Validity of Random Walk Hypothesis and Technical Analysis on Pakistan Stock Market

By

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Dedications

To my wife and loving parents

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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.

Chapter 1: Introduction

Several studies have tried to explain the behavior of stock market and how to respond on market actions. These researches have focused on investor's problem to allocate their investments efficiently. In an efficient market, current price quickly absorbs information available and hence such mechanism doesn't have any scope to make abnormal profits. 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 exist no correlation between them. This was highlighted for the first time by Kendal (1953), the same idea that financial market follows random walk became more interesting topic when Malkiel (1973) relates price changes to a drunk man moving without any direction.

The theory of random price change plays a vital role for individual investor also, because it describes the characteristic of the market and if stock markets follows random walk then the market is said to an efficient market and investors cannot utilize the information of historical prices, and technical analysis algorithms and indicators are used rarely.

Random walk theory emphasizes that stock price movement will not follow any standard path or direction and that movement of price is not useful for the prediction of future price movements. This is because of the fact that current prices of securities have already incorporated any news with very efficient manner and one cannot beat the market. In this research validity of random walk and technical analysis is tested for stock traded in Pakistan Stock exchange.

From the beginning when people were trading in the market, there has been debate on the either it will trend up, trend down or remain same. The increase in stock prices will impact positive for

those who has hold a lot of stock but at the same time impact negatively to those who already sold it. Fama (1995) suggested that fund managers should apply buy hold strategy because it give good rate of return in a longer run instead of taking risk on day to day trading. Pakistan stock exchange (Formerly Karachi Stock Exchange) which is 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.

1.1 Background of the Study

The concept of random walk hypothesis first used by Louis in his Ph.D. thesis named "*The Theory of Speculation*[1]" (1900*).* The same concept was later suggested by Professor Paul Cootner in his book "*The Random Character of Stock Market Price"* (1964). The term 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 Eugene Fama's article *"Random Walks In Stock Market Prices"* (1965). The theory of stock prices move randomly was proposed by Maurice Kendall in his paper, "*The Analysis of Economic Time Series"* (1953).

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 those price at which buying and selling of stock is less risky with maximum returns. Professional traders and investments analysts in financial markets normally uses both 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,

[1] Theory of speculation states that *"There is no useful information contained in historical price movements of securities".*

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 publically 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 depicts some trends. Practitioners and users of this technique study price patterns and plot different charts for understanding the trends in it Turner (2007).

Technical Analysis is a technique which uses different technical indicator to forecast future prices. The indicators includes 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.

Technical analysis first introduced by Charles H. Dow, the theory has six standard pillars.

1) The first pillar is on the grounds that market moves with a particular trend: primary trend, secondary trend and a minor trend. Primary trend is a long lasting trend it stays in the market for more than a year it might have long lasting impact also. Secondary trend are formed on the reaction of primary trend and may continue for weeks and months while minor trend also known as short swing lasts from hours to months.
2) According to Dow's theory second basis pillar is that market has three phases accumulation phase[2], distribution phase and public participation phase/absorption phase. In accumulation phase the demand of the stock is less as compared to supply and buyer and seller use general information of the market to buy-sell stock. In distribution phase

[2]Accumulation phase is considered to be a point where an informed investor enters in market.

over rated stocks price begin to fall .In public participation there is a huge participation of buyer and seller and investor purchase more stock using technical indicators as they all works well in this phase.

3) Market reflects all information and news and all markets are efficient and absorb every information quickly this is the third pillar of the theory. This fact is related to efficient market hypothesis which states that stock markets are efficient.
4) The fourth pillar is that market on average will move the same direction as their correlated market. If one market is going up the other associated market must follow same path. If the consumer sector is performing well in the market, logistics and shipping sector will also perform well because if consumer goods are produced they are shipped by the logistics one.
5) In his fifth pillar Dow Jones explains the nature of value. According to this pillar volume is directly related with the trend. Volume[3] is related to the trend is always true for primary trend also sometimes it is true for secondary trend. The Dow Theory focuses totally on price action. If primary trend is down, volume ought to increase throughout market declines. If the trend is up, volume ought to increase throughout market advances.
6) The sixth pillar emphasizes that trends always continue and if there is slight disturbance in the trend there will be a reversal soon.

Investors always have an interest on buying undervalued stocks to increase their investment value in future. Many investors, including investment managers and asset management firms believe that by using advanced and modern techniques they can select the higher valued stock.

[3] Volume of a share is defined as number of shares traded in a single security or in entire market for a given period of time

They use a range of different forecasting and valuation methods to support them in their daily investment decisions. Evidently, any advantage that an investor holds can be converted into considerable profits. The random walk asserts that none of these techniques are viable and effective (i.e., the edge gained does not overreach the transaction and research costs incurred), and that is why no one can effectively outperform the market. In the study of stock price movements and its returns random walk hypothesis has been long influenced by random properties of returns. Justification for this research is not difficult to find, given that presence/absence of random walk in stock price has very important implications for investors, trading strategies, fund managers, asset pricing models, capital markets and consequently financial and economic development as a whole. Trading strategies differ when prices are characterized by random walks. Studying the validity of random walk and technical analysis will help the investors/traders to identify the nature of the market and select the strategy that will increase their returns.

The reason behind random walk theory is the area of interest of different researchers is because of the fact that it will give indication regarding market efficiency. And a well-informed investor can use this efficiency to generate good profits.

The efficient market hypothesis has a clear linkage with random walk. The random walk states that the price of tomorrow is not dependent on today's price, prices can only be determined on the basis of daily economic condition (e.g. Supply and Demand); historical price can't be useful to forecast or predict the future prices. If a market follows a random walk then it means that there are no patterns present in the market and any new information that is available is rapidly reflected in the stock prices and investor can't earn the extra profit by identifying trends and patterns.

This research has been carried out to test validity of random walk and technical analysis. This research will help the investor to dig out the market potential and predictability of stock prices. This will help the academia's to focus most on predictability of stock return though technical analysis as it was criticize by many of the academician's due to lack of support of theoretical evidences but these are still used by many market professional's.

1.2 Problem Statement

Random Walk hypothesis states that "*Stock price are not predictable on the basis of historical price and hence use of technical analysis is useless"*. If past prices doesn't reflect any relation to current price than investor cannot earn any abnormal profits in a short run. If the market doesn't follow random walk than it will be beneficial for the investor to read the pattern using technical analysis and find out the best undervalued and overvalued conditions.

In understanding the theories of stock market many theories like Fifty percent principle, Odd lot theory and prospect theory but random walk has acquired as important place in understanding the behaviors of stock market. This theory need to be understood for the better understanding of the market at academic level. Hence there is a need to undertake the research on random walk theory to understand the market efficiency in a sufficient manner. If it is not studied at academic level there is a threat that there will be lack of scientific knowledge in the field of stock price movements with reference to random walk.

1.3 Research Objectives

Many literature debates the validity of stock price prediction within these researches random walk theory was examined. This research is particularly focused on whether the stock price follow random walk and whether certain basic technical analysis methods for investing in the

stock market can results higher returns, on average, than a simple buy-and-hold strategy. The method of technical analysis selected for investigation which uses crossovers of moving averages, such an approach allows for research objective to be addressed where the main objective was to identify that how effective and useful the stock market is, more specifically the trading rule approach and predictions whether it yields higher returns lower losses than a simple buy-and-hold trading strategy.

Following are the objectives of the research

- To check the validity of random walk hypothesis on Pakistan Stock Exchange (Formerly Karachi Stock Exchange).
- To check the predicting ability of technical analysis on future price fluctuations.
- To check technical trading strategies could outperform/beat a buy and hold strategies.

The main purpose of this research is to validate whether Pakistani stock market follows random walk process. This research is for those investors who use technical analysis and its indicator to find out the best investment strategies also market movements can be predicted using this.

1.4 Research Question

Pakistan Stock exchange is considered to be most emerging market. Tough one can observe many ups and downs in the market and due to such high deviations in the market random walk theory is always the main area of interest. Movement of stock price according to random walk is always random in nature and one cannot beat the market because market quickly absorb every available information in itself as well as in stock price.

The first research question therefore generated below

1) ***Does stock index/price follows random walk in Pakistani stock market?***

Further if stock price follows random walk than how effectively technical analysis able to read the market as so it generates second research question as below

2) ***Does technical analysis strategies are viable for predicting future price movements?.***

1.5 Focus of the Research

The main focus of the research is to check the validity of random walk hypothesis in the Pakistani stock market and predictive power of technical analysis although technical analysis is used by many of the traders and professionals but not have that academic significance as compared to fundamental analysis this is probably because of the fact that there is not a theoretical basis for it. Second reason is that earlier theoretical studies often assumes a random walk model for a stock price which completely eliminates profitability from technical trading. Academics, however have long been reservations about the usefulness of technical analysis in spite of its wide speared acceptance and adaption by practitioners[4].

1.6 Research Gap and Significance

This research will fill the gap by examining the behavior of stock market using random walk hypothesis in Pakistani stock market. This research will give the better insight regarding behavior of Pakistan Stock Exchange and in this research advance econometric techniques are used for better estimation and good and reliable conclusion. Random walk and EMH was tested

[4] Some academics take a strong view against technical analysis. For example Malkiel (1981, p.138) says, "*Technical analysis is anathema to the academic world."*

by many of the researcher but the forecasting ability of the technical analysis and validity of outperforming the market and buy and hold strategy was never tested for Pakistani stock market.

Study will be fruitful both for current and prospect investors and all stake holders on Pakistani stock market. The purpose of this study is to analyze how quickly stock market absorbs information which reflect in form of price of the stocks and if there is any correlation between stock prices which help investor to outperform market. On the other hand this research also taken in to account how valid is technical analysis in this market.

1.7 Research Limitations

Although research will reach its aim, however there will be some unavoidable limitation. First because of the time constraints and limited resources, this research was conducted only on a small size of population which might be bit compromising the generalization of the result and lack of generalization in case of other stock exchanges working in Pakistan. Further study and analysis is recommended in case of comparative analysis for getting revolutionary and innovative results regarding rest of the stock exchanges behavior and movements working in Pakistan.

Secondly there was lack of prior research availability on the topic of technical analysis other limitations includes non-availability of primary data from the real traders and research doesn't include any cost associated with the trading strategies in it. Furthermore, this research only focused on first two principles of technical analysis there is trend in a market with consistency.

Chapter 2: Literature Review

2.1Theoretical Framework

2.1.1 Random Walk Theory

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.

Campbell, 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.

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 a 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 effect 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 (1986) contend, "*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.

2.1.2 The Efficient Market Hypothesis

Introduced by Fama (1970) and investment theory that is based upon market efficiency[5] and states 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 change 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 and MacKinley (1998). This

[5]Market efficiency is the degree to which stock prices reflect all available, relevant information.

leads to a random walk where the more the efficient market exist the more random the sequence of price changes.

Strong form Efficiency: 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.

The strong-form EMH in other words claims that prices immediately reflect even "concealed" or "insider" information thus even insider information is not helpful. The strong-form efficiency declare that all information is either public or private is already incorporated in stock prices. In strong-form efficiency, stock prices reveal all information, public and private. "*If there are legal hurdle to private information becoming public, as with insider trading laws, strong-form efficiency is not possible, except in the case where the laws are ignored universally*." Correa, et al.(2007).

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 insider who knows 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).

Weak form Efficiency: states that that "*all information are 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 today's price is not correlated with yesterday 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. If the stock prices follows the random walk than future stock price will not take any influence from the past prices than it can be concluded that market is efficient in the weak form. In his theory of speculation, Bachelier (1900), proved that the mathematical expected value of the speculator is zero and this conditions is considered to be a "Fair Game". However, he also gives efficient market hypothesis theory relating to Random Walk Theory – which states that in financial markets the prices moves randomly and are not connected with each other. However, they are independent of each other and therefore, by quantifying the patterns and trends of price changes in a market could not be used to predict the future value of the stock price. All three form of the efficient market hypothesis regret the validity of fundamental analysis and technical analysis. Expectations are vitally important in that and they play an important role in the economy since many transactions require investor to project the future outcome.

"Information efficiency" is the vital concept in efficient market hypothesis which states that how efficiently information impact the stock market and how quickly any news is incorporated in the

stock price. The measure of the information is the important issue in the previous studies, Mustafa, K (2008) argues that the proxy of information is the political and economic news that the publicly announced through newspaper, TV headlines and social media. These information if are in accordance with the investor expectation it will not impact the stock price, however if this news is unexpected to the investor it will impact the stock price.

The implication of "Informational efficiency" will provide a guard to investor for high variations and volatility in stock price. SECP can play an important role by applying strict policies and regulation on the technological advancement and implementation of advance powerful trading systems.

2.1.3 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 confits the EMH through observed patterns of choice.

Kahneman & Tversky (1979) introduced "*The prospect theory"* is considered one of the key concept of behavior finance. This theory states "*Choices can be made by people where the probabilities of outcome or events are known"*. In contrast with expected utility theory[6], the prospect theory says that individuals are more concerned with the losses as compared to gain. It means individual can also be happy if their investment is closed at a break even and compared to investment closed in a loss. Kahneman et al (1979) proves that for certain outcome investor feel confidence in their choice of selection and in case of uncertainty their confidence on investment decision will shake On the other hand Loome & Sugden (1982) introduced "*The regret theory*"

[6]"*The expected utility theory states that individuals will chose between risky prospects by comparing expected utility values .In other words, individuals will value prospects by multiplying expected utility with the respective probability and chose the prospect generating the highest weighted value*" (Barbera, Hammond &Seidl, 2004).

describes the human nature in feeling of regret. This thinking of regret make their investment decision failed. Behavioral finance is a new and interesting area of financial research that encompasses the psychological factors the affects investment decision. It also attempts to describe market irregularity and other market activity that is not describes by the efficient market hypothesis. The elementary basis of behavioral finance is behavioral biases and psychological factors that do effects investors, which restricts and distorts their information and may result them to reach incorrect conclusions even when they have correct information.

2.1.4 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 analyse 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. 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).

When and investor want to make decision regarding their investments there are two routes one is fundamental analysis and the second one is technical analysis. Fundamental analysis is based on analyzing the value of the company and assumes that company's value is directly related with

their stock price movement. It involves a critical analysis of the company's background, profits, turnovers, directors and management reports in order to check the future prospects of the company. Technical analysis is an entirely different field it never emphasizes on the company's valuation but focused on price action (i.e. the movement of the price) secondly it also analyses supply & demand of the particular security or stocks, because price actions are dependent on the supply and demand. If there is a lot of demand or more people want to buy that particular stock then obviously there price will go up and if there is a lesser demand then price will shoot down. Thirdly, it focuses on determining the trend in price action trend may be uptrend or down trend and on consolidated state investor can decide using technical analysis that what kind of trend market is following.

There are many indicators of technical analysis used in the professional market but two of them very commonly used are trend and momentum indicator. Trend indicator helps to identify the trend of the market while momentum indicator investor can extract that at what speed the price is going up or down.

2.2 Previous Researches

Many Researches have been done in the area of random walk which have jotted down in a table. Very less number of research in case of testing validity of technical analysis though below researches has been assembled below.

Sno	Author/s	Title of the publication/thesis	Publication Year	Journal
1	Fama, E & Blume, M.	"Filter rules and stock market trading profits"	1966	Journal of Business. Vol. 39
2	Poterba. J., and L Summers	"The Persistence of Volatility and Stock Market Fluctuations"	1986	American Economic Review. 76

3	Pruitt, S W, & White, R E	"The CRISMA trading system: Who says technical analysis can't beat the market?"	1988	Journal of Portfolio Management, 14
4	Brock, W, Lakonishok, J and LeBaron	"Simple technical trading rules and the stochastic properties of stock returns"	1992	The Journal of Finance . Vol. 47
5	Song and Weigen	"An Empirical Study of the Efficiency of the Shanghai Stock Exchange"	1995	The Economist, 4
6	Wu, Shinong	"Efficiency Analysis of China Stock Market"	1996	Economic Research Vol 4.
7	Hussain, F.	"The Random Walk Model In Pakistani Equity Market : An Examination"	1997	The Pakistan Development Review, PIDE
8	Bessembinder, H and Chan, K	" The profitability of technical trading rules in the Asian stock markets"	1998	Pacific-Basin Finance Journal. Vol. 3
9	Lo, A and MacKinlay, A .	"Stock markets do not follow a random walk: evidence from a simple specification test".	1998	The Review of Financial Studies 1 (1)
10	Al-Loughani.	"Random Walk in Thinly Traded Stock Markets: The Case of Kuwait"	2001	Arab Journal of Administrative Science , Vol 3
11	Kwon, K-Y. Kish	"Technical trading strategies and return predictability"	2002	Applied Financial Economics Journal , Vol. 12
12	Bee, M & Gazini , A	"Testing the Profitability of Simple Technical Trading Rules"	2004	International Journal of Finance
13	Craig, A and Parbery, S	"Is smarter better? A comparison of adaptive, and simple moving average trading strategies"	2005	Research in International Business and Finance. Vol. 19
14	Metghalchi, M, Chang, Y-H and Marcucci, J	"Is the Swedish stock market efficient? Evidence from some simple trading rules"	2005	International Review of Financial Analysis, Vol 17
15	Vasiliou, D., N. Eriotis, & S. Papathanasiou	"How Rewarding Is Technical Analysis? Evidence from Athens Stock Exchange"	2006	Journal of Operational Research
16	Kamal,Y & Rehman, K	Random Walk of Security Prices	2006	Journal of Independent Studies and Research
17	Hussain, F. Hamid, K. Akash, R.S.I. and Khan, M.I.	"Day of the Week Effect and Stock Returns"	2011	Far East Journal of Psychology and Business
18	Sami, Abushammala	"Testing the Weak Form Efficiency and Random Walk of Palestine Exchange"	2011	International Journal of Economics and Finance
19	Dan	"The Validity of Technical Analysis for	2012	International Review of

	Gustafsson	the Swedish Stock Exchange"		Economics and Finance, 26
20	Irshad, Hira and Sarwar, Ghulam	"Is Karachi stock market weak form efficient"	2012	The Journal of Commerce, Vol. 5
21	M. S. Mehmood	"Stock Market Prices Follow the Random Walks: Evidence from the Efficiency of Karachi Stock Exchange"	2012	European Journal of Economics, Finance and Administrative Sciences, Vol. 51
22	Zeren, F & Konuk, F	"Testing Random Walk hypothesis for emerging markets : Evidence from linear and non-liner unit root test"	2012	Romanian Economic and Business Review Vol. 8
23	Hao Yu, Gilbert V. Nartea, Christopher Gan, Lee J.Yao	"Predictive ability and profitability of simple technical trading rules: Recent evidence from Southeast Asian stock markets."	2013	International Review of Economics and Finance, 25
24	Mudassar M, Ali A, Nawaz M and Amir S	"Test of Random Walk Behavior in Karachi Stock Exchange"	2013	Pakistan Journal of Commerce and Social Sciences, Vol. 7
25	Nicholas, M	"An Empirical Investigation Of The Random Walk Hypothesis Of Stock Prices On The Nairobi Stock Exchange"	2013	European Journal of Accounting Auditing and Finance Research
26	Terence , Wing-Kam & Venus Khim	" Revisiting the Performance of MACD and RSI Oscillators"	2014	Journal of Risk & Financial Management
27	Ahmed SolimanWafi	"Profitability of Technical Analysis Rules in Emerging and Developed Markets: Review"	2015	China-USA Business Review
28	Mohammad Anees&Sumit Kumar	"Testing Random Walk Behavior Of Major Asian Stock Markets"	2015	A Journal of Management. Vol 20
29	Owen Jakata , Patience Hlupo& Cliff Gondo	"Random Walk Hypothesis: Evidence from Market Efficiency of the Zimbabwe Stock Exchange"	2015	International Journal of Science and Research
30	SuleMagaji, Ismaila Daddy Abubakar& Tahir	"The Efficacy of the Random Walk Hypothesis in the Nigerian Stock Exchange Market"	2015	European Journal of Business and Management, Vol.7

Random walk theory asserts that stock price follows random path, and returns obtain from the price change are random , Al-Loughani (1995) Using different statistical and econometrics techniques on stock price return, concluded that KSM (Kuwait Stock Market) does not follow

the random walk model. One of the wide spread assumption of random walk is that stock price returns follows normal distribution. This distributional assumption is important because it can describe the characteristic of stock returns. Hussain, F (1997) uses stock closing price of 36 company's stock and market index. Applying both independent and distributional part from the period of 1989 to 1993 and concluded that stock price do not follow normal distribution and random walk model is not applicable in Pakistani stock market. Nicholas, M. (2013) applied random walk model on NSE 20 index and the study supports nonrandom walk for the sample period of 2008 to 2011. Kamal, Y & Rehman, K (2006) check random walk character of stock price using ADF, Q test and VR test and study support for random walk.

Stock market possess anomalies, one of market anomaly is day of the week effect which is totally in contradiction with random walk hypothesis because if stock price depicts any pattern then they are considered to be nonrandom. Hamid, et.al (2011) check for "Day of the Week Effect and Stock Returns" using time series modeling and concluded that on average Tuesday gives higher returns in comparison with rest of the day which proves that there is a pattern in the market flow. Market efficiency is lined with random walk hypothesis as the root cause of the price randomness is efficient market. Irshad and Sarwar (2012) checked weak form of efficiency of Karachi stock market using daily, weekly and monthly KSE 100 index for sample period (1998-2012) which fails to prove efficiency of the Karachi Stock Market and conclude that stock price did not follows random walk hypothesis. Lo and Mackinaly (1988) in their research tested three different form of random walk for weekly stock price change using variance estimators from sampled data at different frequency levels and this study concludes a non-random walk model for the period (1962-1985) and also of all different portfolios of different time period. Mehmood (2012) used simple unit root test, ADF test and Jenson Co-integration test form the

sample period of 2001-2015 and concluded that KSE is an efficient market and KSE-100 index follows random walk hypothesis.

Less developed or emerging market are found to be inefficient and follows nonrandom walk Anees, Mohammad & Kumar, Sumit checked random walk hypothesis on three Major Asian stock market (India, China and Japan) they uses Run test and Autocorrelation on daily, weekly and monthly stock closing index returns for the sample period of 2009 to 2014 and concluded that three major Asian stock market are weak form efficient. However for emerging market efficiency is a big question mark. Zeren & Konuk (2012) using combination of both linear and non-linear unit root test conclude that developed markets proves to be efficient while emerging market are still striving to be a efficient market place for the investors. Mudassar et al (2013) uses market index from the sample period of 2008-2011 and applied different statistical test and concluded that market is weak form inefficient and investor can get higher rate of return on their investments, investors were able to generate abnormal profits from the securities/investments. Owen et al (2015) also checked random walk hypothesis for Zimbabwean Stock market and found that the market is weak form inefficient using the variable of closing returns. Abushammala (2011) tested the validity of weak form of market on Palestine stock Exchange from 1st Jan, 2007 to 31st Dec, 2010 using data of different indexes and concluded that market are weak form inefficient and there be a scope of higher than expected return. Sule et el (2015) worked on checking efficacy of Nigerian stock market using unit root and ADF test for NSE 30 closing index/returns and conclude that Nigerian stock market is weak form efficient. Wu (1996) check the validity market efficiency in Shanghai and Shenzhen stock market, and the findings of this study conclude string form efficiency at bottom line. Song and Weigen (1995) used average

return of 29 stocks listed on Shanghai Stock Exchange (SSE) findings of this study conclude that SSE is a not an efficient market.

As far as investment strategies are concerned, random walk theory is a big wall against these strategies and always assert price pattern to be random. Seeing this financial economists and researchers tried to beat the market using different investment strategies and technical indicators. Metghalchi et al (2005) concludes that one can use moving average techniques to obtain better results then buy and hold. Though in fixed length moving average volatility is not encountered however adaptive moving average techniques take in to account volatility also which gives more accurate results. Craig & Parbery (2005) used adaptive moving averages and fixed length moving averages and found that adaptive moving average strategies is more flexible and encounter all market dynamics and volatility as compared to simple moving average. Developed markets, due to their efficiency do not allow technical investor to earn excess return. Chan (1998) use 26 different strategies on both emerging and developed Asian stock market and found that more developed market failed to support these strategies also concluded that buy days returns are significantly larger then sell days return even after incorporating cost. However, the case is reversed for emerging markets. Yu et el (2013) checked the validity of technical analysis for the emerging market for the sample period of 1991 to 2008 and found that technical trading rules are valid for emerging market of Malaysia, Thailand, Indonesia and Philippines. Effectiveness and profitability of technical analysis are based on market behavior , if the market follows random walk then there exist no pattern in the price series and technical indicators will always failed to give effective and accurate results and this shows a linkage of technical analysis and random walk. Gutafsson (2012) tested the validity of both technical analysis and random walk using daily return series and conclude that stock prices doesn't follows random walk and

technical trading rule and outperform buy and hold strategy. Brock et al (1992) uses moving averages techniques to test the effectiveness of technical analysis. One sample t test was applied on returns obtain from trading rules and the results showed that buy days returns are significantly higher as compared to sell days return and are less volatile. The same work was completed by Soliman (2015) while checking profitability of technical analysis rule. Researcher found that technical analysis is still applicable but it was only work with the historical data of price and volume indicators. Most popular trading indicators are momentum and trend indicators. Trend indicators are used to find out the trend in the market, however momentum indicators help to track the how quickly the stock price is changing. Market professionals in the industry uses combinations of technical indicators for decision making. Kwon and Kish (2002) used moving averages, volume and momentum indicator on NYSE index for the sample period of 1962 to 1996 and concluded using t-test that technical trading rules can give better returns as compared to buy and hold strategy. Pruitt, S W, & White, R E using CRISMA indicators concludes that trading rule can outperform the market. Vasiliou et el (2006) used moving average technique and MACD indicator on Athens general index for the sample period of 1990 to 2004 and conclude that technical trading rule have predictive powers. As far as profitability is concerned, cost plays and important role. Terence et el. (2014) used moving average convergence divergence and RSI to check the profitability of technical analysis for top five indexes of the world and concluded that technical analysis have forecasting power even after incorporating cost. Bee and Gazini (2004) tested technical analysis on Italian stock market using statistical t test and concluded that technical analysis indicators are profitable.

2.3 Conceptual Framework

Markets are the place where buyer and seller make transaction and as far as financial market are concerned it consist of flows of money as well as flows of information. Good information has the positive impact on stock market while bad information impacts it negatively. Some part of the information might be considered as rumor. If information is quickly absorb in the stock price due to market efficiency then no investor can gain extra ordinary surplus, this is align with the random walk because it uses same phenomena that prices are random in nature. But if this information impact the stock price lately then one can use the information read the market anomalies and can produce larger than expected return this market is considered to be inefficient and doesn't follow random walk. The question arise that how investor use good information or bad information to earn profits in strong form of efficiency of the market as this is probably not possible because of the similarity of information , each investor has the same information and no one can take advantage. But in case of an inefficient market these good and bad/news can earn healthy returns.

The question of empirical adequacy and validity of random walk model is very vital from practical point of view whatever tools investor used stock market pricing model is basic ingredient therefore considerable effort have been devoted to prove or disapprove random walk model.

If stock price follows random walk it must satisfy its three forms. RW1 states that stock return will be independent and identically distributed, RW2 on the other hand relax the assumption of identically distributed return whereas RW3 states that return must be uncorrelated. If stock price satisfy these conditions it follows random walk and technical analysis is of no use.

2.4 Variable Identification

For testing the validity of random walk hypothesis and technical analysis the variables will be daily stock market index and selected samples of indices of stock of different listed companies. As this research is based on solely time series data dependent variable will be stock price and independent variable will be the lag[7] of the stock price.

According to random walk hypothesis stock price cannot be predicted from its past price so to check the validity of random walk hypothesis historical prices are used as independent variable and current stock prices are used as dependent variable.

The selected sample of companies includes Atlas Honda Cars (Pvt.) Limited, Fauji Fertilizer Company Limited, Pakistan Oilfield Limited, Treet Corporation, Adamjee Insurance Company Limited, Oil and gas Development company, Sui Southern Gas Company and Glaxo Pakistan Limited.

2.5 Hypothesis Formulation

As this research is divided in to two part firstly random walk hypothesis is tested for Pakistani stock market and secondly effectiveness of technical analysis is tested.

Stock Price follows Random Walk

The randomness in the stock prices limits the investors to outperform the market to gain extra returns. The concept of the RWH can be extracted from Bachelier (1900) as "The Theory of Speculation" included extraordinary insights and narration. Same ideas regarding random walk were later discussed by Cootner (1964) in his book named "*The Random Character of Stock Market Prices"*. The term was familiarize by Malkiel (1973) by his great research work namely

[7] Lag of stock price refers to as difference in time between current stock price and historical stock price. It might be daily, weekly or monthly.

"A Random Walk Down Wall Street" and was earlier used in Fama's (1965) research named "Random Walks in Stock Market Prices". Lo and Mackinaly (1988) tested the RWH for weekly stock market returns by comparing and estimating variances from randomly sampled data at different frequencies. However, this study dismiss the random walk model for the entire sample period (1962-1985) and for all sub periods for different portfolios. Hamid, et.al (2011) check for "Day of the the Week Effect and Stock Returns" using time series modeling and concluded that On average Tuesday gives higher returns in comparison with rest of the day which proves that there is a pattern in the market flow and used the hypothesis that stock price follows random walk on a particular day. Hassan and Abdullah (2007) tested for hypothesis of random walk for Pakistan stock exchange (formerly Karachi Stock exchange) and suggest nonrandom walk prices. Mehmood (2012) conclude KSE is an efficient market and uses the same null hypothesis that KSE-100 index follows random walk hypothesis for the sample period of 2001-2015. Considering this the first alternative hypothesis is synthesized below.

H1: Stock price/index follows nonrandom walk model

Predictive Power of Technical Analysis

It has been extracted through different researches that predictive power of technical analysis can be tested using statistical inference or using complex programming algorithm. Statistical inference is used, by comparing results of mean returns on moving averages for buying and selling days same had been tested by e.g. (Brock et al., 1992, Chan et al 1995 and Fang and Xu, 2003). MACD and Moving averages were used by Vasiliou et al. (2006) and found them the best indicators of technical analysis. Kwon & Kish (2002), examined NYSE and found that technical analysis more profitable. Reviewing this third hypothesis is concluded below.

H2: Technical analysis have forecasting ability to predict stock price

Technical Trading Rules Vs Buy and Hold Strategy

Pruitt and White (1998), using the University of Chicago's CRSP daily data of Chicago stock exchange for the sample period of 1976 to 1985 and found technical analysis and trading strategies after entertaining all cost is superior to buy-hold strategy. The extraordinary work in this area Allen & Karjaleinen (1999) found technical profitable rules, but which did not outperform a directly "buy and hold" strategy. Yu et al. (2013) study whether trend and momentum indicator like moving average and other indicators can outperform a simple buy-and-hold strategy and their selected sample are from 1991 to 2008 Southeast Asian stock markets they use the hypothesis as below

H3: Technical trading rules will outperform buy and hold strategy.

The first hypothesis to be tested is "Does stock price follows non-random walk model" which exhibit that stock market are working efficiently and there is no margin for any anyone to beat the market. Or second hypothesis is linked with the first hypothesis which states that "Technical trading rules have ability to forecast price movement", because if price follows random walk then historical prices cannot be used to predict the future price movement. Last hypothesis is linked with the first two hypothesis that "If price follows random pattern than one cannot outperform or beat the market". These hypothesis are tested in the same arranged manner.

Chapter 3: Research Methodology

3.1 Research Nature

As Random walk model and technical analysis are used to model quantitative behaviors of stock price. In this research, quantitative research methodology is selected and secondary data will be used for further analysis.

3.2 Universe and Target Population

As this research is quantitative in nature the universe of the population of this research is Pakistan stock exchange (Formerly Karachi Stock Exchange) which is largest stock market of Pakistan with 554 listed companies having listed capital of 1,269,703 million and market capitalization of 6,947,358 million. The target population will be active listed companies whose stocks are traded in Pakistani stock market. (Source: "*https://www.psx.com.pk"*)

3.3 Sampling Design and Technique

This research design will be archival research design. Data of KSE 100 index for the period of Jan 2004 to Dec 2015 is used. For individual indices stratified random sampling technique is

used from which, stock will be selected from each sectors. In stratified random sampling[8] the population of listed companies in Pakistan Stock Exchange is divided with respect to sector (Strata) so that representation of each sector will incorporate in the sample and used market capitalization as a proxy. Top 20 companies are selected from different sector on the basis proportionate market capitalization and from those 8 companies are extracted having available data of the selected period above.

3.4 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.

[8]"Stratified random sampling is a probability sampling technique in which population is divided in to separate group then randomly choose the sample proportionately from separate group".

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.

3.4.1 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 obtain from these stock should be IID and according to central limit theorem the limiting distributions of these returns must follow normal.

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 distributions or not.

Ho: The Stock Return follows Normal Distribution.

Ha: The Stock Return doesn't follows Normal Distribution

Test Statistics:

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

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

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

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

3.4.2Run 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.

3.4.3BDS Test

Brock et al. developed a test in 1996 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 non linear. 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 distance ε, 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.

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

3.4.4Autocorrelation 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.

3.4.5Lujng 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 $X^2_{cal} > X^2_{tab}$

3.4.6 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 series is 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.

3.5 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).

3.5.1 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 (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.

3.5.2 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.

3.5.3 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.

3.5.4 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.

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

Where $\bar{X}$ 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

$$t = \frac{\bar{X}1 - X2}{s_{X1-X2}}$$

Where $\bar{X}1$ the average daily buy days return, $\bar{X}2$ 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 price is rejected.

Chapter 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 follows 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 for detecting uncorrelated increments.

Autocorrelation are calculated up to 16^{th} 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 = 0.5 S	M = 3 , ε = 0.5S	m= 2 , ε = S	m = 3 , ε = S	m = 2 , ε = 1.5 S	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 6 again 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[9] 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 $\pm 2/\sqrt{T}$

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

[9] In statistics any sequence of random variable is said to be homoscedastic if variance among groups are equal and finite

Table 6: Ljung Box test statistics of stock returns.

	Lags	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	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
KSE -100	Prob (Sig) * *	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	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
HCAR	Prob (Sig) * *	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	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
FFCL	Prob (Sig) * *	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	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
POL	Prob (Sig) * *	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	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
TREET	Prob (Sig) * *	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	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
AICL	Prob (Sig) * *	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	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
OGDC	Prob (Sig) * *	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	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
SSCG	Prob (Sig) * *	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	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
GLAXO	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 are 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 conclude 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 S M A	0.23 %	1.02 %	2031	10.15	-0.27 %	1.67 %	979	-5.06	8.12	0.00
		150 Day S M A	0.15 %	1.10 %	2203	6.42	-0.21 %	1.75 %	707	-3.18	5.12	0.00
		200 Day S M A	0.14 %	1.13 %	2250	5.87	-0.18 %	1.78 %	610	-2.50	4.21	0.00
	Double Crossover	S M A (50-150)	0.10 %	1.24 %	2146	3.74	0.00 %	1.47 %	746	0.00	1.23	0.11
		S M A (50-200)	0.09 %	1.23 %	2218	3.45	-0.02 %	2 %	642	-0.35	1.74	0.04
	Triple Crossover	S M A (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 S M A	0.57 %	2.90 %	1499	7.62	-0.49 %	2.99 %	1387	-6.10	9.68	0.00
		150 Day S M A	0.40 %	2.82 %	1570	5.62	-0.36 %	3.18 %	1216	-3.95	6.56	0.00
		200 Day S M A	0.34 %	2.81 %	1603	4.84	-0.30 %	3.24 %	1133	-3.12	5.41	0.00
	Double Crossover	S M A (50-150)	0.18 %	3.38 %	1586	2.12	-0.08 %	2.95 %	1191	-0.94	2.27	0.01
		S M A (50-200)	0.17 %	3.03 %	1586	2.24	-0.06 %	3 %	1150	-0.68	2.04	0.02
	Triple Crossover	S M A (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 S M A	0.35 %	1.77 %	1669	8.08	-0.44 %	2.67 %	1242	-5.80	9.02	0.00
		150 Day S M A	0.22 %	1.76 %	1688	5.12	-0.28 %	2.82 %	1123	-3.33	5.27	0.00
		200 Day S M A	0.20 %	1.78 %	1631	4.53	-0.24 %	2.81 %	1130	-2.87	4.59	0.00
	Double Crossover	S M A (50-150)	0.05 %	2.12 %	1713	0.98	-0.04 %	2.46 %	1098	-0.54	1.04	0.15
		S M A (50-200)	0.04 %	2.13 %	1656	0.76	-0.01 %	2 %	1105	-0.13	0.50	0.31
	Triple Crossover	S M A (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	Single Crossover	50 Day S M A	0.48 %	2.45 %	1651	7.95	-0.61 %	2.82 %	1235	-7.60	10.87	0
		150 Day S M A	0.24 %	2.41 %	1751	4.16	-0.33 %	2.94 %	1035	-3.62	5.27	0
		200 Day S M A	0.19 %	2.40 %	1767	3.33	-0.24 %	3.02 %	969	-2.47	3.78	0
	Double Crossover	S M A (50-150)	0.05 %	2.49 %	1741	0.84	0.00 %	2.86 %	1045	-0.03	0.50	0.309
		S M A (50-200)	0.05 %	2.48 %	1812	0.77	-0.03 %	3 %	924	-0.27	0.17	0.433
	Triple Crossover	S M A (4-9-18)	0.38 %	2.55 %	1031	4.77	-0.17 %	2.73 %	1887	-2.68	5.41	0
TREET	Single Crossover	50 Day S M A	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
		200 Day S M A	0.38 %	3.27 %	799	3.29	-0.20 %	3.43 %	1220	-2.04	3.83	0
	Double Crossover	S M A (50-150)	0.14 %	3.40 %	1156	1.40	-0.10 %	3.48 %	913	-0.87	1.53	0.0625
		S M A (50-200)	0.18 %	2.88 %	1147	2.12	-0.17 %	4 %	872	-1.28	2.24	0.0125
	Triple Crossover	S M A (4-9-18)	0.78 %	3.48 %	697	5.92	-0.32 %	3.51 %	1504	-3.54	6.90	0
OGDC	Single Crossover	50 Day S M A	0.32 %	1.75 %	1694	7.53	-0.37 %	2.16 %	1226	-6.01	9.33	0
		150 Day S M A	0.20 %	1.84 %	1632	4.39	-0.22 %	2.07 %	1188	-3.66	5.55	0
		200 Day S M A	0.20 %	1.87 %	1603	4.28	-0.21 %	2.05 %	1167	-3.50	5.37	0
	Double Crossover	S M A (50-150)	0.09 %	1.93 %	1615	1.87	-0.05 %	1.98 %	1205	-0.88	1.81	0.0352
		S M A (50-200)	0.09 %	1.94 %	1613	1.87	-0.06 %	2 %	1157	-1.02	1.94	0.02635
	Triple Crossover	S M A (4-9-18)	0.34 %	1.89 %	1142	6.09	-0.16 %	1.95 %	1810	-3.48	6.94	0
GLAXO	Single Crossover	50 Day S M A	0.42 %	2.10 %	1327	7.28	-0.37 %	2.23 %	1536	-6.50	9.84	0
		150 Day S M A	0.25 %	2.21 %	1254	4.00	-0.20 %	2.13 %	1509	-3.65	5.36	0
		200 Day S M A	0.23 %	2.19 %	1266	3.74	-0.19 %	2.19 %	1447	-3.31	4.94	0
	Double Crossover	S M A (50-150)	0.01 %	1.99 %	1427	0.19	0.00 %	2.37 %	1336	-0.04	0.15	0.439
		S M A (50-200)	0.03 %	2.02 %	1357	0.49	-0.01 %	2.4 %	1356	-0.17	0.38	0.353
	Triple Crossover	S M A (4-9-18)	0.23 %	2.29 %	956	3.08	0.11 %	2.18 %	1939	2.19	3.78	0
FFC	Single Crossover	50 Day S M A	0.45 %	2.72 %	1635	6.70	-0.50 %	3.08 %	1273	-5.79	8.657	0
		150 Day SM A	0.27 %	2.56 %	1588	4.20	-0.27 %	3.29 %	1220	-2.87	4.744	0
		200 Day S M A	0.28 %	2.53 %	1533	4.33	-0.26 %	3.30 %	1225	-2.75	4.699	0
	Double Crossover	S M A (50-150)	0.08 %	2.51 %	1542	1.25	-0.02 %	3.34 %	1266	-0.21	0.87	0.1912
		S M A (50-200)	0.11 %	2.51 %	1491	1.69	-0.05 %	3 %	1267	-0.54	1.44	0.0749
	Triple Crossover	S M A (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.com*

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 most risky 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 16^{th} 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.

Chapter 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 (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 Gustafsson (2012) while checking validity of technical analysis for Swedish stock market found that prices doesn't follow any form of random walk.

Market must possesses 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. 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 work appears to portray 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 less number of deviation however sell signal is generated when market have negative return on higher standard deviations. This research only point out very few aspect 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. However this not vastly studied at academic level due to lack of theoretical grounds and researches. Researches also used complex scientific algorithm to evaluate the importance and strategies of technical analysis.

It concludes the discussion that in order to have a growing economy the market need to be efficient however due to many reasons and irregularities Pakistani stock market is a weak form inefficient. This inefficiency would let the informed investor to take profit from the price

differences and they also use technical analysis to generate better profit then by just taking a stock and holding it for the long period and ignoring time value of money.

Further for testing random walk model 1and 3 both parametric and non-parametric statistical tests were used. Non parametric test were used to avoid the assumption of normal distribution and it can be seen that successive price change follows normal distribution. But for random walk 2 technical analysis is used to check for the existence of second form of random walk.

This research asserts that behavioral finance has a greater degree of importance in random walk hypothesis as human behavior is not same for all investors in fact most of the investors react irrationally due to difference in the perception. One can also add that investor exists with different behavior some of them are over confident claiming that they are accurately reading the market trends also some of them gamble and draws a line between profit and loss. Behavior biases can also distort the results in allotting investments.

Chapter 6: Conclusion & Recommendation

6.1 Conclusion

It is very important for the investors as well as the government both, who should work for the improvement of flow of financial market's information system, to be more effective. This change not only impacts the economy of the country but also on the individual. To invest 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 are tested, it is 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 Pakistan stock exchange (Formerly Karachi stock market) 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 role of the regulatory body of

Pakistan “Securities and Exchange Commission of Pakistan (SECP)” is to improve the market efficiency in order to protect the investment of individual investors. SECP has taken measures in improving efficiency by increasing transparency, introducing fiscal reforms, launching new products, restrictions against brokers, eliminating insider trading and price manipulation in the market. However they must apply zero tolerance policy on insider trading, price manipulations, blank selling and front running. SECP must ensures strict compliance of rules and regulations for the corporate companies and brokers in order to get significant change in market efficiency. 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. Strict application of these measures must enhance the confidence of the local as well as foreign investors. However, security and economic conditions of Pakistan is yet another 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.

6.2 Recommendations

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 markets 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 the SECP will 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 that technical analysis must be added as part of academics course 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 very vast field with a lot of dimensions in investment management.

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Abbreviations

RWH – Random Walk Hypothesis

SMA – Simple Moving Average

MACD – Moving Average Convergence Divergence

IID – Independent and identically distributed

INID – Independent but not identically distributed

HCAR- Honda Atlas Car (Pvt.) Limited

FFCL – Fauji Fertilizer Company Limited

POL – Pakistan Oilfields

AICL- Adamjee Insurance Company Limited

OGDC – Oil and Gas Development Company

SSGC- Sui Southern Gas Company Limited

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