The Random Walk Hypothesis Pertaining to Stock Prices in India: A Firm Level Analysis

Purna Chandra Padhan
Assistant Professor
Xavier Labour Relation Institute, (XLRI)
School of Business and Human Resources
pcpadhan@xlri.ac.in, pcpadhan@yahoo.com

Abstract

Modelling various financial variables involving time series data have received greater attention among economists and policy makers across economies. Random walk model is one among such model which has widely applied pertaining to stock prices and other time series data. However, this paper applies a different dimension of the model for stock prices using firm level data in the Indian context. Daily adjusted closing prices of A rated 33 companies, spread across, different categories of Bombay Stock Exchange (BSE) Mumbai, have been used to tests whether stock prices follow random walk process or not. Perhaps this is a unique piece of study of RWM which applies to firm level data. Applying various unit root tests such Dickey and Fuller, Ng-Perron etc. The study finds sufficient evidence that stock prices of various firms supports random walk hypothesis during the study period and conclude that, it is practically difficult to predict the stock price based on past observations. Stock price do follow random walk process mainly due to firm specific factors apart from economic and financial factors.

Keywords: *Random Walk Hypothesis, Stock Price, Unit root, firm level*

JEL Classification: C12, C22, G10, G14

I. Introduction

Various theoretical propositions and empirical models have been extensively developed with highly restrictive assumptions to determine and predict the stock prices across economies. The Random Walk Model (RWM) is one among them. The RW model is used to test whether stock prices follow a random walk process. The essence of the model is that if the concerned series follow random process, then the past values cannot help to predict the current and future values. They are essentially random in nature. Various studies have been conducted to examine the validity for the random walk hypothesis pertaining to various macroeconomic and financial time series variables including stock price across economies. Noted among them are Fama (1976), Fama and French (1983), and many others. While there have been a large number of research paper on random walk hypothesis across developed countries relating to the stock price index (i.e. at aggregate level), paucity of studies found in the context of developing countries like India using firm level data. An attempt has been made here to empirically examine whether stock prices of individual firms follow random walk process or not using various unit root tests.

The rests of the paper are as follows. The section II represents the random walk hypothesis pertaining to stock price and reviews some of the prominent studies, while section III explains the econometric methodology applied to test the random walk hypothesis, the section IV endow with data with the empirical results and discussion. Finally, section V summarises the study.

II. Review of Literature

Voluminous literatures are available on studying the behaviour of stock price over time. However, the subject still receives substantial attention. Couple of prominent studies are reviewed here. Using several correlation tests Cootner (1962), Fama (1965), Kendall (1953), Moore (1962) supports the random walk theory. These studies have established that, the sample serial correlation coefficients computed for successive price changes were extremely close to zero, implying that successive changes in prices are independent. On the other hand, using spectral analysis technique, Granger and Morgenstern (1963), Godfrey, Granger and Morgenstern (1964) hold up the independent assumption of the random walk model. Several tests using serial dependence have rejected the random walk model e.g. Fama (1976, 1995), Fama and French (1988), Lo and McKinley (1988). On the other hand, Kasa (1992) ascertain mixed evidence. Not surprisingly, few studies such as Shiller (1989) put forward that there are sufficient evidence that the random walk behaviour of the stock price should hold and there are plenty of evidence that stock price do follow random walk. Zivot and Andrew (1992) find out that stock price of 10 countries out of 18 countries study does not track random walk model, whereas rest 8 do so. Similarly, Zhu (1998) through panel unit root tests for G-7 country found that stock price do follow random walk model. Narayan and Smyth (2006) found strong support of Random Walk Hypothesis for 15 European countries.

Various statistical and econometric techniques have also been applied to study the Random Walk Hypothesis across economies. Blasco et al(1997) studies the random walk hypothesis in the Spanish stock market using a disaggregated daily database spanning from January 1980 to December 1992. It is found that daily returns are strongly correlated and nonlinear dependent. Furthermore, the variance-ratio test results suggest that the rejection of the random walk hypothesis cannot be attributed completely to the effects of time-varying volatilities. The Lo and MacKinlay variance-ratio test is used to examine random walks in Taiwan's 1971-1996 stock prices by Chang and Ting(2000). Their empirical results show that with weekly value-weighted market index, the null hypothesis of random walk is rejected. The study also finds that the random walk hypothesis cannot be rejected with monthly, quarterly and yearly value-weighted market indexes.

On the other hand, Chaudhuri and Wu (2003) investigate whether stock-price indexes of emerging markets can be characterized as random walk (unit root) or mean reversion processes. Applying a panel based test from 17 emerging equity markets during the period January 1985 to April 2002, they have rejected the null hypothesis of random walk in favour of mean reversion at the 5 percent significance level. A couple of statistical tests are applied in Hasan (2004) studies to examine the random walk hypothesis using the daily data of the Dhaka Stock Exchange. The estimated results show that the null hypothesis of randomness cannot be rejected and stock prices have a significant random walk or permanent component. Per et. al.(1993) studies the random walk hypothesis on a new set of monthly data for the Swedish

stock market, 1919-1990. Both the variance ratio test and the test for autoregression of multi period returns are employed. The results suggest that Swedish stock prices have not followed a random walk in the past 72 years. Phengis (2006) re-examines the univariate property of stock market price indices in ten emerging markets which are evidenced by prior empirical work, specifically by Chaudhuri and Wu (2003), to be I(0) or stationary. Important findings from standard Dickey and Fuller (1979, 1981) and Zivot and Andrews (1992) unit root tests include: (1) the majority of these price indices can be more appropriately regarded as I(1) or non-stationary, and (2) the I(1) processes in these price indices have been increasingly discernible over time. In an effort Lean and Smyth (2007) have applied univariate and panel Lagrange Multiplier (LM) unit root tests with one and two structural breaks to examine the random walk hypothesis for stock prices in eight Asian countries. The results from the univariate LM unit root tests and panel LM unit root test with one structural break suggest that stock prices in each country is characterized by a random walk, but the findings from the panel LM unit root test with two structural breaks suggest that stock prices in the eight countries are mean reverting. The present study is distinct from the rest. It re-examines the random walk model relevant to stock price of several firms in India.

The financial markets in India comprises mainly the credit market, the money market, the foreign exchange market, the debt market and the capital market in addition to the recently developed derivatives market. Most of these markets were characterised by controls over the pricing of financial assets, restrictions on flows or transactions, barriers to entry, low liquidity and high transactions costs till early nineties. However, the globalisation and liberalisation policies of 1990's have fetched a drastic change in the Indian economy. Due to liberalisation policy a number of reforms have been embarked on various sectors, including financial sectors in general and stock market in particular. For example, introduction of free pricing of financial assets, relaxations of quantitative restrictions, removal of barriers to entry, increasing number of financial instruments, improvements in trading, clearing and settlement system, transparency etc. As a result, phenomenal changes have been observed both in the primary and secondary market. The stock market indicators have shown tremendous increase up to 1999-2000. However, the Mexican crisis of 1994, East-Asian turmoil in 1997-98 and of course the global economic slowdown during 2000 has severely affected the Indian stock market. As a result of which, the stock prices of individual firms became more volatile. The Table 2 shows the descriptive statistics, such as mean, standard deviation, skewness and kurtosis for the Indian stock market for 33 A rated firms. A close look at the table 2 reveals that the stock prices show highest volatility. Despite this, Indian stock market is one of the largest stock market in the world and has a significant role in the development of the economy. With this brief background, the objective of the paper is to analyse the behaviour of the stock price for various sectors of the economy and tries to determine whether it follows random walk hypothesis or not. The subsequent sections briefly thrash out the methodology used, empirical analysis and summary & conclusion.

III. Empirical Verification of Random Walk Hypothesis of Stock Prices.

Random Walk Model is a well established model. Most of the Econometric Textbook discussed this model; therefore we will briefly highlight the specification and essence of the model. In mathematical notation, a time series {Yt} follows a random walk process if,

$$Y_t = Y_{t-1} + \epsilon_t \quad \text{----------} \quad (1)$$

Where $t = 0,1\ldots T$. time period

$Yo \rightarrow$ Initial value at time period zero,

$\{\epsilon_t\} \rightarrow$ white noise process

Considering random walk model as a special case of AR (1) model, then the co-efficient Y_{t-1} is unity which does not satisfy the weak stationary condition of an AR (1) model. Therefore, a random walk series is not weakly stationary and we call it a unit root non-stationary time series. If the coefficient of Y_{t-1} is less than zero then Y_t goes down, and if it is greater than zero then it goes up. The random walk model can also be specified including a constant term, a trend term with alternative combinations such as, (a) Random walk model with drift

$$Y_t = \mu + Y_{t-1} + \epsilon_t \quad \text{-------} \quad (2)$$

The constant term μ of the model (2) represents its time trend of the Y_t and is often referred as the drift term. If $\mu > 0$ it has positive drift and $\mu < 0$ it has negative drift and (b) Random walk model with drift around a stochastic trend.

$$Y_t = \mu + \beta t + Y_{t-1} + \epsilon_t \quad \text{----------} \quad (3)$$

Where t is the time or trend variable. In order to experiment whether stock price Y_t follows a random walk for all the three specification such as, a random walk with drift, a random walk model with drift and trend, or a random walk model with no drift and no trend can be tested through unit root tests. If a time series is non-stationary, it generally follows a random walk. For that reason stationary or non-stationary properties can reveal about random walk model, which can be checked through various types of unit root tests. In this paper we have applied the extensively used unit root tests such as ADF and Ng-Perron Tests. The specification and essence of these tests may briefly chalk out follows.

The ADF Tests

The essence of the Dickey-Fuller, DF test is that it is estimable through OLS. As extension of the Dickey-Fuller, DF test (Dickey and Fuller, 1979, 1981) test augmented by the lagged term is known as ADF tests, which makes a parametric correction in DF tests for higher order serial correlation by assuming that the series follows an AR (p) process. The ADF approach controls for higher order correlation by adding lagged difference in terms of the dependent variable to the right hand side of the regression. We can spell out the ADF test in terms of the following regression equations. If we confiscate the lagged period then ADF test become DF tests. The ADF equation may be specified as,

$$\Delta Y_t = \beta Y_{t-1} + \sum_{j=1}^{l} \gamma_j \Delta Y_{t-1} + \varepsilon_t \quad \text{----------} \quad (4)$$

Where, Δ= first difference operator, l = lag operator (number of lags), t = time subscripts and ε_t = random disturbance term. The lag length j in the ADF test regression can be determined by Schwarz Bayesian Criteria. The specifications of the equation is equation (4)

with no constant no trend. The models can also be specified with inclusion of a constant, no trend and with constant and trend. For further details of ADF one may refer the original article of Dickey and Fuller else the standard econometrics time series text books.

The Ng-Perron Test

Phillips-Perron (1988) unit root test is a non-parametric test which expends the difficulty of parametric tests of ADF. However it does not consider sufficiently about the size and power of the test. Therefore Ng-Perron (2001) recommends a new test for unit root that has good size and power properties. They have constructed four tests statistics. They are based on upper GLS detrended data. These tests statistics are modified form of PP test Zα and Zt statistics, the Bhargav (1986) R_1' statistics, i.e., ERR point optimal statistics. They construct four M-test statistics that are based upon the GLS de-trended data (MZ_α^{GLS}, MSB^{GLS}, $MZ_t^{GLS} = MZ_\alpha^{GLS}$. . MSB^{GLS}., and MP_t^{GLS}). These tests have similar size and power properties. They perform better than the DFGLS test. They have also address the problem of sensitivity of unit root test to choice of lag length. Subsequently they have proposed the modified information criteria (MIC), which seize the bias in the sum of the autoregressive coefficients, are highly dependent on the number of lags that the general Akaike and the Schwarz Bayesian criteria do not. They formulate the null hypothesis that the series has unit root against the alternative of not.

IV. Empirical Results and Discussion

This section provides insight about the data used and then analyses the empirical results. This paper tests whether stock prices of an assortment of firms in Indian context follow random walk process or not. The data for 33 firms are considered across various industries. These companies are A rated companies enlisted at BSE based on market capitalisation as of mid February 2007 and randomly selected. Out of total 31 companies: 17 are software companies; 4 are pharmaceutical companies (namely Cipla, Lupin, Ranbaxy, Sunpharma); 3 are steel companies (such as Ispat, SAIL, TATA Steel); 3 are two wheeler companies (Bajaj Auto, HeroHonda, TVS Motors) and rest 4 are banks (namely ICICI, HDFC, Bank of India, SBI). The daily data collected from Centre for Monitoring Indian Economy (CMIE) prowess database are used. The daily adjusted closing stock prices of these companies are gathered since April 1990 to Feb 15, 2007 for empirical analysis. One can find out the detailed information about the company from the Prowess data base. The details of the time period and data points are given in table 1 for each individual company.

In the first step of empirical analysis, the descriptive statistics of each individual firm are briefly reported in the table 2, which provides some statistical information about the stock prices of each firm. The embodied result reveals that except CMC Ltd, the stock price of other companies do not follow normal distribution as represented by Jarque-Bera test and the corresponding probability values. Similar results also found from skewness and kurtosis, which provides about the shape of curve. For a normal distribution, the value of skewness and kurtosis should be equal to 0 and 3 respectively. If the stock price follows normal distribution, it implies that stock price could be non-random. Higher the value of standard deviation implies higher scatteredness in the distribution of data and thereby possibility of randomness in the structure of the data. The brief description of descriptive statistics provides some necessary but not sufficient conditions about random walk model of stock prices.

Further, in order to test random walk hypothesis pertaining to stock prices we have invoke the ADF and Ng-Perron unit root tests. The estimated results are discussed here. All these results are estimated with Eviews 5.1 software. The unit root tests results using ADF tests for stock price are reported in table 3 both at level and first difference. The results are also estimated with various specification of the model such as including a constant term; with constant and trend; and finally without constant and trend term. The results provide sufficient evidence about unit root hypothesis. The *, **, and *** signifies the rejection of null hypothesis of non-stationary against the alternative of stationary at 1%, 5% and 10% significance level. Figures in the parenthesis entail the minimum lag length selected based on Schwarz Bayesian Criteria (SBC). With the ADF test almost all variables are stationary at first difference, though there is the existence of few outliers. The stock price of few companies such as Igate, Mastek, GTL, Ramco and Wipro are stationary at level with various alternative specifications. For rest of the companies it is found that the series are stationary at first difference. Therefore the stock price for these companies follows I(1) stochastic process. It clearly reveals from the results that non-stationary variables supports random walk hypothesis than stationary variables. The graphical representation of the stock price for each firm can also be revealed from the graph 1 itself. The graphical portray of data offer a visual inspection of the data structure against the time, which reveals about the randomness of it.

On the other hand, while table 4 represents unit root test results using Ng-Perron tests, table 5 presents its critical values with 1% (*), 5%(**) and 10%(***) significance level for alternative tests statistics at level and first difference of the series. The results found are consistent with ADF tests. Except few companies namely GTL and Mastek, the result shows that stock prices follow random walk for rest of the companies. Here also the symbol, *, ** and *** implies that the null hypothesis of non-stationary is rejected against the alternative of stationary at the respective significance level. The modified Schwarz Bayesian Criteria based selected lag length for level data is given in the 7^{th} column of the table whereas for first difference it is given in the last column. The results show that the variables are I (1), means stationary at first difference but non-stationary at level.

The empirical results summarises that, the variables at level are non-stationary whereas in the first difference they are stationary except few exceptional cases. Therefore the stock prices are independent of the past stock price and the successive random error terms are also independent of the past errors. In lieu of this the present results accept the random walk hypothesis.

V. Summary, Conclusion and Further Research

The financial markets, especially the stock market are one of the most dynamic markets in India. These markets have shown tremendous growth over last couple of years, especially after 1990's due to liberalization policy. With regard to the capital market, mainly the stock markets (consisting of Bombay Stock Exchange (BSE, estb. 1857) and National Stock Exchange (NSE)) have expanded in terms of number of companies enlisted and the volume of trades, mainly due to adoption of hitech and transparent (online) trading system. The Bombay Stock Exchange is the largest of 22 exchanges in India, with over 6,000 listed companies. It is also the fifth largest exchange in the world,

with market capitalization of $466 billion. Such trends in capital market reflected by the changes (ups and downs) in the rates and prices of financial products traded in the financial markets, provides valuable information about investment and trading opportunities available for prospective players in the financial markets. In lieu of this, the paper is interested in studying the behavior of stock price of some of the enlisted firm at Bombay Stock Exchange.

The main objective of the paper is to study the pattern of stock price of individual firms and test whether they follow random walk process or not. Since the determination of stock price is very difficult, the present study commences with the question of random walk model and it's validity in the Indian Stock market at firm level. The paper starts with preliminary discussion about the nature and necessity of the random walk model pertaining to stock prices and then reviews some of the prominent studies carried out across economies. The primary focus of this study is to empirically validate the random walk hypothesis pertaining to stock prices of some of the Bombay Stock Exchange (BSE's) A rated firms. The paper investigates the random walk hypothesis applying two widely used unit root tests namely, ADF and Ng-Perron tests using daily data. The results do not provide much evidence against unit roots/ non-stationarity of stock prices, except for firms like GTL, Igate, Mastek, Ramco Sys, Wipro. For these firms the stock price is stationary with some alternative specifications of the model. The reason might be due to difference in the internal features of these firms. However in general, the empirical results support the validity of random walk hypothesis for stock price of Individual firms implying that stock prices remain unpredictable. However, although stock prices supports the random walk theory, if the market is efficient, then at any point of time the stock prices reflects the market fundamental and hence there is better chance to predict. But in reality market is not efficient due to imperfect information. Looking at the graphs of the stock price movements of various firms (as shown in the graph1) one can easily find out the bearish or bullish tendencies of it. If we observe closely, it is found that the firms under same industries have similar pattern in the movement of stock price (with few exceptions.) Looking at the price and volume of the number of shares traded on a particular exchange on a daily basis one can also get a good idea about where the market is heading. If the market has a high-volume day and prices (of the indexes) are up, usually an upward market trend is observed suggesting big players to invest more, where as a high-volume day with prices falling (more sellers then buyers) could indicate a downward market trend showing that big players can pool out from market. The implications are that it might help the investor to adjust their portfolios accordingly.

Further research on the topic could be extended to several aspects of the random walk hypothesis. First, while the oldest stock exchange in India, these days the Bombay Stock Exchange only accounts for 12% of the Indian stock market. The National Stock Exchange (NSE) is the major stock market in India accounting for 85% of the Indian market. So the study could be extended to companies enlisted in NSE. Second, Since there are several temporary changes in stock index prices which can arise due to certain extraneous causes (such as the 26/11 terrorist attacks on the Bombay, US sub-prime crisis, monetary policy changes, changes in economic fundamentals etc) a better understating of stock prices movement need to be addressed carefully and

thoroughly. There is every possibility that in the long run though stock price supports the random walk hypothesis, but during the short period it might not. Therefore, further research could be done to study this kind of pattern by identifying the single or multiple structural breaks. Since the stock price movements for different firm is different and may be due to several reasons, it is essential to find out the reason of it and it's relationship if any with the various factors such as market fundamental, firms performance, market capitalization, trading volume, investors perceptions about the firms etc. Third, since several unit root tests have been developed that accommodate structural breaks. The application of such tests would give better result. The timing of breaks across stocks could be examined. Fourth, the study can also be extended to several small, medium and large firms and see the differences in pricing behaviour. Therefore further research can be done on several dimensions of stock price movements, which we can consider as limitations of the present study.

Table-1: Data List of companies

Name of the Company	Data period	Name of the Company	Data period	Name of the Company	Data period
Bajaj Auto	4 April1990-15 Feb 2007	Hexaware	3 Feb 1997-15 Feb 2007	Ranbaxy	4 April 1990-15 Feb 2007
State Bank of India	4 March1994-15 Feb 2007	Hinduja TMT	6 April 1995-15 Feb 2007	RoltaIndia	26 Nov 1990-15 Feb 2007
Bank of India	5 May 1997-15 Feb 2007	Iflex	28 Jun 2002-15 Feb 2007	SAIL	1 Oct 1992-15 Feb 2007
HDFC	28 May 1995-15 Feb 2007	Igate solutions	12 June 2000-15 Feb 2007	Satyam computers	26 Nov 1992-15 Feb 2007
ICICI	24 Sept 1994-15 Feb 2007	Infosys	14 June93-15 Feb 2007	SunPharma	19 Dec1994-15 Feb 2007
Cipla	4 April 1990-15 Feb 2007	Ispat	4 April 1990 -15 Feb 2007	TATA Steel	4 April 1990-15 Feb 2007
CMC	13 Jan 1997-15 Feb 2007	Lupin	8 Oct 1993-15 Feb 2007	TATA Elxis	2 April 1992-15 Feb 2007
Geometric Software	29 March 2000-15 Feb 2007	Mastek	8 April 1993-15 Feb 2007	TCS	25 Aug 2004-15 Feb 2007
GTL	12 Aug 1992-15 Feb 2007	Mphasis	23 Feb 1994 -15 Feb 2007	TVS	4 April 1990-15 Feb 2007
HCL	11 Jan 2000-15 Feb 2007	Polaris software	29 Sept 1999 -15 Feb 2007	Visualsoft	3 Nov 1998-15 Feb 2007
HeroHonda	4 April 1990-15 Feb 2007	Ramco	9 Oct 2000 -15 Feb 2007	Wipro	6 April 1990-15 Feb 2007

Table- 2: Descriptive Statistics

Name of Company	Mean	Median	Max	Min	Stand Dev.	Skewness	Kurtosis	Jarque-Bera	Prob
Bajaj Auto	668.879	496.95	3267.70	70.000	656.643	2.193	7.360	6256.43	0.000
BOI	53.993	38.20	209.40	8.750	44.852	1.369	4.253	922.39	0.000
CIPLA	26.966	16.020	137.79	0.0660	30.979	1.436	3.878	943.636	0.000
CMC	406.59	450.40	1221.85	10.00	201.095	0.0679	3.070	2.461	0.29*
GSS	59.204	49.870	144.805	5.220	34.988	0.348	2.051	99.742	0.000

GTL	212.730	100.35	3309.20	19.530	361.89	3.848	20.250	51842.17	0.000
HCL	397.616	349.55	1442.28	109.45	207.349	1.187	5.059	733.661	0.000
HDFC	276.587	224.800	1144.75	24.50	257.830	1.3494	4.139	1037.43	0.000
HERO HONDA	216.94	142.05	923.400	1.280	239.73	1.252	3.873	1027.91	0.000
HEXAWARE	0.229	0.50	19.970	-22.36	4.209	0.247	5.948	887.480	0.000
Hinduja TMT	200.671	183.30	804.25	12.10	165.60	0.873	3.384	375.630	0.000
ICICI	243.329	150.250	997.90	21.50	210.678	1.374	4.431	938.878	0.000
Iflex	796.389	649.82	2148.55	225.47	411.896	1.137	3.883	289.296	0.000
Igate	214.902	227.65	524.900	63.000	75.667	0.238	-3.674	47.667	0.000
INFOSYS	515.345	434.02	2374.35	1.160	548.142	1.137	38.00	803.397	0.000
ISPAT	17.780	13.685	91.750	0.600	14.549	1.247	4.509	1351.83	0.000
LUPIN	210.847	130.00	635.650	30.770	150.839	0.800	2.476	378.065	0.000
Mastek	173.543	118.68	1430.50	7.500	207.108	2.693	12.064	14282.80	0.000
Mphasis	78.438	67.340	320.40	1.750	65.433	0.864	3.441	410.017	0.000
Polaris Software	212.316	154.20	996.636	50.650	156.665	2.278	8.254	3734.664	0.000
Ramco Systems	277.985	238.880	925.670	96.910	135.968	1.741	6.735	1735.051	0.000
Ranbaxy	207.376	118.01	634.670	0.000	166.217	0.760	2.341	437.207	0.000
Rolta India	94.075	62.950	940.750	0.000	105.604	2.968	16.423	34163.64	0.000
SAIL	29.916	23.052	116.20	4.000	24.1210	0.839	2.811	413.159	0.000
Satyam Comp	119.903	90.970	713.50	0.000	131.467	1.168	3.765	368.497	0.000
SBI	371.502	248.225	1360.20	140.55	225.388	1.666	4.907	1953.080	0.000
Sun Pharma	228.180	138.745	1059.95	0.000	265.003	1.466	4.106	1215.209	0.000
Tata Steel	168.812	118.670	670.650	44.776	123.934	1.609	4.816	2238.085	0.000
Tata Elxsi	88.381	74.550	327.00	13.700	67.359	0.996	3.189	592.953	0.000
TCS	810.785	756.988	1327.90	481.18	206.568	0.637	2.582	46.639	0.000
TVS	42.0698	37.400	175.450	1.050	33.644	0.845	3.319	477.119	0.000
Visual soft Tech	450.024	185.550	3358.33	60.100	666.407	2.448	8.125	4347.878	0.000
Wipro	205.159	192.4	1604.00	0.560 0	206.346	1.313	6.372	2570.487	0.000

Table- 3: Augmented Dickey Fuller Unit Root Test

Name of Company	Level			First Difference		
	C	TC	NCT	C	TC	NCT
Bajaj Auto	2.295(21) 1.000	0.713(21) (0.999)	3.1883(21) 0.999	-13.837(20)* 0.000	-14.082(20) *(0.000)	-13.652(20) *(0.000)
BOI	0.855(1) 0.9622	-1.889(1) 0.6591	0.784(1) 0.882	-44.335(0) * (0.0001)	-44396(0) * 0.000	-44.324(0) (0.000)
CIPLA	-0.579(6) 0.873	-2.061(6) 0.567	0.319(6) 0.778	-21.778(5) * (0.000)	-21.789(5) * 0.000	-21746(5) * 0.000
CMC	-1.619(1) 0.473	-3.076(1) 0.112	0.274(1) 0.765	-41.064(0) * 0.000	-41.003(0) * 0.000	-41.048(0) * 0.000

GSS	-0.675(1) (0.851)	-3.824(1) 0.015	0.075(1) 0.706	-449676(0) * 0.0001	-45.017(0) * 0.000	-44.973(0) * 0.0001
GTL	-3.394(23) 0.011**	-3.390(23) 0.053***	-2.879(23) 0.004*	-10.396(22) 0.000*	-10.395(22) 0.000*	-10.347(22) 0.000*
HCL	-2.337(6) 0.160	-2.260(6) 0.455	-1.384(6) 0.158	-21.538(5) * 0.000	-21.653(5) * 0.000	-21.540(5) * 0.000
HDFC	1.903(2) 0.999	-0.387(2) 0.988	3.175(2) 0.999	-41.482(1) * 0.000	-41.582(1) * 0.000	-41.362(1) * 0.000
HERO HONDA	0.402(3) 0.983	-1.715(3) 0.745	1.577(3) 0.972	-40.648(2) * 0.000	-40.675(2) * 0.000	-40.589(2) * 0.000
HEXAWARE	-2.438(16) (0.131)	-2.492(16) 0.332	-1.385(16) 0.155	-9.825(15) * 0.000	-9.825(15) * 0.000	-9.823(15) * 0.000
Hinduja TMT	-1.699(1) 0.432	-4.643(1)* 0.0008	-0.933(1) 0.312	-44.850(0) * 0.0001	-44.905(0) * 0.000	-44.857(0) * 0.0001
ICICI	2.245(2) 1.000	0.168(2) 0.998	3.334(2) 0.999	-34.926(1) * 0.000	-35.056(1) * 0.000	-34.801(1) * 0.000
Iflex	0.593(0) 0.989	-1.162(0) 0.916	2.159(0) 0.993	-32.687(0) * 0.000	-25.482(1) * 0.000	-32.581(0) * 0.000
Igate	-3.605(1)* 0.006	-4.132(1)* 0.006	-1.542(1) 0.116	-37.539(0) * 0.000	37.651(0) * 0.000	-37.547(1) * 0.000
INFOSYS	2.304(7) 1.000	0.354(7) 0.998	3.414(7) 0.999	-26.767(6) * 0.000	-26.906(6) * 0.000	-26.675(6) * 0.000
ISPAT	-1.994(16) 0.289	-2.755(16) 0.214	-1.301(16) 0.179	-16.324(15) 0.000*	-16.324(15) 0.000*	-16.326(15) 0.000*
LUPIN	-0.314(0) 0.920	-0.912(0) 0.953	0.556(0) 0.836	-56.182(0) * 0.0001	-56.221(0) * 0.000	-56.176(0) * 0.0001
Mastek	-2.986(23) 0.036**	-3.219(23) 0.080***	-2.081(23)** 0.036	-8.911(22) * 0.000	-8.911(22) * 0.000	-8.909(22) * 0.000
Mphasis	-0.094(1) 10.998	-1.807(1) 0.701	0.992(1) 0.9167	-47.461(0) * 0.0001	-47.478(0) * 0.000	-47.434(0) * 0.0001
Polaris	-1.983(6) 0.294	-2.405(6) 0.345	-1.214(6) (0.206)	-19.722(5) * 0.000	-19.7187(5) 0.000*	-19.728(5) * 0.000
Ramco Sys	-4.152(1)* 0.0008	-3.958(1)** 0.0102	-2.879(1)* 0.0039	-34.497(0) * 0.000	-34.539(0) * 0.000	-34.472(0) * 0.000
Ranbaxey	-1.185(0) 0.683	-2.733(0) 0.223	0.083(0) 0.709	-62.572(0) * 0.000	-62.504(0) * 0.000	-62.562(0) * 0.0001
Rolta India	-2.493(24) 0.117	-3.065(24) 0.115	-1.476(24) 0.131	-12.974(23) 0.000*	-12.980(23) 0.000*	-12.964(23) * 0.000
Sail	0.204(2) 0.973	-0.370(2) 0.989	0.821(2) 0.889	-44.961(1) * 0.000	-45.051(1) * 0.000	-44.954(1) * 0.000
Satyam Computer	-0.564(20) 0.876	-2.813(14) 0.193	0.347(20) 0.785	-13.173(19) 0.000*	-13.212(19) 0.000*	-13.124(19) * 0.000
SBI	0.887(2) (0.995)	-0.778(2) 0.966	1.880(2) 0.986	-42.056(1) * 0.000	-42.115(1) * 0.000	-42.011(1) * 0.000
Sun Pharm	2.345(0) 1.000	-0.052(0) 0.996	3.548(0) 0.999	-53.972(0) * 0.000	-54.101(0) * 0.000	-53.847(0) * 0.000
Tata Steel	-0.849(0) 0.804	-1.514(0) 0.825	0.304(0) 0.774	-61.122(0) * 0.000	-61.123(0) * 0.000	-61.114(0) * 0.000
Tata Elxsi	-1.394(1) 0.587	-4.444(1)* 0.002	-0.634(1) 0.443	-56.406(0) * 0.000	-56.465(0) * 0.000	-56.413(0) * 0.000
TCS	-0.053(0) 0.952	-2.192(0) 0.492	2.065(0) 0.991	-23.734(0) * 0.000	-23.734(0) * 0.000	-23.583(0) * 0.000
TVS	-1.589(1) 0.489	-2.518(1) 0.319	-4.445(1) 0.522	-59.237(0) * 0.000	-59.231(0) * 0.000	-59.237(0) * 0.000
Visual soft	-1.418(8) 0.574	-2.046(8) 0.578	-1.181(8) 0.218	-16.003(7) * 0.000	-16.613(7) * 0.000	-16.007(7) * 0.000
Wipro	-1.679(22) 0.441	-3.379(20) 0.054***	-0.629(22) 0.445	-14.278(21) 0.021*	-14.286(21) 0.000*	-14.258(21) * 0.000

a) C- Denotes constant, C & T - Denotes Constant and Trend, NCT – Denotes no constant no trend

b) *, ** and *** Implies 1%, 5% and 10% significance levels respectively. The critical values for ADF test with respective significance level without constant, are –2.58, -1.95, and –1.62. With constant and not trend it is-3.46, -2.88 and –2.57 and with constant and trend term they are –3.99, -3.43, and --3.13 respectively. Figures in the parenthesis show the McKinnon (1996) one sided p value for ADF. Figures in the brackets show the maximum lag length selected based on Schwarz Bayesian Information Criteria.

Table 4- Ng-Perron Unit Root Test.

Company		MZ_α	MZ_t	MSB	MPT	lag	MZ_α	MZ_t	MSB	MPT	lag

Name											
Bajaj Auto	L	4.641	3.442	0.741	69.689	21	0.418	0.171	0.409	47.13	21
	F	-410.68*	-14.33*	0.035	0.06	20	-2543.8*	-35.663*	0.014	0.036	20
BOI	L	-0.249	-0.111	0.372	13.198	1	-2.124	-0.783	0.368	30.402	1
	F	-2059.29*	-32.04*	0.016	0.034	0	-38.36*	-4.187*	0.109	3.419	9
CIPLA	L	0.533	0.287	0.539	23.397	6	-6.350	-1.718	0.270	14.360	6
	F	-3242.87*	-40.25*	0.0124	0.013	5	-88.11*	-6.574*	0.075	1.289	12
CMC	L	0.538	0.227	0.422	17.041	1	-19.33*	-2.941*	0.152	5.732	1
	F	-1213.5*	-24.63*	0.02	0.021	0	-1208.2*	-24.577*	0.02	0.077	0
GSS	L	-1.663	-0.826	0.497	13.349	1	-1.691	-0.822	0.486	45.925	1
	F	-0.097	-0.07*	0.733	32.612	17	-3.869	-1.387	0.359	-23.51	17
GTL	L	-19.319*	-3.104	0.161	1.283	23	-24.14*	-3.469*	0.144	3.805	23
	F	-146.24*	-8.55*	0.059	0.168	22	-152.13*	-8.721*	0.057	0.599	22
HCL	L	-1.213	-0.769	0.634	19.900	6	-2.031	-0.834	0.411	35.299	6
	F	0.004	0.004	1.33	93.927	24	-0.438	-0.331	0.756	111.41	24
HDFC	L	3.519	3.119	0.886	84.192	2	-0.488	-0.188	0.386	39.591	2
	F	-1758.01*	-29.6*	-9.017	0.035	1	-50.27*	-4.882*	0.097	2.469	11
HERO HONDA	L	1.921	1.576	0.821	58.097	3	-3.095	-1.088	0.352	25.932	3
	F	-32073.3*	-40.4*	0.012	0.027	24	-4.858*	-1.107	0.228	16.647	24
HEXAWARE	L	-5.448	-1.583	0.0291	4.496	16	-8.694*	-2.085	0.239	10.481	16
	F	-81.301*	-6.360*	0.078	0.334	15	-75.66*	-6.148*	0.082	1.216	15
Hinduja TMT	L	-2.174	-1.019	0.469	11.082	1	-2.325	-0.911	0.392	32.148	1
	F	-18.273*	-3.005	0.164	1.405	12	-25.10*	-3.403*	0.138	4.116	12
ICICI	L	4.364	3.285*	0.753	69.386	2	0.087	0.032	0.365	39.067	2
	F	-1079.68*	-23.15*	0.021	0.077	0	-7.423*	-1.465	0.197	13.212	16
Iflex	L	2.472	2.032	0.822	63.491	1	-4.896	-1.285	0.262	17.272	0
	F	-543.666*	-16.47*	0.031	0.061	0	-561.1*	-16.731*	0.0298	0.194	0
Igate	L	-0.596	-0.507	0.85	36.374	1	-1.111	-0.553	0.498	51.722	1
	F	-14.172*	-2.544	0.179	2.184	13	-211.8*	-10.285*	0.049	0.444	4
INFOSYS	L	4.294	3.465*	0.807	78.076	7	0.264	0.099	0.377	41.44	7
	F	-30965.2*	-1211.4*	0.004	0.003	6	-3.072	-0.741	0.241	19.926	23
ISPA	L	-4.644	-1.466	0.316	5.403	16	-15.76*	-2.761*	0.175	6.071	16

T	F	-90.599*	-6.725*	0.074	0.2801	15	-44.68*	-4.727*	0.106	2.039	17
LUPIN	L	-1.045	-0.369	0.352	11.261	0	-2.180	-0.791*	0.363	30.167	0
	F	-8.809**	-2.091	0.237	2.809	18	-24.83*	-3.400*	0.137	4.413	16
Mastek	L	-11.055*	-2.262	0.204	2.571	23	-23.49*	-3.426*	0.146	3.887	23
	F	-46.988*	-4.846*	0.103	0.523	22	-47.67*	-4.882*	0.102	1.912	22
Mphasis	L	2.121	0.941	0.443	22.481	1	-10.33*	-1.943	0.188	10.347	1
	F	-1498.32*	27.316*	0.018	0.044	0	-80.23*	-6.192*	0.077	1.723	10
Polaris	L	-7.147**	-1.887	0.264	3.441	6	-10.35*	-2.245**	0.217	8.953	6
	F	-2.662	-1.055	0.396	8.841	20	-6.609	-1.816	0.275	13.789	20
Ramco Systems	L	0.261	0.291	1.116	72.577	1	-1.418	-0.798	-0.562	59.139	1
	F	-0.018	-0.018	0.959	51.804	12	-1.789	-0.886	0.495	46.479	12
Ranbaxy	L	0.078	0.052	0.665	29.115	0	-12.81	-2.527	0.197	7.139	0
	F	-1900.06*	3.822*	0.016	0.013	0	-1902.7*	-30.844*	0.016	0.048	0
Rolta India	L	-8.325**	-1.749	0.210	4.019	24	21.269	-3.191	0.150	4.716	24
	F	-147.102*	-271.2*	0.002	0.0002	23	-1952.8*	-31.245*	0.016	0.049	23
Sail	L	-0.910	-0.512	0.563	18.477	2	0.141	0.063	0.451	52.507	2
	F	0.702	0.613	0.874	51.879	16	-2.475	-1.104	0.446	36.517	16
Satyam comp	L	0.639	0.255	0.399	16.249	20	-16.04*	-2.678*	0.167	6.614	14
	F	-3686.92*	-42.9*	0.116	0.017	19	-16.05*	-2.592*	0.161	7.115	23
SBI	L	2.93	1.552	0.529	32.244	2	-1.571	-0.578	0.368	33.001	2
	F	-3.239	-1.051	0.325	7.384	13	-15.96*	-2.816	0.176	5.765	13
Sun Pharma	L	3.937	3.501*	0.889	89.33	0	0.430	0.202	0.469	57.401	0
	F	-26.763*	-3.534*	0.132	1.318	18	-1477.0*	-27.175*	0.019	0.069	0
Tata Steel	L	-0.029	-0.012	0.426	15.812	0	-5.663	-1.579	0.279	15.899	0
	F	-37.053*	-4.302*	0.116	0.667	14	-1998.6*	-31.611*	0.016	0.046	0
Tata Elxis	L	-1.831	-0.922	0.503	12.923	1	-1.765	-0.744	0.422	37.769	1
	F	-3307.00*	-40.64*	0.013	0.017	0	-23.55*	-3.254*	0.138	4.941	13
TCS	L	1.812	1.713	0.945	73.438	0	-11.02*	-2.212	0.211	8.968	0
	F	-339.478	-12.98*	0.038	0.119	0	-317.7*	-12.585*	0.039	0.328	0
TVS	L	-0.922	-0.482	0.522	16.856	1	-12.92*	-2.526*	0.195	7.147	1
	F	-1931.81*	-31.07*	0.016	0.016	0	-1920.8*	-30.986*	0.016	0.052	0
Visual	L	-3.342	-1.292	0.387	7.329	8	-3.422	-1.302	0.380	26.520	8

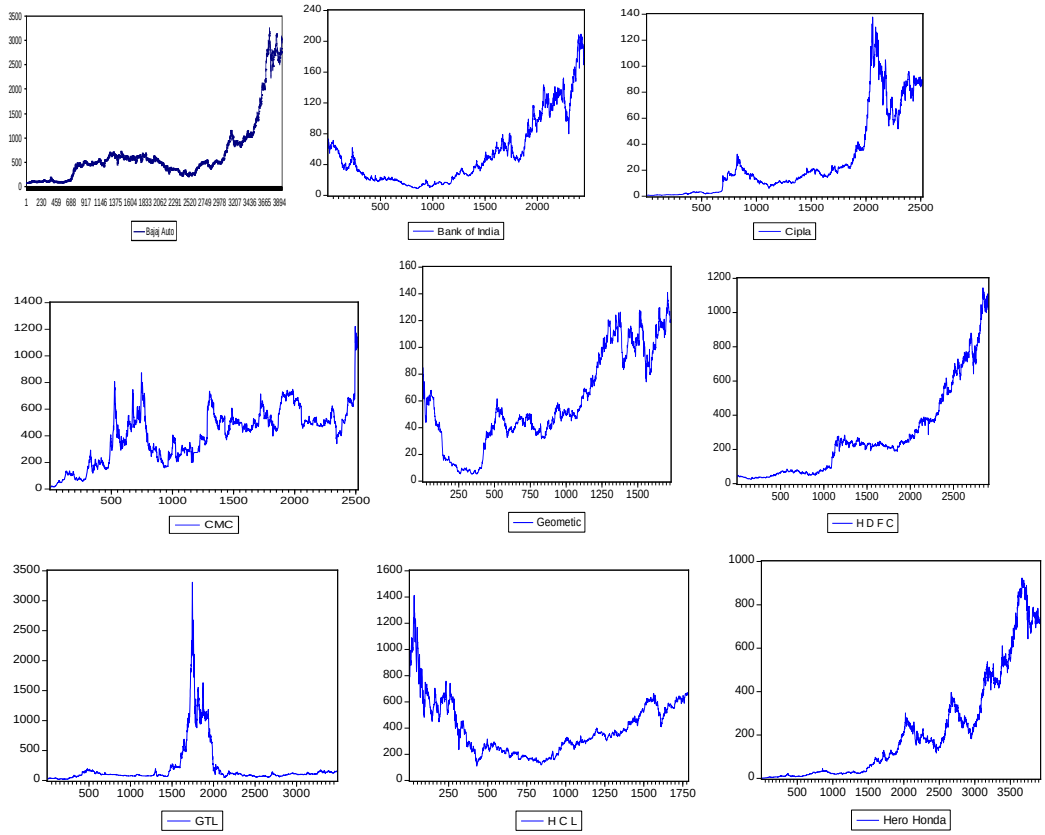
Soft	F	-531.749*	-16.31*	0.031	0.046	7	-830.23*	-20.374*	0.024	0.109	7
Wipro	L	-2.189	-0.698	0.319	8.864	22	-24.20*	-3.418*	0.141	4.135	20
	F	-741.427*	-19.23*	0.025	0.052	21	-110.5*	-7.389*	0.067	0.978	24

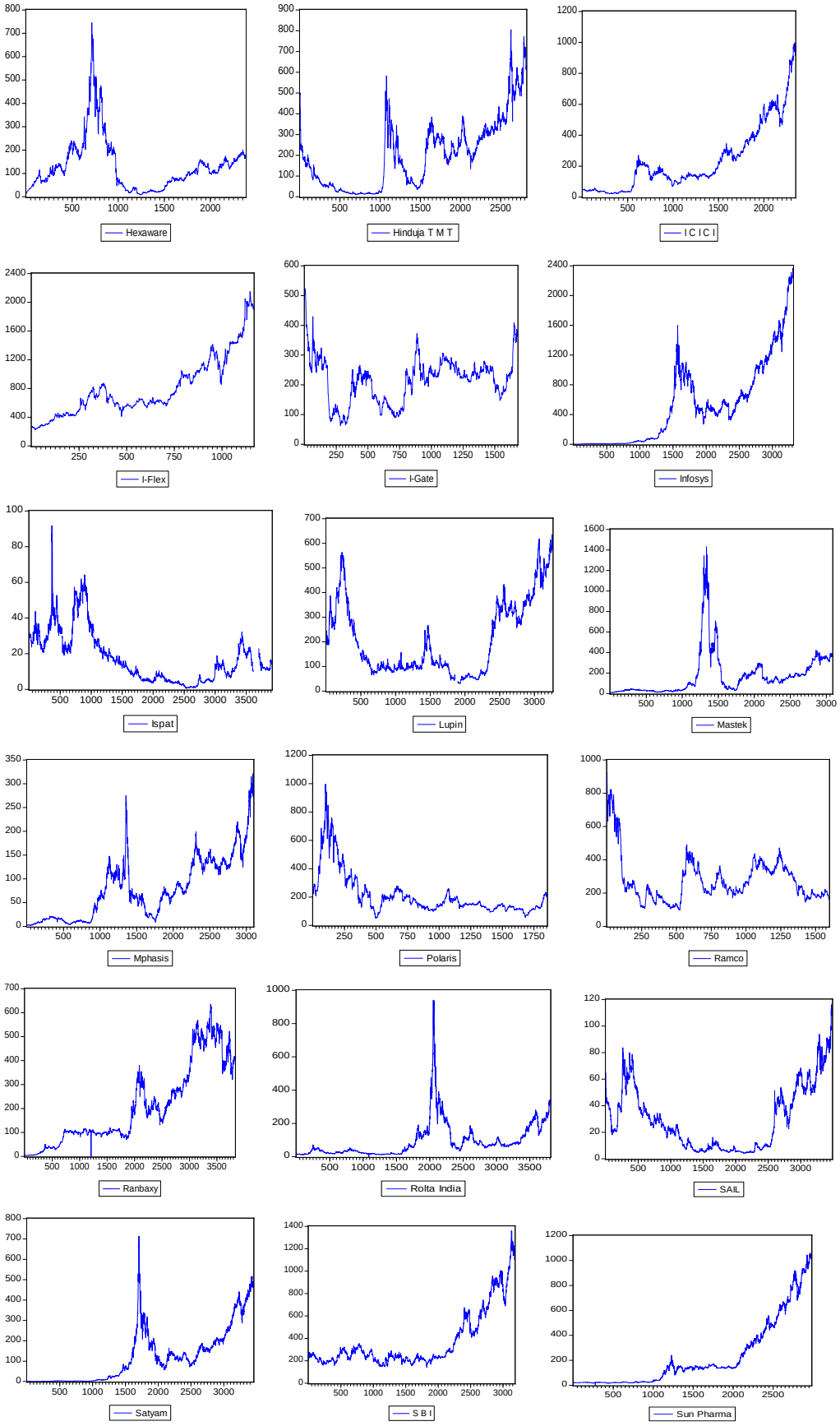
*, ** and *** Implies 1%, 5% and 10% significance levels respectively, L- stands for Level, F- stands for First difference.

Table-5: The Critical values for Ng-Perron Tests: Ng-Perron (2001) Table 1

Asymptotic critical values	Sig Level	Mza	Mzt	MSB	MPT
With Constant Term	1%	13.8	-2.58	0.174	1.78
	5%	-8.1	-1.98	0.233	3.17
	10%	-5.7	-1.62	0.275	4.45
With constant and trend term	1%	-23.8	-3.42	0.143	4.03
	5%	-17.3	-2.91	0.168	5.48
	10%	-14.2	-2.62	0.185	6.67

Graph 1. Plot of the Stock Price Index Data: Company




Hexaware
Hinduja T M T
I C I C I
I-Flex
I-Gate
Infosys
Ispat
Lupin
Mastek
Mphasis
Polaris
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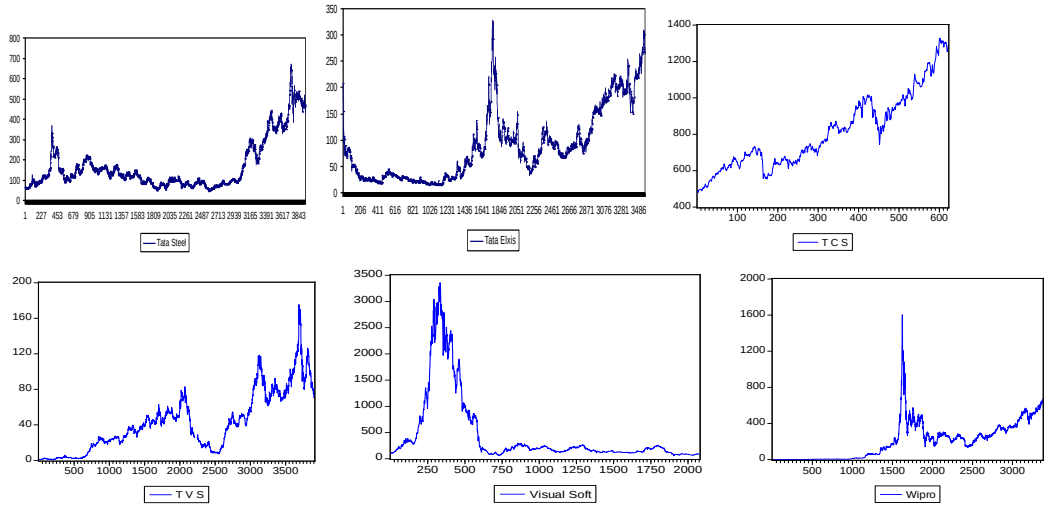
Ranbaxy
Rolta India
SAIL
Satyam
S B I
Sun Pharma



X- Axis No of days
Y- Axis Stock Price

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