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# Testing the Weak Form Efficiency of Pakistani Stock Market (2000–2010)

**Abdul Haque**
Department of Management Sciences, COMSATS Lahore, Pakistan.
Email: ahaque@ciitlahore.edu.pk , ahaque_257@yahoo.com

**Hung-Chun Liu**
Department of Finance, Minghsin University of Science and Technology,
Taiwan, ROC. Email: hungchun65@gmail.com

**Fakhar-Un-Nisa**
Department of Management Sciences, COMSATS Lahore, Pakistan.
Email: fakharunnisa@ciitlahore.edu.pk

**ABSTRACT**: This empirical paper tests out the weak form efficiency of Pakistani stock market by examining the weekly $KSE-100$ index over the period $2000-2010$. Return series has a leptokurtic and negatively skewed distribution, which is away from normal distribution as reflected by significant Jarque-Bera statistic. Estimated results of ADF (1979), PP (1988) and KPSS (1992) tests, Ljung-Box Q-Statistic of autocorrelations and runs test of randomness reject the Random Walk Hypothesis (RWH) for the returns series. Moreover the results of variance ratio test (Lo and MacKinlay (1988)) also reject the RWH and prove the robustness of other estimated results. The rejection of RWH reveals that the Pakistani stock prices are not Weak Form Efficient.

**Keywords**: Weak Form Efficiency, Variance Raito, Random Walk
**JEL Classification**: C22, G12, G14

## 1. Introduction

In the last few decades a lot of research efforts were made on investigating the efficiency of stock markets and its significant role in challenging the financial resources. The term Efficient Market was introduced by an American economist Eugene Fama in early 60's. He defined this term as the market which hastily tunes itself to new information. In generic terms market efficiency hypothesis predicates that security prices mull over all information backed by it. An obligatory thing for hypothesis is the information and the trading cost i.e. the cost of getting prices to reflect information are always zero (Grossman and Stieglitz, 1980).

Efficient Market Hypothesis (EMH) opines that when investors are looking for alternative vogue in the stock market, each of the investors behaves in a very divergent manner. Efficient market hypothesis leads the market toward perfect competition where none of the investors can exploit the market in the long run. In fact EMH is the application of Random Walk Theory (RWT), the central idea of which is that if the stream of available information is not restricted and in succession immediately reflected in stock prices, it simply means that rumors roaming around have no relationship with the current change in stock price. Stock prices fluctuate in response to spontaneous information and since it enters the market randomly, so the price fluctuations also become random.

There are three versions of efficient hypothesis i.e. i) Weak form efficiency, ii) Semi strong form efficiency, and iii) Strong form efficiency. These versions have their respective impact on the market. In Weak Form Efficiency (WFE), the investors can't forecast the future prices despite having deep understanding of the past prices. Even if they do, they can't extend it for a longer period. Most of the stock prices fluctuate randomly and thus are hard to predict. In semi strong form, share prices hastily tune themselves to new information available publicly but restrain the investors to earn excess returns by trading on that news. In semi strong form efficiency, the adjustments must be of reasonable size and must be without delay. In order to test such efficiency in the market the consecutive upward and downward adjustment after the initial stage must be kept into account. In strong form efficiency, as the name itself signifies, the information obtained through public or private and even historical means pretends visible which forbids the investor to realize abnormal rate of return. Strong form efficiency holds true in a market where the investors do not or cannot earn supernormal returns consecutively in long run.

Different research efforts persuaded on financial markets by various economists have enlightened this whole theory. In the case of developed countries the work done by Hawawini and Michel (1984), Hudson, Dempsey and Keasey (1994), Nicolaas (1997), Sung and Johnson (2006) and Evans (2006) support that the changes in the stock prices show unsystematic pattern; thus it's hard to predict the future prices. In Emerging markets due to emaciated trade, the empirical studies confer mix outcomes. Economists like Omran and Farrar (2006) used the Random Walk Model to test the randomness in five different Middle East countries like Morocco, Jordan, Israel, Turkey, and Egypt. Another worth seeking work done in much detail by covering twenty European markets is by Worthington and Higgs (2006). The results of unit root tests, autocorrelations, runs test and variance ratio (VR) test revealed that only five markets meet the purely RWH.

With the above mentioned lighter tone of introduction it seems reasonable to further investigate the quest of WFE in the case of developing and emerging markets and we continued to this struggle by conducting an empirical study in the case of Pakistan. Our study investigated the WFE of Pakistan's stock market by analyzing the weekly data of $KSE-100$ index over the period $2000-2010$. The results of Unit Root Tests, Autocorrelations, Runs Test, and Variance Ratio (VR) test strongly rejected the EMH in the case of Pakistan. There are obvious patterns and market directions which are of great help in predicting the future prices and thus benefit the investors to yield high volumes of abnormal returns. This phenomenon has made Pakistan's market inefficient. With reference to Pakistan there are informational shortcomings in Pakistani capital market which lead the market to be weak form inefficient. Our results are updated since we have used the very recent data for the empirical analysis. The next section of this paper provides a detailed literature review, covering the research efforts done in the context of developed and emerging markets.

## 2. Literature Review

This concept of Efficient Market didn't earn much fame in the commencement but became conspicuous when the evident version of efficient market hypothesis was published. The influential work of Fama (1970) provided some new insights in the Efficient Market Hypothesis (EMH) and laid down the basis of Random Walk Model (RWM). In addition, the researchers did not focus on a specific technique or model rather developed numerous techniques. These various techniques, though apparently different in assumptions and execution but addressing the same motive of studying the market efficiency have been well appreciated and employed. Although empirically different techniques, ranging from parametric to non-parametric tests, have been applied to diagnose the WFE of stock market but each of them focuses on the RWH. Sometimes deviations in conclusions may appear because of the different time periods or the varying frequency of the data utilized in the study or perhaps driven by the macro or global financial conditions. Nevertheless, the differences in estimated results may lead towards the rejection or questions the validity of these technique rather provide us with a wide range of options, which enable us to model any of the practical situations that could have not been modeled under the stringent assumptions of one specific technique and thus may be studied under different assumptions.

The empirical findings on developing and emerging countries have somewhat mixed results and do not support the EMH. Barnes (1986) analyzed Kuala Lumpur Stock Exchange and found it to inefficient. Dickinson and Muragu (1994) supported the EMH in the case of Nairobi stock market. Panas (1990) found the stock market of Greece to be efficient but at the weak level. Urrutia (1995) examined the four emerging markets of Latin America including Argentina, Brazil, Chile, and Mexico by applying the runs test and VR test for testing RWH, the results of runs test of randomness supported the weak form efficiency but the VR test rejected the RWH. While for Brazil and Mexico, Grieb and Reyes (1999) supported the RWH in their equity prices. On the other hand, Ojah and Karemera (1999) accepted the RWH in the case of Latin American countries and found these markets to be WFE. El-Erian and Kumar (1995) applied serial correlations and runs test on the stock markets of Turkey and Jordan. Their findings suggested that these markets are inefficient. In the case of Istnabul Stock Exchange, Antoniou and Ergul (1997) found the Turkish stock market to be inefficient but efficiency was greatly improved soon after the liberalization. Narayan and Smith (2004) applied the Zivot and Adrews (ZA) (1992) and Lumsdaine and Papell (1997) structural break test on the South Korean stock market, their findings reported the Korean stock market to be WFE. Mookerjee and Yu (1999) examined the stock markets of China and found them to be weak form inefficient and similar findings were reported by Groenewold et al. (2003). While, Fawson et al (1996) and Chang and Ting (2000) found the stock market of Taiwan to be WFE. Whereas in the case of Hong Kong the studies of Karemera et al. (1999) and Lima and Tabak (2004) reported the results in the favor of weak form efficiency hypothesis. Awad and Daraghma (2009) tested the WFE of Palestinian securities by applying ADF (1979) and PP (1988) unit root test, serial correlations and runs test. The market was reported to be inefficient on the basis of runs test and significant serial correlations. Oskooe et al. (2010) studied the stock market of Iran by employing the ADF (1979), PP (1988) and KPSS (1992) tests, estimated results reported the random walk in stock prices and supported the EMH hypothesis in the case of Iran.

In addition to country specific studies some researchers have focused on the cross country analysis to envision the understanding in a larger matrix. Campbell (1995) studied the twenty emerging stock markets covering the Asia, Africa, Europe, Latin America, and Middle East. Findings of the study suggested that in contrast to developed stock market the returns behavior of emerging stock market is more predictable of the future. Abraham et al (2002) applied the VR and runs tests on the Bahrain, Kuwait, and Saudi Arabian stock markets. Both of the tests rejected the RWH in the case of Kuwaiti stock market. By applying the ZA (1992) structural break test on the seventeen emerging markets, Chaudhuri and Wu (2003) observed that for ten of the sampled stock markets the hypothesis of random walk was rejected. Omran and Farrar (2006) tested the RWH for the stock markets of Egypt, Isreal, Jordan, Morocco, and Turkey and the hypothesis was rejected for all of the countries under study. Marasdeh and Shrestha (2008) tested the RWH over the securities markets of Emirates and the results of ADF (1979) and PP (1988) test supported the RWH. Cooray and Wickermaisgle (2005) studied the WFE of the South Asian stock markets including Bangladesh, India, Pakistan, and Sri Lank by applying the unit root tests and Elliot-Rothenber-Stock (ERS) test. Findings of the study revealed that the except Bangladesh rest of the three stock markets were WFE. Worthington and Higgs (2006) applied the unit root tests (ADF (1979), PP (1988) and KPSS (1992)), serial correlation test, runs test of randomness, and variance ratio test on twenty seven emerging economies. The results of the unit root tests and serial correlations along with the runs test revealed that majority of the stock markets are inefficient and the same results were reported by the variance ratio test.

With the above mentioned literature background and mixed results we assume more than one technique to be sure that the findings might not be related to a particular technique but rather prove the robustness of the results.

## 3. Methodology

After having an extensive literature review of the developed and emerging markets and having reviewed the different techniques applied to study the WFE of the stock market this study does not focus on one particular technique. The present study will be using the unit root testing, serial correlations, runs test, and famous variance ratio (VR) test for testing the WFE of Pakistani stock market. The use of more than one technique provides the robustness of estimated results and thus adds to the rigor of the study.

### 3.1 Unit root test

An ultimate criterion to investigate the WFE of a stock market is a test of random walk hypothesis (RWH) in returns series. Wide range of empirical literature investigating the WFE of stock markets emphasized on the randomness of stock prices. The randomness ensures that successive price movements are independent of each other and are stochastically determined. In other words, current price ($P_t$) is independent of past prices ($P_{t-1}, P_{t-2}, \ldots\ldots$) and are not even helpful in predicting the future price ($P_{t+1}$) movements. If the log price series ($P_t$) follows a random walk and returns are independently and identically distributed, can be expressed as follows

$$P_t = \mu + P_{t-1} + \varepsilon_t \qquad t = 1,2,3\ldots\ldots,N \tag{1}$$

Where $P_t$ and $P_{t-1}$ are the current and lagged values of the log of stock price, parameter $\mu$ is mean or drift and $\varepsilon_t$ is the random error term. In econometric perspectives, a random walk series contains a unit root at the levels form and may become stationary at the differenced form. Finally, a significant unit root test in returns series forms the basis of random walk and thus ensures the week form efficiency of the stock market. Contrary to it, rejection of unit root at the levels forms implies that successive price movements are not independent of each other and this signals a deterministic or time trend. The study employed the widely used and largely accepted unit root tests, ADF (1979), PP (1988), and KPSS (1992).

**3.1.1 Augmented Dickey and Fuller (1979) unit root test**

For an AR (1) series of the form $P_t = \mu + \rho P_{t-1} + \varepsilon_t$. Where $P_t$ and $P_{t-1}$ are the current and lagged values of the log price, $\mu$ is the mean or drift parameter and $\varepsilon_t$ is supposed to be white noise. A test of unit root calls for testing the modulus value of coefficient $\rho$ of $P_{t-1}$ is greater than or equal to 1. Under null hypothesis of $H_0:|\rho|>1$, the series has a unit root and is non-stationary. Acceptance of $H_0:|\rho|>1$ implies that the variance of the series is uncontrollable and various price fluctuations are independent and unpredictable, eventually supports the RWH.

$$P_t = \mu + \rho P_{t-1} + \varepsilon_t \tag{2}$$

$$\Delta P_t = \beta P_{t-1} + \sum_{i=1}^{k} \delta_i \Delta P_{t-i} + \varepsilon_t \tag{3}$$

$$\Delta P_t = \alpha_1 + \beta P_{t-1} + \sum_{i=1}^{k} \delta_i \Delta P_{t-i} + \varepsilon_t \tag{4}$$

$$\Delta P_t = \alpha_1 + \alpha_2 t + \beta P_{t-1} + \sum_{i=1}^{k} \delta_i \Delta P_{t-i} + \varepsilon_t \tag{5}$$

Eq-3 is obtained by subtracting $P_{t-1}$ from both sides of eq-2 and adding the $k$ lagged difference parameters $\delta_1, \delta_2, \ldots\ldots \delta_k$. The eq-4 and eq-5 are the simple extended form of equation-2, including a constant term $\alpha_1$ and a time trend parameter $\alpha_2$.

Dickey and Fuller (1979) used the t-statistic (as given by eq-6) for testing the null hypothesis $H_0:\beta=0$ of unit root against $H_1:\beta<0$, which is exactly the same to test $H_0:\rho=1$ in eq-1 as $\beta=\rho-1$.

$$t_\beta = \hat{\beta} \Big/ \left(se(\hat{\beta})\right) \tag{6}$$

Where $\hat{\beta}$ is an estimate of $\beta$ and $se(\hat{\beta})$ is the standard error of $\hat{\beta}$.

**3.1.2 The Phillip-Perron (PP) Test**

PP (1988) is a nonparametric approach for testing unit root in a time series. Unlike the ADF (1979), which augment the $k$ lagged differenced terms in the basic first differenced equation to control for the serial correlation in the series PP (1988) modify the t-statistic so that the asymptotic distribution of $\tilde{t}_\beta$ is unchanged. Modified $\tilde{t}_\beta$ is as given below:

$$\tilde{t}_\beta = t_\beta \sqrt{\frac{\gamma_0}{f_0}} - \frac{T\left(f_0-\gamma_0\right)\left(se(\hat{\beta})\right)}{2\sqrt{f_0}\,.\,s} \tag{7}$$

Where $t_\beta$ is the test statistic given in eq-6, $se(\hat{\beta})$ and $s$ are the standard error of $\hat{\beta}$ and test regression respectively. Moreover, $\gamma_0$ is an estimator of random error term and $f_0$ is an estimator of the residual spectrum.

**3.1.3 The Kwiatkowski, Phillips, Schmidt and Shin (KPSS) (1992) test**

This test differs from both ADF (1979) and PP (1988) test in sense as both of these tests follow the null hypotheses of unit root against the alternative of stationarity while KPSS (1992) test the null hypothesis of stationarity against the alternative of unit root in the series. So in case of KPSS (1992) test, rejection of null indicates the presence of unit root and thus supports the random walk hypothesis (RWH). For a return series $P_t$ of the form (given in eq-8) to

$$\begin{aligned} P_t &= r_t + \beta t + \varepsilon_t \qquad t = 1, 2, \cdots, N \\ r_t &= r_{t-1} + u_t \qquad u_t \sim iid\,N\left(0, \sigma_u^2\right) \end{aligned} \tag{8}$$

be tested for stationarity. The $P_t$ series is decomposed into a random walk component $r_t$, a deterministic trend component $\beta t$ along with an error term $\varepsilon_t$. By assuming the series to be stationary (trend stationary) KPSS test's the null hypothesis $H_0 : \sigma_u^2 = 0$ against the alternative of unit root $H_1 : \sigma_u^2 > 0$. Under the $H_0 : \sigma_u^2$ of statioanarity, $e_1, e_2, \ldots\ldots, e_N$ are the residuals obtained from eq-8 i.e $e_t = \hat{\varepsilon}_t$. Let $S(t)$ is the partial sum of the residuals such that $S(t) = \sum_{j=1}^{t} e_j$ and $\sigma^2$ is the variance of residuals $e_1, e_2, \ldots\ldots, e_N$. A consistent estimator $\hat{\sigma}^2(p)$ of $\sigma^2$ is obtained by applying Newey and West (1987). Finally the LM statistic of KPSS is given by eq-9, the critical values of test statistic are provided by KPSS (1992).

$$KPSS = N^{-2} \sum_{t=1}^{N} S_t^2 \Big/ \hat{\sigma}^2(p) \tag{9}$$

**Runs Test:**

Famous "runs" test has been widely used in the empirical finance literature for testing the randomness of a financial series. By assuming the serial independence it tests for whether the successive occurrences of runs are independent of each other or not? A run is a sequence of successive positive or negative returns $"+++++"$ or $"-----"$ and the run length is a count of consecutive signs. Being a non-parametric test it does not require a specific form of a probability distribution and the test statistic uses the run counts of both of the positive and negative runs. Under the assumption of random walk, actual number of $runs(r)$ and the expected number of runs are same. Let for a return series $R_t$, $N_+$ and $N_-$ are the count of positive and negative runs and $N = N_+ + N_-$ is the total count of runs. Under $H_0$ the successive runs are independent and for large sample sizes the test statistic follows the normal distribution and is given by:

$$Z = \frac{r - \mu_r}{\sigma_r} \sim N(0,1) \tag{10}$$

Where $\mu_r = \frac{2(N_+)(N_-)}{N} + 1$ and $\sigma_r = \sqrt{\frac{2(N_+)(N_-)(2(N_+)(N_-) - N)}{N^2(N-1)}}$ are the sample mean and standard deviation respectively.

**3.2. Variance Ratio Test**

For testing the randomness of a series Lo and Mckanlay (1988) introduced a Variance Ratio (VR) test. For a return series $R_t, t = 0, 1, 2, \cdots, nq$ such that

$$R_t = \mu + R_{t-1} + \varepsilon_t \quad E(\varepsilon_t) = 0 \text{ and } \begin{aligned} \operatorname{cov}(\varepsilon_t, \varepsilon_s) &= 0 \quad t \neq s \\ &= \sigma^2 t = s \end{aligned} \tag{11}$$

where, $\mu$ is the drift parameter and $\varepsilon_t$ is the random error term. If $R_t$ follows a random walk then the variance of the first difference $R_t - R_{t-1}$ is $1/q$ times the variance of $R_t - R_{t-q}$ or in other words the variance ratio $VR(q)$ of $\text{var}(R_t - R_{t-q})/q$ to $\text{var}(R_t - R_{t-1})$

$$VR(q) = \frac{\text{var}(R_t - R_{t-q})/q}{\text{var}(R_t - R_{t-1})} = 1 \text{ under } H_0 \text{ of a random walk.}$$

Let $\hat{\mu} = \frac{1}{nq}\sum_{k=1}^{nq}(R_k - R_{k-1}) = \frac{1}{nq}(R_{nq} - R_0)$ and $\bar{\sigma}_a^2 = \frac{1}{nq-1}\sum_{k=1}^{nq}(R_k - R_{k-1} - \hat{\mu})^2$ is the unbiased estimator of $R_t - R_{t-1}$ and $\bar{\sigma}_q^2 = \frac{1}{q(nq-q+1)\left(1-\frac{q}{nq}\right)}\sum_{k=q}^{nq}(R_k - R_{k-q} - q\hat{\mu})^2$ is the unbiased estimator of $R_t - R_{t-q}$. The VR test uses the $Z(q)$ test statistic for testing the hypothesis of randomness. The $Z(q)$ follows an asymptotic normal distribution and is given below in eq-

$$Z(q) = (VR(q)-1).[\hat{S}^2(q)]^{-1/2} \sim N(0,1) \qquad (12)$$

Where $\hat{S}^2(q) = \frac{2(2q-1)(q-1)}{3qT}$

For heteroskedastic error terms, the modified test statistic $\overset{*}{Z}(q)$ is given by

$$\overset{*}{Z}(q) = (VR(q)-1).[\hat{s}_*^2(q)]^{-1/2} \sim N(0,1) \qquad (13)$$

Where $\hat{S}_*^2 = \sum_{j=1}^{q-1}\left(\frac{2(q-j)}{q}\right)^2.\hat{\delta}_j$

and $\hat{\delta}_j = nq\left\{\sum_{k=j+1}^{nq}(X_k - X_{k-1} - \hat{\mu})^2(X_{k-j} - X_{k-j-1} - \hat{\mu})^2\right\} * \left\{\sum_{k=1}^{nq}(X_k - X_{k-1} - \hat{\mu})^2\right\}^{-2}$

**4. Data and Descriptive Statistics**

The study uses the weekly data of $KSE-100$ index of Karachi Stock Exchange (KSE) over the period of $2000-2010$. The weekly observations of index were obtained from the KSE website (http://www.kse.com.pk/). The continuous weekly returns $r_t$ are $r_t = \ln(P_t/P_{t-1})$, where $P_t$ *and* $P_{t-1}$ are the log index at time $t$ and $t-1$. The basic descriptive statistics of the returns series for our sample period $2000-2010$ are reported in the Panel-A of Table-1. Over the sample time period, return series has an average of 0.0072 and standard deviation of 0.039. The returns are negatively skewed as the skewness is -0.2634. Moreover, the return series exhibits a leptokurtic distribution as it has a positive kurtosis and a significant Jarque-Bera statistic.

**Table 1. Descriptive statistics, unit root tests, and autocorrelations for $p_t$ and $r_t$ series of KSE-100 index for the period 2000-2010**

Panel-A: Descriptive statistics of $p_t$ and $r_t$ for the sample period 2000-2010

| Series | N | Min | Mean | Median | S. D | Max | Skew | Kurto | Jarque-Bera |
|---|---|---|---|---|---|---|---|---|---|
| $p_t$ | 571 | 7.03300 | 8.5418 | 0.0037 | 0.815 | 9.659 | -0.4889*** | 1.7288*** | 61.1931*** |
| $r_t$ | 570 | -0.2009 | 0.0037 | 0.0072 | 0.039 | 0.257 | -0.2634*** | 9.0299*** | 871.6824*** |

Panel-B: The results of unit root tests of $p_t$ and $r_t$ for the sample period 2000-2010

| | ADF (1979) | | PP (1988) | | KPSS (1992) | |
|---|---|---|---|---|---|---|
| Series | No Trend | Trend | No Trend | Trend | No Trend | Trend |
| $p_t$ | -1.0232 | -1.1831 | -1.1103 | -1.2434 | 2.6367 | 0.5607 |
| $r_t$ | -21.2727 | -21.2689 | -21.3962 | -21.3917 | 0.1694 | 0.0976 |

Panel-C: The autocorrelations of $r_t$ series up to lag-12 for the sample period 2000-2010

| | $\rho_1$ | $\rho_2$ | $\rho_3$ | $\rho_4$ | $\rho_5$ | $\rho_6$ | $\rho_{12}$ | $Q_6$ | $Q_{12}$ |
|---|---|---|---|---|---|---|---|---|---|
| **AC** | 0.115 | 0.038 | 0.038 | 0.106 | -0.043 | -0.045 | 0.046 | 18.037*** | 21.977*** |
| **P-val** | 0.006 | 0.015 | 0.026 | 0.003 | 0.005 | 0.006 | 0.038 | 0.006*** | 0.038*** |

**Note:** $p_t$ is the Log of KSE-100 index and $r_t$ is the returns (first difference of $p_t$), $Q_6$ and $Q_{12}$ are the Ljung Box statistics for the lag 6 and 12 respectively.***,**,* indicate the significant values at 1%, 5% and 10% level of significance.

### 4.1 Estimations of Unit root test

In our pursuit of studying weak form efficiency of Pakistani stock market we start our empirical investigation with the unit root tests. For this purpose the estimated results of unit root tests of ADF (1979), PP (1988) and KPSS (1992) applied to the $\log(index)$ and return series are reported in Panel-B of Table-1. All the three tests significantly reject the hypothesis of stationarity for the log price of $KSE-100$ index. These significant results clearly reject the RWH in the case of $KSE-100$ index series and which implies that the stock prices are not week form efficient. The above stated results suggest that the stock prices are predictable and the investors may follow the systematic pattern to earn the abnormal profits. The results of stationarity analysis for the return's series do not turn to be significant which implies that the log price series is differenced stationary i.e $I(1)$. Next we analyze the autocorrelation of returns series $r_t$ to further high light the debate of weak form efficiency.

### 4.2 Autocorrelation Tests

After the rejection of RWH on the basis of the unit root tests we continue our pursuit for randomness by inspecting the autocorrelations and Ljung Box Q-statistics for return series. Under the null hypothesis $Q-statistic$ assumes that the all the autocorrelations are equal to zero i.e different values are not correlated and thus are not helpful in predicting the future observations and ultimately the series is random or stochastic. The rejection of null hypothesis in the case of significant Q-statistic implies that successive values are correlated to each and thus are predictive of future values and ultimately the series is not random and the stock prices are not weak form efficient. For our selected sample period as is evident from the Panel-c of Table-1, uptill $lag-12$ the autocorrelations of return's series are significant. The significant autocorrelations (Q-statistic) provide another evidence to reject the RWH and thus support to reject EMH in the case of Pakistan. Further to check for the randomness of returns the study employees runs test and the next section provides the estimations of the runs test applied to our sample period.

**Table-2. Estimated Results of Runs Test and Variance Ratio Test applied to the returns series of KSE-100 index.**

| Panel-A: The results of Runs Test of Randomness | | | |
|---|---|---|---|
| $K = mean$ | $K = mean$ (0.0038) | $K = 0$ | 0.0000 |
| $cases < K$ | 251 | $cases < K$ | 220 |
| $Cases \geq K$ | 320 | $Cases \geq K$ | 351 |
| Total Cases | 571 | Total Cases | 571 |
| No of Runs | 241 | No of Runs | 237 |
| Z | -3.514*** | Z | -3.049*** |

| Panel-B: The results of Variance Ratio (VR) Test | | | | |
|---|---|---|---|---|
| | $j = 2$ | $j = 4$ | $j = 8$ | $j = 16$ |
| $VR(j)$ | 0.5435 | 0.2507 | 0.1367 | 0.0705 |
| $Z(j)$ | -10.898*** | -9.5621*** | -6.9676*** | -5.0415*** |
| $Z^*(j)$ | -5.6394*** | -5.4521*** | -4.17628*** | -3.2425*** |

**Note:**. $VR(j)$ is the variance ratio statistic for $j = 2,4,8,16$, $Z(j)$ and $Z^*(j)$ are the z-statics under the assumption of homo/hetero skedastic increase. ***, **, * indicate the significant values at 1%, 5% and 10% level of significance.

### 4.3 Runs test of randomness

The runs test of randomness in not affected by the non-normality of the return's series as the reported results of descriptive statistics in the Panel-A of Table-2 suggest. Under the null of randomness the test assumes the sequence of positive (increasing) and negative (decreasing) runs to be independent of each other and don not follow any systematic pattern of occurrence and thus are not of any help in predicting the pattern of occurrences. The estimated results of runs test for both values of $K$, $K = mean$ and $K = 0.0000$ of the returns series for our sample period 2000-2010 are reported in the Panel-A of Table-2. According the reported results the computed value of Z-Statistic is negative and significant at 1% of significance. The negative Z-Statistic value indicates, the actual number of runs is far less than the expected number. Significant test statistic is indicative of the non randomness of the returns series. In other words there are obvious patterns (both positive and negative) in the return series of Pakistani stock market which indicate that the market is not WFE. Finally, to prove the robustness of earlier estimated results the study applies the variance ratio (VR) test of Lo and MacKinlay (1988) in the next section.

### 4.4 Test of Robustness: Variance Ratio (VR) test

We apply the VR test of Lo and MacKinaly (1988) to prove the robustness of our finding that the Pakistani stock prices are not weak form efficient. The estimated results of VR test of randomness for the returns series of $KSE-100$ index are reported in the Panel-B of Table-2. The estimated variance ratio $VR(j)$ along with both $Z(j)$ and $Z^*(j)$ are reported for $j = 2,4,8 and 16$. The estimated results are significant at 1% level of significance which clearly rejects the random walk hypothesis (RWH). These results further provide the robustness of our earlier results based on unit root tests, serial correlations and runs test that the Pakistani stock market is not WFE.

**5. Conclusion**

This research article adds to ongoing debate on weak form efficiency of developing stock markets by analyzing the returns behavior of Pakistani stock market. For this purpose the study uses the latest weekly data of $KSE-100$ over the sample period $2000-2010$. In order to test the weak form efficient hypothesis the study examines RWH in the returns series. Instead of relying on a single test of RWH the study rather applied different econometric tests to test the robustness of the estimated results. Descriptives reveal that returns distribution is non-normal, leptokurtic and negatively skewed. To test the RWH the study applied the ADF (1979), PP (1988) and KPSS (1992) unit root tests on the log of index. The estimated results of all these tests significantly rejected the hypothesis of stationarity and thus reveal that Pakistani stock market is not weak form efficient. Secondly the study applied the Lung-Box Q-Statistic for testing the autocorrelations of the returns series. Estimated Q-Satistics are significant up to lag-12 which clearly rejected the joint hypothesis of zero auto correlations. The significant autocorrelations imply that the stock prices do not follow RW and are predictive of future prices. Thirdly the study applied the Runs test of randomness to test for the RWH; the estimated results significantly rejected the null hypothesis of randomness and provide third evidence in the support of rejection of the weak form efficient hypothesis in the case of Pakistan. Finally to test for the WFE hypothesis the study applied the most reliable VR test of Lo and Mackinlay (1988) to check the randomness of return series. In the line of earlier tests the results of VR test also rejected the hypothesis of randomness and thus provided the robustness of our estimated results.

In the light of above mentioned facts based on the estimated results we conclude the weak form efficient hypothesis does not hold true in the case of Pakistani stock market. Thus the current stock prices are helpful in predicting the future prices. This predictive trend of stock prices may benefit the investors to yield some arbitrage benefits and abnormal profits.

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