002	-0.040	-0.061	-0.016
p3	-0.037	0.049	-0.002	-0.069	-0.001	-0.038	-0.006	0.078	-0.022	-0.048	-0.062	0.070
p4	0.039	-0.004	-0.037	0.031	0.067	0.031	-0.076	0.015	-0.018	-0.001	-0.009	-0.003
p5	-0.004	-0.089	0.033	0.029	0.041	0.015	0.065	-0.029	-0.061	-0.091	-0.104	-0.053
p6	-0.037	0.007	-0.046	-0.031	-0.112	-0.041	-0.041	-0.030	-0.008	0.021	0.029	-0.058
p7	0.035	-0.001	-0.002	-0.012	-0.007	-0.009	-0.034	-0.008	0.075	0.057	0.007	0.038
p8	0.059	0.011	-0.020	-0.016	0.024	-0.087	-0.051	-0.007	0.045	0.021	0.011	-0.004
p9	0.020	0.035	-0.019	-0.007	0.079	0.048	-0.014	0.036	0.003	-0.032	0.054	0.012
p10	-0.006	0.031	0.026	0.042	-0.046	-0.004	0.039	0.063	-0.017	-0.008	0.046	0.031
p11	-0.004	0.019	-0.029	0.062	-0.081	0.036	0.030	0.047	0.073	0.023	0.030	0.033
p12	-0.012	-0.001	0.047	-0.002	0.032	-0.016	-0.002	-0.024	0.056	0.066	-0.003	-0.002
p13	0.000	-0.020	-0.053	-0.029	0.015	-0.001	-0.027	0.123	-0.021	0.020	0.026	0.016
p14	-0.069	-0.008	0.005	0.043	0.033	0.004	0.027	0.007	-0.024	-0.021	-0.044	0.055
p15	0.014	0.019	0.018	0.030	-0.006	0.033	0.011	0.136	0.055	0.020	-0.029	0.005
p16	0.017	0.008	-0.014	0.054	0.050	0.001	0.008	-0.060	-0.020	-0.001	-0.040	0.043
p17	-0.003	-0.004	-0.002	-0.040	-0.010	-0.035	0.027	0.006	-0.004	-0.004	0.048	0.000

p18	-0.113	-0.016	-0.002	0.001	0.003	-0.061	-0.010	-0.014	-0.021	0.008	-0.049	-0.019
p19	-0.035	0.011	-0.033	-0.018	-0.031	-0.019	-0.004	-0.062	0.043	0.052	-0.024	0.025
p20	0.050	0.032	-0.011	0.018	-0.045	-0.026	-0.013	0.009	-0.032	-0.071	-0.091	-0.022
p21	0.022	0.001	-0.007	-0.070	-0.015	-0.017	-0.035	-0.035	0.061	0.051	0.104	0.003
p22	0.001	-0.013	-0.010	-0.004	-0.055	-0.052	0.009	-0.014	-0.016	0.020	0.030	-0.013
p23	-0.006	0.025	0.080	-0.067	0.054	-0.059	-0.038	0.061	-0.028	-0.029	0.025	-0.048
p24	-0.019	-0.026	-0.010	0.036	-0.073	0.014	0.029	0.095	-0.037	0.022	-0.050	0.021
p25	-0.001	-0.054	0.046	-0.009	-0.039	0.022	-0.038	-0.018	0.081	-0.038	0.000	0.034
p26	-0.051	0.009	0.010	-0.021	0.007	0.026	-0.014	0.022	0.034	0.020	0.063	-0.075
p27	-0.029	0.008	-0.009	-0.011	0.030	0.035	0.051	0.020	0.034	0.021	-0.010	0.037
p28	0.001	0.051	-0.018	-0.006	0.007	0.030	-0.021	0.110	0.003	-0.002	-0.007	0.081
p29	0.000	-0.007	-0.026	-0.010	-0.047	-0.011	0.017	-0.040	0.010	-0.039	-0.019	-0.051
p30	0.022	0.006	-0.004	-0.015	0.040	0.005	0.018	0.012	-0.018	-0.003	-0.010	-0.011
p31	0.035	-0.112	-0.048	0.023	0.022	-0.038	-0.032	0.016	0.000	-0.021	-0.028	0.062
p32	-0.046	-0.034	0.002	0.020	-0.010	-0.026	0.072	0.006	-0.018	-0.070	-0.016	0.003
p33	-0.044	-0.042	0.029	-0.032	0.003	-0.033	0.033	0.030	0.038	0.065	0.002	0.008
p34	-0.038	-0.015	0.053	-0.031	-0.083	-0.041	-0.062	0.016	0.014	0.025	0.049	-0.022
p35	0.000	-0.042	0.002	0.035	0.033	0.003	-0.105	-0.011	-0.011	0.089	0.061	0.090
p36	0.052	0.003	-0.016	0.036	0.038	0.022	0.067	-0.012	-0.030	-0.015	0.016	0.034

	Sample:05/01/2000 to 20/10/2003				Sample:21/10/2003 to 29/06/2007				Sample:30/07/2007 to 31/03/2011			
	BSE	HANG SENG	NIKKEI	SSE	BSE	HANG SENG	NIKKEI	SSE	BSE	HANG SENG	NIKKEI	SSE
(Q)1	3.750	1.210	0.237	0.583	1.435	0.158	0.351	0.220	1.077	0.004	0.793	0.111
p-value	0.053***	0.271	0.626	0.445	0.231	0.691	0.554	0.639	0.299	0.952	0.373	0.739
(Q)2	4.293	2.289	0.281	0.587	6.760	0.788	0.775	0.566	1.079	1.298	3.746	0.324
p-value	0.117	0.318	0.869	0.745	0.034**	0.674	0.679	0.753	0.583	0.523	0.154	0.851
(Q)3	5.394	4.189	0.284	4.381	6.760	1.962	0.809	5.444	1.468	3.152	6.847	4.238
p-value	0.145	0.242	0.963	0.223	0.080***	0.580	0.847	0.142	0.690	0.369	0.077**	0.237
(Q)4	6.596	4.204	1.411	5.174	10.378	2.735	5.517	5.623	1.733	3.152	6.919	4.245
p-value	0.159	0.379	0.842	0.270	0.035**	0.603	0.238	0.229	0.785	0.533	0.140	0.374
(Q)5	6.611	10.632	2.285	5.875	11.711	2.917	8.936	6.307	4.729	9.798	15.661	6.537
p-value	0.251	0.059***	0.809	0.319	0.039**	0.713	0.112	0.278	0.450	0.081**	0.008*	0.257
(Q)6	7.718	10.666	4.016	6.659	21.800	4.308	10.299	7.030	4.777	10.145	16.333	9.252
p-value	0.260	0.099***	0.675	0.354	0.001*	0.635	0.113	0.318	0.573	0.119	0.012**	0.160
(Q)7	8.686	10.667	4.020	6.767	21.840	4.374	11.226	7.080	9.338	12.822	16.371	10.395
p-value	0.276	0.154	0.777	0.454	0.003*	0.736	0.129	0.421	0.229	0.077***	0.022**	0.167
(Q)8	11.502	10.770	4.351	6.984	22.322	10.492	13.345	7.119	10.961	13.180	16.468	10.410
p-value	0.175	0.215	0.824	0.538	0.004*	0.232	0.101	0.524	0.204	0.106	0.036**	0.237
(Q)9	11.840	11.765	4.639	7.028	27.392	12.396	13.507	8.144	10.970	14.002	18.876	10.522

p-value	0.222	0.227	0.865	0.634	0.001*	0.192	0.141	0.520	0.278	0.122	0.026**	0.310
(Q)10	11.872	12.522	5.170	8.476	29.098	12.412	14.737	11.405	11.216	14.057	20.591	11.290
p-value	0.294	0.252	0.880	0.582	0.001*	0.258	0.142	0.327	0.341	0.170	0.024**	0.335
(Q)11	11.888	12.824	5.871	11.648	34.465	13.440	15.486	13.188	15.537	14.477	21.318	12.156
p-value	0.372	0.305	0.882	0.391	0.000*	0.266	0.161	0.281	0.159	0.208	0.030**	0.352
(Q)12	12.001	12.825	7.677	11.651	35.297	13.648	15.491	13.654	18.062	18.076	21.326	12.158
p-value	0.446	0.382	0.810	0.474	0.000*	0.324	0.216	0.323	0.114	0.113	0.046**	0.433
(Q)13	12.001	13.146	9.972	12.344	35.489	13.648	16.072	26.074	18.430	18.389	21.894	12.371
p-value	0.528	0.437	0.696	0.500	0.001*	0.399	0.245	0.017**	0.142	0.143	0.057***	0.497
(Q)14	15.947	13.196	9.992	13.884	36.387	13.659	16.680	26.110	18.882	18.762	23.445	14.870
p-value	0.317	0.511	0.763	0.458	0.001*	0.475	0.274	0.025**	0.170	0.174	0.053***	0.387
(Q)15	16.114	13.496	10.261	14.610	36.413	14.557	16.776	41.340	21.400	19.098	24.125	14.890
p-value	0.374	0.564	0.803	0.480	0.002*	0.484	0.332	0.000*	0.125	0.209	0.063***	0.459
(Q)16	16.356	13.555	10.422	16.965	38.433	14.557	16.834	44.257	21.736	19.099	25.436	16.403
p-value	0.428	0.632	0.844	0.388	0.001*	0.557	0.396	0.000*	0.152	0.264	0.062***	0.425
(Q)17	16.365	13.568	10.425	18.287	38.514	15.535	17.424	44.289	21.750	19.111	27.353	16.403
p-value	0.498	0.697	0.885	0.371	0.002*	0.557	0.426	0.000*	0.195	0.322	0.053***	0.495
(Q)18	26.867	13.785	10.429	18.288	38.519	18.619	17.510	44.461	22.100	19.164	29.291	16.700
p-value	0.082***	0.743	0.917	0.437	0.003*	0.416	0.488	0.000*	0.228	0.382	0.045**	0.544
(Q)19	27.848	13.887	11.339	18.564	39.289	18.909	17.523	47.638	23.652	21.418	29.747	17.227
p-value	0.086***	0.790	0.912	0.485	0.004*	0.463	0.554	0.000*	0.210	0.314	0.055***	0.574

	Sample:05/01/2000 to 20/10/2003				Sample:21/10/2003 to 29/06/2007				Sample:30/07/2007 to 31/03/2011			
	BSE	HANG SENG	NIKKEI	SSE	BSE	HANG SENG	NIKKEI	SSE	BSE	HANG SENG	NIKKEI	SSE
(Q)20	29.879	14.713	11.437	18.823	40.983	19.454	17.655	47.711	24.480	25.548	36.636	17.630
p-value	0.072	0.793	0.934	0.533	0.004*	0.493	0.610	0.000*	0.222	0.181	0.013**	0.612
(Q)21	30.281	14.714	11.474	22.903	41.176	19.682	18.645	48.695	27.534	27.731	45.623	17.636
p-value	0.086***	0.837	0.953	0.349	0.005*	0.541	0.608	0.001*	0.154	0.148	0.001*	0.672
(Q)22	30.282	14.850	11.564	22.913	43.645	21.901	18.710	48.860	27.750	28.077	46.378	17.770
p-value	0.112	0.869	0.966	0.407	0.004*	0.466	0.663	0.001*	0.184	0.173	0.002*	0.720
(Q)23	30.316	15.348	16.846	26.608	46.062	24.754	19.889	51.887	28.408	28.793	46.908	19.712
p-value	0.141	0.882	0.817	0.273	0.003*	0.363	0.649	0.001*	0.201	0.187	0.002*	0.659
(Q)24	30.622	15.926	16.924	27.670	50.512	24.915	20.598	59.306	29.571	29.192	48.958	20.088
p-value	0.165	0.891	0.852	0.274	0.001*	0.410	0.662	0.000*	0.199	0.213	0.002*	0.692
(Q)25	30.622	18.378	18.642	27.739	51.776	25.304	21.815	59.572	35.068	30.365	48.958	21.038
p-value	0.202	0.826	0.814	0.320	0.001*	0.445	0.646	0.000*	0.087***	0.211	0.003*	0.690
(Q)26	32.818	18.447	18.732	28.091	51.817	25.871	21.966	59.992	36.009	30.689	52.273	25.653
p-value	0.167	0.859	0.848	0.354	0.002*	0.470	0.691	0.000*	0.092**	0.240	0.002*	0.482
(Q)27	33.505	18.501	18.793	28.190	52.554	26.892	24.149	60.320	36.966	31.061	52.361	26.770
p-value	0.181	0.887	0.877	0.401	0.002*	0.470	0.622	0.000*	0.096***	0.269	0.002*	0.476
(Q)28	33.506	20.667	19.064	28.220	52.594	27.663	24.511	70.397	36.972	31.064	52.400	32.260

p-value	0.218	0.839	0.896	0.453	0.003*	0.482	0.654	0.000*	0.119	0.314	0.003*	0.264
(Q)29	33.506	20.707	19.613	28.308	54.399	27.772	24.754	71.716	37.049	32.308	52.712	34.403
p-value	0.258	0.870	0.905	0.501	0.003*	0.530	0.691	0.000*	0.145	0.307	0.005*	0.225
(Q)30	33.920	20.740	19.626	28.489	55.705	27.796	25.014	71.829	37.326	32.317	52.792	34.495
p-value	0.284	0.896	0.926	0.545	0.003*	0.581	0.724	0.000*	0.168	0.353	0.006*	0.261
(Q)31	34.943	31.160	21.586	28.934	56.123	29.016	25.844	72.054	37.326	32.668	53.445	37.702
p-value	0.286	0.458	0.896	0.573	0.004*	0.568	0.729	0.000*	0.201	0.385	0.007*	0.189
(Q)32	36.737	32.119	21.589	29.273	56.205	29.576	30.178	72.088	37.590	36.755	53.663	37.711
p-value	0.259	0.461	0.918	0.605	0.005*	0.590	0.559	0.000*	0.228	0.258	0.010*	0.224
(Q)33	38.348	33.571	22.308	30.112	56.211	30.464	31.115	72.827	38.782	40.291	53.666	37.768
p-value	0.240	0.440	0.921	0.612	0.007*	0.594	0.561	0.000*	0.225	0.179	0.013**	0.260
(Q)34	39.527	33.748	24.641	30.937	61.963	31.853	34.355	73.034	38.937	40.828	55.670	38.180
p-value	0.237	0.480	0.880	0.619	0.002*	0.573	0.451	0.000*	0.257	0.195	0.011**	0.285
(Q)35	39.527	35.239	24.644	31.980	62.880	31.862	43.642	73.130	39.031	47.479	58.756	45.000
p-value	0.275	0.457	0.904	0.615	0.003*	0.620	0.150	0.000*	0.293	0.078**	0.007*	0.120
(Q)36	41.762	35.246	24.858	33.049	64.089	32.284	47.460	73.243	39.792	47.676	58.979	45.949
p-value	0.235	0.504	0.919	0.610	0.003*	0.646	0.096	0.000*	0.305	0.092**	0.009*	0.124

***Significant at 1 % level

****Significant at 5% level

*****Significant at 10% level

Table 13 provides the results of the sample autocorrelation coefficients and the Lung- box statistics for the daily returns for the daily returns for 3 periods of BSE Sensex, HANGSENG Nikkei and SSE composite. Table 13 provides the results for Auto-correlation and Ljung- Box Q- statistic test for the 3 sub periods i.e. 5th January 2000 to 20th October 2003, 21st October 2003 to 29th June 2007 and 3rd July 2007 to 31st March 2011. In the period of January 2000 to October 2003 returns did not have autocorrelation at 5% level of significance for all the markets under study. It means the returns in 1st period are not auto correlated which shows that market holds weak form of market efficiency.

In the period October 2003 to June 2007 returns on all the 4 markets show the significance auto correlation at all the lags except lag 1 and 3 in BSE Sensex at 5 % level of significance. For HANGSENG and Nikkei returns do not have auto correlation at 5 % level of significance. For SSE composite returns show significant auto correlation for lags 1 to 12 only at 5 % level of significance.

In 3rd period from June 2007 to July 2007 BSE Sensex, HANGSENG, SSE market shows no sign of autocorrelation at any lags. The null hypothesis is accepted at 5 % significance level in BSE Sensex, HANGSENG, and SSE market which shows that the returns are not auto correlated. But for Nikkei the null hypothesis is rejected at 5 % level at lag 5 to 12, 18 and 20 to 36. It shows that the returns are auto correlated at lag5 to 12, 18 and 20 to 36 which indicates that it does not hold weak form of market efficiency.

4.6 Variance Ratio Test

Variance Ratio test introduced by Lo and Mackinlay (1988) is most commonly used as a tool for investigate for randomness. When the random walk hypothesis is rejected and VR (q) > 1, returns are positively serially correlated for emerging markets positive serial correlation in returns could simply describe market growth. When the random walk hypothesis is rejected and VR (q) < 1,

returns are negatively serially correlated. The situation is often described as a mean reverting process and consistent. Under null hypothesis the variance ratio should be approximately equal to 1. If the value is not equal to one then it means that the series is auto correlated in first-order and the variance ratio is sum of first-order autocorrelation coefficient estimator and unit value pointed by Bhanu Pant and T. R. Bishnoi as per our literature.

From Table 14 in Appendix, we can interpret that the standardized VR (J)test statistics for z (j) and p value is significant from J = 2 to J=16 for all markets BSE Sensex ,HANGSENG,NIKKEI and SSE Composite (as p value is less than 0.05). An important observation in the above cases is that ,as variance ratio increases with j, the z(j) also increase in all cases which indicates that as 'j' increases, the significance of rejection become stronger pointed out by Kashif Hamid et al. (2010).

Our results of Variance ratio test are indicate similarity of previous findings in emergence markets, e.g. Guidi, Rakesh and Maheseshwari (2010), Kashif Hamidet al (2010), Mohammed Omran and Suzanne V. Farrar (2006).They find that the markets are inefficient during the study so it can easily predicted. According to Variance ratio test for our study is inferred that the market of Asian region under the study remains in inefficient for the period 2000 to 2011. Therefore our null hypothesis cannot be accepted which indicated that markets does not follow Random Walk. (H_0: VR (q) = 1).

In Appendix, Table 15 presents the results of the Variance Ratio test for the daily returns for three periods of BSE Sensex, HANGSENG, NIKKEI and SSE Composites. Here VR (j) is the variance at leg j, z (1) to z(16) are represents z-statistics values and p-values are provide to test null hypothesis of VR (q) = 1 to know the return series follow random walk. Table provides the results of the variance and z statistics for the sub period i.e., Sample: 05/01/2000 to 20/10/2003, Sample: 21/10/2003 to 29/06/2007, Sample: 03/07/2007 to 31/3/2011. In the first period, The standardize Variance Ratio and test statistics for z(j) is significance at

j 2 to 16 for all markets and so that he returns series did not follow random walk in the markets under the study, because here our null hypothesis cannot be accepted at 1% level of significance (p-values is less than 0.05) in all legs from 2 to 16.In the period 2, null hypothesis cannot be accepted at 1% level of significance all p-values of daily returns series is not significance(p-values <0.05, significance) and indicates the series did not follow random walk at none of the leg in observation likewise happened in period 3, also null hypothesis cannot be accepted and series of daily returns are not random walk. According to variance ratio test it is inferred that the equity markets of the Asian region under the study remained inefficient for the all period intervals and so investor can easily predict market behavior and take benefit of profit.

4.7 Major Findings of the Study

Our study investigates the weak form of market efficiency in the selected markets of Asia. The sample size consisted of 4 equity markets with their daily closing returns. The purpose of the study is to find out whether the selected markets follow weak form of efficiency or not. In Appendix Table 16 shows the findings of our study of full sample period as well as period wise analysis which is divides into three intervals.

5 Conclusion

The study provides the evidence of weak form of inefficiency of the selected stock markets over the full sample period as well as period wise sample. The overall results from the empirical analysis suggest that the stock markets under study are weak-form inefficient. To verify the normal distribution of the data we

performed Jarque-Bera test and visualized the skewness and kurtosis. The results reveal in the Jarque-Bera test. To verify the weak-form of efficiency of selected Asian markets, Unit Root test, Auto-correlation and Variance Ratio test were applied. By applying unit root test the results review that the data series are stationary for full sample period as well as sub-period. The results of Auto-correlation suggest mixed observation weak-form of efficiency and inefficiency for all the markets for the full sample period as well as for the first and second period whereas in third period only NIKKEI holds Weak-form of inefficiency. The results of Variance Ratio test elucidates all the four markets does not follow Weak-Form of efficiency which means that they are inefficient in the entire sample.

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Appendix

Table 12: Results of Autocorrelation and Q-Statistics for Returns (Full Sample)

Lag	BSE SENSEX			HANGSENG			NIKKEI			SSE COMPOSITE		
	AC	Q-Stat	Prob	AC	Q-Stat	Prob	AC	Q-Stat	Prob	AC	Q-Stat	Prob
1	0.049	5.6937	0.017**	0.012	0.3538	0.552	0.009	0.1768	0.674	0.008	0.1539	0.695
2	-0.009	5.8973	0.052***	-0.037	3.6404	0.162	-0.036	3.3592	0.186	-0.001	0.1578	0.924
3	-0.02	6.8705	0.076***	-0.019	4.4714	0.215	-0.033	6.058	0.109	0.048	5.7472	0.125
4	0.018	7.6522	0.105	0.002	4.4831	0.345	-0.028	7.9371	0.094***	0.011	6.0465	0.196
5	-0.02	8.5785	0.127	-0.078	19.258	0.002*	-0.032	10.476	0.063***	-0.034	8.7956	0.118
6	-0.04	12.364	0.054***	0.01	19.508	0.003*	-0.005	10.535	0.104	-0.043	13.286	0.039
7	0.045	17.309	0.016**	0.035	22.405	0.002*	-0.003	10.552	0.159	0.023	14.563	0.04**
8	0.044	22.014	0.005*	0.007	22.517	0.004*	-0.01	10.78	0.214	-0.007	14.682	0.066***
9	0.026	23.698	0.005*	-0.002	22.528	0.007*	0.022	11.906	0.219	0.013	15.076	0.089***
10	-0.021	24.751	0.006*	0.002	22.541	0.013**	0.039	15.491	0.115	0.045	19.859	0.031**
11	0.017	25.488	0.008*	0.024	23.986	0.013**	0.013	15.892	0.145	0.041	24.001	0.013**
12	0.033	28.096	0.005*	0.039	27.751	0.006*	0.016	16.55	0.167	-0.006	24.091	0.02**
13	-0.006	28.178	0.009*	0.009	27.959	0.009*	-0.006	16.636	0.216	0.038	27.59	0.01**
14	-0.021	29.237	0.01*	-0.013	28.372	0.013**	-0.014	17.081	0.252	0.036	30.739	0.006*
15	0.03	31.433	0.008*	0.019	29.234	0.015**	-0.005	17.143	0.31	0.047	36.048	0.002*
16	0.012	31.778	0.011**	0.004	29.271	0.022**	-0.021	18.251	0.309	0.021	37.164	0.002*

17	-0.003	31.805	0.016**	-0.005	29.33	0.032**	0.03	20.475	0.251	-0.007	37.289	0.003*
18	-0.038	35.367	0.008*	-0.004	29.361	0.044**	-0.028	22.399	0.215	-0.016	37.909	0.004*
19	0.005	35.423	0.012**	0.031	31.633	0.034**	-0.026	24.097	0.192	-0.008	38.071	0.006*
20	-0.009	35.62	0.017**	-0.036	34.82	0.021**	-0.054	31.272	0.052***	-0.005	38.126	0.009*
21	0.034	38.372	0.012**	0.031	37.139	0.016**	0.048	36.931	0.017**	-0.013	38.524	0.011**
22	-0.017	39.102	0.014**	0.005	37.201	0.022**	0.017	37.595	0.02**	-0.009	38.723	0.015**
23	-0.004	39.142	0.019**	-0.015	37.741	0.027**	0.03	39.833	0.016**	-0.029	40.718	0.013**
24	-0.041	43.242	0.009*	0.007	37.866	0.036**	-0.023	41.171	0.016**	0.049	46.564	0.004*
25	0.026	44.92	0.009*	-0.036	40.989	0.023**	0.01	41.433	0.021**	0.013	46.969	0.005*
26	0.004	44.956	0.012**	0.015	41.558	0.027**	0.034	44.248	0.014**	-0.037	50.367	0.003*
27	0.014	45.446	0.015**	0.018	42.374	0.03**	0.005	44.307	0.019**	0.025	51.883	0.003*
28	0.001	45.447	0.02**	0.018	43.124	0.034**	-0.013	44.731	0.023**	0.074	65.208	0.000*
29	-0.004	45.479	0.026**	-0.027	44.846	0.03**	-0.016	45.333	0.027**	-0.038	68.762	0.000*
30	0.009	45.664	0.033**	0.001	44.848	0.04**	-0.001	45.334	0.036**	-0.001	68.768	0.000*
31	0.017	46.409	0.037**	-0.049	50.788	0.014**	-0.034	48.168	0.025**	0.047	74.058	0.000*
32	-0.02	47.343	0.039**	-0.053	57.512	0.004**	0.011	48.461	0.031**	0	74.058	0.000*
33	0.009	47.537	0.049**	0.027	59.262	0.003**	0.018	49.235	0.034**	0.003	74.081	0.000*
34	-0.021	48.651	0.05**	0.009	59.458	0.004**	0.035	52.217	0.024**	-0.01	74.345	0.000*
35	0.006	48.731	0.061***	0.042	63.689	0.002**	0.015	52.78	0.027**	0.052	80.963	0.000*
36	0.013	49.152	0.071***	-0.008	63.866	0.003**	0.011	53.076	0.033**	0.024	82.373	0.000*

*Significant at 1% level **Significant at 5% level ***Significant at 10% level

Table 14: Results of Variance Ratio Test at the return series (Full Sample)

Markets	**Period=J**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
BSE SENSEX	VR(J)	0.53	0.36	0.26	0.21	0.18	0.14	0.13	0.11	0.11	0.09	0.09	0.08	0.08	0.07	0.07
	z(j)	-11.76	-11.31	-10.86	-10.13	-9.57	-9.26	-8.83	-8.43	-8.05	-7.78	-7.52	-7.26	-7.03	-6.86	-6.67
	p-value	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
HANGSENG	VR(J)	0.52	0.34	0.25	0.22	0.17	0.14	0.13	0.11	0.10	0.09	0.08	0.08	0.07	0.07	0.06
	z(j)	-9.46	-9.27	-8.84	-8.20	-7.96	-7.62	-7.26	-6.97	-6.72	-6.50	-6.29	-6.07	-5.88	-5.73	-5.57
	p-value	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
NIKKEI	VR(J)	0.52	0.35	0.26	0.21	0.17	0.14	0.13	0.11	0.10	0.09	0.08	0.08	0.07	0.07	0.06
	z(j)	-12.00	-11.23	-10.25	-9.44	-8.91	-8.43	-8.02	-7.72	-7.44	-7.15	-6.93	-6.70	-6.51	-6.35	-6.18
	p-value	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
SSE COMPOSITE	VR(J)	0.50	0.32	0.25	0.21	0.18	0.14	0.13	0.11	0.10	0.09	0.08	0.08	0.07	0.06	0.06
	z(j)	-14.45	-13.83	-12.56	-11.60	-10.92	-10.48	-9.95	-9.56	-9.23	-8.89	-8.56	-8.33	-8.09	-7.87	-7.66
	p-value	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*

*indicate 1% level of significance

Table 15: Results of Variance Ratio Test at the return series (Period wise Analysis)

	Sample: 5/01/2000 to 20/10/2003				Sample: 21/10/2003 to 29/06/2007				Sample:03/07/2007 to 31/3/2011			
	BSE SEN.	**HANG SENG**	**NIKKEI**	**SSE COMP.**	**BSE SEN.**	**HANG SENG**	**NIKKEI**	**SSE COMP.**	**BSE SEN.**	**HANG SENG**	**NIKKEI**	**SSE COMP.**
j2	0.524	0.539	0.496	0.512	0.566	0.522	0.502	0.480	0.519	0.520	0.548	0.515
j3	0.373	0.330	0.330	0.365	0.350	0.349	0.326	0.302	0.355	0.350	0.367	0.314
j4	0.259	0.261	0.256	0.248	0.245	0.245	0.262	0.242	0.266	0.251	0.262	0.254
j5	0.217	0.228	0.191	0.199	0.202	0.199	0.182	0.202	0.222	0.220	0.230	0.214
j6	0.187	0.173	0.173	0.176	0.195	0.175	0.170	0.169	0.176	0.165	0.169	0.179
j7	0.149	0.150	0.142	0.148	0.152	0.146	0.145	0.142	0.139	0.136	0.148	0.140
j8	0.127	0.129	0.126	0.131	0.129	0.138	0.129	0.124	0.126	0.124	0.129	0.128
j9	0.118	0.112	0.112	0.115	0.108	0.107	0.111	0.106	0.117	0.117	0.110	0.113
j10	0.109	0.102	0.097	0.099	0.111	0.102	0.094	0.092	0.108	0.103	0.100	0.100
j11	0.099	0.094	0.093	0.088	0.104	0.089	0.087	0.086	0.090	0.091	0.092	0.091
j12	0.092	0.088	0.079	0.087	0.086	0.086	0.082	0.085	0.084	0.080	0.086	0.086
j13	0.084	0.083	0.081	0.082	0.081	0.078	0.078	0.067	0.084	0.077	0.077	0.078
j14	0.083	0.076	0.071	0.071	0.074	0.072	0.069	0.070	0.078	0.075	0.077	0.070
j15	0.072	0.069	0.066	0.067	0.072	0.066	0.065	0.057	0.068	0.067	0.071	0.069
j16	0.067	0.065	0.064	0.062	0.064	0.064	0.061	0.066	0.069	0.065	0.068	0.062
Z(2)	-7.482	-8.174	-9.924	-7.909	-6.409	-9.275	-9.460	-8.103	-7.309	-6.188	-6.541	-9.491
p-value	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*
Z(3)	-6.951	-8.410	-9.193	-7.162	-6.627	-8.923	-8.826	-7.687	-6.920	-5.955	-6.252	-9.310
p-value	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*
Z(4)	-6.833	-7.743	-8.383	-6.937	-6.333	-8.622	-7.875	-6.957	-6.561	-5.745	-5.822	-8.307
p-value	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*

Z(5)	-6.386	-7.165	-7.965	-6.429	-5.869	-8.071	-7.594	-6.478	-6.124	-5.310	-5.221	-7.648
p-value	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*
Z(6)	-6.040	-6.981	-7.352	-5.954	-5.344	-7.561	-6.926	-6.155	-5.880	-5.184	-5.058	-7.198
p-value	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*
Z(7)	-5.866	-6.639	-7.014	-5.665	-5.182	-7.251	-6.532	-5.909	-5.676	-4.970	-4.768	-6.932
p-value	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*
Z(8)	-5.655	-6.357	-6.659	-5.400	-4.962	-6.851	-6.174	-5.684	-5.381	-4.728	-4.551	-6.546
p-value	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*
Z(9)	-5.414	-6.103	-6.369	-5.183	-4.784	-6.694	-5.915	-5.522	-5.112	-4.514	-4.387	-6.267
p-value	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*
Z(10)	-5.212	-5.852	-6.144	-5.017	-4.526	-6.386	-5.699	-5.367	-4.885	-4.365	-4.215	-6.022
p-value	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*
Z(11)	-5.050	-5.622	-5.881	-4.851	-4.350	-6.173	-5.472	-5.202	-4.739	-4.226	-4.062	-5.794
p-value	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*
Z(12)	-4.896	-5.410	-5.721	-4.664	-4.258	-5.925	-5.261	-5.027	-4.555	-4.100	-3.924	-5.572
p-value	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*
Z(13)	-4.765	-5.221	-5.490	-4.515	-4.120	-5.735	-5.077	-4.960	-4.370	-3.951	-3.819	-5.401
p-value	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*
Z(14)	-4.606	-5.062	-5.354	-4.418	-4.007	-5.556	-4.943	-4.789	-4.234	-3.820	-3.692	-5.255
p-value	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*
Z(15)	-4.518	-4.925	-5.210	-4.300	-3.889	-5.405	-4.796	-4.716	-4.137	-3.725	-3.602	-5.085
p-value	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*
Z(16)	-4.406	-4.783	-5.061	-4.204	-3.809	-5.242	-4.667	-4.540	-4.003	-3.622	-3.513	-4.963
p-value	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*

*indicate 1% level of significance

Table 16: Overall findings of the study

No.	Test Applied	Full Period	First period (05/01/2000 to 20/10/2003)	Second Period (21/10/2003 to 29/06/2007)	Third period (03/07/2007 to 31/03/2011)
1	Descriptive Statistics	BSE Sensex (0.05%) has paid the highest mean returns to the investor followed by SSE Composite (0.03%) and HANGSENG (0.01%) BSE Sensex could be considered as high risk markets as it has reported the highest SD (1.88%).	In the first period NIKKEI provides negative returns followed by HANGSENG and BSE Sensex. BSE Sensex has highest SD as compared to other markets which indicates that it is highly risky market.	The results of second period are same as that of full period.	BSE Sensex and HANGSENG provided positive returns (0.04% and 0.01%) whereas SSE Composite and HANGSENG have negative returns (0.03% and 0.08%). Highly risky market is HANGSENG with the highest SD of 2.42%.
2	Runs Test	BSE Sensex and NIKKEI does not hold weak form of efficiency which	BSE Sensex is inefficient whereas HANSENG, NIKKEI and SSE Composite follow weak	BSE Sensex, HANSENG and SSE Composite are weak form of efficient	BSE Sensex, HANSENG and SSE Composite are weak form of efficient

		means both these markets are inefficient Whereas HANSENG and SSE Composite hold weak form of efficiency.	form of efficiency or RWH.	market whereas NIKKEI remains inefficient.	market whereas NIKKEI remains inefficient.
3	Unit Root Test	This test indicates that all the markets under the study follow random walk model which shows that the markets follow weak form of efficiency.	The test in the first periods indicates that there exists some evidence of random walk model suggesting weak form of market efficiency.	Findings in the second period are same as that of first period.	Findings in the third period are same as that of first period
4	K-S Test	This test shows that the returns of all the four selected markets under study are not normally distributed.	Under this period the returns in NIKKEI follow normal distribution.	The returns of all the four selected markets under study are not normally distributed.	The returns of all the four selected markets under study are not normally distributed.
5	Auto correlation	BSE Sensex was not auto correlated from lag 4. The HANGSENG returns	Returns in the first period did not have autocorrelation at 5% level of significance for all the markets under	Returns show the significance auto correlation at all the lags except lag in BSE	SSE market shows no sign of autocorrelation at any lags. BSE Sensex,

		was not auto correlated in earlier lag up to 4. The returns of NIKKEI and SSE Composite were not auto correlated in earlier lag.	study	Sensex. For ANGSENG and Nikkei returns do not have auto correlation. For SSE composite returns show significant auto correlation after lags 12	HANGSENG, and SSE market shows that the returns are not auto correlated. But for Nikkei the returns are auto correlated after lag 5.
6	Variance Ratio Test	All the markets under study does not follow random walk	All the markets under study does not follow random walk	All the markets under study does not follow random walk	All the markets under study does not follow random walk
7	Correlation Matrix	There is more correlation between the returns of NIKKEI and HANGSENG (0.633) whereas there is low correlation between the returns of BSE Sensex and SSE Composite (0.211)	There is more correlation between the returns of NIKKEI and HANGSENG (0.539) whereas there is low correlation between the returns of BSE Sensex and SSE Composite (0.057)	There is more correlation between the returns of NIKKEI and HANGSENG (0.573) whereas there is low correlation between the returns of BSE Sensex and SSE Composite (0.081)	There is more correlation between the returns of NIKKEI and HANGSENG (0.705) whereas there is low correlation between the returns of NIKKEI and SSE Composite (0.337)