Volume 2 No.5, May 2012 ISSN 2224-3577
International Journal of Science and Technology

http://www.ejournalofsciences.org

A Parametric and Non-Parametric Approach for Testing Random Walk Behavior and Efficiency of Pakistani Stock Market

Faisal M. Zahid[1], Shahla Ramzan[1], Shumila Ramzan[2]

[1]Department of Statistics, Government College University Faisalabad-Pakistan
[2]Department of Mathematics & Statistics, University of Agriculture Faisalabad-Pakistan

ABSTRACT

This paper aims at testing weak form efficiency of Karachi stock exchange (KSE) market of Pakistan. Different parametric and nonparametric tests of random walk model are used. The bid and offer rates of Karachi Stock Exchange (KSE) of Pakistan for the period March 2000 to October 2011 are considered for investigating the weak form efficiency. The return series was found to be non-normal in the aspect of skewness and kurtosis. The Jarque-Bera test and Kolmogorov-Smirnov test also detected the violation of normality in the return series. The hypothesis of randomness in return series of KSE market is also rejected with runs test and auto-correlation test. The results revealed that stock return series do not follow the random walk model and the significant autocorrelation rejects the hypothesis of weak form efficiency.

Keywords: *Weak form efficiency, Karachi Stock Exchange, Parametric and non-parametric tests, Random walk model*

1. INTRODUCTION

Efficiency of capital stock market has been an important issue since its beginning. Several attempts have been made to arrive at a solid conclusion since Bachelier [1] but it could not. Market efficiency has received an enormous consideration of the researchers over the last two decades because on a large extent it depends on the structure of market, investment patterns and several others. Fama [2] was the first who used the term efficient market. However, the concept of market efficiency was originally initiated by Bachelier [1].

Several studies are present in literature in which the existence of weak form efficiency and the hypothesis of random walk model, are tested for different markets. Abrosimova et al. [3] investigated the existence of week form in the Russian stock market by using daily, weekly and monthly Russian Trading System (RTS) indices. An Attempt by Gilmore and McManus [4] is made to investigate the random walk model in the equity markets of the three main Central European transition economies (the Czech Republic, Hungary, and Poland). Interesting results were obtained for the newly developed stock market of United Arab Emirates (UAE) by Moustafa [5]. The returns of 40 out of 43 stock markets of UAE did not follow the random walk model. Marashdeh and Shrestha [6] explored that the stock price index in the Securities Market of United Arab Emirates is efficient in weak form. Oskooe et al. [7] found that Iran stock market (ISM) follows a random walk model and hence efficient in weak form. Other similar literature includes [8, 9, 10, 11, 12].

Pakistan is a developing country with three main stock markets; Karachi, Lahore and Islamabad. An important empirical question is whether the Karachi stock market (KSE) of Pakistan is efficient at weak level. The main purpose of this paper is to investigate the behavior of Karachi stock exchange in the light of Efficient Market Hypothesis (EMH). To investigate whether the Karachi stock exchange meets the criterion of weak form market efficiency, the daily indices of stock market are considered for the period from March 13, 2000 to October 31, 2011. Different parametric and non-parametric tests such as Augmented Dickey-Fuller (ADF) test, Phillips Perron (PP) test, graphical method, correlogram test, are used. ARIMA model is also applied on the data. The findings of this study are expected to serve the investors for gaining profit, providing an evidence to be added to international evidences, and will enable the KSE to improve the level of efficiency.

The paper is organized as follows: The methodology used in this paper is explained in Section 2. Section 3 presents the description and some statistical features of the data. The results and findings are presented in Section 3 with some discussion. Some concluding remarks are given in Section 4.

2. METHODOLOGY

The efficient market hypothesis (EMH) is an important concept related to the random walk theory. The random walk is used to refer to successive price changes which are independent and identically distributed random variables. Samuelson [13] and Fama [14] indicate that the Efficient Market Hypothesis (EMH) supposes that share price adjust rapidly to the appearance of new information. Thus, current prices fully reflect all available information and should follow a random walk process, which means successive stock price returns are independently and identically distributed (IID) random variables. Fama [14] formalized the theory, organized the empirical evidences and broken-down the market efficiency into three levels depending on the type of information:

1. Weak form efficiency reveals that current stock prices fully reflect all historical market information such as: prices, trading volumes, and any market oriented information.
2. Semi-strong form efficiency refers to the concept that not only prices fully reflect the historical information

but also all public information together with non-market information such as earning and dividend announcements, and economic and political news.

3. Strong-form efficiency contends that stock prices reflect all information from historical, public, and private sources, so that no investor can realize abnormal rate of return.

2.1 The Random Walk Model (RWM)

The random walk model is one of those models which assume that successive price changes are independently and identically distributed random variables, so that future price changes cannot be predicted from historical price changes. The random walk model (RWM) and the weak form efficient market hypothesis (EMH) are frequently tested in both developed and developing countries. Several comprehensive reviews of the empirical evidence include [14, 15, 16, 17, 18].

The simplest way to describe the random walk model is:

$$p_t = p_{t-1} + \varepsilon_t \tag{1}$$

Where p_t is financial asset price observed at time t, and ε_t is random error term that is independently and identically distributed with mean zero and variance σ^2. A number of statistical tests have been used in the literature to examine the validity of weak form EMH and the RWM. These tests tend to fall into two groups: first group entails a comparison of risk-return results for trading or filter rules that make investment decisions based on past market information versus results from a simple buy-and-hold strategy and the second group involves statistical tests of independence between rates of return. Autocorrelation tests and runs test are the most popular ones in this group [19].

Nonstationarity is the necessary condition for random walk model. The presence of a unit root is not a sufficient condition for a random walk. We use the Augmented Dickey-Fuller and Phillips-Perron tests to identify the existence of nonstationarity in the data of bid and offer rates of Karachi stock exchange of Pakistan. Further, we perform Kolmogrov-Smirnov goodness of fit test and Q-Q probability plots to check normality of the series. Autocorrelation test, Box-Pierce and Ljung-Box statistics are also computed for constructing ARIMA model.

We apply the tests discussed above to the KSE index time series. On the basis of the unit root and autocorrelation tests, we proceed to investigate the validity of random walk null hypothesis. In case of rejection of null hypothesis of random walk, we choose a linear model which fits the data best in order to analyze its forecasting performance. For this purpose, we run dynamic time series model ARIMA to examine whether the stock return series depends on its past values and on past and current disturbance terms. We follow the Box-Jenkins approach [20] for ARIMA building. If no further adjustments to model parameters are required, we proceed to the forecast analysis.

2.2 Box-Jenkins Methodology

Box and Jenkins [20] ushered a new generation of the time series models. The popularly known Box-Jenkins methodology (or ARIMA methodology) emphasizes on analyzing the probabilistic or stochastic properties of the observed series under the philosophy of *Let the data speak for themselves*. In Box-Jenkins methodology, the first objective is to develop appropriate model that best explains the movements of a time series. These models provide a description of random nature of the stochastic process which is assumed to have generated the observed series in terms of how it is embodied in the process. Usually they are expressed as equation with fixed coefficients representing a stochastic structure that is invariant with respect to time.

Autoregressive (AR) Model

In the autoregressive process of order p, the current observation is generated by a weighted average of past observations going back p periods together with the random disturbance in the current period. We denote this process as AR(p) and write in equation as:

$$Z_t = \Phi_1 Z_{t-1} + \Phi_2 Z_{t-2} + ... + \Phi_p Z_{t-p} + \delta + \varepsilon_t \tag{2}$$

Here $\Phi_1, \Phi_2, ..., \Phi_p$ are unknown coefficients to be estimated, δ is a constant term related to the mean of the stochastic process, and ε_t is a white-noise process.

Moving Average (MA) Model

In the moving average process of order q, each observation Z_t is generated by a weighted average of random disturbances going back q periods. We denote this process as MA(q) and write its equation as:

$$Z_t = \mu + \varepsilon_t - \theta_1 \varepsilon_{t-1} - \theta_2 \varepsilon_{t-2} - .... - \theta_q \varepsilon_{t-q}, \tag{3}$$

where the parameters $\theta_1, ..., \theta_q$ may be positive or negative. The random disturbances are assumed to be independently distributed across time. In particular, each disturbance term ε_t is assumed to be normal variable with mean 0 and variance σ_ε^2.

Autoregressive and Moving Average Model

Many stationary random processes cannot be modeled as purely moving average or as purely autoregressive since they have the properties of both types of processes. The logical extension of the autoregressive and the moving average models is the mixed Autoregressive Moving average process of order (p,q). We denote this process as ARMA (p,q) and is given by

ISSN 2224-3577
International Journal of Science and Technology

http://www.ejournalofsciences.org

$$Z_t = \Phi_1 Z_{t-1} + \Phi_2 Z_{t-2} + \dots\dots\dots + \Phi_p Z_{t-p} + \delta + \varepsilon_t - \theta_1 \varepsilon_{t-1} - \theta_2 \varepsilon_{t-2} - \dots\dots - \theta_q \varepsilon_{t-q} \quad (4)$$

Autoregressive Integrated Moving Average (ARIMA) Model

If we have to difference a time series d times to make it stationary and then apply the ARMA(p,q) model to it, we say that the original time series is ARIMA(p,d,q), that is, it is an Autoregressive Integrated Moving average time series. Here p denotes the number of autoregressive terms, d is the number of times the series has to be differenced before it becomes stationary, and q is the number of moving average terms.

4. RESULTS AND DISCUSSIONS

The data used in the present study consists of Bid and Offer rates of Pakistan (Pak rupees per US $). The data is obtained from the State Bank of Pakistan (SBP) Karachi with sample period ranging from March 13, 2000 through October 31, 2011. The results are obtained by using the mid points of bid and offer rates for 2813 observations.

The weak form efficiency test is concerned with finding the normality in the distribution and basic assumptions of random walk model. If the distribution of the return series follows normal distribution, it belongs to the assumption of random walk model, hence market efficiency. This paper addresses these two issues by testing the following hypotheses using parametric and non-parametric approach.

H_0: The stock returns in KSE market are distributed normally.
H_1: The stock returns in KSE market are not normally distributed.
H'_0: The stock returns in KSE market are random over the time period of the study.
H'_1: The stock returns in KSE market are not random over the time period of the study.

The concept of using the stated hypotheses is similar to that of Moustafa [5] where weak form efficiency of United Arab Emirates stock market is investigated.

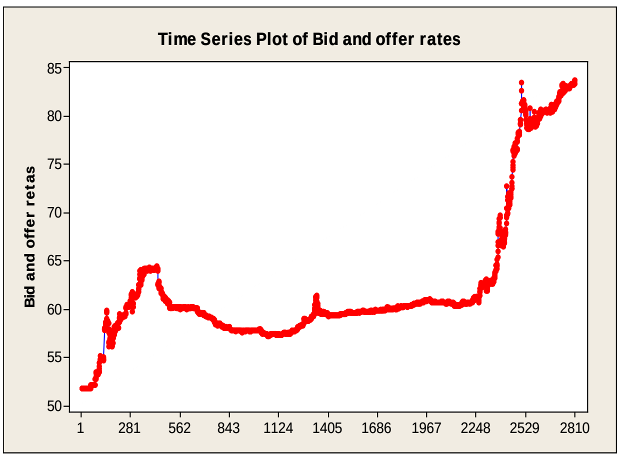


Figure 1: Time Series Plot of Bid and offer Rates of KSE Index

The time series plot in Figure 1 is showing an upward trend, suggesting that the data is non-stationary. To make the data stationary, first differences of the return series of KSE are plotted in Figure 2. This graph shows that the mean of the series is almost constant. So the first difference of the series is stationary, even though the variance becomes high. The large variation exhibits volatility clustering [5, 21].

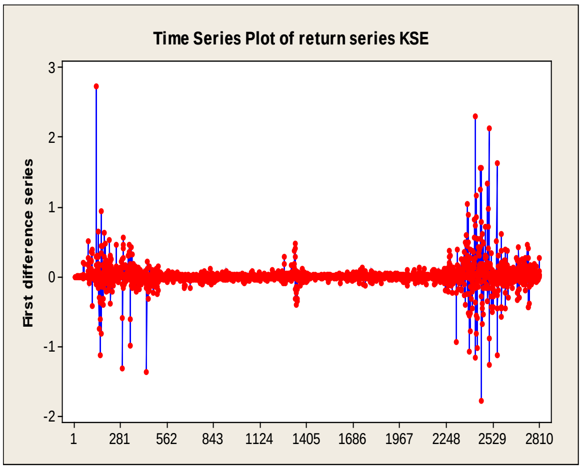


Figure 2: Time Series Plot of Return Series of KSE Index

Under the assumption of random walk model, the distribution of the return series must be normal. To examine normality of the data, Q-Q probability plot is plotted. The observed values of a single variable are plotted against the expected values. If the sample is from a normal distribution, points should cluster around a straight line. The Q-Q plot in Figure 3 demonstrates that market return series of KSE is not normal.

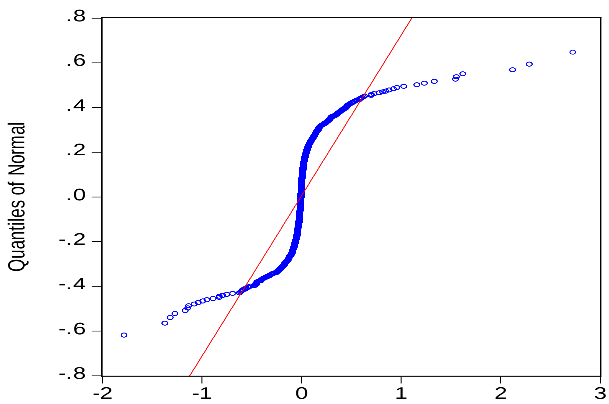


Figure 3: Q-Q Plots of Return Series of KSE Index

Various descriptive statistics for the data under consideration also show evidence against normality. These results are reported in Table 1. The measure of skewness of return series of KSE indices is 2.6671, which indicates a positive skewness in the data. The value of kurtosis is also very large that is 61.54, showing the non-normality of the series.

To test the hypothesis of normality of the data, Kolmogorov-Smirnov goodness of fit test is used. The Kolmogorov-Smirnov Z-value of 0.256 rejects the hypothesis of normality with p-value 0.001. The same conclusion is reached with Jarque-Bera test with p-value less than 0.001. All of these results reflect deviation from the assumption of random walk model.

Table 1: Descriptive Statistics of Return Series of KSE Index

Mean	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	p-value
0.0113	0.1770	2.6671	61.5431	404897.9	<0.001

We use Run test to determine the presence of statistical dependencies or non-randomness, which may not be determined by auto-correlation test. Here our null hypothesis is H_0: The return series of KSE is random. The results presented in Table 2 provide sufficient evidence to conclude that the stock return of KSE is not in random order with p-value less than 0.001. Hence we can conclude that the return series do not follow random walk model.

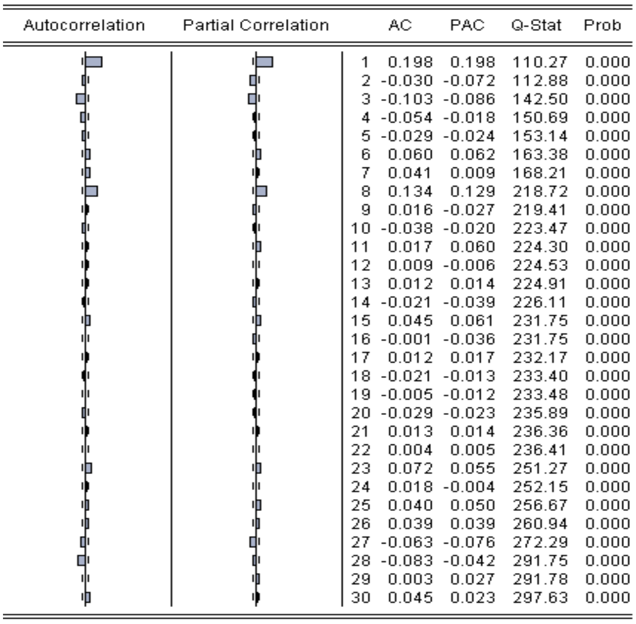
Table 2: Result of Run Test on the Return Series of KSE Index

	Return series of KSE
Mean	0.0113
The observed number of runs	954
The expected number of runs	1313.28
P-value	<0.001

The Autocorrelation test

Autocorrelation measures the association between two sets of observations of a series separated by some lags. It also tests whether the correlation coefficients are significantly different from zero. One simple test of stationarity is based on the so-called autocorrelation function (ACF) and Partial Autocorrelation function (PACF). Autocorrelations and Partial Autocorrelations are computed for 30 lags of return series.

Figure 4 shows the correlogram of market return series. It is found that autocorrelation coefficients of 1st and 8th lags of return series are significant (i.e. they are significantly different from zero) at 95 percent confidence level. Box-Pierce and Ljung-Box statistics also provide similar results. The coefficients for all 30 lags are significant for the return series. On the basis of correlogram test, we can reject the hypothesis of the random walk i.e. the Karachi Stock Market does not follow the random walk model. A similar observation was made in the study of Abrosimova et al. [3]. The graphical representation of ACF for random walk model shows that in the start ACF has positive values and variation in the sign is observed for the remaining series. ACFs in the Figure 4 do not show gradual declination as random walk does. Hence it can be concluded that KSE market return series does not support random walk.



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.198	0.198	110.27	0.000
		2	-0.030	-0.072	112.88	0.000
		3	-0.103	-0.086	142.50	0.000
		4	-0.054	-0.018	150.69	0.000
		5	-0.029	-0.024	153.14	0.000
		6	0.060	0.062	163.38	0.000
		7	0.041	0.009	168.21	0.000
		8	0.134	0.129	218.72	0.000
		9	0.016	-0.027	219.41	0.000
		10	-0.038	-0.020	223.47	0.000
		11	0.017	0.060	224.30	0.000
		12	0.009	-0.006	224.53	0.000
		13	0.012	0.014	224.91	0.000
		14	-0.021	-0.039	226.11	0.000
		15	0.045	0.061	231.75	0.000
		16	-0.001	-0.036	231.75	0.000
		17	0.012	0.017	232.17	0.000
		18	-0.021	-0.013	233.40	0.000
		19	-0.005	-0.012	233.48	0.000
		20	-0.029	-0.023	235.89	0.000
		21	0.013	0.014	236.36	0.000
		22	0.004	0.005	236.41	0.000
		23	0.072	0.055	251.27	0.000
		24	0.018	-0.004	252.15	0.000
		25	0.040	0.050	256.67	0.000
		26	0.039	0.039	260.94	0.000
		27	-0.063	-0.076	272.29	0.000
		28	-0.083	-0.042	291.75	0.000
		29	0.003	0.027	291.78	0.000
		30	0.045	0.023	297.63	0.000

Figure 4: Correlogram of Return Series of KSE Index

Unit Root Test

The simplest way to state the unit root test is:

$$y_t = \rho\, y_{t-1} + u_t \qquad -1 \le \rho \le 1, \qquad (5)$$

where u_t is a white noise error term. If $\rho = 1$, that is, in the case of the unit root, the above model becomes a random walk model without drift, which is a non-stationary stochastic process. We use the Augmented Dickey-Fuller and Phillips-Perron tests to identify the existence of unit root in the return series of KSE indices by taking the random walk as null hypothesis. Table 3 reports the results of Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) test for the return series of KSE indices.

Table 3: Results of ADF and Phillip-Perron Test on Return Series of KSE Index

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		**-16.2540**	<0.001
Test critical values	1% level	-3.4325	
	5% level	-2.8624	
	10%level	-2.5673	

ISSN 2224-3577
International Journal of Science and Technology

http://www.ejournalofsciences.org

Phillips-Perron test statistic		**-43.0438**	<0.001
Test critical values	1% level	-3.4325	
	5% level	-2.8624	
	10%level	-2.5673	

Critical values reported in Table 3 are offered by Mackinnon [22] to test the null hypothesis of the presence of unit root. The statistic value for both ADF and PP tests is less than their corresponding critical values. Therefore we reject the null hypothesis of random walk and conclude that the Karachi Stock market is not efficient in weak form.

ARIMA Model Building

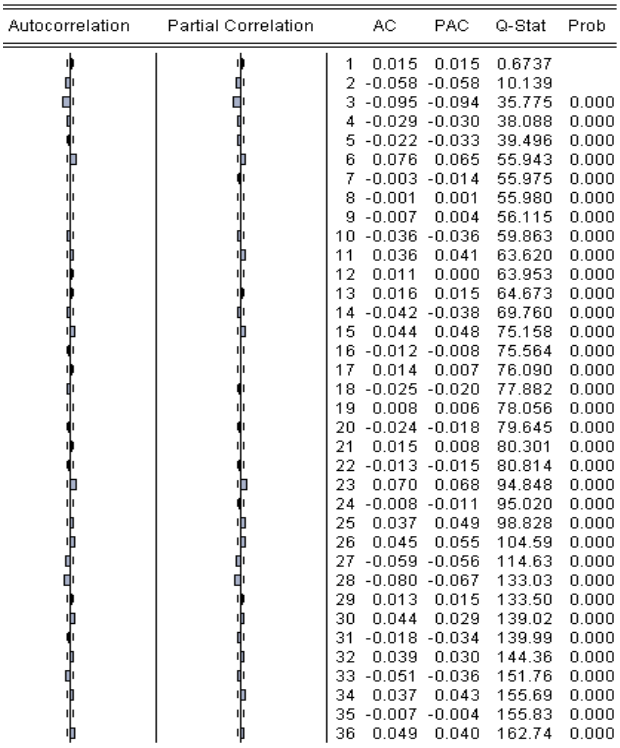
In empirical work, usually we don't have any idea about the actual order of ARIMA model that best approximates the series in hand. Autocorrelation function (ACF) and partial autocorrelation function (PACF) not only serve as a tool for obtaining a partial description of the underlying stochastic process for modeling purpose but also useful in identifying the appropriate order of the ARIMA model. For our data set, on the basis of PACF and ACF analysis, we set p = 1 and q = 8. From Table 3, ADF test statistic shows that return series for KSE indices is highly significant. So the null hypothesis that KSE have a unit root is rejected. The order of integration is set as zero. These results are consistent with the findings of Moustafa [5] and Abrosimova et al. [3].

To decide a suitable ARIMA model for the series, Akaike information criterion (AIC) and Bayesian information criterion (BIC) are used. Different values of p and q are considered for this purpose. The results of AIC and BIC for p = 1, 2, 3 and q = 1, 3, 8, are presented in Table 4. The AIC and BIC both recommend ARIMA(1, 0, 8) as the best model for our return series.

Table 4: ARMA (p, q) Order Selection

	p \ q	1	3	8
Akaike info criterion	1	-0.666	-0.671	**-0.682**
Schwarz criterion		-0.659	-0.664	**-0.675**
Akaike info criterion	2	-0.665	-0.632	-0.642
Schwarz criterion		-0.659	-0.626	-0.636
Akaike info criterion	3	-0.674	-0.634	-0.652
Schwarz criterion		-0.668	-0.628	-0.645

The correlogram for the residuals of ARIMA(1,0,8) is shown in Figure 5. This figure provides insignificant values of the autocorrelation and partial autocorrelation. The residuals from this model do not follow any specific pattern therefore ARIMA(1,0,8) is the selected model on the basis of AIC and BIC.



	AC	PAC	Q-Stat	Prob
1	0.015	0.015	0.6737	
2	-0.058	-0.058	10.139	
3	-0.095	-0.094	35.775	0.000
4	-0.029	-0.030	38.088	0.000
5	-0.022	-0.033	39.496	0.000
6	0.076	0.065	55.943	0.000
7	-0.003	-0.014	55.975	0.000
8	-0.001	0.001	55.980	0.000
9	-0.007	0.004	56.115	0.000
10	-0.036	-0.036	59.863	0.000
11	0.036	0.041	63.620	0.000
12	0.011	0.000	63.953	0.000
13	0.016	0.015	64.673	0.000
14	-0.042	-0.038	69.760	0.000
15	0.044	0.048	75.158	0.000
16	-0.012	-0.008	75.564	0.000
17	0.014	0.007	76.090	0.000
18	-0.025	-0.020	77.882	0.000
19	0.008	0.006	78.056	0.000
20	-0.024	-0.018	79.645	0.000
21	0.015	0.008	80.301	0.000
22	-0.013	-0.015	80.814	0.000
23	0.070	0.068	94.848	0.000
24	-0.008	-0.011	95.020	0.000
25	0.037	0.049	98.828	0.000
26	0.045	0.055	104.59	0.000
27	-0.059	-0.056	114.63	0.000
28	-0.080	-0.067	133.03	0.000
29	0.013	0.015	133.50	0.000
30	0.044	0.029	139.02	0.000
31	-0.018	-0.034	139.99	0.000
32	0.039	0.030	144.36	0.000
33	-0.051	-0.036	151.76	0.000
34	0.037	0.043	155.69	0.000
35	-0.007	-0.004	155.83	0.000
36	0.049	0.040	162.74	0.000

Figure 5: Correlogram of the Residuals of ARMA (1, 0, 8) Model

The actual and fitted values along with the residuals of the selected model, that is ARIMA (1,0,8), are plotted in Figure 6. This graph indicates that the actual and fitted values are very close to each other. Hence, there is no need to search out another ARIMA model.

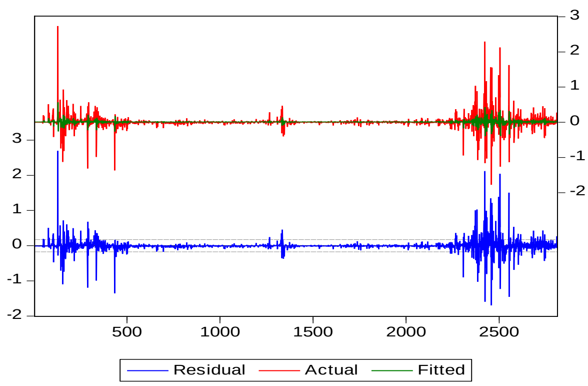


Figure 6: Residual, Actual and Fitted graph for the ARIMA (1, 0, 8)

After performing ARIMA model estimation, results suggest that ARIMA model (1, 0, 8) do not support the random walk model (Table 5). The coefficients of AR(1) and MA(8) for return series are 0.1982 and 0.1387 with standard errors 0.0185 and 0.0187 respectively. As the p values for both are less than

0.001, we reject the null hypothesis of random walk. Hence KSE return series do not follow the random walk. The results of present study are similar with the findings of Nourrendine [21] on the Saudi Arabian market, Moustafa [5] on Bangladesh stock Exchange, Abrosimova et al. [3] on Russian stock market and Poshakwale [23] on Indian stock market, who find the evidence of weak-form efficiency.

Table 5: Results of ARMA (1, 0, 8) model estimation

	Coefficient	Std. Error	t-Statistic	Prob.
C	0.0113	0.0046	2.4653	0.0137
AR(1)	0.1982	0.0185	10.7144	<0.001
MA(8)	0.1387	0.0187	7.4178	<0.001
R-squared	0.0569	Mean dependent var		0.0113
Adjusted R-squared	0.0563	S.D. dependent var		0.1770
S.E. of regression	0.1719	Akaike info criterion		-0.6821
Sum squared resid	83.0316	Schwarz criterion		-0.6757
Log likelihood	961.6394	Hannan-Quinn criter.		-0.6798
F-statistic	84.7522	Durbin-Watson stat		1.9690
Prob(F-statistic)	<0.001			

4 CONCLUSION

This research is mainly hunted for the evidence of weak form efficiency of KSE stock market for the period 13th March 2000 to 31st October 2011, using bid and offer rates of Karachi Stock Exchange by hypothesizing normality of the series and random walk assumption. Different parametric and non-parametric approaches like Kolmogrov-Smirnov goodness of fit test, run test, Q-Q probability plots, Auto-correlation coefficient test, unit root test, correlogram test and ARIMA model are used to test the certainty of the KSE market. The skewness and kurtosis measures for the stock return series declare it as non-normal. The same conclusion is reached with Kolmogorov-Smirnov (K-S) test. The parameters of AR (p) and MA (q) were compared according to the different criteria like Akaike information criterion and Schwarz criterion to select the best fitting model and ARIMA (1,0,8) was selected. All parametric and nonparametric methods used in this text reject the hypothesis of normality of the series and randomness of stock returns in Karachi Stock Market and strongly recommend that return series of Karachi Stock Market do not follow the random walk model. Overall results from the empirical analysis suggest that the Karachi Stock Market of Pakistan is not efficient in weak-form.

REFERENCES

1. Bachelier, L. (1900). Théorie de la Spéculation. (Doctoral dissertation in Mathematical Sciences, Faculté des Sciences de Paris, defended March 29, 1900), Annales de /'ÉcoleNormale Supérieure, Vol. 3, pp. 21 -86. Translated with permission of Gauthier-Villars, Paris, France, as Chapter 2 in Cootner, Paul H. (1964), Ed. The RandomCharacter of Stock Market Prices, Cambridge, MA: The MIT Press.

2. Fama, E., 1965. The Behavior of Stock Market Prices. Journal of Business, 38: 34-105.

3. Abrosimova, N., G. Dissanaike and D. Linowski, 2005. Testing the weak from Efficiency of the Russian Stock Market. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=302287.

4. Gilmore, C. G. and G. M. McManus, 2003. Random-walk and efficiency tests of Central European equity markets, Managerial Finance, 29 (4): 42 – 61.

5. Moustafa, M. A., 2004. Testing the Weak-Form Efficiency of the United Arab Emirates Stock Market. International jurnal of business, 9(3): 309-325.

6. Marashdeh, H. and M. B. Shrestha, 2008. Efficiency in Emerging Markets - Evidence from the Emirates Securities Market. European Journal of Economics, Finance and Administrative Sciences, 12: 143-150.

7. Oskooe, S. A. P., H. Li and A. Shamsavari, 2010. The Random Walk Hypothesis in Emerging Stock Market. International Research Journal of Finance and Economics, 50: 51-61.

8. Onour, I. A., 2004. Testing Weak-Form Efficiency of Saudi Stock Exchange Market. Available at SSRN: http://ssrn.com/abstract=611209

9. Rahman, S. and M. F. Hossain, 2006. Weak-form Efficiency: Testimony of Dhaka Stock Exchange. Journal of Business Research, 8: 1-12.

10. Cooray, A. and G. Wickremasinghe, 2007. The Efficiency of Emerging Stock Markets:Empirical Evidence from the South Asian Region. The Journal of Developing Areas, 41(1): 171-183.

11. Emenike, K. O., 2008. Efficiency across Time: Evidence from the Nigerian Stock Exchange. http://mpra.ub.uni-muenchen.de/22901/

12. Mobarek, A., A. S. Mollah and R. Bhuyan, 2008. Market Efficiency in Emerging Stock Market: Evidence from Bangladesh. Journal of emerging market finance, 7(1): 17–41.

13. Samuelson, P., 1965. Proof that properly anticipated prices fluctuate randomly. Industrial Management Review, 6: 41–50.

14. Fama, E., 1970. Efficient Capital Markets: A Review of Theory and EmpiricalWork. Journal of Finance, 25(2): 383 – 417.

15. Granger, C., 1975. A Survey of Empirical Studies on Capital Markets, in: E. Elton and M. Gruber. eds, International Capital Markets, (North–Holland, Amsterdam) pp: 3 – 36.

16. Hawawini, G., 1984. European Equity Markets: Price Behavior and Efficiency. Monograph Series in Finance and Economics, Saloman Center New York University.

17. Fama, E., 1991. Efficient Capital Markets: II. Journal of Finance, 46: 1575 – 1617.

18. Lo, A. W., 1997. Market Efficiency: Stock Market Behaviour in Theory and Practice. Volume I and II, Chethenham, UK. An Elgar Reference Eollection.

19. Reilly, F. and K. Brown, 2003. Investment Analysis and Portfolio Management, 7th (ed), Mason, Ohio: South-Western, Thomson.

20. Box, G. E. P. and G. M. Jenkins, 1976. Time Series Analysis: Forecasting and Control (revised edition), Holden Day: San Francisco.

21. Nourrendine, K., 1998. Behavior of stock prices in the Saudi Arabian Financial Market: Empirical research findings. Journal of Finance Management & Analysis, 11(1): 48-55.

22. Mackinnon, J.G., 1991. Critical values for cointegration tests, in Long Run Economic Relationships, eds. R.F. Engle and C.W.J. Granger, Oxford University Press, Oxford, 267-276.

23. Poshakwale, S., 1996. Evidence on the Weak form efficiency and the day of the week effect in the Indian Stock Market. Finance India, 10 (3): 605-616.