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Testing Random Walk and Weak Form Efficiency Hypotheses: Empirical Evidence from SAARC Region

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ABSTRACT

This empirical study attempts to examine Random walk and Weak Form Efficiency of capital markets of Pakistan , India , Srilanka and Bangladesh constituted as SAARC countries . The Daily , Weekly and Monthly observations of period Jan 2005 to Dec 2010 were examined by using broadly used tests; Autocorrelation, Ljung-Box Q-Statistic, Run test, Unit root test and Variance Ratio tests were used. All daily returns of indices found to be follow non-normal distribution and all monthly returns of all indices were negatively skewed. To sum all, we conclude that none of capital markets is characterized by Random walk and hence are not Weak form Efficient for the examined period. This indicates that there exists utility for technical analysis, availability of arbitrage profit and opportunities for investment management by diversification of portfolios across the markets.

Introduction

Man has long desire to anticipate future events. Economists have no escape from this desire, for whom following questions, among others, have always been a part of their wondering: Are security prices knowable? Does information run in multiple markets all together? Can there be investors with information that is not reflected in security prices and returns? Do all investors have the same ability to attain process and propagate information? Is there any possibility exist to obtain abnormal returns knowing given market dynamics coupled with knowing nature and sources of variations in stocks prices. Perhaps nothing so straight well illustrates the validity of aforesaid questions, as Efficient Market Hypothesis. This investment theory was bound to capture the wide attention of researchers for its underlying theoretical and practical importance and there is less surprise that Efficient Market Hypothesis and Random walk theory have remained very popular in research community for the last four decades.

In attempt to understand efficiency we see different connotations in economics and finance. Speaking specifically, it presents the mechanism according to which asset prices respond to news and the speed with which the adjustment takes place to prices of securities with the advent of information. Speaking of a perfectly efficient market, the influx of a particular news should cause an instantaneous and full adjustment of the asset prices to their new fair values so this news will not act no longer as a token to get above average returns (Campbell, Lo and MacKinlay (1997)). In other words, the assimilation of the arriving information is so fast and correct that no one is able to get abnormal profits by trading on the same set of news flowing to the market at a given time. Furthermore, an exceptional return can be taken if there lies a gap in the market information and efficiency, if not, it is not possible but only through to luck element.

In retrospect, by the early 1970.s a consensus had emerged and developed among financial economists, seems convincing them that stock prices could be well approximated by a random walk model and that variations in stock prices and returns are basically unpredictable (Pesaran(2010). Samuelson (1965) invoked a new life to the random walk theory of asset prices which in latter episodes provided a foundation stone for Efficient Market Hypothesis .The works of Kendall(1953), Osborne (1959), Cowles (1960), Osborne (1962), and many others had already Provided statistical substantiation on the random character of equity price change. Fama (1970) provides an early and ground-breaking definitive proclamation of this particular position and came up with distinctive but interdependent versions of efficiency namely: Weak form efficiency, Semi strong form efficiency and strong form efficiency. Information is central to all three versions splitting up into market, public and private information for respective stated versions.

Considering both the theoretical and practical significance, why is the presence of market efficiency so vital in reality? And why the validity of the EMH has significant implications for financial theories and investment strategies. There are both theoretical and practical reasons for that. Attempting on theoretical point of view, the Efficient Markets Hypothesis gives some of the basic assumptions upon which most of the asset pricing models are constructed.. If, in reality, we confront that markets are not efficient, then the finance professionals will not be in a position to rely on the precision of the asset prices derived from such models. For sake of illustration, Technical analysis, a famous investment analysis, puts credence on past market data to predict future movements and, thus, contradicts with the weak form of the efficient market hypothesis. If historical price (and volume) data may be used to forecast future movements of market prices, the given market is said to be weak

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form inefficient in essence. If the equity market(though the concept is not only limited to equity markets) in question turns out to be efficient , exploring miss-priced assets will be a waste of time, therefore, there will be no undervalued security offering higher than likely return or overvalued security offering lower than the likely return. All assets will be properly priced in the given market offering optimal reward to given risk exposure and no arbitrage opportunity exist in a given market. Finally, if a stock market is not efficient, the pricing mechanism does not make sure the efficient allocation of capital within an economy, which is bound to bring negative effects for the overall economy. Copeland and Weston (1988) puts it differently that if the equity market is working efficiently, the prices of assets will demonstrate the intrinsic values of the equity and in turn, the limited savings can be allocated to the productive investment sectors, most advantageous in such a way that will make available stream of benefits to the individual investors and to the economy of the country as a whole. So now it is not very difficult to find out significance and implications of weak form efficiency for financial theories and investment strategies, and why this issue is so pertinent for investors, academicians, and regulatory authorities.

In this study, we mainly focus only on the weak form efficiency of equity markets in seven SAARC(The South Asian Association for Regional Cooperation) countries, an economic and political organization founded on 1985 of seven countries namely India, Pakistan, Sri Lanka, Bangladesh, , Nepal, Bhutan, Maldives, and Afghanistan, the latest member since April 2007. The equity markets of Nepal, Bhutan, Maldives, and Afghanistan, some are newly born and other have very thin trading volume so we are excluding them for this study to meet size effect.. Our study will test weak form efficiency on said countries representative equity exchanges by taking daily, weekly and monthly returns streams covering period January 1997 to December 2010.

The remaining paper is ordered as follows. Section 2 reviews germane empirical literature. Methodological issues are highlighted in Section 3 and results and findings are recorded in Section 4.

2. Literature Review

The Efficient Market Hypothesis is one of the most important and widely disputed propositions in finance and economic science (Pesaran(2010)). There is no doubt that EMH is a cornerstone of modern finance. Market efficiency is a concept intimately related to the diffusion of information. In retrospect, we see that the efficient market hypothesis is inextricably related to the Random walk theory as Reilly and brown (2005) asserts that the primary work of EMH is based on random walk theory. It is commonly believed in academic circles that the most prominent work done in this regard originates to Bachelier in 1900 (Pesaran 2010). The random walk is used to refer to subsequent price changes which are independent of each other. In other words, tomorrow's price change cannot be anticipated by looking at today's price change (Angelov(2009)). The most notable subsequent works such as Working (1934), Cowles and Jones (1937), Kendall(1953) are based on empirical evidence to support Random walk hypothesis but, hitherto, it lacks theory based model to explain random walk in prices. The gap filled by more general model based on the concept of efficiency of the markets which we know as EMH. This theory was proposed by Fama in late 1970s. Since its inception it becomes a subject for constant debate in research community in view of its importance and implications.

FamabpaintsbEfficientmMarketoHypothesislinitermsjofbfai rngamelmodelk(Hassan,Abdullah& Shah(2007). A prerequisite of strong form of EMH is that information and trading costs, the cost of getting prices to reflect information, are always 0(Grossman and Stiglitz(1980)) . A weaker and more sensible version of the efficiency hypothesis says that prices fully reflect information to the point where the marginal benefits of acting on information exceed the marginal costs (Jenson1978).He introduce three versions of EMH namely weak form of efficiency, semi strong form of efficiency and strong form of efficiency A market is weak form efficient if the current stock prices or return series are not predictable from past prices or put it differently, return information (Fama 1991).The market is semi-strong form efficient if the current security prices fully reflect all publicly available Information and consistent above average return is not possible from same token of information. Finally, the market is strong form efficient if security prices reflect all private and public and market information (Hin Yu Chung(2006)). The Random Walk Model is widely used to testify the weak-form Efficient Market Hypothesis. The Random Walk Model (RWM) is the model which assumes that subsequent price changes are sovereign and concludes that changes in future prices cannot be forecasted through historical price changes and movements (Hamid, Shah ,Suleman and Imdad (2010)). This theory gathered wide reputation all over the world as economist as long been fascinated by changes in prices. It initiates a plethora of studies for its underlying significance. While examine the findings of these studies for sake of convenience , we study the findings of studies in developed and emerging countries separately. We have fundamental rationale behind this that in comparative terms, while the Developed markets with well-established institutions are characterized as having high level of liquidity and trading activity, substantial level of market depth and low information asymmetry, on the other hand, the emerging market are seen to exhibit more information asymmetry, thin trading and shallow depth because of their weak institutional infrastructure. (Khaled and Islam (2005)).

Speaking for studies of developed centered countries, Lee (1992) use variance ratio test to examine whether weekly stock returns of the United States and 10 industrialized countries namely: Australia, France, Italy, Japan, Netherlands, Belgium, Canada, Switzerland, United Kingdom, and Germany follow a random walk process for the period 1967-1988. He concludes that the random walk model is still appropriate characterization of weekly return series of for majority of these countries and validates weak form of efficiency in study of aforesaid countries. Choudhry (1994) explore the stochastic structure of individual stock indices in seven OECD countries: the United States, Japan and Italy, the United Kingdom,Canada, France, Germany. The Augmented Dickey-Fuller and KPSS unit root tests, and Johansen's co-integration tests was used to test the log of monthly stock indices from the period 1953 to 1989. He finds out that stock markets in OECD countries are efficient during the sample period, validity of the EMH market hypothesis. Al-Loughani and Chappel (1997) examine the validity of the EMH market hypothesis for the United Kingdom stock market using,lDickey-Fuller unit root, the Lagrange multiplier (LM) serial correlation, and Brock, Dechert and Scheinkman (BDS) non-linear tests. Their finding are found to be consistent with

EMH assumptions. Groenewold (1997) examines both weak and semi-strong forms of the EMH for New Zealand and Australia and rejects EMH for said markets. Lima and Tabak (2004) contend that the random walk hypothesis for Hong Kong equity markets is not rejected, but for Singapore markets it is rejected. Solink (1973) examines stocks from eight stock markets of the France, Italy, Belgium, Neither land, Switzerland, UK, Germany, Sweden and USA. The RWM reveals that the variations are slightly more apparent in European stock markets than the USA market counting technical conditions behind it.

Now we examine some studies examine in developing countries scenario. Appiah-Kusi and Menyah (2003) test out the weak-form efficiency of 11African stock markets including Botswana,Mauritius, Morocco, Nigeria, South Africa, Egypt, Ghana, Ivory Coast, Kenya, Swaziland, and Zimbabwe Their results indicate that except the markets in Egypt, Kenya, Mauritius, Morocco, and Zimbabwe, rest of the six markets are arrived consistent with weak form efficient. Using the serial correlation, runs and unit root tests Abeysekera (2001) indentifies that the Colombo Stock Exchange (CSE) in Sri Lanka is weak-form inefficient. Mobarek and Keasey (2002) use the runs and autocorrelation tests to examine the validity of weak-form efficiency for the Dhaka stock market in Bangladesh he says that returns of Dhaka stock market do not follow random Walks. Gilmore and McManus (2003) explore whether the stock markets in Central European countries including Czech Republic, Poland and Hungary .They assert that these three markets are not weak-form efficient in functioning. Abrosimova et al. (2005) tested for weak-form efficiency in the Russian stock. They end up with conclusion that supports weak-form efficiency in the Russian stock market. According to Hassan et al. (2006), markets in Czech Republic, Poland and Russia and Hungary are found to be unpredictable supporting EMH. Abraham et al. (2002) reject the random walk hypothesis for the Saudi Arabia and Bahrain markets.

In research studies on South Asian markets, it is quite evident researchers arrive at mix set of results. As Sharma and Kennedy (1977) and Alam et al. (1999) report that the random walk hypothesis cannot be rejected for stock price changes on the Bombay (India) and Dhaka Stock Exchange (Bangladesh) respectively. Gupta (1985), Srinivasan (1988), Ramachandran (1985) Gupta (1985), Srinivasan (1988) ,Vaidyanathan and Gali (1994) and Prusty (2007) supports the weak form efficiency of Indian capital market. However, some studies like Kulkarni (1978), Chaudhury (1991), Pandey (2003), Gupta and Basu (2007), Mishra, (2009) Poshakwale (1996), Pant and Bishnoi (2002), and Mishra and Pradhan, (2009) do not support the existence of weak form efficiency in Indian capital market. Regarding to the scenario of Pakistan (Hasan, Shah and Abdullah (2007)) examine the weak-form market efficiency of Karachi Stock Exchange (KSE). The results reveal that prices behavior is not supporting random walks and hence these are not weak-form efficient. According to Kashif and Yasir (2005) there exist evidence of weak form of efficiency in Karachi stock exchange for partly sample of study. Abeysekera (2001) concludes thatvthen Colomboz Stockn Exchange (CSE) linn SriLankadislweakformlinefficient.Cooray,Arusha,Wickremasinghe and Guneratne (2007) support weak form efficiency for all countries in South Asian region including Pakistan, India ,Srilanka and Bangladesh. This study mainly seeks evidence on whether the South Asian stock markets return series is independent or follows the random walk model. Hence, it is a fascinating empirical question whether and to what extent less developed markets like the SOUTH ASIAN equity markets is efficient and what return generation factors drive the market. As mentioned above plenty of work has been done on this topic but this is equally true that there exists a plenty of conflict and to erase this gap has been an inspiring objective of this study.

3.DatanandmMethodology

In order to test Random Walk and weak efficiency of SAARC representatives capital markets, monthly, weekly and daily closing prices of indices ranging from Jan 2005 to Dec 2010, have been taken. Their representative capital markets are Karachi Stock Exchange, Bombay stock Exchange, Colombo Stock Exchange and Dhaka Stock Exchange for Pakistan ,India , Srilanka and Bangladesh respectively. All closing prices were gathered from yahoo finance except for Dhaka Stock Exchange. DSE prices were taken from its official website land its publications. The closing monthly, weekly and daily closing prices were used to calculate the monthly, weekly and daily log returns respectively. These returns are computed as follows

$$R_t = \ln (P_t / P_{t-1})$$

Where Pt = Market Price at time 't', Pt-1 = Market Price at time't-1'

The authors of the study were concerned about the measures to test the Efficiency and Random Walk Hypothesis. The authors were aware of the current developments in the same chapter but finally decided to use general measures to invite general acceptance for this study. For this reason , number of econometrics tools were employed, started from weak descriptive statistics to strong multiple variance test(MVR).

To see in one quick glimpse, following tests are widely recognized as general measures of testing weak form efficiency:

Tests for Normality
Tests for Serial Correlation
Unit Root Tests
Multiple Variance Ratio tests

3.1. Normality and Descriptive Statistics

There are various assumptions upon which various statistical methods are based; one crucial assumption is normality of data that a random variable is normally distributed. Speaking to EMH, this presumes that if stock prices are in random fashion then its distribution should conform to normal distribution. To put it differently, if changes in indices pursue the normal distribution the series can be called random (Fisher and Jordan (1991)). Many researchers conveniently implicit normal distribution without any empirical evidence or test but normality becomes critical especially when this assumption is dishonored and any given interpretation and deduction cannot be reliable or valid. Normality of data can be examined by two ways: Graphical method and Numerical methods. Graphical methods envisage the Distributions of random variables or the differences between the given empirical distribution and a theoretical distribution. On the other hand, Numerical methods gives summary of statistics such as skewness and kurtosis , or by conducting statistical tests for normality.

Furthermore, Descriptive statistics for the observations includes the Arithmetic Mean, Median, Range , Variance, Skewness, and Kurtosis. As normality tests seek either given set of data keeps similarity to the normal distribution or not. So the null hypothesis is thus that the given set of data is similar to normal distribution , thus a small p-value will leads us to non-normal distribution of data. Jarque- Bera test have been employed for testing the normality of data

3.2. Autocorrelation

Autocorrelation is also at times called "serial correlation "and "lagged correlation" which measures the correlation coefficient between a series of returns and lagged returns in the same series. A significant positive autocorrelation leads us to believe that a relationship exists in the tested trend. As we noticed in literature that, Autocorrelation has been the most commonly used test for the measurement of randomness. Autocorrelations are widely considered one of the most reliable measures to check the dependence or independence of variables in a series. If no autocorrelations are found than the considered series will appear to be random in nature. Under the assumption of weak form version it is believed that the increments or first-differences of level of the random walk are uncorrelated at all lags and leads and autocorrelation coefficient will have zero value. Or to put it differently a series will be truly random when it will have a zero autocorrelation coefficient.

$$P(k) = \frac{Cov[R_t, R_{t-k}]}{\sqrt{(Var[R_t)]}\sqrt{Var[R_{t-k}]}} = \frac{Cov[R_t, R_{t-k}]}{Var[R_t]}$$

Where p(k) refers to the serial correlation coefficient of the given time series R_t and $R_t$denotes the log return of the index at time t , and k is the lag of the period . Hence Cov(R_t, R_{t-k}) is the covariance between the return of the index ,over time period (t-1, t) and lagged return t-k periods (earlier) and Var(R_t) is the variance of return on a security over time period (t-1, t). we can also determine the autocorrelation function ACF (k) for the time series Yt and the k-lagged series Yt_k is discussed as follow

$$ACF(k) = \frac{1}{T-K}\sum_{t=k+1}^{T}(y_t - \bar{Y})(y_{t-k} - \bar{Y})$$

According to Hassan, Abdullah and Shah (2007) two approaches are widely employed to test the autocorrelation in the returns: (i) Parametric autocorrelation coefficient and (ii) Nonparametric run test. Speaking to Parametric test, this is to test the autocorrelation and to determine correlation coefficient P(k) , Ljung Box Test is available which provides, as researchers believe, a superior fit to Chi-Square (□2) distribution though for the little samples. This can be computed as follow

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

3.3. Run Test

Run test is nonparametric test and this does not require returns to be normally distributed. This test has been a long time and time tested test for examine the random walk. Fama (1965), among other indicators, used run test to test the RWH of stock price movements. This test inquires that whether successive price changes are Independent and autonomous as contemplated by random walk hypothesis. When we make attempt to evaluate the possibility of independence in particular series with the help of correlation coefficient, we confront with a situation where correlation coefficient is dominated by extreme values. To conquer this possible situation, researchers use this test. According to Campbell et al. (1997) the null hypothesis of randomness is examined by observing the number of runs which derive it essence from sequence of successive price changes. In this paper a positive return is implied as 1, otherwise 0. The sequence of 0001110000 has three runs so same signs make one run. Positive return (+) which imply that return >0 and negative return (-) imply <0 with respect to mean return. The foundation on which this test is built is that if price changes or returns appear random then actual number of runs must be close to the projected number of runs.

3.4. Unit Root Test

In our study unit root test has been employed to test that time series is non-stationarity , a condition for random walk which support weak form efficiency for the given market. This particular methodology was put forwarded by Dicky and Fuller(1981) to examine the stationarity of financial time series (Campbell et al.(1997)). A series will be said in stationary state if the auto covariance and the mean value do not depend on time . In addition to above, series with a unit root is indicating nonrandom walk because unit root indicates no stationary implies that if the data points move away from past mean for long time periods. The most commonly employed tests to examine the unit root are (i) Augmented Dickey-Fuller test (1979) parametric and (ii) Phillips-Perron (1988) nonparametric and keeping consistent with other studies we have used these widely accepted tests.

The Augmented Dickey Fuller (ADF) test finds out the possibility or existence of unit root by employing an autoregressive (AR) model. The equation for an autoregressive AR (1) model is given below:

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

Where, P_t is the variable under study, "t" shows the time period and ε_t denotes the error term for that period. The following equation can be used as regression equation:

$$\Delta P_t = (\varphi - 1)P_{t-1} + \mu_t = \delta P_{t-1} + \varepsilon_t$$

Here, Δ is the symbol of first difference operator. The model of above equation can be estimated for unit root in ADF test.

The Phillips-Perron (PP) test also applies to check out the stationarity of the time series.The Phillips-Perron (PP) test is considered a less strict test than of ADF test and it works under the assumption that the error terms are heterogeneously distributed. Mathematically, it can be written as:

$$P_t = \rho + \eta_1 P_{t-1} + \eta_t\left\{t - \frac{T}{2}\right\} + \varepsilon_t$$

So we can infer from statistical guidance that

$H_{0:}$ p= 0 (Non –Stationary or unit root)

H_1: p≠ 0 (Stationary or no unit root)

The null hypothesis of random walk is $H_{0:}$ p= 0 and its alternative hypothesis is H_1: p≠ 0 Failing to H_0 indicate that we can not reject that the time series has properties of random walk.

3.5. Variance Ratio Test

Another property of random walk is determined with our last test, Variance ratio test, proposed by, inter alia, (Lo and Mackinlay (1988)) with the specific intention of testing the random walk model (Ma (2004)). Variance Ratio Test invites it appeal from the fact that this is a non-parametric test and does not depend on normality of observations. In addition to above, the problem of rejection of random walk hypothesis caused by heteroscedasticity which is present very often in financial time series does not exist because VRT is a heteroscedasticity robust test statistic. A property of the random walk is that the variance of returns will be relative to the period between returns. For example, the variance of returns consequential of price index quoted weekly (k=7) will be seven times greater than if the same index is quoted daily (k=1). Deviations from this property, act as rejection of the random walk. Furthermore, the variance ratio test employs the fact that the variance of the increments in a random walk presents linear in sampling interval such that , if the returns series follows a random walk model, the variance of its q-differences would be q times the variance of its first differences. Speaking generally for this test, if times series follows random walk, the variance of q period returns should be q times as large as the one period returns.

$$VR(q) = \frac{\sigma^2(q)}{\sigma^2(1)}$$

Where σ^2 (*q*) is 1/ *q the variance of the q-differences and* σ^2 (*1*) refers to variance of the first differences. Under the null hypothesis *VR*(*q*) must present unity. Lo and MacKinlay (1988) who proposed this test for a sample size of *nq* +1 observations come up with following mathematical formulas

$$\sigma^2(q) = \frac{1}{m}\sum_{t=q}^{nq}(P_t - P_{t-q} - q\hat{\mu})^2$$

where

$m = q(nq - q + 1)\left[1 - \frac{q}{nq}\right]$ and $\hat{\mu}$ is the sample mean of $(P_t - P_{t-1})$: $\hat{\mu} = \frac{1}{nq}(P_{nq} - P_0)$ and

$$\sigma^2(1) = \frac{1}{(nq-1)}\sum_{t=1}^{nq}(P_t - P_{t-1} - \hat{\mu})^2$$

Lo and MacKinlay (1988) create two test statistics namely: Z(q) and Z^* ,under the null hypothesis of homoskedastic increments random walk and hetroskedastic random walk. If hypothesis come true then the associated test statistic has an asymptotic standard normal distribution. Speaking for homoskedastic increments

$$Z(q) = \frac{VR(q) - 1}{\phi_0(q)} \approx N(0,1)$$

Where $\phi_{(q)} = \left[\frac{2(2q-1)(q-1)}{3q(nq)}\right]\frac{1}{2}$. Assuming hetroskedastic increments, the test statistic is

$$Z^*(q) = \frac{VR(q) - 1}{\phi_e(q)} \approx N(0,1) \text{ where } \quad \phi_e(q) = \left[4\sum_{t=1}^{q-1}\left(1 - \frac{t}{q}\right)\widehat{\delta_t}\right]^{1/2}$$

And

$$\widehat{\delta_t} = \frac{\sum_{j=t+1}^{nq}\left(P_j - P_{j-1} - \hat{\mu}\right)^2\left(P_{j-t} - P_{j-t-1} - \hat{\mu}\right)^2}{\left[\sum_{j=1}^{nq}\left[\left(P_j - P_{j-1} - \hat{\mu}\right)^2\right]\right]^2}$$

The earlier works on this specific test, modified by Chow and Denning (1993) who proposed multiple variance ratio (MVR) test. This is used to identify autocorrelation and hetroskedasticity in the returns. This test statistics are for random walk under varying distributional assumptions.

Let consider a set of m variance$\{ M_r(q_i t) \quad i = 1,2,\dots\dots, m M_r(q) = VR(q) - 1 \}$ and attached with the set of aggregation intervals $\{q_t \quad i = 1,2,\dots\dots\dots, m\}$

Under the random walk , there are multiple sub-hypotheses which are as follow

H_{0i}: $M_r(q_i) = 0$ for i=1,2,………,m

H_{0i}: $M_r(q_t) \neq 0$ *for any* $i = 1,2,\dots\dots\dots, m$

The Chow and Denning (1993) multiple variance ratio(MVR) test is based on the result which is as follow

$$PR\{\max[(Z(q_1),\dots\dots\dots\dots, Z(q_m)) \leq SMM(\alpha; m; T)\} \geq 1 - \alpha]$$

Where *SMM*(α;*m*;*T*) refers to the upper α point of Studentized Maximum Modulus (*SMM*) distribution with parameters *m* and *T* (sample size) degrees of freedom. Speaking specifically for this specific test Chow and Denning (1993) controlled the Size of the multiple variance ratio(MVR) test by comparing the calculated values of the standardized test statistics, either Z(q) or Z*(q) with the SMM critical values. If the maximum absolute value of , say, Z(q) is bigger than the critical value at a preset significance level then the random walk hypothesis is rejected.

4. Results and Discussions:-

A careful summary of descriptive Statistics has been provided in Table A.

Daily, weekly and monthly returns of said indices have been employed to examine descriptive statistics. Descriptive statistics examine condition of random walk, according to which residuals are normally distributed. This ideally calls for equal variance, kurtosis three and no skewness. From descriptive Statistics, we can infer that CSE presents highest monthly mean return which is 1.7 percent for 7.4 percent and KSE provides lowest monthly mean return which is .8 percent for 9.2 percent standard deviation. Returns are negatively skewed for monthly returns of all indices, tell that negatively returns exceed positively returns in aggregate and KSE is highly negatively skewed for monthly returns. Kurtosis is positive for indices (daily returns) indicating leptokurtic structure; more higher peaks as expected in normal distribution. Jarque –Bera rejects null hypothesis for daily and weekly returns but cannot reject normal distribution for CSE and DSE monthly returns indicating normal distribution and weak form efficient at monthly returns. Probability for these two indices is reasonably high of monthly observations at P- value at 5 percent significance. So these findings lead to non-rejection of null hypothesis for CSE and DSE at monthly returns.

Autocorrelation attempts to measure the relationship between two sets of observations of a series, separated by some distinct lags. Positive autocorrelation implies that predictability of returns in short horizon that runs against the evidence of random walk and subsequently to market efficiency. On the other hand negative autocorrelation implies that mean reversion in means. The summary of results can be seen in Table B.

This test is employed to know whether the correlation coefficients are significantly different from zero (0). On the same time, ljung Box Q statistic is employed to identify white noise of series given which is jointly significant at 5 percent level at 30 degrees of freedom. Speaking technically, this test diagnoses white noise series which is completely random, a constant variance and mean zero. We infer that the series is not white noise when significant level is less than 5 percent and series is white noise when this is parallel with white noise when the level of significance is greater than or equal to zero. In our study we employed daily returns to diagnose serial correlation by separating our observations (1410) into ten lags.

KSE presents positive P(k) up to seventh lag only lag eight shows negative auto coefficient correlation. Table B provides equal positive and negative auto coefficient correlation for BSE but can reject null hypothesis for all lags and accept alternative hypotheses for all lags for BSE, implies predictive element exist in series. Same can be said for CSE and DSE where p value is not greater than .05 for any given lag. Speaking for Ljung Box Q statistic, all the probability falls below the tolerance level of .05 that leads to rejection of hypothesis of white noise. Hence results in Table B suggest that series of all said indices do not follow random walk and markets are not weak form efficient by accepting alternative hypothesis for given markets. Now we test the series by using non parametric test of run test.

Table A: Descriptive Statistics for SAARC Countries for period of 2005:2010

	KSE Daily	KSE weekly	KSE Monthly	BSE daily	BSE Weekly	BSE Monthly	CSE daily	CSE Weekly	CSE Monthly	DSE daily	DSE Weekly	DSE Monthly
Mean	0.000261	0.001233	0.008136	0.000788	0.003732	0.015742	0.000878	0.004042	0.017749	0.000547	0.003022	0.007447
Median	0.000711	0.00742	0.012983	0.001521	0.009244	0.021916	0.000626	0.003483	0.022666	0.000526	0.003573	0.021446
Maximum	0.082547	0.109173	0.202276	0.1599	0.131709	0.248851	0.305353	0.288831	0.192041	0.290535	0.289787	0.122041
Minimum	-0.06042	-0.20097	-0.448796	-0.11604	-0.17380	-0.272992	-0.29676	-0.31229	-0.17615	-0.28676	-0.21227	-0.15415
Std. Dev.	0.015994	0.039732	0.092624	0.018522	0.038045	0.082107	0.016535	0.037584	0.074764	0.015435	0.047784	0.075764
Skewness	-0.32576	-1.37716	-1.880209	0.071386	-0.58201	-0.683312	0.181657	-0.53527	-0.147871	0.151857	-0.53527	-0.247211
Kurtosis	4.809485	7.373753	10.19165	9.463062	5.332895	4.864951	171.2423	31.06379	3.275561	10.2423	31.06379	3.375544
Jarque-Bera	221.7692	336.1768	194.8375	2514.459	86.383	16.03711	1541476	9333.215	0.456151	1541476	7533.215	0.432151
Probability	0	0	0	0	0	0.000329	0	0	0.796064	0	0	0.549606
Sum	0.375345	0.372282	0.577621	1.137714	1.138397	1.133391	1.148042	1.148042	1.189207	1.148042	1.044804	1.084207
Sum Sq. Dev.	0.367873	0.475168	0.600543	0.495037	0.44002	0.478653	0.357053	0.399743	0.368916	0.337053	0.399743	0.368916
Count	1410	305	71	1410	305	71	1410	305	71	1410	305	71

Notes:[The Jarque-Bera test is a goodness-of-fit measure of departure from normality, based on the sample kurtosis and skewness, and is distributed as a chi-squared with two degrees of freedom. The null hypothesis is combined hypothesis of both excess kurtosis being 0 and the skewness]. Null hypothesis rejection significant at the 5% level.

Table B: Serial Correlation for Period 2005:2010

INDICES	LAGS	1	2	3	4	5	6	7	8	9	10
KSE	AC	0.163	0.054	0.057	0.039	0.077	0.012	0.007	-0.021	0.066	0.074
	Q-Statistic	39.237	43.563	48.314	50.549	50.613	50.834	50.899	51.565	58.137	66.32
	Probability	0	0	0	0	0	0	0	0	0	0
	Ljung Box Stat	39.23669	43.56289	48.31391	50.54851	50.61322	50.83435	50.89939	51.56538	58.13671	66.31965
BSE	AC	0.071	-0.042	-0.014	-0.025	-0.035	-0.042	0.022	0.077	0.029	0.013
	Q-Statistic	7.3745	9.9182	10.211	11.147	12.967	15.511	16.225	24.92	26.152	26.385
	Probability	0.007	0.007	0.017	0.025	0.024	0.017	0.023	0.002	0.002	0.003
	Ljung Box Stat	7.374495	9.91817	10.21079	11.14694	12.96703	15.51132	16.22485	24.92028	26.15195	26.385
CSE	AC	-0.149	0.024	0.032	0.023	-0.025	-0.033	0.031	0.056	-0.002	0.027
	Q-Statistic	29.131	29.906	31.273	31.983	32.81	34.222	35.455	39.626	39.634	40.601
	Probability	0	0	0	0	0	0	0	0	0	0

Table C: Run Test When K=Mean For Period 2005:2010

	KSE Daily	KSE Weekly	KSE Monthly	BSE Daily	BSE Weekly	BSE Monthly	CSE Daily	CSE Weekly	CSE Monthly	DSE Daily	DSE Weekly	DSE Monthly
K=mean	0.00026	0.00123	0.008135	0.00078	0.0036	0.001574	0.00087	0.00404	0.01777	0.00054	0.00214	0.018799
K<mean	688	130	32	679	129	34	678	147	31	644	139	38
K>mean	751	172	39	731	175	37	629	137	40	671	166	33
Total Cases	1410	305	71	1410	305	71	1410	305	71	1410	305	71
Observed Runs	668	121	33	684	138	42	534	117	31	659	125	34
Expected Runs	719.2	149.079	36.15	720	149	36.8	653	142.824	34	751	180	36
Z	-3.44	2.008	0.896	-1.892	-1.448	1.277	-6.771	-2.771	-0.92	-4.521	-3.23654	1.02314
P-value	0.007	0.001	0.446	0.054	0.176	0.224	0	0.002	0.412	0	0.003	0.514

Null hypothesis rejection significant at the 5% level.

Table C: Run Test When K=0 For Period 2005:2010

	KSE Daily	KSE Weekly	KSE Monthly	BSE Daily	BSE Weekly	BSE Monthly	CSE Daily	CSE Weekly	CSE Monthly	DSE Daily	DSE Weekly	DSE Monthly
K=0	0	0	0	0	0	0	0	0	0	0	0	0
K<mean	678	119	25	671	115	25	625	127	24	644	139	33
K>mean	800	191	47	810	198	47	716	165	44	766	166	38
Total Cases	1410	305	71	1410	305	71	1410	305	71	1410	305	71
Observed Runs	678	129	33	701	134	34	553	121	27	655	124	33
Expected Runs	734.965	147.639	33.6389	678	146.495	33.638	668.415	144	32	710	135	29
Z	-3.045	-3.676	-0.168	-0.0178	-1.522	0.095	-6.438	-2.806	-1.355	-4.2314	-3.3365	-0.9458
P-value	-3.045	0.0025	0.867	0.054	0.128	0.925	0	0.005	0.175	0	0.002	0.554

Null hypothesis rejection significant at the 5% level.

Table E: Unit Root Test

	KSE Daily	KSE Weekly	KSE Monthly	BSE Daily	BSE weekly	BSE Monthly	CSE Daily	CSE Weekly	CSE Monthly	DSE Daily	DSE Weekly	DSE Monthly
ADF test stat (Level)	-1.5041	-1.3764	-1.535598	-1.29116	-1.1259	-1.180697	-1.180697	-1.56868	-1.65487	-1.8777	-1.25478	-1.54781
P-P test stat(Level)	-1.5024	-1.6346	-1.670482	-1.25093	-1.2702	-1.287003	3.234536	-1.68638	1.789325	-1.9987	-1.47814	-1.55365
ADF test stat (1st Diff)	-32.925	-15.7525	-7.190848	-35.27804	-10.259	-7.810878	-39.60146	-12.2971	-5.971968	-34.254	-13.5478	-4.25479
P-P test stat(1st Diff)	-33.087	-15.8474	-7.190113	-35.21129	-17.751	-7.819407	-39.44479	-12.4920	-6.007628	-34.214	-13.5578	-6.32154
5% level	-2.8633	-2.87093	-2.903566	-2.863338	-2.8708	-2.903566	-2.863545	-2.87486	-2.906923	-2.7454	-2.95478	-2.85745
10% level	-2.5677	-2.57184	-2.589227	-2.567776	-2.5718	-2.589227	-2.567887	-2.57395	-2.591006	-2.6547	-2.62547	-2.74154

Null hypothesis rejection significant at the 5% level. Null hypothesis rejection significant at the 1% level.

Table F: Variance Ratio Test

	period=J	2	4	8	16
KSE	VR(J)	0.565483	0.288041	0.153451	0.072782
	Z(J)	-10.999	-10.0152	-7.89894	-6.0743
	Z*(J)	-1.02	-1.95	-2.79	-1.38
	Probability	0.108	0.059	0.0076	0.326
BSE	VR(J)	0.562443	0.276558	0.125394	0.06799
	Z(J)	-9.14048	-8.69449	-7.0972	-5.31902
	Z*(J)	-2.59	-3.87	-1.91	-1.29
	Probability	0.0009	0.0001	0.0951	0.0656
CSE	VR(J)	0.42488	0.21316	0.102995	0.053124
	Z(J)	-1.85167	-1.64358	-1.57678	-1.53562
	Z*(J)	-1.90	-2.84	-2.04	-1.99
	Probability	0.0941	0.0013	0.0048	0.0246
DSE	VR(J)	0.522354	0.262255	0.125455	0.074512
	Z(J)	-2.54871	-2.14578	-1.99925	-1.87745
	Z*(J)	-1.3	-1.98	-2.71	-4.13
	Probability	0.4441	0.0051	0.00299	0.00009

Null hypotheses rejection significant level at 5 percent level

Table G: Summary of Random Walk Hypotheses Existence

Country	SERIAL CORRELATION	ljung - BOXRUN	RUN TEST	UNIT ROOT	VARIANCE RATIO
KSE	NO	NO	NO	YES	NO
BSE	NO	NO	NO	YES	NO
CSE	NO	NO	NO	YES	NO
DSE	NO	NO	NO	YES	NO

A run is defined as change in series of prices having identical signs. Being a nonparametric test assumption of normality does not hold here. The runs test tests for a statistically significant difference between the actual numbers of runs versus expected number of runs. Total cases present total number of observations under study and total number of runs denotes the randomness since too few or too many runs indicates dependence between observations under study. Cases less than mean denote the number of cases below to mean and cases greater then mean denote the cases above to mean. A positive change when return is greater than the mean value, on other hand, a negative change when return is less than the mean and equal to mean in wake of returns equal to mean. The Z statistic is observed level of significance. The null hypothesis is that the successive price changes are independent, random and have no common relationship. The findings of run test are presented in Table C and Table D.

During the period, the runs remained less than the expected runs for daily and weekly returns exception for monthly returns where runs inclined to close to expected runs. Fork=0 this inclination further receive impetus. So we can reject null hypothesis for daily and weekly returns indicating autocorrelation in said returns but safely cannot reject null hypothesis for monthly returns indicating no autocorrelation in returns.

A necessary condition of random walk is unit root. As per Random walk hypothesis, the log price series contains unit root and return series must have unit root. The price series has been employed to test hypothesis. The number of lagged variables was decided on by the AKaike info Criterion and for testing this condition, the Augmented Dickey-Fuller test and Phillp-Perron test has been used. According to distribution theory supporting the Dickey fuller test takes in to account that errors are statistically independent and contain a constant variance. This cannot be case here. So, an alternative test, the Phillp-Perron test being a non parametric test, allows to error disturbances to be weakly dependent and heterogeneously distributed (Hassan et al(2007))

The findings are in strong favor of random walk for all countries and for all periods (daily, weekly and monthly). The time series of indices can be seen as non-stationary at order I(0) and times series of indices becomes stationary at order I(1) at 1 percent and 5percent level of significance. The ADF test statistic does not exceed Mackinnon tabulated value at order I(0) and exceed for all countries at I(1). So we can not reject the null hypothesis at order I(0)for all the countries for all the periods. Now we throw light on findings of variance ratio test.

Lo and MacKinlay (1988) conclude that the variance ratio test (VRT) is more powerful than the Dickey-Fuller unit root test. VR(q) shows the variance ratio of the returns, and Z(q) and Z*(q) are the statistics of the variance ratio under the assumption of homoscedasticity and heteroscedasticity, respectively. In order to assist comparisons with the other studies, we have adopted the common practice of selecting lags 2, 4, 8 and 16. Daily series of returns have been tested giving VR(J) lees then unit though many researchers have performed this test on price series. Rationale was to make findings comparable with serial correlation. The findings can be seen in Table F. For KSE this test is significant at only lag 8,BSE lag 16 is insignificant, and finally DSE&CSE only lag 2 is insignificant. So findings of these results suggest non-random walk and this is parallel with the results of serial correlation and run tests for the full sample period. This leads to rejection of null hypotheses for all indices that may be due to autocorrelation in daily returns.

Conclusion:-

This study attempts to explore random walk and the weak form of efficiency for SAARC countries namely: Pakistan, India, Srilanka and Bangladesh. The sample size consists of four representative capital markets of said countries for period of Jan 2005to Dec 2010 .The purpose of the study is to probe that whether the markets under consideration follows random walk or reality is other way round. This has paramount effect on the utility of technical analysis, opportunities for investment management and existence of arbitrage profit. Under statistical guidance, we employed various tests and briefly discussion of findings is as follow

To examine the normal distribution we performed Jarque-Bera test and observed the skewness and kurtosis. The results reject null hypothesis for daily and weekly returns but cannot reject normal distribution for CSE and DSE monthly returns. Further, Jarque –Bera rejects null hypothesis for daily and weekly returns for all the markets. To authenticate the weak form of efficiency, Autocorrelation, Ljung-Box Q-Statistic, Run test, Unit root test and finally Variance Ratio tests were used. Ten lags were employed for the whole observations of daily returns and Autocorrelation coefficient reveals that there exists a relationship and findings of Ljung-Box Q-Statistic found to be consistent. Speaking for unit root test, Augmented Dickey-Fuller test and Phillp-Perron test were used; indicating that the time series of indices can be seen as non-stationary at order I(0) and times series of indices becomes stationary at order I(1) for all the markets. Run test reveals that there exists a predictive element in daily returns of all the markets though this is not true for monthly returns. This study is conducted on Five year data and cannot be generalized for other periods. The summary of tests can be seen in Table G.

The findings of variance ratio test safely reject the null hypothesis of random walk for all the markets. So there exists utility for technical analysis, availability of arbitrage profit and opportunities for investment management with diversification of portfolios.

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