Project Dissertation

A Study on Testing Weak-Form Efficient Market Hypothesis of Asian Markets

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CERTIFICATE FROM THE INSTITUTE

This is to certify that the Project Dissertation titled **A Study on Testing Weak-Form Efficient Market Hypothesis of Asian Markets** is a bonafide work carried out by Mr. **Jayendran B** of MBA 2014-16 and submitted to Delhi School of Management, Delhi Technological University, Bawana Road, Delhi-42 in partial fulfillment of the requirement for the award of the Degree of Masters of Business Administration.

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DECLARATION

I, **Jayendran B**, student of MBA 2014-16 of Delhi School of Management, Delhi Technological University, Bawana Road, Delhi-42 declare that Project Dissertation on **A Study on Testing Weak-Form Efficient Market Hypothesis of Asian Markets** submitted in partial fulfillment of Degree of Masters of Business Administration is the original work conducted by me.

The information and data given in the report is authentic to the best of my knowledge.

This Report is not being submitted to any other University for award of any other Degree, Diploma and Fellowship.

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ACKNOWLEDGEMENT

I would like to extend my heartfelt thanks to Dr. G C Maheshwari for his valuable guidance, interest and suggestions throughout the course of the project. I am thankful to him for providing me with useful references and information, which were of significant importance for the completion of my project. I feel honoured and privileged to work under him. He shared his vast pool of knowledge with me that helped me steer through all the difficulties with ease. This project file would not have been possible without his guidance and I would like to thank him for everything he has done for me. I perceive this opportunity as a big milestone in my career development. I will strive to use skills and knowledge gained here in the best possible way, and I will continue to work on their further improvement, in order to attain my desired career objectives.

Executive Summary

Stock markets are unpredictable and it is hard to find complete information about the stocks and market. If the markets are efficient and current prices reflect complete information then buying and selling stock is an attempt to outperform the market. The efficient market hypothesis states that at any given time, securities reflect complete information based on the various factor such as company discloser, company announcements, dividend, policy of the company, company fundamentals and change in government policies, etc.

The purpose of this study is to test the weak form of market efficiency of selected Asian stock markets. We have taken daily closing price of five stock markets BSE, SSE, TSE, KRX and HKEX under the study from the period -1st January 2005 to 31st March 2016 and have applied various test like Runs Test, K-S Test, Sign Test, Auto Correlation, Unit Root test and Monte Carlo simulation for Brownian motion. These modern tests helps in finding relationship between the future stock prices and their past performance through Efficient Market Hypothesis. The overall results from the empirical analysis suggest that the stock markets under study are weak-form efficient.

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1. INTRODUCTION

An index is a statistical measure of change in an economy or a securities market. In the case of financial markets, an index is a made-up portfolio of securities representing a particular market or a portion of it. Each index has its own calculation methodology and is usually expressed in terms of a change from a base value. Thus, the percentage change is more important than the actual numeric value.

A stock market index is created by selecting a group of stocks that are representative of the whole market or a specified sector or segment of the market. An Index is calculated with reference to a base period and a base index value. An Index is used to give information about the price movements of products in the financial, commodities or any other markets. Financial indexes are constructed to measure price movements of stocks, bonds, T-bills and other forms of investments. Stock market indexes are meant to capture the overall behaviour of equity markets.

Broad Market Indices: These indices are broad-market indices, consisting of the large, liquid stocks listed on the Exchange. They serve as a benchmark for measuring the performance of the stocks or portfolios such as mutual fund investments.

Fixed Income Indices: Fixed income index is used to measure performance of the bond market. The fixed income indices are useful tool for investors to measure and compare performance of bond portfolio. Fixed income indices also used for introduction of Exchange Traded Funds.

HOW IT WORKS:

Let's say we want to measure the performance of the Indian stock market. Assume there are currently four public companies that operate in India: Company A, Company B, Company C, and Company D. In the year 2015, the four companies' stock prices were as follows:

Company A	Rs.10	
Company B	Rs.8	
Company C	Rs.12	
Company D	Rs.25	Total Rs.55

To create an index, we simply set the total (Rs.55) in the year 2015 is equal to 100 and measure any future periods against that total. For example, let us assume that in 2016 the stock prices were:

Company A Rs.4

Company B Rs.38

Company C Rs.12

Company D Rs.24 Total Rs.78

Because Rs.78 is 41.82% higher than the 2015 base, the index is now at 141.82. Every day, month, year, or other period, the index can be recalculated based on current stock prices.

This index is price-weighted i.e., the larger the stock price, the more influence it has on the index. Indexes can be weighted by any number of metrics, including shares outstanding, market capitalization, or stock price.

The indexer may add or delete companies from the index or "re-weight" the index to accommodate stock splits or other factors.

The daily results of stock market indexes are perhaps the most popular numbers cited in the finance and investing world. The Dow Jones Industrial Average (DJIA) is probably the best-known and most widely followed stock market index in the world. It consists of 30 large, publicly traded firms in the United States.

The S&P 500 Index is also very popular. The 500 companies included in the S&P represent over 70% of the total market capitalization of all stocks traded in the U.S.

The Nasdaq Composite is a broad market index that has about 4,000 issues traded on the Nasdaq National Market - virtually every firm that trades on the exchange.

1.1. INTRODUCTION TO THE PROJECT

The global investment theory states that it is impossible to "beat the market" because stock market efficiency causes current share prices to always incorporate and reflect all relevant information. It is believed that share prices appear to follow random walks but why it follows was matter of great concern and thus need answer through a model of share price behaviour to explain the random walk. The existing gap was filled by model based on the concept of efficiency of the market in which shares are commonly traded is the efficient market hypothesis (EMH). Under this (EMH) theory it is assumed that capital markets operate to a high degree of perfection. Its foundation base on the random walk hypothesis, which suggests the share price changes are of a random, rather than correlated, nature.

The EMH theorist assume that the efficient capital market refers to a market and approach that adjusts rapidly to new information which are costless and are spontaneously transmitted to the markets to establish share prices which are tend to be a fair price. It is a place where there are large numbers of intelligent investors and rational profit maxi-misers, who compete with each other freely in an atmosphere where there is no transaction cost and taxes. All investors take similar views on the implications of current available information which are easily available to all incoming and outgoing participants about current prices and distribution of the future prices of each securities and simultaneously try to predict future market values of individual securities.

Under EMH, the adjustment processes tend to allow price to vary randomly around the norms and stock are always traded at their fair value on stock exchanges, and it is impossible for the general investors to transact, either purchase depreciated value stocks or sell stocks for inflated prices because in efficient market at any point in time the actual price of a security will be a good estimate of its intrinsic value. As new information is learnt, prices move, and due to adjustment process, the movement will be up and down depending upon stimulus. This adjustment becomes random due to overreaction of speculators and investors.

The EMH emphasizes that it will be impossible to outperform the overall market through selected and expert stock selection or market timing, and simultaneously this prevailing situation is the only ultimate way an investor can possibly obtain higher returns by purchasing riskier investments as EMH states on the capital market efficiency.

In an EMH, prices fully and instantaneously reflect all relevant available information which means that when stock transactions held, prices normally proves accurate signal for capital allocation. According to *Fama (1970)* that market normally operates in three different forms in term of their level of efficiency: weak, semi-strong & strong, according to the type or scope of information which will quickly and fully reflected in price. Each level designed to correspond with the different types of picking winners investment strategies, which were used in practice to try to achieve excessive returns.

Weak form of market efficiency is identical with random walk model in which technical analysis is of no use, each share price is assumed to reflect fully the information content of the entire past share price and it advices that stock prices have no recall as yesterday has nothing to do with tomorrow.

Semi-strong form of efficiency deals only with publicly known information, where fundamental analysis is of no use, in this form the information is assumed to include not only that given by all past share prices but all the public available information relevant to the share value including company announcement, broker reports, industry forecasts and company account.

Strong form of efficiency deals with complete information in which insider information is of no use. In this form, EMH requires all known information to be impounded in the current share price, whether publically and generally available or not. The strong form of EMH also include what is known as insider information like details of an impending takeover bid confidentially known only to top management of both parties to the bid. An “efficient” market, i.e., a market that adjusts rapidly to new information.

Assumption of EMH:

The basic assumption in an efficient capital market is that, prices of traded securities always fully reflect all public available information concerning the securities and the other general assumptions on which EMH spins are.

- Investors are rational.
- Markets are rational.
- All available information is costless to all market participants.
- There are no taxes or, more specifically, taxes play no part in financial decision-making.
- There are no transaction costs.
- A company and its investors are uncaring about an additional debt and an additional equity.

Characteristics of EMH

In general an efficient market for securities possesses the following characteristics.

- Under EMH at any given point of time there is timely and accurate information available on the price and volume of past transactions and on prevailing supply and demand.
- Under EMH Liquidity always prevail, means transaction of an asset which are bought or sold take place quickly at a price to the price of the previous transaction assuming no new information has been received.
- Under EMH transaction cost are almost low, means that all aspects of the transaction are carried out on low costs, like the actual brokerage cost involved in the transaction and the cost of transferring the securities and also the cost of reaching the market

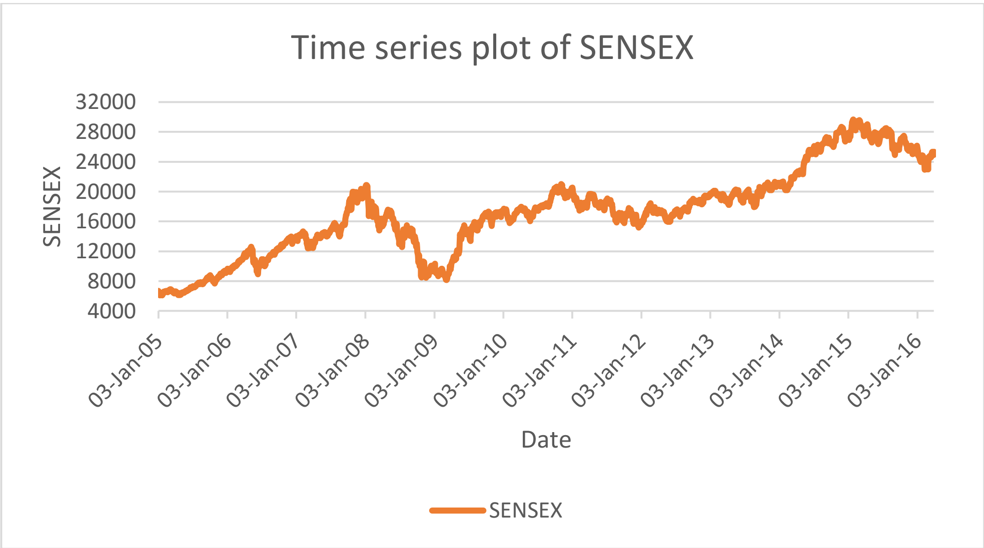
In this study we took 5 Asian stock indexes which are explained below.

BSE SENSEX

The Bombay Stock Exchange **Sensitive Index** usually known as SENSEX or BSE 30. SENSEX is regarded as the pulse of the domestic stock markets in India. SENSEX 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. These companies directly represents various industrial sectors of the Indian economy. SENSEX was first launched on January 1, 1986. The base value of the SENSEX is taken as 100 on April 1, 1979, and its base year as 1978-79. Initially Sensex was launched on full – market capitalization method which was effective till August 31, 2003.BSE launched a dollar-linked version of SENSEX, called Dollex-30 on 25 July, 2001. During 2008-12, Sensex Index fell from 49% to 25%. In March 2015 Sensex breaches 30000 mark due to the steps taken by RBI in cutting the repo rates while in August 2015 market fell maximum of 1,624.51 points.

The 11 year and 3 months Index prices taken for study is show cased in figure 1.1.

Figure 1.1 ***Time Series Plot of SENSEX***

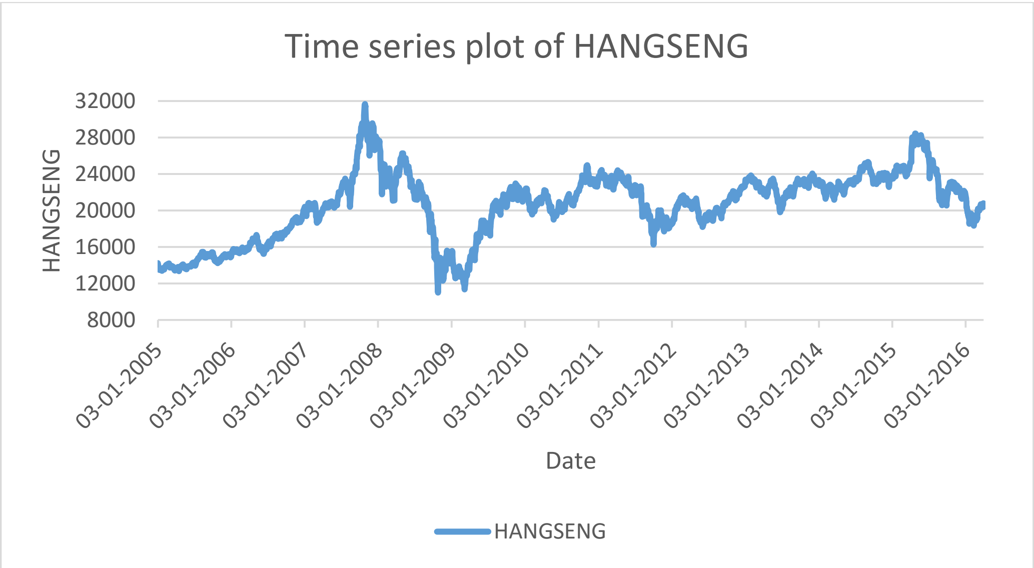


HENG SANG

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. HSI comprises 45 constituent companies which represent about 60% of capitalization of the Hong Kong Stock Exchange. 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. Hang Seng Bank is one of the largest banks registered and listed in Hong Kong in terms of market capitalization. Hang Seng Bank 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

The 11 year and 3 months Index prices taken for study is show cased in Figure 1.2.

Figure 1.2 ***Time Series Plot of HANGSENG***

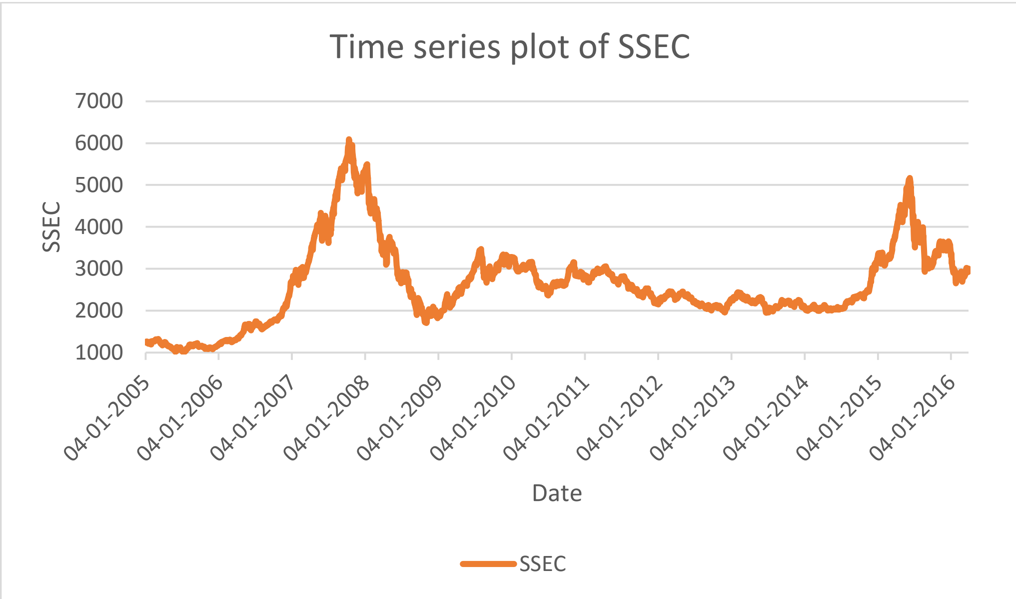


SSE Composite

The **SSE Composite Index** is an index of all stocks 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.

The 11 year and 3 months Index prices taken for study is show cased in graph 1.3.

Figure 1.3 ***Time Series Plot of SSEC***

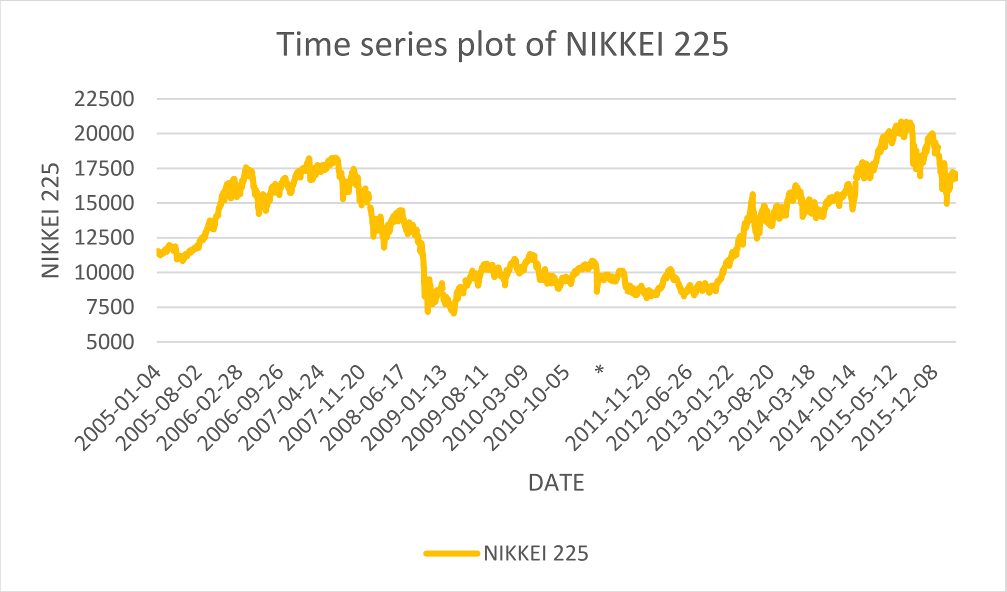


NIKKEI 225 Index

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, and the 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. It was known as the "Nikkei Dow Jones Stock Average" from 1975 to 1985. The Nikkei 225 had been launched on September 7, 1950. From 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.

The 11 year and 3 months Index prices taken is show cased in Figure 1.4.

Figure 1.4 ***Time Series Plot of NIKKEI 225***



KOSPI

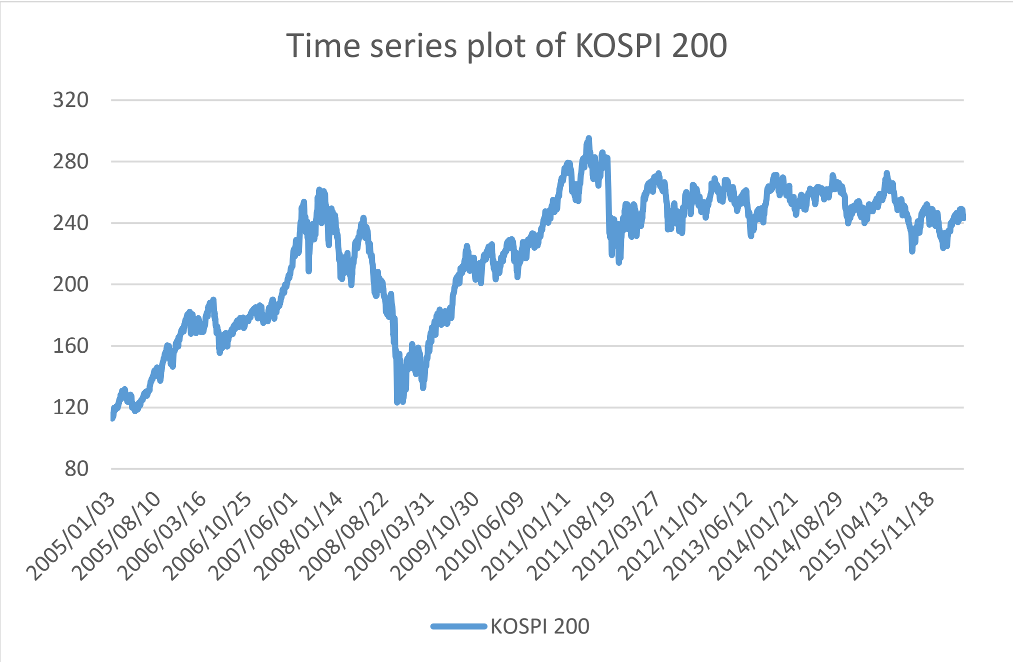
The KOSPI 200 Index is a capitalization-weighted index of 200 Korean stocks which make up 93% of the total market value of the Korea Stock Exchange. The index was developed with a base value of 100 as of January 3, 1990. KOSPI 200 is important because it is listed on futures and option markets and is one of the most actively traded indices in the world. The KOSPI is calculated as current market capitalization at the time of comparison divided by base market capitalization (as of January 4, 1980).

Current index = Current total market cap of constituents × 100 / Base Market Capitalization

Its all-time low is 31.96, reached on June 16, 1998, during the financial crisis. It closed above 200 for the first time on April 24, 2007.

The 11 year and 3 months Index prices taken for study is show cased in Figure 1.5.

Figure 1.5 ***Time Series Plot of KOSPI 200***



The Summary of the Stock exchanges taken are given in the table 1.1

Table 1.1 ***Summary of stock exchanges***

Particulars	BSE	HKEX	SSE	TSE	KRX
Location	Mumbai, India	Hong Kong, China	Shanghai, China	Tokyo, Japan	Busan & Seoul, South Korea
Founded	1875	1891	1990	1949	2005
Key People	Ashish Chauhan (CEO)	Charles Li (CEO)	Geng Liang (Chairman) Zhang Yujun (President)	Atsushi Saito	Choi Kyung-Soo (CEO / Chairman)
Currency	Indian Rupees	Hong Kong dollar	Renminbi	Japanese yen	South Korean won
No of listings	5749	1775	1071	2292	2050
Market cap	US$ 1.64 Trillion (Sept 2015)	US$3.9 trillion (April 2015)	US$3.5 trillion (Feb 2016)	US$4.09 trillion (April 2015)	US$1.2 trillion
Website	http://www.bseindia.com/	https://www.hkex.com.hk	http://english.sse.com.cn/	http://www.jpx.co.jp/english/	https://global.krx.co.kr/main/main.jsp
Logos					

1.2. OBJECTIVE OF THE STUDY

PRIMARY OBJECTIVE

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

SECONDARY OBJECTIVE

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

HYPOTHESIS OF THE STUDY

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

1. H0 : Daily distribution of stock markets returns is normally distributed (DS)
2. H0 : The succeeding price changes are not dependent and move randomly (Runs Test)
3. H0 : The stock returns of the markets under the study follow normal distribution (K-S test)
4. H0 : The stock prices are not normally distributed(Sign test)
5. H0 : Series contains a unit root (Unit Root test)
6. H0 : There is no autocorrelation between the stock prices (Auto-correlation test)
7. H0 : The share prices follow Brownian motion (Monte-Carlo simulation on Brownian Motion)

2. LITERATURE REVIEW

The literature review is summarized in the Table 2.1.

Table 2.1 ***Literature Review***

S. No	Author	Markets Under Study	Period of study	Procedure used	Results
1	Bhanu Pant and T.R. Bishnoi (2002)	India	1996-2000	Unit Root test, Auto-correlation and Variance Ratio.	The random walk hypothesis for daily and weekly market indices returns was not accepted.
2	Bin Liu (2003)	China	1996-2002	Fama-MacBeth, regressions and Auto-correlation	Evidence that is not favouring the weak-from EMH. Evidence does not provide any support for the proposition that the SSE is a weak-form.
3	Ashutosh Verma (2005)	India	1996-2001	Serial Correlation	Over all the market is weak form efficient
4	Arusha Cooray and Guneratne Wickremasinghe	India, Sri Lanka, Bangladesh and Pakistan	1996-2005	Pair-wise Correlation, Auto-correlation, Co-integration 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.

5	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.
6	Batool Asiri (2008)	India	1990-2000	ARIMA, Auto-correlation and 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.
7	P K Mishra and B B Pradhan (2009)	India	2001-2009	Unit Root Test, Phillips-Perron test and Augmented Dickey-Fuller(ADF)	The study provides the evidence of weak form inefficiency of Indian capital market.
8	Saif Sadiqui and P.K.Gupta (2010)	India	2000-2008	Runs test, K-S test, Auto-correlation, Auto-regression and ARIMA	The results of both indices suggest do not exhibit weak form efficiency.
9	P K Mishra (2010)	India	1991-2009	Unit Root test and GARCH Model	It represents inefficiency of Indian capital market.
10	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.

11	Saqib Nisar and Muhammad Hanif (2012)	India, Pakistan, Bangladesh and Sri Lanka	1997-2011	Durbin-Watson Test, Runs Test, Unit Root Test, and Variance Ratio Test	Overall results indicate that all of these markets are not weak form efficient

3. METHODOLOGY

3.1. DATA COLLECTION SOURCES

The study is done with special reference to Asian stock market indexes. For the purpose of the study daily market prices for 11 years and 3months have been taken from all five indexes for period January 1st 2005 to March 31st 2016. The research is descriptive in nature and judgmental sampling technique has been used to analyse the weak form of efficient market hypothesis. For the study secondary data are used which was collected from the websites of BSE – BSE Sensex, HKEx - HANG SENG, SSE - SSE Composite, TSE - NEKKEI and KRX – KOSPI. Also published national documents and magazines have been taken as references for the study. Index prices have been collected for the period of 1st January 2005 to 31st March 2016.

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 3 months.

Summaries of Market under study shown in the table 3.1

Table 3.1 ***Stock Market summaries***

No.	Markets	Country	Index	Period From	Period To	Total No. of Observations
1	BSE	India	BSE Sensex 30	01-01-2005	31-03-2016	2792
2	HKEx	Hong Kong	Hang Seng	01-01-2005	31-03-2016	2818
3	TSE	Japan	Nikkie225	01-01-2005	31-03-2016	2756
4	SSE	China	SSE Composite	01-01-2005	31-03-2016	2735
5	KRX	Korea	KOSPI	01-01-2005	31-03-2016	2813

3.2. DATA COLLECTION STRATEGIES

RUNS TEST

Runs test is used to find whether a data set is from a random process. We applied runs test to find out the serial independence in return series which will find out the trend in the succeeding price variations. A run is defined as a series of increasing values or a series of decreasing value. Total number of increasing and decreasing values is length of the run.

A series of 21 coin tosses might produce the following sequence of heads (H) and tails (T).

H H T T H H T T T T H H H T T T T H H T T T

H0: The distribution of toss is random

H1: The distribution of toss is not random

Where in H H T T- H H is a run and T T is another run so

$n_1 = 9$ ⟶ there are 9 occurrences of the value H

$n_2 = 13$ ⟶ there are 13 occurences of the value T

$u = 8$ *(Runs)*

$\propto = 0.05$

$u_{critical} = 6,17$

There are 2 critical values of *u*, if the calculated value falls between these then Ho is accepted

$6 < 8 < 17$ accept Ho

The distribution of toss is random (u_8, $p>0.05$)

The share prices are checked whether they are above mean or below mean then the runs are calculated according to the graph. Every time when the share price series cuts mean line and moves up or down wards then they are taken as 1 run.

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.

The Kolmogorov-Smirnov test is defined by:

H0: The data follow a specified distribution

Ha: The data do not follow the specified distribution

Test Statistic: The Kolmogorov-Smirnov test statistic is defined as

$$D = \max_{1 \le i \le N} \left(F(Y_i) - \frac{i-1}{N}, \frac{i}{N} - F(Y_i) \right)$$

F - Theoretical cumulative distribution of the distribution being tested which must be a continuous distribution

SIGN TEXT

The Sign test is a non-parametric test that is used to test whether or not two groups are equally sized. The sign test is used when dependent samples are ordered in pairs, where the bivariate random variables are mutually independent.

It is based on the direction of the plus and minus sign of the observation, and not on their numerical magnitude. It is also called the binominal sign test, with p = .5.

Procedure:

1. Calculate the + and – sign for the given distribution.
2. Denote the total number of signs by 'n' (ignore the zero sign) and the number of less frequent signs by 'S.'
3. Obtain the critical value (K) at .05 of the significance level by using the following formula

$$Z = \frac{S - np}{\sqrt{np(1-p)}}$$

Compare the value of 'K' with the critical value (Z). If the value of S is greater than the value of Z, then the null hypothesis is accepted. If the value of the K is less than the critical value of Z, then the null hypothesis is rejected.

UNIT-ROOT TEST

In statistics, a **unit root test** tests whether a time series variable is non-stationary using an autoregressive model. A commonly used test that is valid in large samples is the augmented Dickey–Fuller test.

$$\Delta R_t = b_0 + b_i + \pi_0 R_{t-1} + \sum_{t=1}^{j} \Psi_i \Delta R_{it-1} + \varepsilon_t$$

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.

$$Q_{Ljung\_Box} = n(n+2) \sum_{t=1}^{k} \frac{\Psi^2(t)}{n-t}$$

MONTE CARLO SIMULATION: GEOMETRIC BROWNIAN MOTION

A Monte Carlo simulation is an attempt to predict the future stock prices many times over and over. The simulation produces thousands or millions of random trials that can be analysed and generate distribution of the outcome. The basics steps are:

1. Specify a model for example geometric Brownian motion

2. Generate random trials

3. Process the output

GBM is technically a Markov process which specify stock prices follows a random walk and is consistent with the weak form of the efficient market hypothesis. In simple terms past prices information is already incorporated and the future movement is independent with the past price movements.

Formula for GBM is

$$\frac{\Delta S}{S} = \mu \Delta t + \sigma \varepsilon \sqrt{\Delta t}$$

Where

S – Stock Price

μ - Expected Returns

σ – Standard deviation of returns

ε – Random Variable

Above formula can be rearranged as

$$\Delta S = S(\mu \Delta t + \sigma \varepsilon \sqrt{\Delta t})$$

$\mu \Delta t$ - Drift

$\sigma \varepsilon \sqrt{\Delta t}$ - Shock

Our Model assumes that for each period the price will drift up by expected return but the drift is shocked by the random shock.

Random trials are generated through Excel with the function

= P*(1+ (NORMINV (RAND (), Mean, STDV)))

Where

P-Initial price / previous day price

For the purpose of the study we run 100 trials with daily steps for 400 days. Then the final prices are charted out in histogram to identify whether the prices are normally distributed.

4. DATA ANALYSIS

4.1. ANALYSIS

4.1.1 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 table 4.1.

During the period from 1st Jan 2005 to 31st Mar 2016 BSE Sensex, HANGSENG, SSE Composite, NIKKEI and KOSPI markets showed positive average daily returns. The highest daily return came from the BSE Sensex at 0.06 % followed by SSEC 0.05% KOSPI 0.04% HANGSENG 0.03%. The high daily returns on BSE Sensex is due to the increase in market capitalisation of Indian companies over the decade. The lowest daily return is witnessed by NIKKEI 0.02%. At the same time SSE Composite is showing 0.10% median which is moving positively and showing good sign for return whereas KOSPI and NIKKEI Indicates 0.06% and shows 1.37% and 1.57% volatility which is less than the other markets where BSE Sensex shows 1.53% volatility, SSE Composite at 1.78% and HANGSENG at 1.57%. 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 3.96% followed by SSEC and KOSPI 2.71% and 2.58%

The Values for Skewness 0 and kurtosis 3 represents that the observed distribution is normally distributed. Here the value of skewness and kurtosis of stock return series of the five selected Asian stock markets are not equal to 0 and 3 respectively, which is (negatively skewed for SSE Composite -0.39, NIKKEI -0.25, KOSPI -0.22 and Positively skewed for HANGSENG 0.302 and BSE Sensex 0.317), and the value of all markets of Kurtosis is positive, thereby indicating leptokurtic distribution.

Table 4.1 ***Descriptive statistics results***

	Sensex	***NIKKEI***	***KOSPI***	***HANSENG***	***SSEC***
Mean	0.06%	0.02%	0.04%	0.03%	0.05%
Standard Error	0.03%	0.03%	0.03%	0.03%	0.03%
Median	0.09%	0.06%	0.06%	0.04%	0.10%
Minimum	-10.96%	-11.41%	-10.33%	-12.70%	-8.84%
Maximum	17.34%	14.15%	12.23%	14.35%	9.46%
Standard Deviation	1.53%	1.57%	1.37%	1.57%	1.78%
Average daily Return to S.D. Ratio	3.96%	1.57%	2.58%	1.85%	2.71%
Sample Variance	0.000233	0.000247	0.000186	0.000246	0.000315
Kurtosis	9.648715	7.748017	7.325285	10.04677	3.558302
Skewness	0.317359	-0.25748	-0.22763	0.302557	-0.39062
Range	0.282958	0.255567	0.225614	0.270471	0.182958
Sum	1.654601	0.673456	0.961442	0.792682	1.315693
Count	2734	2734	2734	2734	2734
Confidence Level (95.0%)	0.000573	0.00059	0.000512	0.000588	0.000666
Jarque-Bera	10651.27	6868.829	6136.356	11540.18	1511.883
p-value	0	0	0	0	0

The calculated Jarque-Bera statistics and p-values in the table 4 are used to test null hypothesis for normal distribution (H0: 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.

4.1.2 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 of 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. It is a positive change when return is greater than the mean, a negative when the return is less than the mean and zero when the return equals to the mean. To perform the runs test, and the runs can be carried out by comparing the actual runs R to the expected number of runs $\overline{R}$.

Table 4.2 ***Results of Runs test***

	SENSEX	HANGSENG	NIKKEI	SSEC	KIOSPI
K=mean	0.0006051	0.00028994	0.000246	0.00048123	0.000351
Cases>K	1406	1376	1403	1421	1405
Cases<K	1328	1358	1331	1313	1329
Total Cases	2734	2734	2734	2734	2734
Number of runs	1279	1405	1436	1357	1356
E(R)	1366.8873	1367.9407	1367.051	1365.86686	1366.943
Stdev(R)	26.117766	26.137916	26.12091	26.0982458	26.11884
Z-value	-3.3650406	1.4178351	2.639573	-0.3397493	-0.41899
p-value (2-tailed)	0.00076532	0.1562389	0.0083011	0.73404530	0.675219

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. 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 indicates that both markets are inefficient, means not weak form efficient for whole period so investor can predict the markets returns. HANGSENG, SSE Composite and KOSPI, we cannot reject null hypothesis, since the values concluded that both markets are efficient and follow random walk so investor cannot predicted the market returns for whole period.

4.1.3 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 4.3 ***Results of K-S test***

	SENSEX	**NIKKEI**	**KOSPI**	**HANGSENG**	**SSEC**
Absolute	0.075	0.069	0.074	0.087	0.082
Positive	0.069	0.053	0.064	0.077	0.059
Negative	-0.075	-0.069	-0.074	-0.087	-0.082
Z-value	3.936	3.596	3.849	4.558	4.282
P-value	0	0	0	0	0

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 table 4.3 indicates the null hypothesis H0: *The stock returns of the markets under the study follow normal distribution* cannot be accepted which means the all markets under the study do not follow normal distribution because it provide p-value which is insignificance at the 1% level of significance. These results are also similar finding with descriptive statistics which also indicate markets under the study do not follow normal distribution.

4.1.4 SIGN TEST

Sign test is a non-parametric test to discover whether the observed distribution fits normal distribution. It is based on the binomial distribution of number of positive and negative signs in the sample. The results of the test is tabulated in table 4.4.

Table 4.4 ***Sign Test Results***

	SSE	**HANGSENG**	**Sensex**	**Kospi**	**Nikkei**
Total Counts	2734	2734	2734	2734	2734
Positive	1421	1376	1406	1405	1403
Negative	1313	1358	1328	1329	1331
Binomial for positive	0.97965	0.627453	0.929581	0.924274	0.912754
p-value	0.02035	0.372547	0.070419	0.075726	0.087246

The data contained in the table 4.4 indicates that except SSEC all other indexes fails to rejects null hypothesis H0: *the stock prices are not normally distributed* implying thereby that returns where not normally distributed and all the markets were exhibiting weak form of efficiency except SSEC.

4.1.5 UNIT –ROOT TEST

Unit root test helps in finding whether the distribution is stationary or non-stationary. Unit root test is applied with all the market prices to see whether there returns are stationary.

The lags are selected based on Schwarz info criterion -27 lags. The result of the test is shown in the table 4.5 and 4.6.

Table 4.5 ***ADF Test Results at levels***

	t-statistics	Probability	Critical Value		
			1%	**5%**	**10%**
NIKKEI	-1.4285	0.8527	-3.9614	-3.4115	-3.1276
KOSPI	-2.7283	0.2251	-3.9614	-3.4115	-3.1276
SENSEX	-2.5812	0.2890	-3.9614	-3.4115	-3.1276
HANGSENG	-2.7551	0.2144	-3.9614	-3.4115	-3.1276
SSEC	-1.9234	0.6419	-3.9614	-3.4115	-3.1276

Table 4.6 ***ADF Test Results at First Difference***

	t-statistics	Probability	Critical Value		
			1%	**5%**	**10%**
NIKKEI	-54.8053	.000	-3.9614	-3.4115	-3.1276
KOSPI	-51.6127	.000	-3.9614	-3.4115	-3.1276
SENSEX	-48.3076	.000	-3.9614	-3.4115	-3.1276
HANGSENG	-53.7870	.000	-3.9614	-3.4115	-3.1276
SSEC	-23.2902	.000	-3.9614	-3.4115	-3.1276

According to the test result presented in the table 4.5 and 4.6 ADF fails to accept the null hypothesis (H0: *The stock prices are non-stationary)* at levels but rejects null hypothesis at first difference which means the stock price indexes are non-stationary and becomes stationary at first difference, in other words they follow a random walk.

4.1.6 AUTO-CORRELATION

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. The serial correlation coefficient measures the relationship between the values of a random variable at time t and its value in the previous period. 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.

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, 4, 5, 6, 11 and 12. HANGSENG also shows significant negative autocorrelation at lag 1, 3, 4, 5, 9, 10, 11 and 14. Nikkei shows negative autocorrelation at lag 1 to 6, 8, 12, 13 and 16. SSE composite shows negative autocorrelation at lag 2, 6, 10 and 14. 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 between the stock prices*) if p-value is significant at 1 % and 5% ($p\text{-value}<0.05$). So in BSE the null hypothesis cannot be accepted for all lags. It means that returns are not auto correlated. Similarly the returns are not auto correlated in the HANGSENG except for lag 1, 2, 3, 6, 7 and 8. The returns for Nikkei market are not auto correlated except for lag 5 to 16. The returns of SSE composite are not auto correlated except for lag 1 to 3.And the returns of KOSPI fails to reject null hypothesis (i.e: market is auto correlated in all lags). 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 4.7 ***Auto-correlation results of SENSEX, HANGSENG and NIKKEI***

	SENSEX			HANGSENG			NIKKEI		
Lag	**Autocorr**	**Q-stat**	**p-val**	**Autocorr**	**Q-stat**	**p-val**	**Autocorr**	**Q-stat**	**p-val**
1	0.0726	14.42	0	-0.0307	2.585	0.11	-0.0497	6.761	0.01
2	-0.0336	17.52	0	0.0137	3.097	0.21	-0.0030	6.786	0.03
3	-0.0217	18.81	0	-0.0420	7.924	0.05	-0.0265	8.706	0.03
4	-0.0246	20.47	0	-0.0276	10.01	0.04	-0.0226	10.11	0.04
5	-0.0218	21.78	0	-0.0276	12.1	0.03	-0.0098	10.37	0.07
6	-0.0375	25.63	0	0.0126	12.53	0.05	-0.0093	10.61	0.1
7	0.0177	26.49	0	0.0164	13.27	0.07	0.0204	11.76	0.11
8	0.0509	33.6	0	0.0284	15.48	0.05	-0.0084	11.95	0.15
9	0.0182	34.51	0	-0.0301	17.96	0.04	0.0009	11.95	0.22
10	0.0120	34.91	0	-0.0592	27.58	0	0.0248	13.64	0.19
11	-0.0116	35.27	0	-0.0081	27.76	0	0.0012	13.65	0.25
12	-0.0009	35.28	0	0.0176	28.62	0	-0.0019	13.66	0.32
13	0.0199	36.37	0	0.0598	38.44	0	-0.0142	14.21	0.36
14	0.0445	41.8	0	-0.0588	47.94	0	0.0185	15.15	0.37
15	0.0006	41.81	0	0.0532	55.73	0	0.0228	16.58	0.35
16	0.0018	41.81	0	0.0187	56.7	0	-0.0244	18.22	0.31

Table 4.8 ***Auto-correlation results of SSEC and KOSPI***

	SSE			KOSPI		
Lag	**Autocorr**	**Q-stat**	**p-val**	**Autocorr**	**Q-stat**	**p-val**
1	0.0211	1.22	0.3	0.0100	0.272	0.6
2	-0.0277	3.326	0.2	-0.0204	1.413	0.49
3	0.0286	5.574	0.1	-0.0044	1.466	0.69
4	0.0707	19.25	0	-0.0366	5.141	0.27
5	0.0064	19.37	0	-0.0343	8.364	0.14
6	-0.0655	31.12	0	-0.0015	8.37	0.21
7	0.0304	33.65	0	0.0073	8.515	0.29
8	0.0154	34.3	0	0.0011	8.519	0.39
9	0.0020	34.31	0	0.0230	9.973	0.35
10	-0.0114	34.67	0	0.0000	9.973	0.44
11	0.0300	37.14	0	-0.0151	10.6	0.48
12	0.0139	37.67	0	-0.0087	10.81	0.55
13	0.0675	50.2	0	0.0061	10.91	0.62
14	-0.0258	52.03	0	-0.0251	12.65	0.56
15	0.0465	57.97	0	-0.0231	14.11	0.52
16	0.0105	58.28	0	0.0192	15.13	0.52

4.1.7 MONTE CARLO SIMULATION: GEOMETRIC BROWNIAN MOTION

Monte-Carlo test is a non-parametric test that is designed to examine whether the price changes are normally distributed. According to the test the future price is simulated through random numbers and find whether the future prices follow Brownian motion. The mean and standard deviation of historical prices are taken to predict the future prices. For the purpose of the study we run 100 trials with daily steps for 400 days. Then the final prices are charted out in histogram to identify whether the prices are normally distributed.

KOSPI

The time series chart of all trails on KOSPI are plotted in figure 4.1 and final prices are plotted in histogram to identify whether the prices are normally distributed.

Figure 4.1 ***Brownian motion: KOSPI***

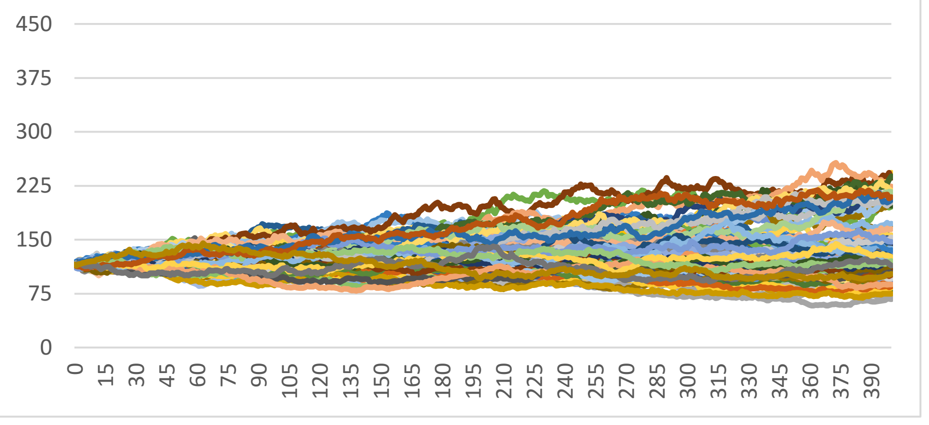
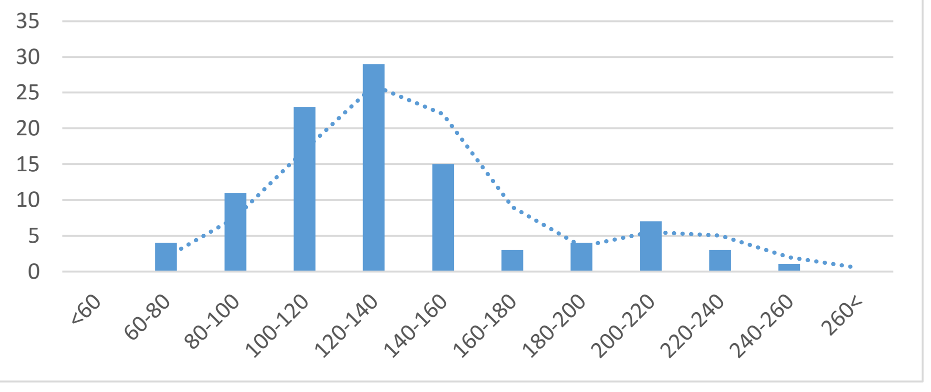


Figure 4.2 ***Histogram of KOSPI final price***



According to the trails run in KOSPI Index shown in the figure 4.2 we have one trail end between 240-260 and 4 trails ending in 60-80. Which produce sudden drop on the left side of the histogram and slow one on the right side of the histogram.

The histogram shows that the end prices of KOSPI does not produce a normal distribution and fails to reject null hypothesis H0: *The share prices follow Brownian motion*. KRX exchange follows Brownian motion.

NIKKEI

The time series chart of all trails on NIKKEI are plotted in figure 4.3 and final prices are plotted in histogram to identify whether the prices are normally distributed.

Figure 4.3 ***Brownian Motion: NIKKEI***

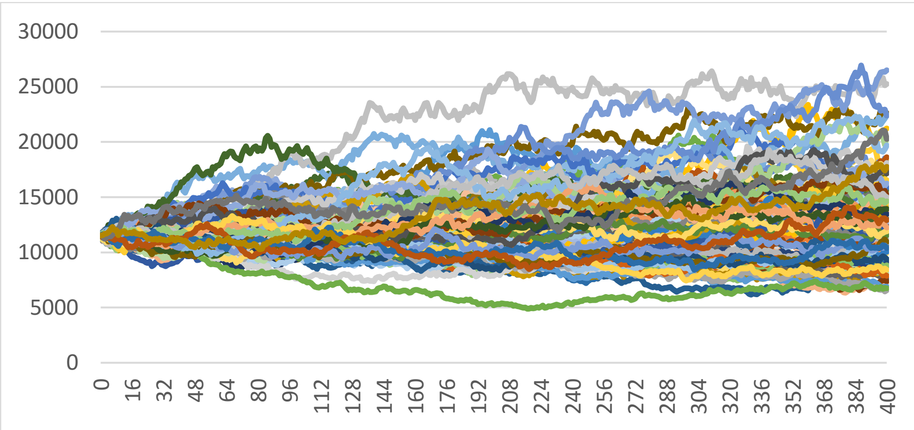
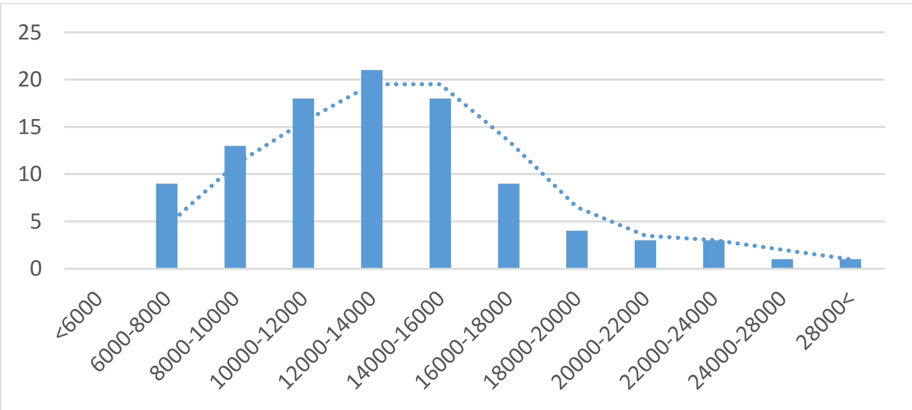


Figure 4.4 ***Histogram of NIKKEI final price***



According to the trails run in NIKKEI Index shown in the figure 4.4 we have one trail end above 28000 and 9 trails ending in 6000-8000. Which produce sudden drop on the left side of the histogram and slow one on the right side of the histogram. The histogram shows that the end prices of NIKKEI does not produce a normal distribution and fails to reject null hypothesis H0: *The share prices follow Brownian motion*. TSE exchange follows Brownian motion.

BSE Sensex

The time series chart of all trails on BSE Sensex are plotted in figure 4.5 and final prices are plotted in histogram to identify whether the prices are normally distributed.

Figure 4.5 ***Brownian motion: BSE Sensex***

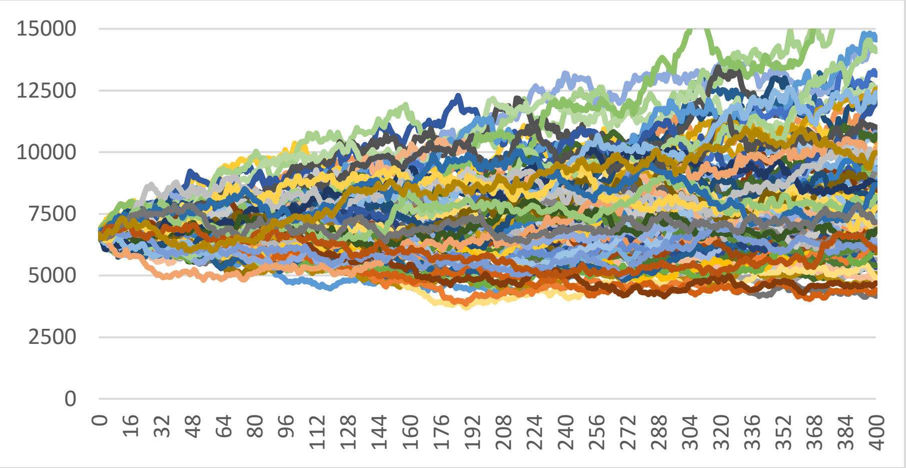
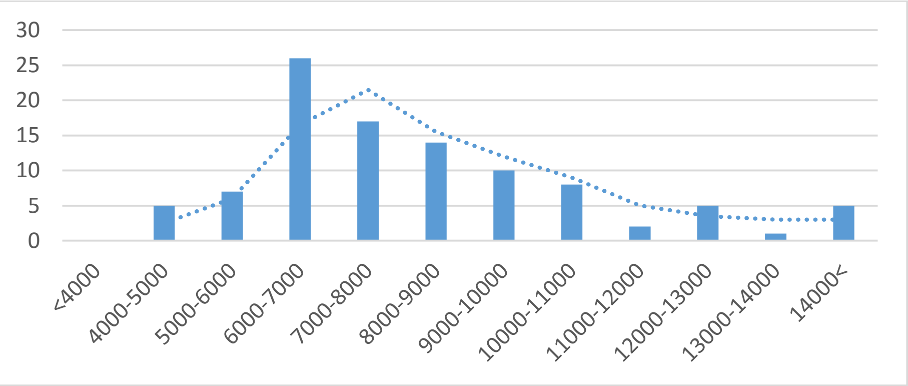


Figure 4.6 ***Histogram of BSE Sensex final price***



According to the trails run in BSE Sensex Index shown in the figure 4.6 we have 5 trail end above 14000 and 5 trails ending in 4000-6000. Which produce sudden drop on the left side of the histogram and slow one on the right side of the histogram. The histogram shows that the end prices of BSE Sensex does not produce a normal distribution and fails to reject null hypothesis H0: *The share prices follow Brownian motion*. BSE exchange follows Brownian motion.

HANG SENG

The time series chart of all trails on HANG SENG are plotted in figure 4.7 and final prices are plotted in histogram to identify whether the prices are normally distributed.

Figure 4.7 ***Brownian motion: HANG SENG***

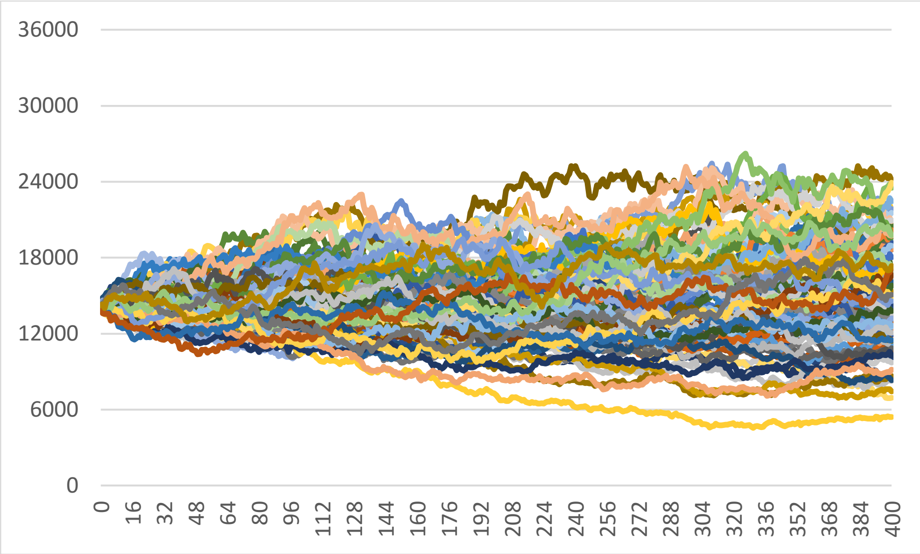
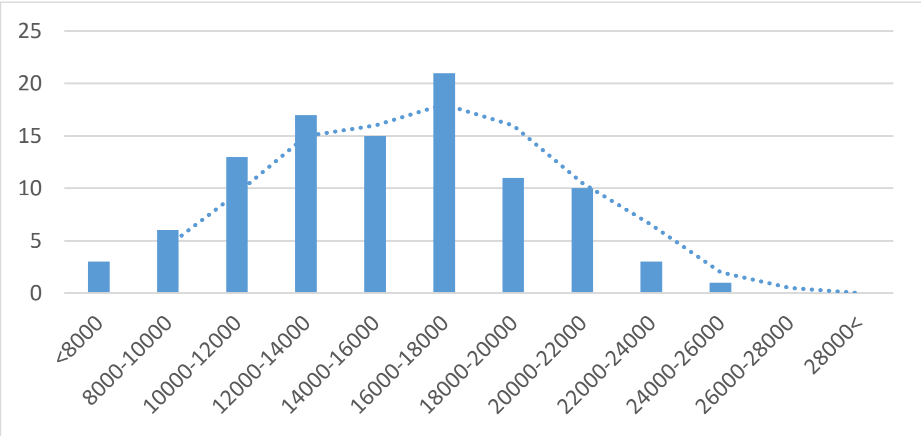


Figure 4.8 ***Histogram of HANG SENG final price***



According to the trails run in HANG SENG Index shown in the figure 4.8 we have 1 trail end between 24000-26000 and 3 trails end below 8000. Which produce sudden drop on the left side of the histogram and slow one on the right side of the histogram. The histogram shows that the end prices of HANG SENG does not produce a normal distribution and fails to reject null hypothesis H0: *The share prices follow Brownian motion*. HSEx exchange follows Brownian motion.

SSEC

The time series chart of all trails on SSEC are plotted in figure 4.9 and final prices are plotted in histogram to identify whether the prices are normally distributed.

Figure 4.9 **_Brownian Motion: SSEC_**

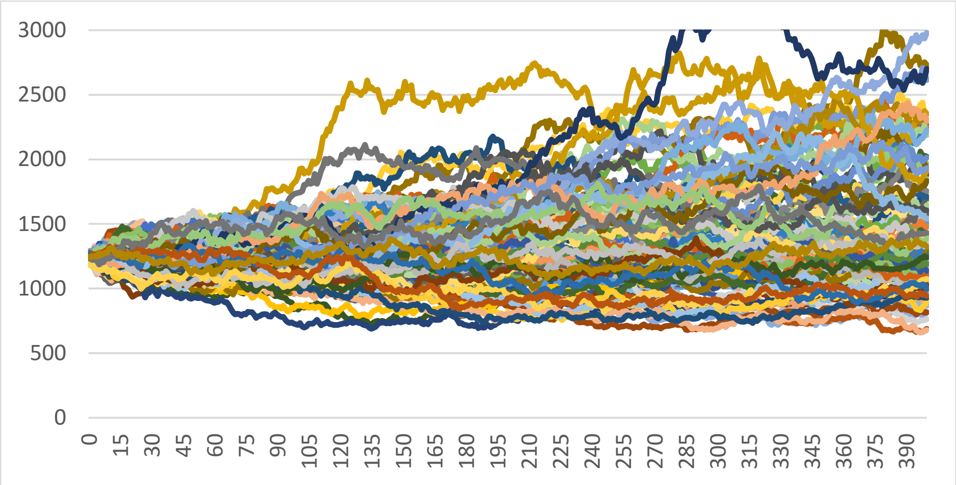
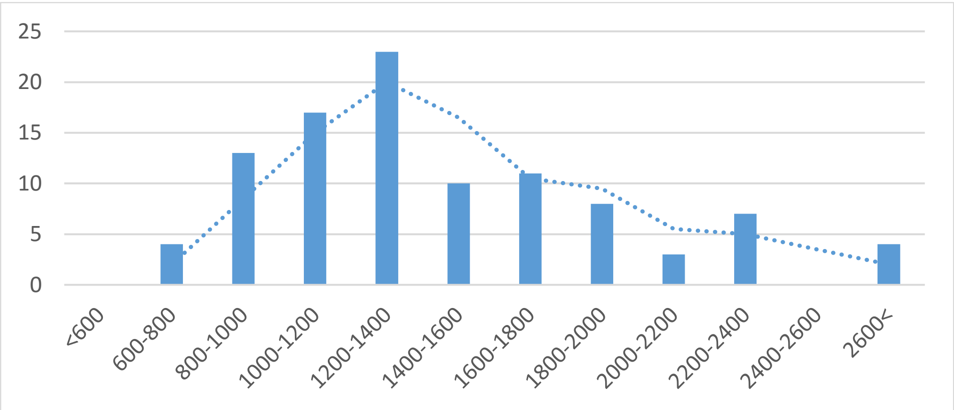


Figure 4.10 **_Histogram of SSEC final price_**



According to the trails run in SSEC Index shown in the figure 4.10 we have 4 trail end above 2600 and 4 trails ending in 600-800. Which produce sudden drop on the left side of the histogram and slow one on the right side of the histogram. The histogram shows that the end prices of SSEC does not produce a normal distribution and fails to reject null hypothesis H0: *The share prices follow Brownian motion*. SSE exchange follows Brownian motion.

4.2. FINDINGS AND RECOMMENDATION

Our study investigates the weak form of market efficiency in the selected markets of Asia. The sample size consisted of 5 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. The table 4.9 shows the findings of our study on full sample period of all indexes.

Table 4.9 ***Findings***

No	Test Applied	Findings
1	Descriptive Statistics	BSE Sensex (0.06%) has paid the highest mean returns to the investor followed by SSE Composite (0.05%), KOSPI (0.04%) and HANGSENG (0.03%) SSE Composite could be considered as high risk markets as it has reported the highest SD (1.78%).
2	Run test	BSE Sensex and NIKKEI does not hold weak form of efficiency which means both these markets are inefficient Whereas HANSENG, KOSPI and SSE Composite hold weak form of efficiency.
3	KS Test	This test shows that the returns of all the five selected markets under study are not normally distributed.
4	Sign Test	Except SSEC all the markets are not normally distributed
5	Unit-Root	This test indicates that all the markets under the study follow random walk model which shows that the markets follow weak form of efficiency.
6	Auto correlation	BSE returns are not auto correlated whereas KOSPI returns are auto correlated. In NIKKEI not auto correlated initial lags and then auto correlated whereas for HANGSENG and SSEC markets are auto correlated initially and then not auto-correlated.
7	Monte-Carlo Simulation for Brownian Motion	This test indicates that all the markets under the study follow Brownian Motion /Random walk model which shows that the markets follow weak form of efficiency.

4.3. 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.

4.4. CONCLUSION

The study provides the evidence of weak form of efficiency of the selected stock markets over the full sample period. 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, Sign test and runs test were applied. By applying unit root test the results review that the data series are stationary for full sample period. The results of Auto-correlation suggest mixed observation weak-form of efficiency and inefficiency for all the markets.

5. BIBILOGRAPHY/REFERENCES

- Marashdeh, H., & Shrestha, M. B. (2008). Efficiency in Emerging Markets - Evidence from the Emirates Securities Market, *European Journal of Economics, Finance and Administrative Sciences,* 12.
- Khan, A.Q., Ikram, S., & Mehtab, M. (2011). Testing weak form market efficiency of Indian capital market: A case of national stock exchange (NSE) and Bombay stock exchange (BSE), *African Journal .of Marketing Management,* Vol. 3(6), pp. 115-127.
- Sewell, M. (2011). History of the Efficient Market Hypothesis, *UCL Department of computer science.*
- Heilmann, M. (2010). Stock Market Linkages - A Cointegration Approach, *University of Nottingham.*
- Pant, B. & Bishnoi, T. R. (2011). Testing Random Walk Hypothesis for Indian Stock Market Indices, *SS International Journal of Business and management research*, Vol. 1(3).
- Liu, B. (2003), Weak-form Market Efficiency of Shanghai Stock Exchange: An Empirical Study.
- Verma, A. (2005), The study of the weak form informational efficiency in Bombay Stock Market, *Finance India*, Vol. 19(4), 1421.
- Cooray, A. & Wickremasinghe, G. (2007), The Efficiency Of Emerging Stock Markets: Empirical Evidence From The South Asian Region, *The Journal of Developing Areas*, Vol. 41(1).
- Gupta, R. & Basu, P. K. (2007), Weak Form Efficiency in Indian Stock Markets, *International Business & Economics Research Journal*, Vol. 6(3), pp. 57-64.
- Mishra, P. K. & Pradhan, B. B. (2009), Capital Market Efficiency and Financial Innovation, *The Research Network*, Vol. 4(1).
- Mishra, P.K. (2010), Indian Capital Market – Revisiting Market Efficiency, *Indian Journal of Capital Market,* Vol. 2(5), pp. 30-34
- Asiri, B. (2008), Testing weak-form efficiency in the Bahrain stock market, *International Journal of Emerging Markets*, Vol. 3(1), pp. 38-53.

- Siddiqui, S., & Gupta P. K. (2010), Weak Form of Market Efficiency- Evidences from selected NSE indices, Retreived from http://ssrn.com/abstract=1355103
- Hamid, K. (2010), Testing the Weak form of Efficient Market Hypothesis: Empirical Evidence from Asia-Pacific Markets, *International Research Journal of Finance and Economics*, Vol. 58, pp. 121-133.
- Dhesi, G., Shakeel, M. B., & Xiao, L., Modified Brownian motion Approach to Modelling Returns Distribution.
- Fama, E. F. (1970), Efficient Capital Markets: A Review of Theory and Empirical Work, *Journal of Finance,* Vol. 25(2), pp 383-417.

6. ANNEXTURE

EMH	Efficient Market Hypothesis
BSE	Bombay Stock Exchange
JPX	Japan stock exchange
HKEX	Hong Kong Stock Exchange
SSE	Shanghai stock exchange
TSE	Tokyo Stock Exchange
KRX	Korean stock exchange
SD	Standard Deviation