The Efficient Market Hypothesis

1. Introduction

A large number of rational, profit-seeking and risk-averting investors exist in the market, so that market needs to be efficient in terms of modern investment theory. The concept of efficiency is central to finance. Primarily, the concept of market efficiency had been anticipated at the beginning of the century in the dissertation submitted by Bachelier (1900). The term efficiency is used to describe a market in which relevant information is impounded into the price of financial assets.
With the assumption of competing freely with each other by estimating the future value of individual stocks, so it is necessary that any new information affecting the value of the security, would be known to all the investment community, it is, therefore, rapidly reflected in the price of the stock to which it relates. So any data affecting the price of any security would be available entirely to the investor analyst roughly in the same form.
Thus the market is said to be efficient because it quickly incorporates any new change or even affecting the value of the security, "the efficient market theory, therefore, holds that at any given time, the price of a stock represents its best valuation since all factors affecting it would have been taken into consideration".
The faster the market adjusted to the new prices the greater the market is efficient. So, in other word no body can predict on the basis of historical data about the security prices or by using any sort of technical or non technical (fundamental) analysis. So it is impossible to beat the market by earning abnormally.
Fama (1970) classified market efficiency in three categories namely, weak form, semi-strong form, and strong form.

1.1 Weak form of efficiency

In weak form of efficiency, the prices of a security reflect the past prices and the trading history of that security. In such market, security prices follow a random walk.
Weak form of efficiency is reflected mathematically as under:

$$P_t = P_{t-1} + \Delta P_t + \varepsilon_t$$

where ΔP_t is expected return and ε_t is random error, so the equation states that the prices today is equal to the last observed price plus expected return on the stock plus a random component occurring over the interval.

1.2 Semi strong form of efficiency

In semi strong efficiency the price of the security fully reflects all public information (not limited to historical data.).

1.3 Strong form of efficiency

The market is efficient with respect to all available information, public or private. Seyhun (1986, 1998) provides sufficient evidence that insiders profit from trading on information not already incorporated into prices. Hence the strong form does not hold in a world with an uneven playing field

1.4 Random walk:

Believer of the efficient-markets concept also tend to espouse the concept of the random walk that the market behaves in discernible way. The advocates of random walk holds that it is impossible to predict the prices of a security from the past performance because changes in economic condition, securities valuations, corporate profits and market as a whole all occur in a myriad of different ways. In random walk process, successive stock returns must be identically distributed and independent so that the correlation between one period's return and the immediate following period is zero, Fama (1965), D'ambrosio (1980), and Cooper (1983).

So any non random fluctuation would be exploited by the technical analyst or speculators would buy before an expected rise in price or sell short before an expected fall in price. In random walk the flow of information is random, and if security prices adjusted with that information so the new security prices would also be randomly attuned, and hence each day securities have different prices depending on the flow of information. And no body can predict about the future security prices. Wall street journal has different thinking on the subject. It believes that past stock prices do show foreseeable trends and that it is possible to forecast the market based on past performance.

According to professor Malkiel (1995) "Thus an accurate statement of the narrow form of the random-walk hypothesis goes as follows: the history of stock price movements contains no useful information that will enable an investor consistently to out perform a buy-and-hold strategy in managing a portfolio".

As McInish and Puglisi (1982) point out, a sufficient condition for weak-form efficiency is that stock price fluctuates randomly. As a result, a market is efficient in the weak form if stock prices follow a random walk process. As Wong and Kwong (1984) point out, if the evidence fails to support weak-form tests there is no reason to examine semi-strong (and/or strong) forms before declaring the market is inefficient on the evidence. So this study only elaborates the weak form of efficiency in Karachi Stock Market.

According to Errunza and Losq (1985), Harvey (1993), Calessens, Dasgupta and Glen (1993) most of the research has conducted on stock market of developed countries and less attention has been paid to emerging stock markets, so this study is a step toward research on emerging stock markets.
In this paper we used variance ratio test, Augmented Dickey Fuller (ADF) test for unit root, the Ljung Box Q-statistics, the Durbin Watson'd' test and correlogram method for autocorrelation. Researchers have consensus that the power of variance ratio test is

superfluous than any other test used for random walk Lo and MacKinlay (1989). Tian, Zhang and Huang (1999) derived the non-overlapping VR (NVR) statistic, which follows a Beta distribution. As argued by Lo and MacKinlay (1989), the OVR test is expected to have higher power than the NVR test. The advantages of the VR test are summarized by Cecchetti and Lam (1994). The application of the Variance Ratio test to measure the time series data was observed by Campbell and Mankiw (1987a, 1987b, 1989), Cogley (1990) and Poterba and Summers (1988).

Ample research work has been documented on the weak form of efficiency through out the world, but in Pakistan little work has been done on the subject. Mustafa and Nishat examined the relationship between aggregate stock market trading volume and serial correlation of daily stock returns during December 1991 to December 2001. Abass (2004) did only relevant work on KSE 100 index; his findings suggest that KSE 100 index follows random walk in both its weekly and monthly returns.

1.5 Problem statement

The purpose of this paper is to find out the weal form of market efficiency of the Karachi stock exchange 100 index. For this we need to test the random walk of the security prices in KSE 100 index. To investigate, weather KSE 100 index follows a random walk advance econometric tools are used. These tool included Augmented Dickey Fuller test for unit root, Ljung Box Q-statistic, correlogram for measuring serial correlation and variance ratio test for random walk.

1.6 Limitation of the study

1. In Pakistan, we are lacking experts in the field of finance, and hence very little work has been documented in finance, especially about KSE 100 index.

2. Data about KSE 100 index was not available.

3. The advance econometric tool, like Eviews is not available in Pakistan, which is also a major problem, by conducting time series analysis, in Pakistan only the student version of the Eviews software is available which has limited functions.

4. Also the time constraint, only one and half month was available for conducting this study.

1.7 Hypotheses

In order to test the **ADF unit root** following hypothesis is formed:

$$\text{Ho: } \delta(\rho-1)=0 \text{ or } \rho=1$$
$$\text{H}_\text{A}\text{: } \delta(p-1)<0 \text{ or } \rho<1$$

For **Durbin Watson'd'** statistic

$$\text{Ho: if } \rho_k=0 \text{ i.e. no autocorrelation then d=2}$$
$$\text{H}_\text{A}\text{: } \quad \rho_k \neq 0 \text{ then } d \neq 2$$

For testing **Autocorrelation** we test the following hypothesis:

$$\text{Ho: } \quad \rho_k = 0$$
$$\text{H}_\text{A}\text{: } \quad \rho_k \neq 0$$

In order to apply **Ljung Box Q-statistics** we will apply the following hypothesis:

H_O: ρ_k is zero at the sum of lag k

H_A: ρ_k is not zero at sum of the lag k

For variance ratio test, if Z (q) and Z*(q) is insignificant then a time series P_t follows a random walk. Then the null and alternative hypothesis under the assumption of homoscedasticity for the standard Z test statistic would be:

$$\text{H}_\text{O}\text{: } \quad VR(q)=1$$

Then Z (q) calculated ≤ Z tabulated =1.96 for 5% significance level for .

$$\text{H}_\text{A}\text{: } \quad VR(q) \neq 1$$

Then Z (q) calculated > Z tabulated=1.96 for 5% significance level

Under the assumption of heteroscedasticity the null and alternative hypothesis for standard Z* test statistic would be:

$$\text{H}_\text{O}\text{: } VR(q)=1$$

i.e., Z*(q) calculated ≤ Z*(q) tabulated=1.96 for 5% significance level

$$\text{H}_\text{A}\text{: } \quad VR(q) \neq 1$$

i.e., Z*(q) calculated >Z*(q) tabulated=1.96 for 5% significance level

2. Review of Literature

The Efficient Market Hypothesis has been tested in hundreds of studies over the past thirty years Fama and French (1996), Malkiel (1995), Ikenberry, Lakonishok, and Vermaelen (1995), Jegadeesh, and Titman (1993), Chopra, Lakonishok, and Ritter (1992), Seppi (1992), Harris (1989), Ippolito (1989), Grossman and Stiglitz (1980), Charest (1978), Black and Scholes (1974), Moore (1964).
Efficient market hypothesis suggests that stock prices must follow a random walk, that's why random walk hypothesis has a very important role in financial theories and statistical modeling.

Recently, several studies have uncovered empirical evidence which suggests that stock returns contain predictable components Fama and French, (1988), Lo and McKinley, (1988), and Keim and Stambaugh, (1986). Some empirical evidence go against the random walk hypothesis for stock returns, Summer (1986), Fama and French (1988), Lo and McKinley (1989), and Poterba and Summers (1988).

Ample research about the market efficiency through random walk hypothesis has been documented through out the world, by testing many models of random walks including Augmented Dickey Fuller unit root test, Auto correlation, Ljung-Box Q-statistic, Variance ratio test and Durbin Watson 'd' test etc.

The variance ratio statistic has been used widely as a test for the random walk hypothesis. Lo and McKinley (1988) provided the asymptotic theory for the variance ratio test. Their results, however, are based on Gaussian assumption.
The modern day anomalies and the degree of random walk in daily stock prices for NYSE were examined by Seiler and Rom (1997) to explain the return series and their results are consistent with the prevalence of modern efficient market studies. Tabak (2003) investigated the Brazilian stock data by using rolling variance ratio test. He argued the reason of this efficiency is maturing of the Brazilian market, increasing liquidity and the openness of Brazilian markets for international capital. The Korean stock market was tested by Ryoo and Smith (2002) concluded that if the price limits are increased, the proportion of stock prices following a random walk increases. That is, the stock market as a whole approaches a random walk as price limits are relaxed. Huber (1997) uses the multiple variance ratio test procedure developed by Chow and Denning (1993) to test for a random walk of stock returns on the Vienna Stock Exchange. Chang and Ting (2000) used the Lo and McKinley variance ratio test to examine that Taiwan's stock market follow random walks, and concluded inversely related to the range of price limits. Abass (2004) finding suggest that KSE 100 index follows random walk in both its weekly and monthly return

3. Data & Methodology

3.1 Data:

The daily stock index of the Karachi stock exchange was taken from the data base of Yahoo finance, the time horizon of the data ranges from July 1997 to May 2005, which is further divided into two data sets one is named pre 9/11 and the other is post 9/11 data set. The pre 9/11 data set comprises of observations starting from July 1997 up to September 11, 2001 and the post 9/11 data set from September 11, 2001 to May 31, 2005.

3.2 Methodology

The serial correlation of successive price change will indicate that stock prices are predictable based on the past movements and where as weak or insignificant serial correlation will indicate the unpredictability of future stock prices changes based just on their past changes. Similarly the presence of unit root indicate that price movement is non stationary (non random) while absence of unit root will indicate that series is stationary. Hence, it follows random walk. If Durbin Watson statistics is equal to 2 then the data is stationary and follows random walk or else where if the data is non-stationary then it exhibit market informational inefficiency. The Ljung Box Q-statistics is asymptotically equal to Chi square distribution, so if Q statistics is greater than Chi square tabulated value we simply reject the null hypothesis of white noise series. In variance ratio test if Z(q) and Z*(q) are insignificant that mean the time series follows a random walk and hence weak form of efficiency will exist in KSE 100 index.

3.3 Measuring the Daily Returns:

The daily closing value on index was used for calculating the daily returns with the assumption of trading done at the closing value. The continuously compounded annual rate of return is a well-accepted approach to measuring the daily returns. The natural log of daily relative mean index value is, thus the measure of daily return used for this study. Following is the formula:

$$R_t = Ln\left[\frac{I_t}{I_{t-1}}\right]$$

Where: R_t = return on day't'
I_t = index mean value on day't'
I_{t-1} =index mean value on day 't-1'
And ln= natural log.

3.4 Augmented Dickey Fuller (ADF) test for unit root

The augmented dickey fuller (ADF) unit root test is given as:

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \alpha_i \sum_{i=1}^{m} \Delta Y_{t-1} + \varepsilon_t \text{ .... (A)}$$

To check the time series data with unit root test we carry out the following steps:
P_t is regressed against P_{t-1} to test for unit root in the time series random model which is given as:

$$Y_t = \rho Y_{t-1} + u_t \text{..............(1)}$$

If ρ is significantly equal to 1 then the statistic variable is said to be having unit root. Series with unit root said to be non stationary and does not follow random walk.

$$\Delta Y_t = (\rho - 1) Y_{t-1} + u_t \text{.......................(2)}$$
$$or$$
$$\Delta Y_t = \delta Y_{t-1} + u_t \text{...............................(3)}$$

In eq. (2) we Subtract Y_{t-1} from each side of equation (1).

If $\delta = 0$ then $\rho = 1$ which mean $\Delta Y_t = u_t$ which says that the first difference of a random walk series (Y_t) is stationary (because u_t is white noise by assumption.
If a series has to be differenced once in order to be rendered stationary then it is called integrated of order one, denoted I (1). In general, if a series has to be differenced k times before it is stationary it is I (k).
Dickey and Fuller developed the tabulated values which are term τ ("Tau") statistics for the possible rejection of $\delta = 0$, Mackinnon revised and extended that table which is also reported by Eviews. If the computed absolute value of τ exceeds the critical value, then we reject the null hypothesis that the series is non-stationary (has a unit root).

3.5 Durbin Watson 'd' statistic

The DW'd' statistics is calculated as under

$$d = \frac{\sum_{t=2}^{t=n} (u_t - u_{t-1})^2}{\sum_{t=1}^{t=n} u_t^2}$$

3.6 Autocorrelation & Ljung-Box Q-Statistics

The term auto correlation may be defined as "correlation between members of series of observation ordered in time (time series data) or space (as in cross sectional data)" William.H.Green (2000). Tintner defines autocorrelation as "Lag correlation of a given series with itself lagged by a number of time units.
In regression context, the classical linear regression model assumes that such autocorrelation does not exist in the disturbances u_i symbolically:

$$E(u_i u_j) = 0 \qquad i \neq j$$

The classical model assumes that the disturbance term relating to any observation is not influence by the disturbance term relating to any other observation.
Fama suggest that autocorrelation coefficient is equal to :

$$P(k) = \frac{Cov(r_t, r_{t-1})}{\sqrt{Var(r_t) \times Var(r_{t-1})}}$$

As previously mentioned, weak-form efficiency implies that past returns cannot be used to predict current returns: and tests of weak efficiency are therefore naturally based on an examination of the interrelationship between current and past returns. The first approach we use here is to consider the autocorrelation structure of stock returns and test the joint significance of the autocorrelation using the Ljung–Box portmanteau statistic (Q). The Ljung–Box Q-statistics are given by:

$$Q_{LB} = T(T+2)\sum_{j=1}^{k} \frac{r_j^2}{T-j}$$

Where r_j is the jth autocorrelation and T is the number of observations. The Q statistic is often used as a test of whether the series is white noise. Q is asymptotically distributed as a chi square distribution with degree of freedom equal to the number of autocorrelations. This test was developed by (Ljung & Box, 1979). To compute auto correlation and Ljung-Box Q statistics, we compute correlogram, which graphs the value of auto correlation at successive lags against the length of the lag and the last two columns reported in correlogram are the Ljung-Box Q-statistics and their P values.

3.6 Variance ratio test

Lo and McKinley (1988) variance ratio test is derived on the assumption that if the natural logarithm of a time series P_t is a pure random walk, the variance of its q^{th} difference grows proportionally with the difference q, that is the variance of its q^{th} difference variable would be q times the variance of its first difference. So if we obtain n+1 observations P_o , P_1 , P_2 ,…..,P_n at equally spaced intervals, 1/q of the variance of P_t , P_{t-q} is expected to be the same as the variance of $P_t - P_{t-1}$, for a time series characterized by random walks.

The variance ratio, VR (q), is defined as

$$\text{VR (q)} = \frac{\sigma_q^2}{\sigma_1^2}$$

or

$$\frac{1}{q}\frac{Var(P_t - P_{t-q})}{Var(P_t - P_{t-1})} = 1$$

Where σ_q^2 is the unbiased estimator of 1/q of the variance of qth difference of the logged security return (P_t-P_{t-q}) and σ_1^2 is an unbiased estimator of the variance of the logged return (P_t-P_{t-1}).

Lo and McKinley (1988) demonstrates that the estimators σ_q^2 and σ_1^2 can be computed by:

$$\sigma_q^2 = \frac{1}{m}\sum_{t=q}^{n}(P_t - P_{t-q} - qu)^2$$

$$\sigma_1^2 = \frac{1}{n-1}\sum_{t=1}^{n}(P_t - P_{t-1} - u)^2$$

Where

$$m = q(nq - q + 1)(1 - \frac{q}{nq})$$

$$and$$

$$u = \frac{1}{nq}(P_{nq} - P_o)$$

And P_o and P_{nq} are the first and last observations of the time series and n is the sample size. The first test statistic, Z (q) is derived under the assumption of homoscedasticity, with the asymptotic variance of the VR statistic $\phi(q)$ defined as:

$$\phi(q) = \frac{2(2q-1)(q-1)}{3q(nq)}$$

And the associated standard Z test statistic, Z (q) as:

$$Z(q) = \frac{VR(q) - 1}{\sqrt{\phi(q)}} \rightarrow N(0,1)$$

There is a growing consensus amongst finance empiricist that volatility is time varying as documented by most of the researchers that variances of most stock returns are conditionally heteroscedastic with respect to time. As a result, a linear relation does not exist over the observation intervals. To overcome this difficulty, Lo and McKinley (1988) derive the heteroscedasticity-consistent variance estimator ϕ^*(q) is given by:

$$\phi^*(\mathrm{q}) = \sum_{j=1}^{q} [\frac{2(q-j)}{q}]^2 \delta^{\wedge}(j)$$

Where

$$\delta^{\wedge}(\mathrm{J}) = \frac{\sum_{t=j+1}^{q-1} (P_t - P_{t-1} - u)^2 (P_{t-j} - P_{t-j-1} - \hat{u})^2}{[\sum_{t=1}^{nq} (P_t - P_{t-1} - \hat{u})^2]^2}$$

The VR statistic can be standardized asymptotically to a standard normal test-statistic, Z^*(q) which as reported by Lo and McKinley (1988), is computed as:

$$Z^*(\mathrm{q}) = \frac{VR(q)-1}{\sqrt{\phi^*(q)}} \ldots. \rightarrow N(0,1)$$

4. Result and Discussion

4.1 The result of Augmented Dickey fuller unit root test is given below:

Pre 9/11 data set result

Table no: 1

ADF Test Statistic	-12.94	1% Critical Value*	-3.44
		5% Critical Value	-2.86
		10% Critical Value	-2.57

Augmented Dickey-Fuller Test Equation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
X(-1)	-0.82749	0.063940	-12.9418	0.0000
R-squared	0.472	Mean dependent var	1.23E-05	
Adjusted R-squared	0.469	S.D. dependent var	0.028926	
S.E. of regression	0.021071	Akaike info criterion	-4.875769	
Sum squared resid	0.436895	Schwarz criterion	-4.846086	
Log likelihood	2419.506	F-statistic	175.9641	
Durbin-Watson stat	1.999373	Prob(F-statistic)		0.000000

<u>Post 9/11 data set result</u>

Table no: 2

ADF Test Statistic	-11.93	1% Critical Value*	-3.443
		5% Critical Value	-2.863
		10% Critical Value	-2.57

Augmented Dickey-Fuller Test Equation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
X(-1)	-0.835	0.070069	-11.92721	0.0000
R-squared	0.473	Mean dependent var	-2.82E-05	
Adjusted R-squared	0.470	S.D. dependent var	0.022154	
S.E. of regression	0.016	Akaike info criterion	-5.411470	
Sum squared resid	0.233477	Schwarz criterion	-5.379594	
Log likelihood	2454.690	F-statistic	161.8903	
Durbin-Watson stat	1.992669	Prob(F-statistic)		0.000000

Table 1 and 2 present our empirical results and the ADF statistic for pre and post 9/11 data set. Our results are in procession with Abass (2004), who tests the RWH for KSE 100 index and concluded that RWH can't be rejected for all investment horizons. Chang and Ting (2000) used the Lo and McKinley variance ratio test to examine that Taiwan's stock market follow random walks.

Based on our pre and post 9/11 sample, the daily return of the stock traded in KSE is independent of serial correlation, and hence following a random walk. This is evidenced by the ADF test and Durbin Watson statistics. The ADF model used four lag here, for I (1) the ADF test statistics (-12.94 and -11.93) is less than the Mackinnon tabulated value (-2.86) so there fore we reject our null hypothesis $\delta = 0$ or $\rho = 1$ or it contain a unit root, and accept the alternative hypothesis that time series is stationary or behave randomly. Moreover R^2 0.47 which indicate that the residuals or error terms is not correlated. F statistic is 175 that mean our model is valid and reliable; the Durbin Watson statistic is almost equal to 2 which indicate that the residual have no autocorrelation

4.2 Autocorrelation and Ljung Box Q-statistics:

To confirm that ρ_k =0 or in other words past prices can not be used to predict future prices by taking 16 lags. The statistically significance of any ρ_k can be judged by its standard error. The sample autocorrelation coefficient ρ_k is approximately normal if it exhibits white noise i.e.

$$\rho_k \sim N\,(0,\ 1/n)$$

We construct confidence interval which is equal to

$$\rho_k \pm 1.96(\sqrt{\frac{1}{n}}) = \quad \rho_k \pm .062 \text{ or } \quad \text{in other words}$$

$$\text{Prob}\ (\rho_k \text{-}0.62 \le \rho_k \le \rho_k + 0.62) = 0.95$$

If the confidence interval includes the value of zero we don't reject the hypothesis that the true ρ_k is zero, but if this interval does not include zero, we reject the hypothesis that the true ρ_k is zero.

Pre 9/11 data set

Table no: 3

lag	AC	CI	PAC	Q-Stat	Prob
1	0.065	$0.003 < \rho_k < 0.127$	0.065	4.2798	0.039
2	0.087	$0.025 < \rho_k < 0.149$	0.083	11.853	0.003
3	0.043	$-0.019 < \rho_k < 0.105$	0.033	13.701	0.003
4	-0.014	$-0.076 < \rho_k < 0.048$	-0.026	13.890	0.008
5	0.030	$-0.032 < \rho_k < 0.092$	0.026	14.767	0.011
6	0.013	$-0.049 < \rho_k < 0.075$	0.012	14.946	0.021
7	0.035	$-0.027 < \rho_k < 0.097$	0.031	16.167	0.024
8	0.039	$-0.023 < \rho_k < 0.101$	0.032	17.730	0.023
9	0.027	$-0.035 < \rho_k < 0.089$	0.018	18.474	0.030
10	-0.036	$-0.098 < \rho_k < 0.026$	-0.048	19.804	0.031
11	-0.003	$-0.065 < \rho_k < 0.059$	-0.003	19.810	0.048
12	0.034	$-0.028 < \rho_k < 0.096$	0.040	20.976	0.051
13	-0.051	$-0.113 < \rho_k < 0.011$	-0.054	23.571	0.035
14	0.021	$-0.041 < \rho_k < 0.083$	0.017	24.037	0.045
15	0.017	$-0.045 < \rho_k < 0.079$	0.020	24.319	0.060
16	-0.006	$-0.068 < \rho_k < 0.056$	-0.008	24.355	0.082

Post 9/11 data Set

Table no:4

Lag	AC	CI	PAC	Q-Stat	Prob
1	0.051	-0.014< ρ_k < 0.116	0.051	2.598	0.107
2	-0.003	-0.068< ρ_k < 0.062	-0.005	2.604	0.272
3	0.055	-0.010< ρ_k < 0.120	0.056	5.662	0.129
4	0.056	-0.009< ρ_k < 0.121	0.051	8.789	0.067
5	0.021	-0.044< ρ_k < 0.086	0.017	9.248	0.100
6	0.014	-0.051< ρ_k < 0.079	0.010	9.455	0.150
7	0.079	0.014< ρ_k < 0.144	0.073	15.669	0.028
8	0.034	-0.031< ρ_k < 0.099	0.023	16.835	0.032
9	0.032	-0.033< ρ_k < 0.097	0.028	17.883	0.037
10	-0.013	-0.078< ρ_k < 0.052	-0.025	18.044	0.054
11	0.022	-0.043< ρ_k < 0.087	0.013	18.518	0.070
12	-0.007	-0.072< ρ_k < 0.058	-0.018	18.566	0.100
13	0.017	-0.048< ρ_k < 0.082	0.015	18.858	0.128
14	-0.016	-0.081< ρ_k < 0.049	-0.026	19.128	0.160
15	-0.017	-0.082< ρ_k < 0.048	-0.019	19.414	0.196
16	0.018	-0.047< ρ_k < 0.083	0.014	19.758	0.231

Now by looking table no 3 we can conclude from Confidence interval of AC that except lag 1 and 2 there is no correlation exists. But the Ljung Box Q-statistics tell us different story that AC at all lags are significant except 12, 15 and lag 16. Since the LB Q-statistic critical value is asymptotically equivalent to χ^2 distribution with lag degree of freedom. In application, if the computed Q exceeds the critical Q value from the chi-square distribution at the chosen level of significance, one can reject the null hypothesis that all the (true) ρ_k are zero, at least some of them must be nonzero. And for nonzero ρ_k we reject our null hypothesis and accept our alternative hypothesis that there exists some sort of AC. The AC in pre 9/11 data set is small and in its weak form is exhibited by the absolute value of AC which is in the range of 0.006 to 0.087.

The post 9/11 data set was up to the expectation, now by gaze the above table 4 we can refined from the Confidence interval of AC that all the lags included zero value and hence from CI method it was concluded that there is no autocorrelation exists. The Ljung Box Q-statistics also confirmed the no autocorrelation assumption at all 16 lags. The computed Q does not exceed from the critical Q value of the chi-square distribution at the chosen level of significance, and the null hypothesis of ρ_k is equal to zero is accepted, which further demonstrate that the security prices exhibit random walk and hence their exists a weak form of efficiency in Karachi stock market for post 9/11 data set.

5. Variance Ratio test

Results of the variance ratio statistic for the pre 9/11 data set.

Table no: 5

	K=2	K=4	K=6	K=8	K=12	K=30	K=36	K=40	K=48	K=64	k=128
VR(q)	1.067	1.210	1.270	1.326	1.411	1.489	1.509	1.530	1.570	1.604	1.830
Z(q)	2.120*	3.545**	3.445**	3.500**	3.512**	2.502*	2.365*	2.333*	2.284*	2.085*	2.017*
Sig level	0.034	0.000	0.000	0.000	0.000	0.012	0.018	0.020	0.022	0.037	0.044
$Z^*(q)$	1.474	2.277*	2.237*	2.280*	2.360*	1.814	1.739	1.733	1.722	1.616	1.666
Sig level	0.141	0.023	0.025	0.023	0.018	0.070	0.082	0.083	0.085	0.106	0.096

*indicate that the Z statistics is significant at 5% confidence level
** indicates that Z statistics is significant at 1% confidence level.

Results of the variance ratio statistic for the post 9/11 data set

Table no: 6

	K=2	K=4	K=6	K=8	K=12	K=30	K=36	K=40	K=48	K=64	k=128
VR(q)	1.061	1.087	1.152	1.213	1.338	1.513	1.4981	1.4715	1.4359	1.2010	0.7538
Z(q)	1.850	1.396	1.850	2.169*	2.716**	2.510*	2.2140*	1.9838*	1.6691	0.6638	-0.5715
Sig. level	0.064	0.163	0.064	0.030	0.007	0.012	0.02683	0.04727	0.09511	0.50679	0.56767
$Z^*(q)$	1.239	0.937	1.247	1.480	1.902	1.888	1.6944	1.5367	1.3217	0.5456	-0.5217
Sig. level	0.215	0.349	0.212	0.139	0.057	0.059	0.09019	0.12436	0.18626	0.58533	0.60189

*indicate that the Z statistics is significant at 5% confidence level
** indicates that Z statistics is significant at 1% confidence level

The variance ratio tests with homoscedastic and heteroscedastic consistency are used for this study to check a random walk in KSE 100 index. Homoscedastic and heteroscedastic test statistics are denoted by Z (k) and Z^*(k) respectively. The empirical results on testing the RWH through out the world found in the literature are conflicting in many cases. For the US, most studies find that the RWH should be rejected, while the opposite results occur for some emerging markets, which in many cases are thinly traded. In general the rejection of the RWH depends on many variables such as liquidity, sampling frequency, among others. The null hypothesis under the homoscedastic and heteroscedastic assumption, is that statistically VR (q) is equal to one i.e. time series followed random walk.

In our result the pre 9/11 data set indicates some significance result under the homoscedastic approach and heteroscedastic approach, so the pre 9/11 data set does not follow random walk and hence at that time some sort of abnormality exist in Karachi stock exchange. This is contradictory to Abass (2004), but well aligns with Kamal (2005) For the post 9/11 data set their exist a mixed sort of efficiency, under homoscedastic approach for eleven lag compilation only 5 lag show a significance result that mean if we don't accept our null hypothesis for these 5 lag also we can't reject the null hypothesis for the remaining 6 lag. The result under the assumption of heteroscedasity is very straight forward, i.e. we can't reject the null hypothesis even for a single lag, and hence under heteroscedastic approach we accept the null hypothesis that the security prices in Karachi stock market in post 9/11 era, follows a random walk and exhibits weak form of market efficiency. Our result for post 9/11 data set is also confirmed by Abass (2004) and Kamal (2005).

6. CONCLUSION

Historical stock returns are used to analyze the market efficiency for the KSE 100 index. The data was divided in to two sets to examine the possible impact of the change in world political scenario due to 9/11 events. Along with variance ratio test the conventional ADF for unit root, Ljung Box Q-statistic, Durbin Watson'd' statistic and autocorrelation were used to find out the market efficiency in KSE 100 index.

Researcher was agreed with the more power of the variance ratio test than any other test used for the random walk [10] Lo and MacKinlay (1989) Cai and Shintoni (2004).
Kamal (2005) suggest that a week day effect exists in KSE 100 Index before 9/11, Monday have highest positive return, and there exists market inefficiency in pre 9/11 data set. Our result was a little confusing about the random walk in pre 9/11 data set, the autocorrelation and Ljung Box Q-statistics suggest that there exists autocorrelation in pre 9/11 data and hence market inefficiency, but the ADF and Durbin Watson test result negate the above statement, and exhibiting market efficiency in pre 9/11 data set which is consistent with the finding of Abass (2004). So there was a need for further investigation or the application of more power full tools. That is why variance ratio was applied. VR test exhibits the autocorrelation in pre 9/11 data set for both its homoscedastic and heteroscedastic assumption and hence agreed with Kamal (2005) market inefficiency in pre 9/11 data set.

For the post 9/11 data set the entire test statistics showed similar results that of existence of random walk in security prices in KSE 100 index, and hence demonstrate market efficiency (weak form) in KSE 100 index, which is also consistent with Kamal (2005), Abass (2004).

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APPENDIXES

Appendix 1:

KSE 100 index companies

Symbol	Volume	Open Rate	High Rate	Low Rate	Current Rate	Price Change	% Change	Index Weightage (%)	Index Points	Outstanding Shares (million)	Market Capt. (million)
OilandGas Dev.XD	46,948,200	108.75	110.70	107.50	107.60	-1.15	-1.06	25.16	-20.28	4300.93	462779.90
P.T.C.L.A	30,528,700	64.20	65.15	64.00	64.00	-0.20	-0.31	13.13	-3.10	3774.00	241536.00
National Bank	20,237,100	109.80	110.90	108.15	108.40	-1.40	-1.28	3.48	-3.39	590.89	64052.77
Pak Oilfields	19,180,300	298.40	310.75	298.40	307.80	9.40	3.15	2.20	5.07	131.41	40449.35
P.S.O.XD	14,777,800	385.20	392.95	386.00	387.75	2.55	0.66	3.62	1.79	171.52	66506.72
Fauji Fert Bin	12,440,000	29.45	30.45	29.35	29.50	0.05	0.17	1.50	0.19	934.11	27556.24
Pak Petroleum	10,823,400	223.00	226.15	214.50	215.00	-8.00	-3.59	8.02	-22.50	685.82	147451.60
PICIC GrowthFund	5,085,400	54.00	55.20	54.15	54.40	0.40	0.74	0.47	0.26	157.50	8568.00
D.G.K.Cement	4,575,800	58.50	59.40	57.25	57.60	-0.90	-1.54	0.58	-0.68	184.39	10621.07
M.C.B.XD	3,874,800	83.30	87.45	83.00	83.00	-0.30	-0.36	1.67	-0.46	370.90	30784.53
Nishat Mills	3,090,900	79.25	80.50	78.60	78.65	-0.60	-0.76	0.62	-0.36	145.26	11424.68
Dewan Salman	2,830,500	17.90	18.90	18.15	18.65	0.75	4.19	0.37	1.13	366.32	6831.89
Union Bank	2,694,000	41.20	43.00	40.85	42.50	1.30	3.16	0.52	1.21	226.22	9614.25
B.O.Punjab	1,898,100	82.50	83.50	81.50	81.60	-0.90	-1.09	0.80	-0.67	180.75	14749.00
Adamjee Ins.	1,642,700	74.50	78.20	73.50	76.75	2.25	3.02	0.34	0.76	82.61	6340.65
Hub Power	1,536,500	26.30	26.90	26.40	26.45	0.15	0.57	1.66	0.71	1157.15	30606.73
P.I.C.I.C.XD	1,519,300	70.45	71.90	70.25	70.50	0.05	0.07	1.05	0.06	273.57	19286.35
Pak.PTA Ltd.	1,315,000	8.20	8.45	8.15	8.30	0.10	1.22	0.68	0.62	1514.21	12567.92
Sui North Gas	1,305,700	62.70	63.75	62.20	63.05	0.35	0.56	1.71	0.72	499.19	31473.72
Fauji Cement	1,280,000	12.85	13.25	12.75	12.85	0.00	0.00	0.26	0.00	370.74	4764.05
I.C.I.	1,203,100	80.75	84.75	81.50	84.50	3.75	4.64	0.64	2.13	138.80	11728.79
Bosicor Pak	1,029,500	14.65	15.15	14.50	14.65	0.00	0.00	0.20	0.00	245.07	3590.21
Askari BankXDXB	929,300	82.00	83.75	82.50	82.80	0.80	0.98	0.68	0.49	150.70	12478.11
Lucky Cement	925,500	45.20	45.75	45.10	45.40	0.20	0.44	0.65	0.22	263.38	11957.22
Fauji Fert.	619,000	129.00	131.60	128.50	128.90	-0.10	-0.08	2.73	-0.16	390.10	50283.65
Sui South Gas	618,500	23.30	23.65	23.10	23.15	-0.15	-0.64	0.84	-0.41	671.17	15537.69
Bank Alfalah XD	574,000	41.00	41.50	40.65	40.75	-0.25	-0.61	0.66	-0.31	300.00	12225.00
Attock Refinery Ltd.	402,600	173.10	178.00	168.50	173.30	0.20	0.12	0.33	0.03	34.99	6064.11
Pak ReInsurance	340,500	57.50	60.35	58.50	60.35	2.85	4.96	0.15	0.53	45.00	2715.75
PICIC Bank	292,000	34.50	34.90	34.25	34.45	-0.05	-0.14	0.43	-0.05	227.91	7851.37
Chakwal Cement	283,000	7.70	7.95	7.65	7.75	0.05	0.65	0.24	0.12	562.46	4359.04
K.E.S.C.	280,500	5.30	5.50	5.35	5.40	0.10	1.89	0.67	0.93	2266.22	12237.56
Faysal Bank	178,000	53.45	54.90	53.25	53.50	0.05	0.09	0.93	0.07	320.39	17140.86
M.Leaf Cem.	165,500	22.65	22.90	22.00	22.25	-0.40	-1.77	0.33	-0.44	270.74	6023.90
P.I.A.C.(A)	127,500	8.55	8.60	8.40	8.45	-0.10	-1.17	0.76	-0.68	1652.24	13961.45
WorldCall Comm	115,000	9.25	9.35	9.00	9.10	-0.15	-1.62	0.08	-0.10	159.28	1449.43
Engro Chemical	103,100	118.50	119.50	118.60	119.00	0.50	0.42	0.99	0.31	152.94	18199.86
Jah.Sid.Bank	73,500	30.00	30.50	30.00	30.05	0.05	0.17	0.14	0.02	85.31	2563.64
Shell Pak	72,100	600.00	610.00	593.00	593.00	-7.00	-1.17	1.13	-1.01	35.07	20794.02
Nishat (Chunian)	52,000	100.70	101.75	98.50	99.00	-1.70	-1.69	0.37	-0.48	68.36	6768.08
Kohinoor Textile	45,500	38.00	38.40	36.80	36.85	-1.15	-3.03	0.19	-0.45	96.22	3545.55
National Ref.	39,700	335.20	340.00	331.00	331.00	-4.20	-1.25	1.20	-1.15	66.64	22057.44
J.O.V.and CO.	27,200	268.95	275.00	268.80	270.70	1.75	0.65	0.29	0.14	20.00	5414.00
Abbott Lab.	22,600	126.90	126.90	125.25	126.00	-0.90	-0.71	0.47	-0.25	67.99	8566.27
Kohinoor EnergyXD	20,500	24.75	24.75	24.50	24.75	0.00	0.00	0.23	0.00	169.46	4194.10
Soneri BankXB	20,000	33.45	33.50	33.10	33.50	0.05	0.15	0.30	0.03	165.35	5539.21
Bank AL-Habib	18,500	45.50	45.50	44.50	45.05	-0.45	-0.99	0.45	-0.34	182.59	8225.80

Prime Bank	16,000	19.20	19.50	19.05	19.20	0.00	0.00	0.24	0.00	232.15	4457.28
Mari GasSPOT	14,900	221.65	232.70	231.00	232.70	11.05	4.99	0.46	1.67	36.75	8551.72
P.N.S.C.	13,600	106.00	107.50	104.00	104.95	-1.05	-0.99	0.69	-0.52	120.06	12600.05
Meezan Bank	13,500	15.20	15.20	14.80	14.85	-0.35	-2.30	0.14	-0.24	169.72	2520.27
Pak Refinery	11,100	209.25	219.00	208.00	210.80	1.55	0.74	0.23	0.13	20.00	4216.00
Bannu Woollen	10,000	24.50	24.75	23.30	24.75	0.25	1.02	0.01	0.01	5.07	125.48
Indus Motor	9,700	91.90	93.95	93.00	93.00	1.10	1.20	0.40	0.35	78.60	7309.80
General Tyre	9,500	33.25	33.50	33.40	33.50	0.25	0.75	0.11	0.06	59.77	2002.34
Jah.Siddiq.Co	8,400	93.95	96.85	94.00	96.40	2.45	2.61	0.18	0.35	35.00	3374.00
Arif Habib Sec.	6,900	367.00	370.00	365.00	365.00	-2.00	-0.54	0.40	-0.16	20.00	7300.00
Ibrahim Fibres	6,000	40.20	39.85	38.60	39.75	-0.45	-1.12	0.67	-0.57	310.51	12342.65
Orix Leasing	6,000	29.55	30.90	30.25	30.25	0.70	2.37	0.10	0.17	60.42	1827.58
Saudi Pak Bank	6,000	12.20	12.50	12.05	12.05	-0.15	-1.23	0.15	-0.14	225.00	2711.25
Pak Suzuki	5,800	103.00	105.00	101.50	103.00	0.00	0.00	0.30	0.00	54.04	5566.56
Honda AtlasXD	5,300	60.00	61.50	60.50	61.50	1.50	2.50	0.14	0.26	42.00	2583.00
Int.Ind.	5,200	102.00	103.00	100.00	101.00	-1.00	-0.98	0.23	-0.18	42.79	4321.73
Cherat Cement	4,900	63.50	64.00	63.00	63.50	0.00	0.00	0.23	0.00	66.49	4222.14
Metro Bank	4,400	58.55	57.10	56.75	57.10	-1.45	-2.48	0.48	-0.93	156.00	8907.60
Packages Ltd.	4,000	145.25	149.00	145.50	147.00	1.75	1.20	0.56	0.50	69.88	10272.29
AL-Ghazi Tractor	3,700	145.00	146.90	144.05	146.90	1.90	1.31	0.34	0.33	42.94	6307.34
GlaxoSmithkline	3,500	177.65	182.20	177.00	180.00	2.35	1.32	0.86	0.84	87.38	15729.12
Clariant Pak	3,100	152.00	155.00	154.00	155.00	3.00	1.97	0.13	0.19	15.60	2417.52
I.G.I.Insurance	2,200	202.50	202.10	202.10	202.10	-0.40	-0.20	0.17	-0.03	15.35	3102.44
Attock Cement	2,000	71.50	75.00	68.20	71.50	0.00	0.00	0.28	0.00	72.16	5159.64
Bata (Pak)	1,200	56.90	56.00	55.00	55.00	-1.90	-3.34	0.02	-0.06	7.56	415.80
BOC (Pak)	1,000	149.55	153.00	152.50	152.80	3.25	2.17	0.21	0.33	25.04	3825.91
Kohinoor Weaving	1,000	31.75	32.00	32.00	32.00	0.25	0.79	0.06	0.03	33.06	1057.89
Century Paper	900	81.50	85.50	82.00	85.50	4.00	4.91	0.15	0.52	31.42	2686.52
Nestle Milk	900	525.00	525.00	525.00	525.00	0.00	0.00	1.29	0.00	45.27	23768.32
Sitara Chemical	600	114.95	112.00	112.00	112.00	-2.95	-2.57	0.11	-0.22	18.55	2078.01
Gadoon Tex.	500	83.00	81.50	81.00	81.00	-2.00	-2.41	0.10	-0.19	23.44	1898.44
Dawood Hercules	400	166.00	169.90	169.80	169.90	3.90	2.35	0.67	1.15	72.06	12242.59
Ghani Glass	300	73.00	76.65	72.25	76.65	3.65	5.00	0.13	0.45	30.21	2315.46
Millat Tractors	300	200.00	206.00	200.55	206.00	6.00	3.00	0.13	0.30	12.01	2474.90
UniLever Pak	120	1455.00	1455.00	1455.00	1455.00	0.00	0.00	1.05	0.00	13.29	19342.60
Dawood Lawrencepur	100	70.00	71.00	71.00	71.00	1.00	1.43	0.14	0.14	35.07	2490.13
Gul Ahmed Tex.	100	60.00	57.00	57.00	57.00	-3.00	-5.00	0.12	-0.47	38.33	2184.95
Security Paper	100	137.00	143.00	143.00	143.00	6.00	4.38	0.17	0.54	21.98	3143.40
Thal Limited	100	105.50	104.00	104.00	104.00	-1.50	-1.42	0.08	-0.09	13.91	1446.97
Atlas Honda	0	281.00	281.00	281.00	281.00	0.00	0.00	0.39	0.52	25.55	7178.43
Colgate Pal.	0	194.25	194.25	194.25	194.25	0.00	0.00	0.13	0.00	12.23	2375.76
Gatron Ind.	0	146.00	146.00	146.00	146.00	0.00	0.00	0.30	0.00	38.36	5601.22
Lakson Tob.	0	255.00	255.00	255.00	255.00	0.00	0.00	0.71	0.00	51.32	13085.78
New Jub.Ins.	0	63.75	63.75	63.75	63.75	0.00	0.00	0.25	0.00	73.24	4668.97
Pak Tobacco	0	60.00	60.00	60.00	60.00	0.00	0.00	0.83	0.00	255.49	15329.62
Pak.Services	0	170.00	170.00	170.00	170.00	0.00	0.00	0.30	0.00	32.52	5529.12
Rafhan Maize	0	631.75	631.75	631.75	631.75	0.00	0.00	0.32	0.00	9.24	5835.10
Shakarganj	0	49.00	49.00	49.00	49.00	0.00	0.00	0.08	0.00	29.29	1435.01
Siemens Engg.	0	650.75	650.75	650.75	650.75	0.00	0.00	0.27	0.00	7.77	5056.07
Stand. Chart.Mod	0	24.00	24.00	24.00	24.00	0.00	0.00	0.05	0.00	37.42	898.13
Bestway Cement	0	42.00	42.00	42.00	42.00	0.00	0.00	0.49	0.00	212.82	8938.29
Dreamworld	0	15.10	15.10	15.10	15.10	0.00	0.00	0.03	0.00	32.00	483.22
Wazir Ali	0	17.90	17.90	17.90	17.90	0.00	0.00	0.01	0.00	7.61	136.14