Validity of Random Walk Hypothesis and Technical Analysis: An Investigation of Pakistan Stock Market

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Abstract

This study is conducted to check the random walk behavior and validity of technical analysis in Pakistan stock market. Random walk hypothesis is a popular theory which asserts that stock price follows random walk and due to this randomness prediction of stock prices is not possible. In this research three different forms of random walk are tested using different parametric and non-parametric statistical test. Data of daily historical stock index/price of KSE 100 index and selected sample of stocks for the sample period of Jan 2004 to Dec 2015 is used. Additionally, validity of popular technical indicators moving averages and MACD (Moving average convergence divergence) is tested using one sample t test and Welch t test for the same sample period. Results concludes that stock price follows nonrandom walk and technical analysis produces statistically significant positive return as compared to buy and hold strategy.

Keywords: Randomwalk, Pakistan Stock Market, Efficient Market Hypothesis

1. Introduction

In past several studies have tried to explain the behavior of stock market having the focus on investor's challenges of entry to and exit from market with positive gain on their part. One of the theories discussed by the scholars is 'Random Walk Theory'. The random walk theory is based on mechanism where price changes are random for all exchange traded securities. This suggested that the process of price change is totally random just because daily prices are independent from one another and there exists no correlation between them. This was highlighted for the first time by Kendall (1953), the same idea that financial market follows random walk became more interesting topic when Malkiel (1973) presented analogy of random price changes is like a drunk man moving without any direction.

From the beginning when people started trading in the market, there has been debate on the either it will trend up, trend down or remain the same. The increase in stock prices have positive impact for those who hold big stock but at the same time impacts negatively to those who already sold it. Fama (1995) suggested that fund managers should apply buy-hold strategy because it gives good rate of return in a longer run instead of taking risk on day to day trading. Pakistan stock exchange (PSE) (Formerly Karachi Stock Exchange) is the largest stock market of Pakistan with 554 listed companies having listed capital of 1,269,703 million rupees and market capitalization of 6,947,358 million rupees. The target population will be active listed companies whose stocks are traded in Pakistani stock market.

This research focuses at "Random Walk hypothesis" which states that stock price is not predictable on the basis of historical price and hence use of technical analysis is useless. If past prices don't reflect any relation to current price than investor cannot earn any abnormal profits in a short run. Theories of stock market like 'fifty percent principle', 'Odd lot theory' and 'prospect theory' are useful but random walk has acquired as important place in understanding the behaviors of stock market. However, acute paucity of scientific research on the subject necessitates scientific studies on this relatively less researched area of stock market. Hence there is a need to undertake the research on random walk theory to understand the market efficiency in a sufficient manner. This study is conducted to check the validity of random walk hypothesis on PSE, to check the predicting ability of technical analysis on future price fluctuations and to check technical trading strategies could outperform/beat a buy and hold strategies.

To achieve the above-mentioned objective, questions "does stock index/price follows random walk in Pakistani stock market?" and "does technical analysis strategies are viable for predicting future price movements?" have been raised as research questions.

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This research fills the gap by examining the behavior of stock market using random walk hypothesis in Pakistani stock markets and results give a better insight regarding behavior of PSE. Random walk and EMH was tested by many of the researchers but the forecasting ability of the technical analysis and validity of outperforming the market and buy and hold strategy has not been tested scientifically for Pakistani stock market. This study will be beneficial both for current and prospect investors and all stake holders of Pakistani stock market.

2. Literature Underpinning

The concept of random walk hypothesis first used by Louis (1900) in his Ph.D thesis titled "The Theory of Speculation Theory of speculation states that "There is no useful information contained in historical price movements of securities". The same concept was later suggested by Cootner (1964) in his book titled "The Random Character of Stock Market Price". The term 'Random Walk' gained popularity in 1973 from a book, "A Random Walk Down Wall Street, by Burton Malkiel, a Professor of Economics at University of Princeton, and was used earlier in Fama's (1965) article "Random Walk In Stock Market Prices". The theory of stock prices' movement randomly was proposed by Maurice Kendall (1953) in his paper, titled "The Analysis of Economic Time Series" in Estimating the movement of stock prices and their returns has been researched by many financial engineers and financial analyst working in the field of finance. The main interest of the traders is to find out that price at which buying and selling of stock is less risky with maximum returns. Professional traders and investments analysts in financial markets normally uses combination of fundamental and technical analysis to check both fundamentals like company financial position and companies' future strategies and technical parts such as price movement, increase and decrease in volume etc. They make investment decisions based on those analyses to get better investment results. Fundamental analysis is the classic way involving a detailed study and digging out the company's information both publicly available and insider information such income statements, balance sheets, growth rates, financial ratio as described by Murphy (1999). But as far as technical analysis is concern the case is totally reverse it assumes that fundamentals are already reflected in the price so only the historical price can depict some trends. Practitioners and users of this technique study price patterns and plot different charts for understanding the trends in it (Turner, 2007).

While technical analysis uses different technical indicators to forecast future market trend. The indicators include trend indicators, volume indicators and oscillators. Dow believed that the stock market is a better proxy to measure of overall business conditions within the nation economy and by analysis of market one can depicts trends and the direction of individual stocks.

Dow (1900) discussed six standard pillars of technical analysis as follows:

a. market moves with a particular trend: primary trend, secondary trend and a minor trend.
b. market has three phases accumulation phase[1], distribution phase and public participation phase/absorption phase.
c. market on average will move the same direction as their correlated market.
d. volume is directly related to the trend.
e. trends always continue and if there is slight disturbance in the trend there will be a reversal soon.

2.1 Theoretical Framework

The Random Walk Hypothesis (RWH) is a financial theory which states that "*the prices of a stock market cannot be predicted because these prices follow a unique random pattern"* that cannot be fully extracted. This random pattern of price change will always set or impose limits to gain above market return. This was traced by Maurice Kendall (1953) this theory cause surprise when Malikeil (1973) wrote "*A Random Walk Down Wall Street".*

$$Random\ Walk\ Model:\ X_t = X_{t-1} + \varepsilon$$

Where Xt is today's stock price and Xt-1 is yesterday's price and ε is a white noise error term with zero mean variance. Cambell, Lo & Mackinlay (1998) illustrate three forms of random walk model. Random Walk 1 (RW1) is the standard form of random walk hypothesis which states that returns are independent and identically distributed. This IID returns indicate that past price movement contains no information regarding upcoming price fluctuations.

RW1 has most restrictive assumption that successive price change is always independent and identically distributed (IID) variable. Assumption identically distributed in (RW1) is not plausible for stock prices over longer time span due to countless changes in economic, social, technological and institutional environment. The Random Walk 2 (RW2) relax the assumption of (RWI) to include the process with independent but no identically distributed (INID) increments (Ahmed 2015). In Random Walk model 3 (RW3) the assumption of independence is taken out. However successive price change must not be correlated with each other. (RW3) is the weakest form of Random walk hypothesis which uplift the assumptions in (RW1) and (RW2).

Stock price change are independent of each other and they have some probability distribution associated with them. It also states that over a period of time, prices maintain an ongoing up trend (Gujarati 2009). If a stock market is said to be following the random walk process, it follows a random and unpredictable path. The random walk hypothesis also states that a stock market price follows stochastic process, making the prediction and estimation of prices more difficult (Brooks 2008). The same idea is derived from the thread of market efficiency which asserts that future stock market movements have no correlations with past movements. The movement of share prices on day one does not affect the movement of share prices on subsequent days (Black 1990). Random walk is the path of a variable over time that shows no predictable patterns at all. If stock price p, follows a random walk, the value of price p in any period will be equal to the value of price p in the period before or subsequent period, plus or minus some random variable or disturbance (Brooks 2008).The random walk hypothesis (RWH) concludes that the present market price is the only best picture of the future market prices with an error or disturbance term that is not deterministic in nature. Hence the future time period price is not anybody's estimate. In an efficient market it is not possible to make abnormal profit on the basis of past or historical information hence the expected value future price conditional to past prices should be zero. The more efficient a market is the more random and unpredictable and random the market returns would be. In the most efficient market the future prices will be random and the prices formation is always assumed to be a stochastic process with mean in price change or return is equal to zero (Black 1990). Random walk process is the main concept behind efficient market hypothesis but one cannot say that if market are efficient then stock price follows random walk. However they are linked with each other. Summers and Poterba (1986) is of the view that contradicting the random walk hypothesis in a given market may only mean that the results obtained are steady with the particular martingale process of random walk. From existing literature, it is hard to say how much reliable this theory is as there are prove that supports both sides of the debate. This research thus aims at drawing conclusions based on whether price changes are not dependent of each other in the Pakistani Stock Market. The random walk hypothesis is closely associated to the weak form of the efficient market hypothesis in that current stock price already incorporates all known information of the past stock prices. If a stock market follows the random walk process, prices quickly absorb new information both internal and external and it is not possible to act so quickly and take advantage of the same.

2.1.1 The Efficient Market Hypothesis

Introduced by Fama (1970) and investment theory that is based upon market efficiency state that it is impossible to beat the market because current stock price contain all relevant information and one cannot outperform the market. This theory is based upon the assumption that security price changes are randomly distributed and this random price movement is due to market incorporation of new information.

The concept of stock prices followed a random walk is linked to that of the EMH. The proposition is that investors react rapid to any informational advantages they have so that eliminating profit opportunities. Thus, prices always fully reflect the information and no excess return can be made from information-based trading strategies (Lo & MacKinley 1998). This leads to a random walk where the more the efficient market exist the more random the sequence of price changes.

2.1.1. Strong form Efficiency states that share price reflect all public and private information in it, hence it is impossible to gain excess return. Investor should follow buy and hold strategy. Investor cannot gain abnormal returns by quantifying the undervalued or overvalued conditions.

2.1.2 Semi- Strong form Efficiency states that share price reflect all public information only the insiders are able to beat the market. Neither fundamental nor technical analysis will help to outperform the market. In semi-strong-form efficiency, only the insiders who know the inner condition of a company can be able to gain excess return. Semi-strong-form efficiency concludes that both fundamentalist and chartist cannot accurately produce returns above market (Black 1990).

2.1.3 Weak form Efficiency states that all information is already incorporated in current price of stock. Companies' fundamentals can be used to outperform the market while technical analysis has no validity. Efficient market hypothesis is associated with the idea of random walk in defining randomness of the price pattern. In weak-form efficiency, one cannot estimate price movement of stock by observing historical prices. This weak form of efficiency also states that one can still use fundamental analysis but technical analysis is not viable.

If the stock price of today is not correlated with yesterday's price, one can say that stock prices is pattern less. According to Blake (1990) weak form of EMH does not require that prices evolve near equilibrium, but only that market participants (rational or irrational) should not be able to regular profit from market inefficiencies. From the above explanation of three forms of efficient markets the most important form is weak form efficient market and it is the main point of consideration for researchers because by using technical analysis strategies in weak form inefficient markets future stock prices can be predicted on the basis of the past and historic stock prices.

2.1.4 Behavioral Finance

Efficient market hypothesis assumed all of the participant in market behave rationally, however most of psychologist proved that this world has different people with different opinions. Specifically, behavior finance comfits the EMH through observed patterns of choice. Kahneman & Tversky (1979. p 36) introduced "*The prospect theory"* is considered one of the key concepts of behavior finance. This theory can be further elaborated that choices can be made by people where the probabilities of outcome or events are known. In contrast with expected utility theory, the prospect theory says that individuals are more concerned with the losses as compared to gain.

2.1.5 Technical Analysis

Technical Analysis is the strategy of forecasting of future financial price movements based on an examination of past price movements. Origin of technical trading strategies is Dow Theory. Dow believed that the stock market is a better proxy of measuring overall economic growth and stability of any country and by analysis and estimations one can get good profits in the market. There are three parts of technical analysis that are directly related to Dow Theory. The first and the most important pillar is that stock market follows trends. Hence technical analysis is used to analyses trends. The second pillar is that recognized trend persist and the last pillar is that volume is in line with trend. If the price goes up there will be the volume goes down and the contra result appears for bear market (Allan 2017). One of the most important assumptions of the technical analysis is that human nature and their action are constant over time. "*Supporter of technical analysis found that there is a huge difference between assumed value and the market value of stock price"* (Edwards & Magee 1997, p 62).

3. Methodology

This research is quantitative in nature based on archival research design. Data of KSE 100 index for the period of Jan 2004 to Dec 2015 has been used for analysis and for individual indices stratified random sampling technique has been used from which, stock will be selected from each sector. In stratified random sampling[1] the population of listed companies in Pakistan Stock Exchange is divided with respect to sector (Strata) so that representation of each sector incorporated in the sample and used market capitalization as a proxy. Top 20 performing companies registered with PSE have been selected from different sectors on

the basis proportionate market capitalization and from those 8 companies are extracted having available data of the selected period above. These companies' data have been accessed from the websites of PSE, companies' websites and their annual/financial reports.

3.1 Testing Random Walk Hypothesis

The Simplest version of random walk (RW1) is IID returns in which the price is given by following equation

$$Random\ Walk\ Model: X_t = \mu + X_{t-1} + \varepsilon$$

Where ε ~ IID $(0,\sigma^2)$ and u is expected price change or ***drift*** and IID $(0,\sigma^2)$ denote that ε is independent and identically distributed with mean 0 and varianceσ^2.

The restriction of IID returns is not convincing and specially when applies this on financial data that spread around several decades and if one assume the marginal distribution of the data varies over time it will become impossible to conduct inference since the sampling distribution of even the most basic statistics cannot be derived. So (RW2) can only be tested through technical analysis.

Random walk 3 (RW3) the most tested in the research can be obtain by uplifting independence of assumption on (RW2) with dependent but uncorrelated increment/returns. This is perhaps the weakest form of random walk (RW).

To test the hypothesis of non-random, walk this research is considering all three forms of random walk describe by Campbell, Lo & MacKinlay (1998) and will be using different parametric and non-parametric statistical test. Distribution of return test, Run test and BDS test for *Random walk 1* RW (1). Technical analysis for *Random walk 2* RW (2). Q-test, Autocorrelation test for *Random walk 3* RW (3) and last but not the least the property of all three types of random walk which is the linearity of increments is tested using variance ratio test.

3.2 Normality of Stock Returns

Stock prices follows random walk this statement is used quite often in the literature books and this is because of the fact that if stock price follows random path than investor will earn random returns. This is because of the fact that if stock price follows random walk than the return obtains from these stocks should be IID and according to central limit theorem the limiting distributions of these returns must follow normal.

3.3 Chi-Square Goodness of Fit Test

The chi-square test Snedecor & Cochran (1989) used to test from which population sample data belongs to. The chi-square goodness of fit test is used to test the hypothesis that data comes from a normal distribution or not.

Ho: The Stock Return follows Normal Distribution.

Ha: The Stock Return doesn't follow Normal Distribution

Test Statistics:

$$\boldsymbol{X^2 = \frac{\sum(Oi - Ei)^2}{Ei}}$$

Rejection Criteria: Reject Ho if $X^2_{cal} > X^2_{tab}$

3.4 Anderson Darling Test

The Anderson-Darling test Stephens (1974) is used to test from which population sample data belongs to. The Anderson-Darling statistic also used the same phenomena to test whether a particular time series follows specific distributions.

H_0: The Stock Returns follows Normal distribution.

H_a: The Stock Returns do not follow Normal distribution.

Test Statistic:

The Anderson-Darling test statistic is defined as

$$\boldsymbol{A^2 = -N - S}$$

Where,

$$\boldsymbol{S = \sum_{i=1}^{N} \frac{(2i-1)}{N} [lnF(Yi) + \ln(1 - F(Yn + 1 - i)]}$$

3.5 Run Test

A Run Test (Bradley, 1968) is a non-parametric test and is used to examine if the returns are random or not. This test analyze total Runs (*R*) presented in series of return, in order to verify whether there are small or large quantities *R* , which reflect non randomness in the data. The purpose of the test is to determine the number of major and minor spurts the average return of stocks. Below is the test statistic.

$$Z = \frac{R - U}{\sigma}$$

$$Mean\ E(R) = \frac{2N_1N_2}{N} + 1$$

$$Varaince\ \sigma^2 = \frac{2N_1N_2(2N_1N_2 - N)}{(N^2)(N-1)}$$

Note: $N = N_1 + N_2$

Where N_1 and N_2 are the number of higher and lower returns respectively. The null hypothesis of independent and identically distributed (IID) will be rejected if P-value is less than the selected level of confidence interval.

H_0: The Stock Returns are independent and identically distributed (IID)

H_a: The Stock Returns are not independent and identically distributed.

The test statistic is defined as

Test Statistic:

$$Z = \frac{R - U}{\sigma}$$

Decision Rule: If p-value is less than confidence interval generally accepted 5% or 10%, reject the hypothesis of IID returns.

3.6 BDS Test

Brock et al. (1996) developed a test for checking time dependence in a series. This test concludes whether a series of variables are random walk with the property of IID (independent and identically distributed, Null hypothesis is that the successive price change are IID (independently and identically distributed) and alternate hypothesis is that successive price change are dependent either linear or nonlinear. The BDS test uses "*correlation dimension"* introduced by Grassberger and Procaccia (1983). To perform the test for a sample of n observations {x1,……..,xn}, an embedding dimension m, and a distanceε, the correlation integral Cm (n,ε) is estimated by :

$$C_m(n,\varepsilon) = \frac{2}{(n-m)(n-m+1)} \sum_{x-1}^{n-m} \sum_{t-s+1}^{n-m+1} I_m(x_s, x_t, \varepsilon)$$

Test statistics is given below with the null hypothesis of IID increments.

$$W_m(\varepsilon) = \sqrt{\frac{n}{V_m}} (C_m(n,\varepsilon) - C_1(n,\varepsilon)^m)$$

3.7 Autocorrelation Test

Random walk 3 (RW3) talks about dependent but uncorrelated increment to check this autocorrelation function of the series of price change will be plotted to check weather auto correlation exist in the return series. ACF can be defined at lag k, as

$$\rho(h) = \frac{\gamma(h)}{\gamma(0)} = \frac{COV(Y_t, Y_{t+h})}{\sigma_t^2}$$

Autocorrelation of stock returns at different lag must be significantly greater than zero to verify non-random walk in stock prices.

3.8 Lujng Box Q Test

Ljung Box Q- test, a more quantitative way to check uncorrelated increments. In an application, if the test statistics exceeds falls in the non-rejection region at 5 or 10% level of significance, one can reject the null hypothesis that all the ρk are zero; at least some of them must be nonzero.
The Ljung–Box (LB) statistic, which is defined as

$$LB = n(n+2)\sum_{k=1}^{m}(\frac{\rho k^2}{n-k}) \sim \chi^2 m$$

H_0: $\rho(1) = \rho(2) = \rho(3) \ldots\ldots = \rho(K) = 0$
H_a: At least one of $\rho(k)$ is non zero.

Test Statistic: The test statistic is defined as

$$LB = n(n+2)\sum_{k=1}^{m}(\frac{\rho k^2}{n-k}) \sim \chi^2 m$$

Decision Rule: Reject Ho if $X^2_{cal} > X^2_{tab}$

3.9 Variance Ratio Test.

Lo and MacKinlay (1998) develop Variance ratio test to check very important property of random walk theory. This test is used to find out whether successive price change seriesis the linear function of time. The variance ratio test for a random walk in returns with trend, i.e. returns are independently and identically distributed (IID) with a constant mean and finite standard deviation that is a linear function of the specific holding period. Campbell, Lo and MacKinlay (1998), states that "*linearity is more difficult to indicate in the case of RW2 and RW3 since the variances of increments might be variable through time.*"

$$VR(q) = \frac{VR[r_t(q)]}{VR[r_t]} = q$$

If the stock prices followed random walk, then the variation of monthly return must be four times as larger then variation of weekly return.

3.10 Testing and Validating Technical Analysis

In this section validity of technical analysis is tested also how helpful are technical analysis in forecasting of stock market movements. Below techniques will be used in this research. This answers the second research question.

- Simple moving average technique- Price, Double & Triple Crossover (SMA).
- Moving Average Convergence Divergence (MACD).

3.10.1 Simple Moving Averages Technique

Simple moving averages is most commonly used by technical analyst. The basic purpose of moving average is smooth the price data and identify the trend in it. Simple moving average is calculated by taking the average of stock closing price over specified period of time.

$$SMA = \frac{1}{N}\sum_{1}^{k} Closing\ Prices$$

Where N is the number of days and K is for moving average time period. 200-day moving average is the benchmark, however investor my choose time horizon according to their investment needs as there is no specific and fixed rule for this. Longer time period takes in to account large number of values and a considered to be less sensitive then the shorter moving average as it takes average of less observation. A shorter average might not capture long term trend. The longer average is slower but more reliable.

1) Price Crossover: Index price and 50, 150- and 200-day moving averages are used.
Decision Rule: To enter in the market and take long position when index move above moving average and take short position when it moves below moving average.

2) Double Crossover: SMA (25-100), (25-150), (25-100), (50-100), (50-150) & (50-200) are used.
Decision Rule: If shorter moving average move above the longer "Buy" signal is generated and if it moves below longer moving average "Sell" signal is generated.

3) Triple Crossover: Using most popular SMA (4-19-18) day moving average.
Decision Rule: A "Buy" signal is generated when 4-day crosses above both 9 and 18. A confirmed "Buy" Signal occurs when 9-day crosses above 18.

3.10.2 Moving Average Convergence & Divergence (MACD)

Moving average convergence divergence is a most effective momentum indicator. Subtracting short term moving and long term moving average will convert trend indicator to momentum indicator. It can be calculated using below.

$$MACD\ Line = 12\ day\ EMA - 26\ Day\ EMA$$

Decision Rule: A "Buy" signal is generated when MACD is above zero and "Sell" signal generated when MACD live below zero.

3.10.3 Trading Rules

I) Moving Average Technique by Arlnod

This technique is used when two moving averages are used in comparison to index price. Whenever price level is high as compared to moving average "Buy Signal" is formed. Whenever price level is low as compared to moving average "Sell Signal" is formed. It give the better and more accurate signal because the use of both shorter and longer moving averages

II) Moving Average in Relation with Price

This is the most simple's case in moving average in which price is compared with the shorter and longer moving average and decisions are made accordingly.

3.10.4 Trading Performances

To check whether the result obtain form moving average techniques are statistically significant below test are used, one sample t-test, and Welch t-test. These tests are used to check that how good technical indicators are performing in terms of higher rerun with lower risk.

I) One sample Z test

To check if the individual index and stock price performing well one sample Z test is employed. This test is used to check if average returns are statistically significant.

$$Z = \frac{X - U}{\sigma/\sqrt{n}}$$

Where X the sample mean of series of returns, σ is the standard deviation and n is the sample size of return series.

II) Welch t-statistics

To test whether the techniques of technical analysis technique are viable or not Welch t-statistics is used, because it will perform better when population variance are unequal. Assumption of difference in the variance of two group is also important so this test will give accurate result
Below is the test statistic

$$t = \frac{X1 - X2}{s_{X1-X2}}$$

Where $X1$ the average daily buy days return, $X2$ the average daily sell days return. Standard deviation of the difference of both returns is S and n is the sample size respectively. If the test statistic falls

on the critical region then hypothesis that technical analysis and strategies did not have forecasting power of movements in stock prices rejected.

4. Data Analysis & Presentation

4.1 Empirical Evidence for Random Walk Hypothesis Testing

In this section result related to random walk are explained. All three forms of random walk as described by Campbell, Lo & Mackinlay (1998) is tested using different parametric and non-parametric statistical test.

For RW1 Table 1 summarize the result of descriptive statistics. It can be seen form the table that excess kurtosis give clear indication that time series of returns of KSE-100 index and other selected sample of scripts are not following normal distribution but for further formal test normality of stock return is tested. Normality of stock return is tested using chi-square goodness of fit and Anderson Darling test using the null hypothesis that stock return follows normal distribution. If stock price follows random walk the returns obtain must be independent and identically distributed and according to central limit the distribution of series of return must be normal.

Table 1: Descriptive Statistics of Stock/index Returns

Script	Sample Size (Days)	Mean	Std. Deviation	Std. Error	Skewness	Excess Kurtosis
KSE -100	3057	0.07%	1.29%	2.32E-04	-0.43191	3.2507
HCAR	2934	0.06%	2.99%	5.52E-04	-1.4298	26.213
FFCL	2956	0.04%	2.91%	5.36E-04	0.16032	6.1645
POL	2959	0.02%	2.23%	4.09E-04	-3.3154	56.143
TREET	2958	-0.07%	5.23%	9.62E-04	-28.263	1191.5
AICL	2958	0.03%	2.67%	4.90E-04	-0.35622	2.6251
OGDC	2968	0.03%	1.94%	3.56E-04	0.04757	2.0972
SSCG	2967	0.00%	2.49%	4.56E-04	-0.60844	8.4039
GLAXO	2966	0.01%	2.21%	4.05E-04	-1.642	16.795

Data Source : *www.psx.com.pk , www.finance.yahoo.com*

Normality of stock return is tested for all script and KSE-100 index. Table 2 demonstrates the result of the test of normality. For all indices chi-square goodness of fit test statistic is way higher the critical value rejecting the null hypothesis of normality at 5% level of significance which shows a clear indication of non-random walk behavior in stock returns. Anderson darling test also reject the normality of stock returns at 5% level of significance for all indices along with KSE-100 index. As both tests conclude the same result that stock returns doesn't follows normal distribution and hence stock price doesn't follow random walk model.

Table 2 : Test of Normality Of Stock Returns

Indices	Anderson-Darling			Chi Square		
	Statistic	P Value	Critical Value	Statistic	P Value	Critical Value
KSE - 100 Index	57.892	0	2.5018	464.86	0	19.675
H CAR	20.995	0	2.5018	328.45	0	19.675
FFCL	45.175	0	2.5018	397.12	0	19.675
POL	81.25	0	2.5018	679.45	0	19.675
TREET	269.06	0	2.5018	2572.6	0	19.675
AICL	27.725	0	2.5018	369.05	0	19.675
OGDC	49.844	0	2.5018	455.41	0	19.675
SSCG	32.124	0	2.5018	352.11	0	19.675
GLAXO	70.084	0	2.5018	617	0	19.675

Note: Level of significance is 5% all index significantly rejecting normality

Data Source : *www.psx.com.pk , www.finance.yahoo.com*

Run test reject the null of IID returns for all index/indices table 3 shows the figure at 5% level of significance reject the null hypothesis of IID return which clearly deviates from (RW1) assumption of IID. It can be seen form Table 3 that for all index the null hypothesis of IID return is rejected.

Table 3: Runs Test of Randomness for Stock Index/Indices

Runs Test	KSE – 100	HCAR	FFC	POL	TREET	AICL	OGDCL	GLAXO
Runs	1362	1345	1407	1429	914	1337	1437	1618
N1	1491	1623	1638	1489	1267	1562	1553	1553
N2	1567	1311	1318	1470	950	1372	1415	1358
N	3058	2934	2956	2959	2217	2934	2968	2911
E [R]	1529.0556	1451.411	1461.679	1480.439	1086.837	1461.848	1481.792	1449.969
Var [R]	763.3058	716.7548	721.5307	739.4389	531.5684	727.1108	738.5452	720.9833
Std [R]	27.62799	26.77228	26.86132	27.19263	23.05577	26.96499	27.17619	26.85113
Z cal	-6.0466069	-3.97467	-2.03561	-1.89165	-7.49646	-4.63	-1.6482	-6.25788
P-Value	0	0	0.021	0.029	0	0	0.05	0

Note: E[R] is the expected runs while Var[R] and Std [R] are the variance and standard deviations of runs. At 5% Level of significance null hypothesis is rejected

Data Source: *www.psx.com.pk , www.finance.yahoo.com*

Run tests detect the linear dependence in the return series however their might exist non-linear dependency in return series to check this BDS test is used. This test detects all kind of linear and nonlinear structure. One more advantage of BDS test is that it doesn't required any distributional assumption. Embedding dimensions of 2 and 3 are used and with ε the distance threshold 0.5, 1, 1.5 and 2 times of standard deviations.

From Table 4 it can be seen that at all embedding dimensions and at all distance threshold test reject the null hypothesis that return is a function of IID. Which clearly reject the RW1 which states that return obtain must be independent and identically distributed.

For testing RW2 technical analysis technique is used the assumption of RW2 is that the return must be INID (independent but not identically distributed). The Random Walk model 3 (RW3) more commonly tested form of random walk obtain by uplifting the independence assumption but dependent and correlated price change.(RW3) is considered to be the weakest form of Random walk hypothesis. Autocorrelation and Ljung Box Q- test are used to check the assumption of RW3 and for detecting uncorrelated increments. Autocorrelation are calculated up to 16th lag. Auto correlations are significant for all index/indices at 5% level of significance. If stock price follow random walk then increment must be uncorrelated but it can be seen from Table 4 that at all lag there exists significant autocorrelation which give a clear indication of non-random walk in stock prices at different lag. It can also be seen from table 5 that for initial lag autocorrelation seems high for all index and scripts price but it gradually decrease down at higher lag for which proves that that stock price absorbing information in quiet lazy manner. Despite of such small values of autocorrelation at almost all lags are significant at 5% level of significance.

Table 4 : BDS test for Independent and Identically Distributed Returns

BDS Test	m=2 , ε= 0.5S	M=3 , ε= 0.5S	m=2 , ε= S	m=3 , ε= S	m=2 , ε= 1.5S	m =3 , ε= 1.5S	m=2 , ε= 2S	m=3 , ε= 2S
KSE 100-Index	17.79 (0.000)	22.83 (0.000)	20.45 (0.000)	24.19 (0.000)	22.14 (0.000)	25.56 (0.000)	22.59 (0.000)	26.05 (0.000)
HCAR	24.4 (0.000)	28.43 (0.000)	26.02 (0.000)	29.67 (0.000)	23.25 (0.000)	26.58 (0.000)	20.76 (0.000)	23.65 (0.000)
FFCL	14.99 (0.000)	19.47 (0.000)	15.18 (0.000)	18.54 (0.000)	13.33 (0.000)	16.26 (0.000)	11.73 (0.000)	14.8 (0.000)
POL	17.74 (0.000)	22.07 (0.000)	21.15 (0.000)	24.13 (0.000)	21.89 (0.000)	24.22 (0.000)	20.65 (0.000)	23.22 (0.000)
TREET	24.65 (0.000)	29.68 (0.000)	18.37 (0.000)	21.37 (0.000)	14.58 (0.000)	16.22 (0.000)	1.67 (0.094)	2.65 (0.008)

AICL	23.89 (0.000)	29.61 (0.000)	25.74 (0.000)	29.9 (0.000)	24.75 (0.000)	28.01 (0.000)	22.82 (0.000)	25.87 (0.000)
OGDC	16.53 (0.000)	20.42 (0.000)	18.1 (0.000)	21.61 (0.000)	19.21 (0.000)	22.06 (0.000)	20.37 (0.000)	22.92 (0.000)
SSCG	16.59 (0.000)	21.15 (0.000)	16.33 (0.000)	19.71 (0.000)	15.01 (0.000)	17.27 (0.000)	15.06 (0.000)	17 (0.000)
GLAXO	18.63 (0.000)	23.43 (0.000)	20.54 (0.000)	24.26 (0.000)	19.26 (0.000)	21.89 (0.000)	16.3 (0.000)	19.12 (0.000)

Note "The table reports BDS test results hence m and ε denote the dimension and distance, respectively and ε equals to various multiples 0.5 , 1.5 & times standard deviation of the data".
Data Source*: www.psx.com.pk , www.finance.yahoo.com*

To get a better picture of serial autocorrelation Lung Box Q- test is used. Autocorrelations at many of lag is significant at 5% level of significance this can be seen from table 6again confirming the same result of non-random walk. So far RW1 and RW3 are tested as define by Campbell, Lo &Mackinlay (1998). One more interesting property of all type of random walk is that the increment is the linear function of its time. The RWH is rejected in the hypothesis of homoscedasticity in all four sampling intervals of 2, 4, 8 and 16. Using the hypothesis of non-random walk, the variance ratio value is expected to be equal to one. Values indicate rejection of the null hypothesis of random walk hypothesis at 5 % level significance. This can be seen from Table 7 except for TREET script prices.

Table 5: Autocorrelations of Stock Returns

Lags	KSE – 100	HCAR	FFCL	POL	TREET	AICL	OGDC	SSCG	GLAXO
1	0.14	0.161	0.038	0.131	0.065	0.217	0.114	0.161	0.118
2	0.046	0.035	-0.099	0.036	0.041	0.043	0.071	0.035	0.005
3	0.046	0	0.037	0.013	0.033	0.03	0.043	0	-0.063
4	0.049	0.02	-0.003	0.064	-0.014	0.017	0.039	0.02	-0.014
5	-0.001	0.017	-0.007	0.018	-0.016	-0.005	0.038	0.017	-0.008
6	0.009	-0.003	-0.026	0.016	0.006	-0.002	0.024	-0.003	-0.02
7	0.02	-0.009	-0.028	0.033	0.015	0.001	0.024	-0.009	-0.04
8	-0.019	-0.031	-0.031	0.011	0.006	0.014	-0.013	-0.031	-0.052
9	0.043	-0.003	0.028	0.036	0.018	0.039	0.063	-0.003	-0.041
10	0.053	-0.016	0.014	0.023	-0.025	0.042	0.022	-0.016	0.017
11	0.002	0.004	-0.018	0.007	-0.022	0.022	-0.035	0.004	0.016
12	0.016	-0.005	-0.025	0.014	-0.032	0.021	0.01	-0.005	0.034
13	0.011	0.015	-0.02	0.021	0.002	0.042	-0.006	0.015	0.026
14	0.021	0.023	0.005	-0.02	-0.007	0.02	0.005	0.023	0.016
15	0.029	0.035	0.041	-0.015	-0.005	-0.007	-0.016	0.035	-0.005
16	0.031	0.055	0.036	-0.02	0.001	0.038	-0.003	0.055	0.03

Note: Autocorrelations at different lags are significant at 5%. Level of significance is calculated by ±2/r . Data Source : *www.psx.com.pk* *www.finance.yahoo.com*

Table 6: Ljung Box Test Statistics of Stock Returns

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
KSE -100	Q–Stat	59.6	66.1	72.6	80.1	80.1	80.4	81.6	82.7	88.5	97.2	97.2	98.0	98.4	99.7	102.3	105.3
	Prob (Sig) **	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HCAR	Q-Stat	75.8	79.5	79.5	80.6	81.4	81.5	81.7	84.5	84.6	85.3	85.4	85.4	86.1	87.7	91.4	100.2
	Prob (Sig) **	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FFCL	Q-Stat	4.2	33.4	37.4	37.4	37.5	39.6	41.8	44.6	47.0	47.6	48.5	50.4	51.5	51.6	56.6	60.6
	Prob (Sig) **	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
POL	Q-Stat	50.7	54.6	55.1	67.1	68.1	68.9	72.1	72.5	76.4	78.0	78.2	78.8	80.0	81.3	81.9	83.1
	Prob (Sig) **	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TREET	Q-Stat	9.3	13.0	15.4	15.8	16.4	16.5	17.0	17.1	17.8	19.2	20.3	22.6	22.6	22.7	22.8	22.8
	Prob (Sig) **	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AICL	Q-Stat	138.2	143.6	146.2	147.1	147.2	147.2	147.2	147.7	152.2	157.3	158.8	160.1	165.5	166.7	166.8	171.1
	Prob (Sig) **	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OGDC	Q-Stat	38.6	53.8	59.3	63.8	68.2	69.8	71.6	72.1	84.0	85.5	89.2	89.4	89.5	89.6	90.4	90.4
	Prob (Sig) **	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SSCG	Q-Stat	75.8	79.5	79.5	80.6	81.4	81.5	81.7	84.5	84.6	85.3	85.4	85.4	86.1	87.7	91.4	100.2
	Prob (Sig) **	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GLAXO	Q-Stat	40.9	40.9	52.6	53.2	53.4	54.6	59.3	67.3	72.3	73.1	73.9	77.3	79.2	80.0	80.1	82.7
	Prob (Sig) **	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note All test statistics are significant at 5% level of significance and compared with chi-square critical value
Data Source : *www.psx.com.pk* , *www.finance.yahoo.com*

Table 7: Variance Ratio Tests Statistic for Index Returns

	Period	Var. Ratio	Std. Error	z-Statistic	Probability
KSE-100	2	0.810	0.032	(10.23)	0.0
	4	0.702	0.065	(9.45)	0
	8	0.701	0.083	(7.87)	0
	16	0.421	0.145	(7.10)	0
HACR	2	0.575	0.054	(7.84)	0
	4	0.292	0 .085	(8.30)	0
	8	0.154	0.109	(7.75)	0
	16	0.071	0.134	(6.93)	0
FFCL	2	0.572	0.035	(12.13)	0
	4	0.261	0.064	(11.63)	0
	8	0.134	0.095	(9.13)	0
	16	0.063	0.134	(7.00)	0
POL	2	0.555	0.065	(6.83)	0
	4	0.270	0.103	(7.08)	0
	8	0.143	0.132	(6.49)	0
	16	0.074	0.160	(5.81)	0
TREET	2	0.513	0.351	(1.39)	0.166
	4	0.272	0.527	(1.38)	0.167
	8	0.134	0.616	(1.41)	0.159
	16	0.068	0.661	(1.41)	0.158
AICL	2	0.612	0.028	(13.70)	0
	4	0.314	0.049	(14.02)	0
	8	0.158	0.071	(11.84)	0
	16	0.078	0.100	(9.24)	0
OGDC	2	0.524	0.030	(16.11)	0
	4	0.272	0.052	(14.01)	0
	8	0.143	0.077	(11.05)	0
	16	0.071	0.110	(8.42)	0
SSCG	2	0.575	0.054	(7.84)	0
	4	0.292	0.085	(8.30)	0
	8	0.154	0.109	(7.75)	0
	16	0.071	0.134	(6.93)	0
GLAXO	2	0.564	0.050	(8.70)	0
	4	0.288	0.079	(9.04)	0
	8	0.150	0.100	(8.48)	0
	16	0.069	0.121	(7.67)	0

Data Source: *www.psx.com.pk, www.finance.yahoo.com*

4.2 Empirical Evidence of Technical Analysis

This portion will illustrate the result for the trading tools validity that are widely used in the industry for performing technical analysis. Second hypothesis that weather technical trading rules can help in predicting future price pattern and technical trading rule have predictive power is also tested. For checking this buy days and selling days returns are calculated and it can be seen from table 8 that average buy days return is significantly larger as compared to selling days return. Trading rules on simple moving averages with price crossover double crossovers and triple crossovers. As per trading strategy developed always enter in the market when shorter moving averages is greater than long moving averages. For KSE 100 index and including script prices it is concluded that price crossovers and triple crossover technical indicator produced positive average buy days returns and they also are significantly greater than sell days return which gives a clear indication that technical trading strategies can forecast over future price movement except for double crossover it fails to provide buy days return greater than sell days return for majority of

the index/indices. Findings are not speculators for all index/indices technical trading rules generate positive buy days return and negative sell days return. However, seeing this it is concluded that second hypothesis exists. This hypothesis is tested for KSE 100 index and other selected sample of stock which gives the same result. Predictability of price movements gives further support that index/indices follows non-random walk. It also concludes that on selling days standard devotions are higher as compared to buying days which clearly states technical analysis give correct indication to be out of the market in higher riskier days.

Table 8: Trading Rules Strategies and Results

Index	Strategy	Trading Rule	Mean (B)	St. Dev (B)	Buying Days	Z Cal	Mean (S)	St. Dev (S)	Selling Days	Z Cal	Buy- Sell (t cal)	P Value
KSE 100	Single Crossover	50 Day SMA	0.23%	1.02%	2031	10.15	-0.27%	1.67%	979	-5.06	8.12	0.00
		150 Day SMA	0.15%	1.10%	2203	6.42	-0.21%	1.75%	707	-3.18	5.12	0.00
		200 Day SMA	0.14%	1.13%	2250	5.87	-0.18%	1.78%	610	-2.50	4.21	0.00
	Double Crossover	SMA (50-150)	0.10%	1.24%	2146	3.74	0.00%	1.47%	746	0.00	1.23	0.11
		SMA (50-200)	0.09%	1.23%	2218	3.45	-0.02%	2%	642	-0.35	1.74	0.04
	Triple Crossover	SMA (4-9-18)	0.25%	0.97%	1402	9.58	-0.10%	1.50%	1508	-2.59	6.39	0.00
HCAR	Single Crossover	50 Day SMA	0.57%	2.90%	1499	7.62	-0.49%	2.99%	1387	-6.10	9.68	0.00
		150 Day SMA	0.40%	2.82%	1570	5.62	-0.36%	3.18%	1216	-3.95	6.56	0.00
		200 Day SMA	0.34%	2.81%	1603	4.84	-0.30%	3.24%	1133	-3.12	5.41	0.00
	Double Crossover	SMA (50-150)	0.18%	3.38%	1586	2.12	-0.08%	2.95%	1191	-0.94	2.27	0.01
		SMA (50-200)	0.17%	3.03%	1586	2.24	-0.06%	3%	1150	-0.68	2.04	0.02
	Triple Crossover	SMA (4-9-18)	0.68%	3.16%	933	6.58	-0.22%	2.87%	1985	-3.41	7.37	0.00
POL	Single Crossover	50 Day SMA	0.35%	1.77%	1669	8.08	-0.44%	2.67%	1242	-5.80	9.02	0.00
		150 Day SMA	0.22%	1.76%	1688	5.12	-0.28%	2.82%	1123	-3.33	5.27	0.00
		200 Day SMA	0.20%	1.78%	1631	4.53	-0.24%	2.81%	1130	-2.87	4.59	0.00
	Double Crossover	SMA (50-150)	0.05%	2.12%	1713	0.98	-0.04%	2.46%	1098	-0.54	1.04	0.15
		SMA (50-200)	0.04%	2.13%	1656	0.76	-0.01%	2%	1105	-0.13	0.50	0.31
	Triple Crossover	SMA (4-9-18)	0.36%	1.79%	1175	6.91	-0.21%	2.46%	1768	-3.59	7.26	0.00

Table 8: Trading Rules Strategies and Results

Index	Strategy	Trading Rule	Mean (B)	St. Dev (B)	Buying Days	Z Cal	Mean (S)	St. Dev (S)	Selling Days	Z Cal	Buy- Sell (t cal)	P Value
AICL		50 Day SMA	0.48%	2.45%	1651	7.95	-0.61%	2.82%	1235	-7.60	10.87	0
		150 Day SMA	0.24%	2.41%	1751	4.16	-0.33%	2.94%	1035	-3.62	5.27	0
	Single Crossover	200 Day SMA	0.19%	2.40%	1767	3.33	-0.24%	3.02%	969	-2.47	3.78	0
		SMA (50-150)	0.05%	2.49%	1741	0.84	0.00%	2.86%	1045	-0.03	0.50	0.309
	Double Crossover	SMA (50-200)	0.05%	2.48%	1812	0.77	-0.03%	3%	924	-0.27	0.17	0.433
	Triple Crossover	SMA (4-9-18)	0.38%	2.55%	1031	4.77	-0.17%	2.73%	1887	-2.68	5.41	0
TREET		50 Day SMA	0.75%	3.13%	949	7.38	-0.52%	3.72%	1220	-4.89	8.64	0
		150 Day SMA	0.45%	3.41%	833	3.81	-0.25%	3.42%	1236	-2.57	4.56	0
	Single Crossover	200 Day SMA	0.38%	3.27%	799	3.29	-0.20%	3.43%	1220	-2.04	3.83	0
		SMA (50-150)	0.14%	3.40%	1156	1.40	-0.10%	3.48%	913	-0.87	1.53	0.0625
	Double Crossover	SMA (50-200)	0.18%	2.88%	1147	2.12	-0.17%	4%	872	-1.28	2.24	0.0125
	Triple Crossover	SMA (4-9-18)	0.78%	3.48%	697	5.92	-0.32%	3.51%	1504	-3.54	6.90	0
OGDC		50 Day SMA	0.32%	1.75%	1694	7.53	-0.37%	2.16%	1226	-6.01	9.33	0
		150 Day SMA	0.20%	1.84%	1632	4.39	-0.22%	2.07%	1188	-3.66	5.55	0
	Single Crossover	200 Day SMA	0.20%	1.87%	1603	4.28	-0.21%	2.05%	1167	-3.50	5.37	0
		SMA (50-150)	0.09%	1.93%	1615	1.87	-0.05%	1.98%	1205	-0.88	1.81	0.0352
	Double Crossover	SMA (50-200)	0.09%	1.94%	1613	1.87	-0.06%	2%	1157	-1.02	1.94	0.02635
	Triple Crossover	SMA (4-9-18)	0.34%	1.89%	1142	6.09	-0.16%	1.95%	1810	-3.48	6.94	0
GLAXO		50 Day SMA	0.42%	2.10%	1327	7.28	-0.37%	2.23%	1536	-6.50	9.84	0
		150 Day SMA	0.25%	2.21%	1254	4.00	-0.20%	2.13%	1509	-3.65	5.36	0
	Single Crossover	200 Day SMA	0.23%	2.19%	1266	3.74	-0.19%	2.19%	1447	-3.31	4.94	0
		SMA (50-150)	0.01%	1.99%	1427	0.19	0.00%	2.37%	1336	-0.04	0.15	0.439
	Double Crossover	SMA (50-200)	0.03%	2.02%	1357	0.49	-0.01%	2.4%	1356	-0.17	0.38	0.353
	Triple Crossover	SMA (4-9-18)	0.23%	2.29%	956	3.08	0.11%	2.18%	1939	2.19	3.78	0
FFC		50 Day SMA	0.45%	2.72%	1635	6.70	-0.50%	3.08%	1273	-5.79	8.657	0
		150 Day SMA	0.27%	2.56%	1588	4.20	-0.27%	3.29%	1220	-2.87	4.744	0
	Single Crossover	200 Day SMA	0.28%	2.53%	1533	4.33	-0.26%	3.30%	1225	-2.75	4.699	0
		SMA (50-150)	0.08%	2.51%	1542	1.25	-0.02%	3.34%	1266	-0.21	0.87	0.1912
	Double Crossover	SMA (50-200)	0.11%	2.51%	1491	1.69	-0.05%	3%	1267	-0.54	1.44	0.0749
	Triple Crossover	SMA (4-9-18)	0.33%	2.72%	1023	3.87	-0.11%	3.00%	1917	-1.60	3.9618	0

Data Source: *www.psx.com.pk, www.finance.yahoo.co*

For further checking moving average convergence divergence indicator is used which is considered to be the best indicators in technical analysis. Buy days returns are significantly greater than 0 while sell days retunes are also significantly less than 0 and their exist a significant difference between by days return and sell days return. Buy days return are significantly higher than sell day returns.

Table 9: MACD technique results.

MACD	KSE – 100	HCAR	FFC	POL	AICL	TREET	OGDCL	GLAXO
Mean (B)	0.15%	0.29%	0.21%	0.17%	0.32%	0.23%	0.16%	0.11%
St. Dev (B)	1.04%	3.20%	2.69%	1.82%	3.79%	2.55%	1.76%	2.45%
Buying Days	2022	1501	1633	1691	951	1667	1706	1306
Z Cal	6.49	3.51	3.16	3.85	2.60	3.69	3.75	1.62
Mean (S)	-0.10%	-0.16%	-0.17%	-0.18%	-0.21%	-0.24%	-0.13%	-0.08%
St. Dev (S)	1.66%	2.79%	3.17%	2.68%	3.30%	2.83%	2.16%	2.00%
Selling Days	1012	1406	1299	1244	1242	1243	1238	1581
Z Cal	-1.92	-2.15	-1.93	-2.37	-2.24	-2.99	-2.12	-1.59
Buy- Sell (t cal)	4.46	4.086	3.462	3.983	3.453	4.606	3.828	2.258
P Value	0	0	0	0	0	0	0	0.0119

Data Source: *www.psx.com.pk, www.finance.yahoo.com*

It can be seen from table 9 that at 5% level of significance all index shows buy day returns significantly higher than sell days return again confirms the predictability of the stock price and conclude that technical analysis is valid for Karachi stock market. AICL give the highest average return about 0.32% daily. GLAXO is considered to be weakest of all in term of returns.

Lastly third hypothesis that buy-hold strategy will outperform technical trading returns is tested .One sample t test is used to check whether buy days return are significantly larger then sell days return, using the one sample t-test can see from table that except for KSE-100 index all indices are not able to generate positive returns also GLAXO has the lowest daily average returns. TREERT prices are more volatile while holding the stock. With the critical value of 1.645 and 5% level of significance, average daily return for buy and hold strategy is not statistically significant. This concludes that technical analysis can outperform buy-hold strategy. GLAXO is the riskiest in terms of risk per unit return.

Table 10: Technical Analysis Outperforming the Market

Index/Indices	KSE -100	HCAR	FFC	POL	TREET	AICL	OGDC	GLAXO
Average Return	0.067%	0.061%	0.042%	0.016%	0.025%	0.024%	0.034%	0.004%
Standard Deviation	1.285%	2.992%	2.913%	2.226%	3.527%	2.672%	1.942%	2.212%
Number of Days	3058	2934	2956	2959	2217	2934	2968	2911
Z Cal	2.890	1.111	0.785	0.386	0.333	0.488	0.953	0.108

Data Source: *www.psx.com.pk, www.finance.yahoo.com*

This research examined the validity of both random walk and technical analysis for the KSE 100 index and selected sample stocks and concluded that stock price follows random walk and moving average techniques can be used to study market trends and behavior for the period between 2004 and 2016. Three different form of random walk is tested in the research. To test the hypothesis of non-random walk all three forms of random walk describe by Campbell, Lo & MacKinlay (1998) are tested by use of different parametric and non-parametric statistical test. Distribution of return test, Run test and BDS test for *Random walk 1* RW (1). Results conclude that KSE-100 index and selected indices returns are not IID random variable and therefore doesn't follows normal distribution. RUNS test is used as a non-parametric test to check if the return series are IID random variable. The basic idea of using run to test if variable is truly i.i.d or not. BDS test checked the hypothesis that the successive price changes are not identically distributed random variable (RW1 hypothesis).Run test is used to check if the returns are IID the basic advantage of run test is that it doesn't required the sample to be normally distributed. If the runs are at extreme (both on positive side and negative side) it gives a clear indication that there is a pattern in price. This study also conclude that for all embedding dimension KSE 100 index and selected indices P value of all selected stock are less than 5% which shows clear rejection of null hypothesis of random walk except for TREET script and dimension 2 and 3 with ε equal to 2 times of standard deviation. Q-test, Autocorrelation test for *Random*

walk 3 RW (3) and found that their exist no auto correlation between stock returns Autocorrelation are calculated up to 16th lag at all lag there exists significant autocorrelation which give a clear indication of non-random walk in stock prices at different lag. Last but not the least the property of all three types of random walk which is the linearity of increments is tested using variance ratio test. To check whether the increments in all type of random walk is linear function of its time variance ratio test is used. Research found support for first hypothesis: that KSE-100 index and selected indices followed a non-random walk. Findings are therefore same with previous studies Irshad and Sarwar (2012) checked weak form of efficiency of Karachi stock market for sample period (1998-2012) which fails to prove efficiency of the Karachi Stock Market and conclude stock price did not follows random walk hypothesis further Mudassar et al (2013) concluded that based on the past information and historical trend of the market, investors were able to generate abnormal profits from the securities/investments.

It is also observed that moving averages strategies on KSE-100 index and selected indices, has worked in terms of profitable return. Both Moving average (single crossovers, Double crossovers and triple crossovers) and MACD technique was used to check the market trend and for better informed decision so it can be concluded that technical analysis is valid for Pakistani stock market. Lastly third hypothesis is checked that buy-hold strategy will outperform technical trading returns. For this purpose one sample t-test is used and concluded that except for KSE-100 index all indices cannot provide positive (significantly positive) rates of returns with the rejection region of 1.645 and 5% level of significance, average daily return of stock price for buy-hold strategy is not statistically significant. This concludes that technical analysis can outperform buy-hold strategy. Also third hypothesis that technical analysis is not useful to beat the holding of stock for specific period is rejected. Furthermore, in this research only focused on first two pillar of technical analysis which are market trends and its consistency. So it is concluded that KSE 100 index and other selected sample of stock doesn't follow any form of random walk and technical analysis have predictive power which can be clearly seen form the results that using technical analysis average buy days return are significantly higher then sell days return further it can also be seen that standard deviations of number of buy days returns are lower as compared the sell days return which indicates that technical inlays produce higher returns in buying days as compared to selling days return with a low level of risk (standard deviation) in comparison. It is also concluded with the result that buy and hold strategy doesn't produce statistically significant returns however technical trading returns are statistically significant with almost the same level of risk so one can infer that technical trading techniques are handy tool to beat buy and hold strategy.

5. Discussion

The randomness or the non-randomness of the stocks and other financial assets is an issue which has been widely explored by number of researchers in the sake of market efficiency debate and keeping in view the growing activities of the speculators and other investors across the globe. The primary concern was to investigate the validity of Random walk hypothesis and technical analysis (used to predict the future price movements) in Pakistani Stock market. The results was similar to previous studies that stock price doesn't follow random walk model which implies that Pakistan stock market is not an efficient market and the same result was concluded by Hussain, Hamid, Akash, and Khan (1997) while checking random walk in Pakistani equity market. The random walk theory is important because it is directly linked with the market efficiency which states that if the market is efficient, stock prices will always show a random pattern revisited by Irshad and Sarwar (2012), while checking weak form of efficiency of Pakistan Stock market it was concluded that market is weak form inefficient and fundamental and technical analysis can be used to get abnormal profits. Most of the previous researches only focused on testing first form of Random walk with independent and identically distributed returns assumptions i.e. IID returns, however exploring more studies it is found that there exist three different form of random walks with a slight difference in properties. According to Campbell, Lo & MacKinlay (1998), "*there is more than one meaning or explanation for random walk, depending on the nature of increments (returns), and the dependence that exists between increments (returns) in different definite time intervals"*. The first form model (RW1) emphasizes that successive price change must have IID. This random walk has clear cut assumptions that time series of successive price change or returns are independent and price changes follows same distributions. Random walk 2 (RW2) assumes the return series to be independent but they are not necessarily from the same distributions. If the assumption of independence is removed and the assumption of uncorrelated increments is added it will be the third form of random walk. This research tested for all above form of random walk for stocks traded in

Pakistan stock exchange and for KSE 100 index itself and found that stock price doesn't satisfy these assumption not in any form of random walk this result is similar to Gustafson, D (2012) while checking validity of technical analysis for Swedish stock market found that prices doesn't follow any form of random walk.

Market must possess high liquidity and good regulatory to become developed market, Pakistan Stock exchange is considered to be emerging stock market of the world due to its fast growth. It was concluded by (Zeren 2012) that developed market are always efficient, however majority of the emerging markets proves to be inefficient which is consistent to our result. Regarding validity of technical analysis it is found the same result has been developed from testing random walk both asserts that historical price have much information in it and which help technical analysis rules to perform more profitable than just by buy- hold. This was consistent with the previous research by Metghalchi et al (2005) which concluded that moving averages technique can outperform buy and hold strategy. The same was concluded by Chan (1998) that developed market failed to support technical analysis however emerging market fully support technical analysis strategies.

Stock market plays a vital role in the economy. The most important functions of stock market is to allot efficiently the share price on the scale of supply and demands and to allow the investor to allocate their investments. Stock buyers will always represents demand and stock seller always represents supply. If there are a lot of seller for one particular stock and very less buyer then the price of stock will go down. But on the other hand, if there a more buyer then seller the stock price will go up definitely. As according to Inam (2017) the investments in stock market then utilized in the growth of the economy. If markets are efficient and all market players have same information about the companies (already incorporated in the stock price of the respective stock), then investment can be utilized in the most effective manner. But if the market is not efficient these investments cannot be utilized in effective manner. However, there is a very important role of the regulatory authority like state bank and security and exchange commission of Pakistan to protect the investments of the individuals.

This research finds that the Karachi Stock exchange is weak form inefficient and doesn't follows random walk, suggesting an opportunity to make speculative gains to exist for the investors, which all investors, other players and markets analyst can exploit. Further technical analysis widely used by market technicians however very less research work has been done to check the effectiveness of technical analysis and it is not well used by the academicians, though technical analysis is very handy in Pakistani Stock Market. Also, it can be seen that trading strategies applied for buy days return have produced positive returns with low level of risk. Similarly, for selling days the returns are negative and the deviations are very high which concludes that technical analysis give buy signal if market have positive return with a smaller number of deviations however sell signal is generated when market have negative return on higher standard deviations. Despite measures are taken in this research to understand the random walk behavior of stock market in the context of PSE, researchers find certain limitations of this study, such as, time constraints and limited resources, small size of population from only one stock exchange (PSE); the largest stock exchange of Pakistan and paucity of scientific research conducted on the topic in Pakistani context. This research points out very few aspects of technical analysis though it is a very huge and drastic field. Also, it not only goes with the numbers but also with the investor sentiments.

6. Conclusion and Recommendations

This research has been conducted keeping the idea in mind that it is important for the investors as well as the government both to have more effective financial market's information system. This positive change in mind, not only, positively impacts the economy of the country but also on individuals. In the less risky environment, there will be a peace of mind that something will not deviate beyond expectations. Financial markets of developed countries normally operate as weak form efficient (not supported by past price, volume and trend), thus not giving chance for the investors to generate abnormal profits from the securities. Rational investor will always look for the maximum return with the lower level of risk and deviation. However, some of the time markets prove efficient against the trading strategies of the investment analyst and fund managers and the prices of the market cannot be predicted accurately. To check the validity of random walk all three form of random walk have been tested and found that Pakistani stock market doesn't follows random walk and price movements are predictable this is perhaps because of the

fact that market is inefficient and unable to absorb the information quickly. It is also concluded that Karachi stock market is an in-efficient financial market that cannot adjust any new available information very quickly and efficiently on daily basis and the prices of the securities that are listed for trading at PSE can be predicted as this market can be beaten to gain any additional returns. Further dimensions of the research are tested regarding validity of technical analysis and found that moving average techniques can be used to outperform market and beat buy and hold strategy. The regulatory body of Pakistan "Securities and Exchange Commission of Pakistan (SECP)" needs to take stand for improving efficiency of the Karachi stock market. They must regulate the exchange with good and more strict polices so that it will help market to grow and also will increase the confidence level in investors. However, security and economic conditions of Pakistan has major concerns in this regard and there is need of greater attention from government, policy makers and of all other stakeholders. Further study and analysis is recommended in case of comparative analysis for getting revolutionary and innovative results regarding rest of the stock exchanges behavior. In terms of strategies for the investors, the study finds that the Karachi stock market is weak form inefficient through the use of different statistical test, as such this provides an opportunity to more sharp and informed investors to earn returns greater than those of the market through the use of trading strategies that incorporate past price information such as moving averages techniques in technical analysis given that transaction cost is minimal.

Policy makers and the regulatory authorities need to escalate efforts to strongly pursue substantial reforms to improve and strengthen the quality of the information flow. One useful way to achieve this would be to encourage more institutional investors to actively participate on the PSE. The regulatory authorities of Pakistan like SECP ensures that they will apply the best practices and standards use by other efficient market and in order to fill this gap they will use good technologies used by other developed countries, uses of advance trading software's and bigger database information and easily extractable historical record. This market inefficiency can lead to many problems but from investor point of view it is easier to take advantage of the price difference and making profits but this fact is true only for those investors who are well informed in the market it is an ideal situation that all buyer and seller are well informed but so it can be bigger loss to beginner investors in stock markets.

It is recommended that SECP should take serious actions on regulating Pakistani stock market so that these price efficiencies are minimized and everybody will get fair chance to earn profit. Also, it will open the doors for the foreign investor to invest in market. It is also recommended to universities that technical analysis must be added as part of curriculum because now a day's investment professionals are using these techniques along with the fundamentals. There is definitely a need of more research at academic level for technical analysis as it is a vast field with a lot of dimensions in investment management.

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