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TESTING WEAK FORM MARKET EFFICIENCY: EMPIRICAL EVIDENCE FROM SELECTED ASIAN STOCK MARKETS

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ABSTRACT

This empirical study examines stock market efficiency of selected fifteen countries from the Asian region using weekly stock returns from the year 2001 to 2017. In order to test the market efficiency, the following statistical methods were conducted on the realized returns: Auto Correlation, Q Statistics, Correlation Matrix, Unit Root Test, and Run Test. It is revealed that the weekly return is not normally distributed as the historical returns from the considering markets are negatively skewed. We came up to a conclusion that weekly returns do not follow the random walk as it rejects the null hypothesis. Therefore, it may be possible for the investors to gain an arbitrage profit by investing in any of the markets in consideration.

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Contribution/ Originality: This study is one of very few studies which have investigated the weak form market efficiency in selected capital markets from the Asian region. This paper also contributes in the existing literature of finance by testing the existence of random walk theory in the stated context.

1. INTRODUCTION

In the realm of falling interest rate in banking industry investors tend to show their interest in investing in capital market with the hope of gaining higher return. However, the risk is relatively higher in this sector. People are now more concerned of risk minimization and finding appropriate techniques to maximize profit. Investors are testing different markets to know the possibility of earning arbitrage profit using different techniques. In this research, market efficiency were studied and tested from fifteen Asian countries - Bangladesh, India, Pakistan, Vietnam, Thailand, Hong Kong, Singapore, Malaysia, Thailand, Sri Lanka, South Korea, Philippines, Indonesia, China, and Japan.

According to Fama (1970) who provides the theory of efficient market hypothesis (EMH), the efficiency is based on weak form, semi strong form, and strong form. Weak form efficiency is whether the historical information is reflected in the present market price or not. In Semi strong form efficiency, the past information and publically available information is reflected in the current market price. Therefore individual cannot achieve arbitrage profit. In the strong form of market efficiency, all publically and privately available information is reflected in the market price. Therefore no one can achieve excess profit. When the market is inefficient in random walk, it suggests that we can reject the null hypothesis of random walk. According to the random walk theory we are unable to predict the future stock price by analysing historical information. Abnormal return is generally not possible to achieve on a continuous basis. Therefore technical analysis does not work in that particular scenario. However, excess return can be achieved in some cases by conducting fundamental analysis since they deal with semi strong form of efficiency.

2. LITERATURE REVIEW

When people become more concerned about return, they tend to behave like "risk-taker" investors by investing in risky stocks in order to realize a higher level of return. However, the consumer satisfaction works at high return along with a lower risk (Fornell *et al*., 2006). To make profit, more people behave irrationally in investment (Shiller, 2000) which is one of the vital reasons to become the market inefficient. Stock price bubbles can also influence the market for which the investors in a stock market tend to behave irrationally and eventually it results crashes in stock market (Kaizoji, 2000). According to the concepts in behavioural finance, trading is mostly influenced by the behaviour of investors studied by Oprean and Tanasescu (2014); Tuyon and Ahmad (2016) and Islam *et al.* (1996). Similar studies were also conducted on various stock exchanges of different countries, for example, Vietnam Stock Market was studied by Phan and Zhou (2014) and the stock market in India was studied by Kumar and Jawa (2017). In addition, Lim and Brooks (2011) reviewed different literatures for understanding the stock market efficiency.

Füss (2005) investigated the financial liberation and stock price behaviour in Asian emerging markets by testing random walk hypothesis and market efficiency over seven Asian emerging countries. In that particular study, he used single variance ratio test, multiple variance ratio tests and non-parametric run test for understanding the week form efficiency in those markets. It was revealed that the major Asian emerging markets do not follow the random walk theory and as a result it may be possible to achieve arbitrage profit by conducting proper technical analysis.

Shaik and Maheswaran (2016) examined the random walk hypothesis on ten emerging Asian stock markets using indices from the year 2001 till 2015 through applying six different root tests. The research showed the findings in two ways i) before financial crisis – from the year 2001 to 2007, where a total of ten major stock markets followed the random walk theory according to the unit root test; ii) the post crisis situation where only five out of ten markets followed the random walk theory based on unit root test.

Gündüz and Hatemi (2005) investigated to explore a relationship between stock price and volume figures in some selective stock markets. Granger Causality Test was used to justify the relationship and they came up to a conclusion that there was no causal relationship exists between the stock prices and volume figures in various stock markets of Czech Republic.

Cooray and Wickremasinghe (2005) examined the efficiency in emerging markets. Empirical evidence from South Asian region consisting of monthly returns from 1996 to 2005 were used and applied in the Augmented Dickey and Fuller (1979;1981); Perron (1988) test and Elliot *et al.* (1996) test. Their objective was to investigate the presence of weak form efficiency in the emerging stock markets. However, their study failed to proof any presence of weak form efficiency in the emerging stock markets.

Chiang and Doong (2001) carried out an empirical study on the stock return and volatility by using historical data from seven Asian Stock Markets based on TAR-GARCH Models. The result suggests that the null hypothesis cannot be rejected for monthly data.

Hamid *et al.* (2017) tested the weak form market efficiency in fourteen countries from the Asia Pacific region using monthly returns of indices from 2004 to 2009. Autocorrelation, Ljung- Box test, Q statistics test, run test, unit root test, and variance ratio test were applied to test the market efficiency. Their finding indicates that the monthly return do not follow the random walk hypothesis in the stock markets of this particular region. Therefore, the study suggests that investors may earn arbitrage profit from these markets.

Shaik and Maheswaran (2016) examined the market efficiency in five Asian stock markets. Individual variance ratio was applied to test their proposition and they found out that, Cambodia, Lau and Singapore stock markets are weak form efficient where as other markets in the study are not weak form efficient.

Hussain *et al.* (2015) studied weak form market efficiency and asymmetric relationship among various stock markets from South Asian region by using monthly data during 1998 to 2013. Asymmetric Co-integration and Asymmetric Error Correlation Models were used to understand the relationship. The result showed that Indian stock market tends to influence Pakistan stock market in the long run.

3. DATA AND METHODOLOGY

3.1. Data and Observation

The observation consists of weekly price indices of 15 Asian countries. Data was collected from the period 2009 to 2017 for the considering countries. The market return is calculated as following:

$$Return = ln\frac{Pt}{P\ t-1} \qquad (1)$$

Where,

Pt = market price at time "t"

Pt-1 = market price at time "t-1"

3.2. Descriptive Statistics

The calculated stock return was used in the following descriptive statistics: mean, median, standard deviation, variance, skewness, and range to observe our study.

3.3. Correlation Matrix

The Correlation matrix gives an insight about the relationship of stock markets among different countries. A correlation matrix is developed to observe the relationship among the stock markets of fifteen Asian countries. Direction of relationship (positive or negative) among stock markets of the concerned countries is derived from autocorrelation matrix.

3.4. Auto Correlation and Ljung-Box Statistics

The serial auto correlation is used to justify the relationship between its own values with the series of different legs. If a negative result is drawn from auto correlation, it means the markets follow the null hypothesis, and if it gives a positive result, it emphasizes that the null hypothesis is rejected.

$$Q = n(n+2)\sum_{k=1}^{n}\left(\frac{p^2k}{n-k}\right) \qquad (2)$$

Where,

n = sample size

pk = auto correlation at legs k and

n = number of legs needed to test

3.5. Run Test

In the observational research method, a "Run" is the series of identical signs where we can see a sequence of observation. The run test evaluates the value of one observation reflected by the value of considering earlier observations. Run test is used to analyse independence of a data series in the return stream. For evaluating a run test in terms of null hypothesis, two approaches can be considered – (i) positive return mean and (ii) negative return mean. Now, if the positive "*m*" and negative "*m*" reflecting total positive return (+*m*) and total negative return (-*m*) with *"m"* observations, then the test statistic is normally distributed as following –

$$Z = \frac{\omega - \mu\omega}{\sigma\omega} \approx N(0,1) \qquad (3)$$

Therefore,

$$1)\ \mu\omega = \frac{2m + m\_}{m} + 1 \qquad (3a)$$

$$2)\ \sigma\omega = \sqrt{\frac{2m + m\_(2m + m\_ - m)}{m^2(m-1)}} \qquad (3b)$$

3.6. Unit Root Test

Unit root of Augmented Dickey Fuller (ADF) test is used to test the time series of stock price change in indices. The main objective here is to test the stationary of the time series. The equation is following:

$$\Delta Rt = bo + bt + \pi o R t\text{-}1 + \sum \Psi\ \Delta R + \epsilon t \qquad (4)$$

Where,

ΔRt = the price change

Rt = price at the time *"t"*

ϵt = error time

4. ANALYSIS AND FINDINGS

In the Table-1 below, descriptive statistics of the fifteen Asian market returns are disclosed. The weekly returns of eleven markets were negatively skewed which indicates that, the empirical returns were more negative than positive in these markets. The rest of the observed returns from the markets of Bangladesh, China, Singapore, and Sri Lanka yielded positive returns. Average weekly return is highest in Pakistan (0.004) with a standard deviation of 3.1%, while China and Japan have the lowest weekly average returns. During the observed period, Bangladesh had a weekly return of 0.1% along with a standard deviation of 2.00%. The Jarque-Bera test rejects the normality on the sample set consisting of weekly returns from the market of the following countries: India, Malaysia, China, Thailand, Singapore, Vietnam, Indonesia, Pakistan, South Korea, Japan, Philippine and Sri Lanka.

According to the findings, it can be observed that, the return series from Bangladesh and Hong Kong during the period from 2001 to 2017 accepts the null hypothesis of normal distribution. For further analysis in justification of randomness, we have studied the autocorrelation and Ljung-Box test. If *p* value is less than .05 and Q statistics and autocorrelation coefficient both are less than zero, we can reject the null hypothesis at 5% significance level.

Table-1. Descriptive Statistics of fifteen Asian market returns

Details	IND	BD	MAL	CHI	THA	SIN	VIE	HoK	INDO	PAK	SoK	JAP	PHI	TAI	SRI
Mean	0.002	0.001	0.001	0	0.002	0.001	0.001	0.001	0.003	0.004	0.002	0	0.003	0.001	0.003
Std. Error	0.001	0	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Median	0.003	0	0.002	-0	0.004	0.002	0.003	0.003	0.005	0.007	0.004	0.003	0.003	0.003	0.001
Std. Dev.	0.023	0.02	0.013	0.034	0.024	0.019	0.029	0.026	0.031	0.031	0.031	0.031	0.023	0.022	0.026
Sample Var.	0.001	0	0	0.001	0.001	0	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0	0.001
Kurtosis	0.828	0.35	2.281	1.834	1.135	1.494	2.01	0.855	5.893	5.716	5.885	8.307	1.464	1.515	5.902
Skewness	-0.08	0.02	-0.25	0.168	-0.37	0.007	-0.22	-0.06	-0.94	-1.245	-0.7	-1.1	-0.41	-0.69	0.725
Range	0.187	0.12	0.105	0.271	0.155	0.134	0.233	0.201	0.349	0.31	0.4	0.393	0.173	0.164	0.293
Jarque-Bera	42.23	6.60	51.13	18.88	42.49	10.28	11.23	4.32	80.87	199.79	91.46	65.64	37.32	9.79	92.35
Probability	0.00	0.03	0.00	0.00	0.00	0.01	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Minimum	-0.1	-0.06	-0.05	-0.14	-0.09	-0.06	-0.11	-0.1	-0.23	-0.201	-0.23	-0.28	-0.1	-0.1	-0.11
Maximum	0.088	0.06	0.052	0.135	0.071	0.071	0.126	0.105	0.116	0.109	0.17	0.114	0.074	0.068	0.18
Sum	0.752	0.26	0.568	0.09	0.945	0.302	0.413	0.328	2.646	3.497	1.395	0.413	1.14	0.393	2.691
Count	417	221	417	412	417	417	410	417	848	853	855	855	417	411	855
Largest(1)	0.088	0.06	0.052	0.135	0.071	0.071	0.126	0.105	0.116	0.109	0.17	0.114	0.074	0.068	0.18
Smallest(1)	-0.1	-0.06	-0.05	-0.14	-0.09	-0.06	-0.11	-0.1	-0.23	-0.201	-0.23	-0.28	-0.1	-0.1	-0.11
Confidence	0.002	0	0.001	0.003	0.002	0.002	0.003	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002

Source: Processed and developed by authors

Table-2. Auto Correlation and Q statistics

	Details	1	2	3	4	5	6	7	8	9	10
IND	AC	-0.498	0.008	-0.017	0.048	-0.071	0.006	0.062	-0.038	-0.018	-0.001
	Q-Stat	104.1	104.2	104.3	105.3	107.4	107.4	109.1	109.7	109.8	109.8
	Prob	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BD	AC	0.251	0.089	-0.059	-0.008	0.020	-0.100	-0.061	0.035	0.036	-0.042
	Q-Stat	14.2	16.0	16.8	16.8	16.9	19.2	20.0	20.3	20.6	21.0
	Prob	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MAL	AC	0.024	-0.032	0.000	0.025	-0.071	0.051	-0.005	-0.019	-0.002	0.053
	Q-Stat	93.1	93.7	93.7	95.4	100.7	103.5	103.6	103.7	103.8	105.3
	Prob	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CHI	AC	-0.540	0.084	-0.072	0.069	-0.053	0.054	-0.054	0.029	-0.023	0.057
	Q-Stat	121.2	124.1	126.2	128.2	129.4	130.6	131.9	132.2	132.5	133.8
	Prob	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
THA	AC	-0.530	0.081	-0.032	-0.034	0.025	0.051	-0.118	0.091	-0.049	0.039
	Q-Stat	118.0	120.8	121.2	121.7	122.0	123.1	129.0	132.6	133.6	134.3
	Prob	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SIN	AC	-0.508	0.116	-0.157	0.057	-0.034	0.055	-0.058	0.069	-0.058	-0.006
	Q-Stat	108.5	114.2	124.6	126.0	126.5	127.8	129.2	131.3	132.7	132.7
	Prob	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VIE	AC	-0.436	-0.011	-0.054	-0.010	0.051	-0.047	0.024	-0.013	0.059	-0.088
	Q-Stat	78.5	78.6	79.8	79.8	80.9	81.8	82.1	82.1	83.6	86.9
	Prob	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HoK	AC	-0.500	0.045	-0.065	0.001	0.013	0.002	-0.019	0.095	-0.079	-0.043
	Q-Stat	105.2	106.1	107.8	107.8	107.9	107.9	108.1	111.9	114.6	115.4
	Prob	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INDO	AC	-0.555	0.065	0.001	-0.055	0.102	-0.051	-0.029	0.069	-0.111	0.116
	Q-Stat	262.0	265.5	265.5	268.1	277.0	279.2	280.0	284.0	294.5	306.1
	Prob	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PAK	AC	-0.464	-0.036	0.032	0.014	-0.033	-0.045	0.032	0.007	-0.006	0.030
	Q-Stat	183.9	185.0	185.9	186.1	187.0	188.7	189.6	189.6	189.7	190.4
	Prob	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SoK	AC	-0.550	0.066	-0.041	0.056	-0.029	-0.044	0.094	-0.073	0.065	-0.070
	Q-Stat	259.7	263.4	264.9	267.6	268.3	270.0	277.6	282.2	285.9	290.1
	Prob	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
JAP	AC	-0.533	0.092	-0.095	0.043	-0.019	0.020	-0.010	0.009	-0.005	-0.001
	Q-Stat	243.8	251.1	258.9	260.5	260.8	261.1	261.2	261.3	261.3	261.3
	Prob	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PHI	AC	-0.582	0.158	-0.117	0.059	-0.003	-0.023	0.014	-0.012	-0.005	-0.002
	Q-Stat	142.2	152.7	158.5	160.0	160.0	160.2	160.3	160.3	160.3	160.3
	Prob	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TAI	AC	-0.560	0.137	-0.112	0.012	0.058	-0.042	-0.022	0.059	-0.065	0.092

	Q-Stat	130.0	137.7	142.9	143.0	144.4	145.1	145.3	146.8	148.6	152.1
	Prob	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SRI	AC	0.272	0.114	0.068	0.046	0.058	0.013	-0.033	-0.023	0.066	-0.047
	Q-Stat	63.6	74.8	78.7	80.6	83.5	83.6	84.6	85.1	88.9	90.8
	Prob	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source: Processed and developed by authors

It can be observed from the above table that, our sample data from all the considering markets provided a *p* value which is almost zero. Therefore, we can conclude that, our findings reject the null hypothesis of random walk. In order to understand the inter-correlation among all the markets, we studied the correlation matrix in Table-3 below where we analysed the auto correlation. The pairwise correlation coefficient in these markets is either positively or negatively related. The positive correlation means the returns from both countries are in same direction and negatively related correlation coefficient reveals that the returns from both countries are inversely related. The observed correlation coefficient range was .71 to -.13. Based on our result, returns from South Korea and Indonesia are highly positively related and those of Indonesia and Hong Kong are highly negatively related.

Table-3. Correlation Matrix

	IND	**BD**	**MAL**	**CHI**	**THA**	**SIN**	**VIE**	**HoK**	**INDO**	**PAK**	**SoK**	**JAP**	**PHI**	**TAI**	**SRI**
IND	1														
BD	-0	1													
MAL	0.02	0.06	1												
CHI	0.03	-0	0.03	1											
THA	0.04	0.06	0.48	0.05	1										
SIN	0.08	0.02	0.6	0.13	0.53	1									
VIE	0	0.06	0	-0.1	-0	0	1								
HoK	0.01	0.02	0.59	0.19	0.56	0.7	-0	1							
INDO	0.14	-0	-0.1	0.15	-0.2	-0.1	0.08	-0.1	1						
PAK	0.14	-0	0.24	0.14	0.21	0.3	0.01	0.23	-0.01	1					
SoK	0.05	-0.1	0.56	0.03	0.5	0.7	-0	0.71	-0.06	0.1	1				
JAP	0.03	0.02	0.39	0.08	0.37	0.6	-0	0.58	-0.03	0.1	0.6	1			
PHI	0.03	-0	0.52	0	0.52	0.6	0	0.53	-0.1	0.2	0.5	0.4	1		
TAI	-0	0	0.13	0.1	0.04	0.1	0.16	0.08	0.16	0.1	0	0	0.1	1	
SRI	0.09	-0	0.14	0.03	0.19	0.1	0	0.17	0.06	0	0.1	0.2	0.1	0.1	1

Source: Processed and developed by authors

Table-4. Unit Root Test

Country	**Augmented Dickey-Fuller (ADF) Test At Level**	**Augmented Dickey - Fuller (ADF) Test at first Difference**
India	-0.631	-20.4
BD	-2.187	-11.6
Malaysia	0.545	-20.1
China	-2.180	-19.9
Thailand	-0.035	-21.6
Singapore	-1.683	-19.1
Vietnam	-2.382	-19.2
Hong Kong	-2.946	-20.1
Indonesia	-1.191	-32.3
Pakistan	-3.593	-30.5
South Korea	-1.069	-30.5
Japan	-2.290	-29.2
Philippines	-0.137	-21.2
Taiwan	-2.427	-21.6
Sri Lanka	-0.571	-22.1

Source: Processed and developed by authors

In the above table, we have conducted a Unit Root Test to justify the stationary which is examined to understand the random walk. We can observe the presence of stationary or non-stationary in a considering market by examining Unit root test. Analysing the data from the period of 2001 to 2017 with almost zero probabilities indicates that, it rejects the null hypothesis of random walk. Here, the series of indices are non-stationary at level and stationary at first difference of 5% significance level. If a market is non-stationary, then it is unpredictable or cannot be forecasted. According to the Augmented Dickey- Fuller (ADF) Test at first difference, the time series of indices are stationary. In a stationary situation, a market can be predicated beforehand and there is a possibility of achieving arbitrage profit.

Table-5. Run Test

Details	IND	BD	MAL	CHI	THA	SIN	VIE	HoK	INDO	PAK	SoK	JAP	PHI	TAI	SRI
K=Mean	0.22	0.14	0.15	0.10	0.28	0.10	0.18	0.12	0.36	0.46	0.21	0.09	0.31	0.12	0.35
No. of Run	2.00	20.00	4.00	23.00	10.00	20.00	14.00	44.00	10.00	6.00	4.00	17.00	4.00	24.00	2.00
Z	-20.37	-12.36	-20.16	-18.18	-19.56	-18.61	-19.01	-16.25	-28.53	-28.84	-29.07	-28.17	-20.17	-18.05	-29.21
P-value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: Processed and developed by authors

In the table above, the *p* values are almost zero for all the considering countries at 5% significance level which indicates that the actual number of runs are less than the expected number of runs. Therefore it rejects the null hypothesis of random walk.

4.1. Summary of Findings

Table-6. Summary of Findings

Country	Auto Correlation	Q statist	Unit Root Test	Run Test
Indication	If accept Random walk 'YES' if reject Random Walk 'NO'			
India	No	No	No	No
BD	No	No	No	No
Malaysia	No	No	No	No
China	No	No	No	No
Thailand	No	No	No	No
Singapore	No	No	No	No
Vietnam	No	No	No	No
Hong Kong	No	No	No	No
Indonesia	No	No	No	No
Pakistan	No	No	No	No
South Korea	No	No	No	No
Japan	No	No	No	No
Philippines	No	No	No	No
Taiwan	No	No	No	No
Sri Lanka	No	No	No	No

Source: Processed and developed by authors

The summary of all findings are compiled and disclosed in the table above. It can be concluded that the considering markets are inefficient according to the results found on the conducted tests. Therefore, excess profit can be earned through analysing.

5. CONCLUSION

The study examines the weak form efficiency in the capital markets from fifteen Asian countries. The considering time period was seventeen years. No one is expected to earn abnormal profit if market follows the random walk. To analyse the normal distribution, we studied the descriptive statistics in Jarque-Bera test and it rejected the null hypothesis in considering markets excluding Bangladesh, Hong Kong, and Thailand. In the Unit Root Test, the markets were found to be stationary which indicates that the considering markets are predictable at first difference. Finally, the findings from Auto-Correlation, Q Statistics and Run Test were unable to show the market efficiency. It indicates that, the considering markets are inefficient and do not follow the random walk.

Therefore, technical analysts can achieve arbitrage profit due to market inefficiency. The outcome of this empirical study can be used for conducting further researches, for example, cross market integration, efficiency and cross market integration among various countries and to test the market efficiency among Europe and Asian countries as well.

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