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The Effectiveness of Optimal Risk Reduction in Indian Futures Market

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ABSTRACT

The hedge ratio compares the value of a position protected through the use of a hedge with the size of the entire position itself and hedging effectiveness is the percentage reduction in variance of the hedge portfolio to the unhedged portfolio. The present study is conducted with an objective to estimate optimal hedge ratio and hedging effectiveness of futures contracts on fifteen individual securities traded in NSE using DVEC GARCH model. Using spot returns and futures returns of the selected individual securities for the entire period of stock futures trade in India till 31st March 2018, the study reveals that Indian equity futures contracts provide hedging opportunity for all selected companies. Among the selected companies, Mahindra and Mahindra Ltd., State Bank of India Ltd. and ITC Ltd. have got highest and consistent optimal hedge ratio and hedging effectiveness providing that hedging with the stock futures of these companies provides maximum variance reduction and hedging effectiveness for the hedgers in the Indian equity futures market.

Keywords: Optimal Hedge Ratio, Hedging Effectiveness, National Stock Exchange of India Ltd., Equity Futures, DVEC GARCH, Variance, Covariance.

INTRODUCTION:

Even though it is expected that higher risk results in higher return, risk reduction stands as one of the main concerns of investors. Among different risk management tools, derivative contracts that are born and flourished on the basis of the concept of risk reduction play a vital role in providing an assured minimum return to the investors. The derivative markets came up with the idea of reducing risk using risk management tools like hedging (Hull and Basu, 2010). Hedging protects the investors by creating a fence to keep them away from potential risks involving price risk and basis risk. Hedging transfers the risk from risk averters to risk lovers. Optimal hedge ratio determines how much future contacts are to be bought or sold to secure a position in the spot market (Hull and Basu, 2016). Based on the degree of risk bearning by the investors, the hedging theories are classified as naive hedging, workings hedge theory, portfolio hedge, etc. Conventional hedging calls for an optimal hedge ratio of 1:1, expecting that there will be no risk when the number of futures contracts equals the spot positions (Ederington, 1979). But the non-integration of the spot and futures markets causes the conventional optimal hedge ratio to fail in providing the minimum variance hedge. Workings hedge theory was also criticized on its biased approach that considers the hedgers as risk lovers (Kapil Gupta and Balwinder

Singh, 2009). As of now portfolio hedge theory of hedgers choosing optimum risk return portfolio is considered as efficient. Hedge effectiveness is the extent to which a hedge transaction results in offsetting changes in fair value or cash flow that the transaction was intended to provide (Kapil Gupta and Balwinder Singh, 2009).
Hedging, being one of the legally approved fundamental functions of the derivative market, the intention of this paper is to examine the hedging effectiveness of Indian equity futures and to suggest the individual stocks having the highest hedging effectiveness, that considers the profits of the traders in the equity futures market. The previous literature on the optimal hedge ratio of futures contracts are concentrated on NSE NIFTY index futures with emphasis on comparison of the hedging effectiveness of different hedging models (Kapil Gupta and Balwinder Singh, 2010; Bhaduri and Dhurai, 2007; Rao and Takur, 2008; Kailash Chandra Pradan, 2011; Sah and Panday, 2011; Gurmeet Singh, 2017 and Anjaly Prashad, 2009). Comparatively, only very few studies have been found on optimal hedge ratio and hedging effectiveness of individual stocks traded in Indian market. The objectives of the study are to estimate optimal hedge ratio of individual securities traded in NSE (National Stock Exchange of India Ltd.) using Genralized Autoregressive Conditional Heteroskedasticity (GARCH) model and to estimate the hedging effectiveness of Indian equity futures. The robustness of results is checked by finding the optimal hedge ratio and hedging effectiveness for various sub periods of the entire period of the study.
The rest of the paper is arranged as follows. The coming portion deals with the summary of the empirical literature reviewed in connection with the topic. The next portion is the description of the data and methodology, which is being followed by finding and discussion, the robustness check and conclusion.

REVIEW OF LITERATURE:

There had been number of studies in the field of hedging effectiveness and estimation of optimal hedge ratio. Park, et.al. (1995) estimated risk minimizing futures hedge ratios for three types of stock index futures and also compared the hedging techniques and confirmed that dynamic hedging strategy using bivariate GARCH (B-GRACH) is superior to conventional constant hedging strategy. Christos Floros, et.al. (2006) studied hedging effectiveness in Greek stock index futures market in order to determine whether the methods Error Correction Model (ECM), Vector Error Correction Model (VECM) or B-GARCH provide better results over conventional Ordinary Least Square (OLS) regression in terms of hedging effectiveness and concluded that the hedge ratio obtained from the bivariate co-integration GARCH model generates better results in terms of hedging effectiveness. Dimitris, et.al. (2008) tried to determine appropriate model when estimating optimal hedge ratios using conventional regression model, ECM, GARCH and Exponential GARCH (E-GARCH) and concluded that the S&P 500 stock index futures contract is an effective tool for hedging risk. Saumitra, et.al. (2008) estimated hedge ratio and tested its effectiveness for both in-sample and out-sample data with 1,5,10 and 20 days horizon using simple OLS, VAR, VECM and a class of multivariate GARCH (M-GARCH). The results clearly vote for the time varying hedge ratio derived from the M-GARCH model with higher mean return and higher average variance reduction across hedged and unhedged position.
Brajesh Kumar, et.al. (2008) found that time varying hedge ratio derived from VAR-MGARCH model provide highest variance reduction as compared to the other methods in both in-sample and out-of-sample period for all contracts in India. Anjali Prashad (2009) investigated whether the introduction of index futures trading in the NSE has been an effective risk management instrument for spot market of Nifty portfolio and explored the properties of financial time series on Nifty index and future returns. Kapil Gupta and Balwinder Singh (2010) estimated the optimal hedge ratio in the Indian equity futures market to examine the hedging efficiency of the Indian equity futures. Gurmeet Singh (2017) suggested optimal hedge ratio to Indian investors and traders by examining three main indices of NSE and investigated the hedge effectiveness of selected future indices from Indian market and found that the hedge ratio estimated through E-GARCH and OLS reduced the portfolio variance by maximum extent.
As emphasised, the studies on optimal hedge ratios and hedging effectiveness revolving over comparison of methods of estimating hedging effectiveness. Therefore, the intention of present study is to estimate the optimal hedge ratios and hedging effectiveness of fifteen companies existing from the beginning of Indian Equity futures market by employing Diagonal Vector Error Correction GARCH (DVEC-GARCH) model to estimate the time varying optimal hedge ratio and hedging effectiveness.

DATA AND METHODOLOGY:

The period of the study is from 9th November 2001 to 31st march 2018. The data for includes the daily closing values of the near month futures as well as spot contracts on the shares of fifteen companies. It contains 4078

observations for each company. The whole data period was divided into various sub periods viz. inception period (9th November 2001 to 31st December 2003), pre-financial crisis period (1st January 2004 to 18th January 2008), financial crisis period (21st January 2008 to 18th may 2009), recovery period (19th may 2009 to 25th June 2010), growth period (19th May 2009 to 25th June 2010) and reforms period (7th November 2017 to 31st March 2018). The sub periods are identified for analyzing the real trend of the market from the very first day of its inception and also to have check for the robustness of the results. The variables are spot and futures returns of the selected individual stocks which were listed in NSE from the beginning of futures market in NSE and are included in the NSE Nifty Fifty index. The data series employed in this study consists of daily closing prices and underlying values of near month futures contracts on individual stocks.

The normality of the data is tested using descriptive statistics. The essential time series properties of the data are also tested. Stationarity of the data series have been checked using Augmented Dickey-Fuller test (ADF) and Phillips-Perron test (PP). Auto correlation of the data series is checked using Q statistics. The results of auto correlation reveals the presence of Autoregressive conditional heteroskedasticity (ARCH) effect and the possibility of applying the Bivariate DVEC-GARCH model to estimate variance of spot and futures return and covariance of spot return and futures return. Covariance measures how two random variables change together and variance is the spread of the data set. Since ARCH effects are present, bivariate DVEC-GARCH model is applied to estimate the values of variance and covariance of spot and future prices which are essential to obtain the results of optimal hedge ratio. Time varying hedge ratio is calculated by applying the following formula (Awang, et al., 2014):

$$H = \frac{\text{Covariance of spot and future}}{\text{Variance of futures}} \quad (1)$$

Where,

H=Time Varying Hedge Ratio

The hedging effectiveness which is the percentage reduction in variance of the hedge portfolio to the unhedged portfolio can be written as (Awang, et al., 2014):

$$HE = \frac{\text{Var (unhedged)-Var (hedged)}}{\text{Var (unhedged)}} \quad (2)$$

Where,

HE=Hedging Effectiveness

Var (unhedged) = σ_s^2

Var (unhedged)= σ_s^2+h^2 σ_f^2-2hσ_(s,f)^2

Individual stock with highest percentage of hedging effectiveness is considered good for risk reduction (Awang, et al., 2014).

FINDINGS AND DISCUSSION:

The empirical analysis of the data gives the following results.

Descriptive statistics:

Descriptive statistics, that give the values of Skeweness, Kurtosis and Jarque-Bera (JB) statistics, reveals the basic behaviour of data, whether it is normal or not.

From table no: 1, it is clear that, in all the cases, the values of the skewness, kurtosis and JB Statistics show that the data is skewed, leptokurtic and non normal in its raw form. The descriptive statistics for the sub periods, also give the same result. Therefore, the entire data has been converted to log values to smoothen the data.

Table No 1: Descriptive statistics of the selected companies for the whole period

Name	Mean	Median	SD	Skewness	Kurtosis	Jarque-Bera	Prob.	Observation
Panel A: Futures Return								
BPCL	482.85	426.65	186.41	0.757	2.887	392.13	0.00	4078
CIPLA	476.18	381.30	270.33	1.261	3.925	1226.71	0.00	4078
DRREDDY	1609.61	1354.85	949.05	0.818	2.608	481.17	0.00	4078
GRASIM	2092.97	2260.43	1103.65	0.112	2.216	112.92	0.00	4078
HDFC	1226.33	1056.23	678.76	1.020	3.104	708.45	0.00	4078
HINDALCO	337.26	164.85	374.48	1.705	4.518	2367.35	0.00	4078

Name	Mean	Median	SD	Skewness	Kurtosis	Jarque-Bera	Prob.	Observation
HINDPETRO	380.86	325.15	175.50	2.144	8.499	8260.64	0.00	4078
HINDUNILIVER	428.20	264.55	313.41	1.188	3.399	986.71	0.00	4078
INFY	2462.82	2350.75	1081.42	0.637	3.069	276.83	0.00	4078
ITC	414.16	277.70	345.02	1.958	6.353	4517.05	0.00	4078
M&M	747.48	715.55	376.20	0.077	2.220	107.37	0.00	4078
RELIANCE	1005.18	917.43	552.13	1.343	4.920	1851.47	0.00	4078
SBIN	1183.70	957.35	870.69	0.418	1.796	365.30	0.00	4078
TATAMOTORS	486.06	433.20	263.95	0.917	3.551	623.68	0.00	4078
TATASTEEL	420.17	408.10	176.62	0.292	2.892	59.85	0.00	4078
Panel B: Spot Return								
BPCL	482.28	427.55	185.84	0.757	2.903	391.15	0.00	4078
CIPLA	474.77	379.93	269.15	1.263	3.931	1230.81	0.00	4078
DRREDDY	1605.99	1351.73	946.34	0.820	2.613	482.62	0.00	4078
GRASIM	2088.83	2253.68	1100.08	0.107	2.215	112.54	0.00	4078
HDFC	1224.92	1053.10	678.06	1.021	3.107	710.98	0.00	4078
HINDALCO	336.72	164.50	374.20	1.705	4.516	2366.62	0.00	4078
HINDPETRO	380.21	324.48	175.39	2.149	8.542	8359.52	0.00	4078
HINDUNILIVER	427.65	264.63	312.64	1.190	3.405	990.87	0.00	4078
INFY	2460.30	2352.65	1080.24	0.637	3.070	276.89	0.00	4078
ITC	414.16	277.70	345.02	1.958	6.353	4517.05	0.00	4078
M&M	746.42	715.05	375.20	0.075	2.225	105.89	0.00	4078
RELIANCE	1002.30	915.10	550.44	1.337	4.887	1820.44	0.00	4078
SBIN	1181.84	954.30	869.71	0.417	1.794	365.49	0.00	4078
TATAMOTORS	486.09	433.20	264.28	0.921	3.559	629.95	0.00	4078
TATASTEEL	419.55	406.58	176.39	0.291	2.883	59.73	0.00	4078

Source: Computation of the researcher

Stationarity Test:

Stationarity of data series are checked using ADF and PP test. For the analysis purpose first log difference of both variables closing and underlying value are taken. Through the conversion of raw data into first log difference price data series is converted into return series. The values of ADF and PP tests for the whole period are presented in the table no: 2. The stationarity of the data for the sub periods are also tested. The results of both futures return and spot return show that the data series is significant and there is no unit root as the probability values of the series are less than 1 percentage. Both ADF and PP Test show that there is no unit root and the data series are stationary. The same results are for underlying value also and are provided as follows. The table below shows the results for the variable underlying value. From the values of ADF and PP Test it is clear that there is no unit root.

Table No 2: Results of Stationarity Tests of the Future returns and spot returns of 15 Companies for the Whole Period

Name	t-statistic			
	Futures Return		Spot Return	
	ADF Test	PP Test	ADF Test	PP Test
BPCL	63.95107***	64.16621***	64.05455***	64.35345***
CIPLA	34.68407***	61.70658***	34.82529***	61.81644***
DRREDDY	12.96181***	58.21691***	12.94797***	57.97073***
GRASIM	28.13866***	64.10741***	28.01707***	63.67658***
HDFC	38.26465***	63.16769***	38.39912***	63.18124***
HINDALCO	63.22683***	63.24341***	63.68192***	63.70186***
HINDPETRO	12.68834***	61.48544***	12.72610***	61.39355***

Name	t-statistic			
	Futures Return		Spot Return	
	ADF Test	PP Test	ADF Test	PP Test
HINDUNILEVER	30.69280***	63.75789***	31.46828***	65.06577***
INFOSYS	38.26576***	63.39723***	38.48490***	63.48941***
ITC	46.62974***	63.70036***	46.61133***	63.37605***
M&M	23.84818***	63.20791***	23.97173***	63.02125***
RELIANCE	22.74898***	62.10502***	14.53452***	61.73203***
SBIN	38.07963***	61.52088***	60.64963***	60.64963***
TATAMOTORS	12.10743***	61.46969***	12.09519***	60.77398***
TATASTEEL	20.95197***	63.22077***	21.15644***	61.96096***

Source: Computation of the researcher
*** denotes level of significance at 1%

Auto correlation:
Auto correlation of the data series is checked using Q statistics. The results of auto correlation reveals that there is ARCH effect and it is possible to apply the Bivariate DVEC-GARCH model to estimate variance of spot and futures return and covariance of spot return and futures return.

Optimal Hedge Ratio and Hedging Effectiveness:
Since there is ARCH effect, DVEC-GARCH model is applied to estimate the values of variance of the futures return and spot returns and covariance among the futures and spot returns, which are essential to obtain dynamic hedge ratio using Equation (1). The optimal hedge ratio is determined by taking the average of time varying hedge ratios. The average of time varying hedge ratios are computed and given as optimal hedge ratio of all selected companies for the whole period under study in table no: 3.

Table No 3: Optimal Hedge Ratio and Hedging Effectiveness of the selected Companies for the whole period

Name	Optimal Hedge Ratio	Hedging effectiveness
BPCL	2.0475	0.5007
CIPLA	0.9976	0.9997
DRREDDY	0.9907	0.9972
GRASIM	0.8518	0.959
HDFC	0.4406	0.6574
HINDALCO	1.0591	0.9963
HINDPETRO	0.7843	0.9397
HINDUNILEVER	0.9895	0.9822
INFOSYS	1.8913	0.5652
ITC	1.0063	0.9956
M&M	0.9968	0.9998
RELIANCE	0.9973	0.9997
SBIN	0.9980	0.9985
TATAMOTORS	0.9935	0.9752
TATASTEEL	0.9977	0.9973

Source: Computation of the researchers

According to theory when optimal hedge ratio is 1, it provides the perfect hedge of positions held in futures market which depends on the underlying assets in futures (Ederington, 1979). Through the analysis it is found that the futures contracts on the stock of ITC Ltd., Hindalco Industries Ltd. and Infosys Ltd. provide the perfect risk protection in the whole period by ensuring 100 percentage hedging of positions in futures. Futures contracts on stocks of all other companies provide the risk protection in whole period except that of HDFC Bank Ltd., Hindustan Petrolium Corporation Ltd. and Grasim Industries Ltd., as they do not provide complete hedging opportunities to its traders in the whole period. However in case of Bharat Petrolium Corporation Ltd., more

number of contracts are to be used to protect a futures position. Among all the companies ITC Ltd. has got the perfect optimal hedge ratio.

Hedging effectiveness, as computed using Equation (2), shows the extent to which risk can be reduced through hedging futures contracts. The result shows that all companies except Bharat Petrolium Corporation Ltd , Infosys Ltd., and HDFC Bank Ltd. have got more than 95 percentage of hedging effectiveness in the whole period. Among all the 15 companies Mahindra and Mahindra Ltd. has got the highest hedging effectiveness, i.e., 99.98 percentage. Least hedging effectiveness is for Bharat Petrolium Corporation Ltd. which is consistent with its optimal Hedge ratio in its whole period. The findings of the study are consistent with results of Gurmeet Singh (2017).

ROBUSTNESS ANALYSIS:

In order to test the robustness of the results of the whole period under study, optimal hedge ratios and hedging effectiveness are estimated for the sub periods. The results are given in table no: 4. Analysis of the sub periods proves that through the recent years all companies are able to provide almost perfect hedge for its stocks. In the growth and reforms period from 28th June 2010 to 28th March 2018 all fifteen companies are able to provide almost perfect hedge to its stocks. At the time of financial crisis and pre-financial crisis futures contracts on stocks of all companies, except Dr. Reddy's Laboratories Ltd. and Cipla Indistries Ltd., are able to provide hedging opportunities for their stocks respectively. During the inception period, except Hindalco Industies Ltd., futures contracts on stocks of all other companies are able to provide hedging opportunities to investors.

Table No 4: Optimal Hedge Ratios and Hedging Effectiveness of the selected companies for the different Sub Periods

Name	Inception	Pre-Fin. Crisis	Fin. Crisis	Recovery	Growth	Reforms
Panel A - Optimal Hedge Ratio						
BPCL	0.9311	0.9963	1.0098	0.9709	1.0152	0.9933
CIPLA	0.9689	0.7418	0.9890	0.9949	0.9901	1.0268
DRREDDY	0.9707	0.9922	0.5314	0.9968	1.0159	1.0489
GRASIM	1.0044	1.0044	0.9637	1.0173	0.9943	0.9901
HDFC	1.0117	1.1282	0.9942	1.0086	0.9965	1.0174
HINDALCO	0.8232	1.0276	1.0033	0.9953	0.9975	0.9929
HINDPETRO	0.9879	1.0412	1.0070	0.9841	0.4482	0.9987
HINDUNILEVER	1.0376	1.0112	0.9681	0.9958	1.0205	1.0355
INFOSYS	1.0200	0.9999	0.9986	0.9656	0.9964	0.9950
ITC	1.0200	1.1704	0.9901	1.0358	0.9946	1.0353
M&M	0.9949	1.0038	1.0927	0.9987	0.9974	0.9956
RELIANCE	0.9303	0.9953	0.9960	0.8066	0.9997	1.0314
SBIN	0.9925	1.1093	1.0325	1.0103	1.0464	0.9935
TATAMOTORS	0.9526	1.0006	1.8250	0.9728	0.9975	0.9993
TATASTEEL	1.0201	0.9905	1.0206	1.0008	0.9981	1.5265
Panel B - Hedging effectiveness						
BPCL	0.8599	0.9837	0.9967	0.9940	0.9994	0.9641
CIPLA	0.9687	0.9090	0.9927	0.9959	0.9994	0.9865
DRREDDY	0.9936	0.9956	0.6371	0.9973	0.9966	0.9938
GRASIM	0.9991	0.9991	0.9917	0.9940	0.9946	0.9966
HDFC	0.9944	0.6712	0.9986	0.9961	0.9939	0.9971
HINDALCO	0.9170	0.9980	0.9972	0.9970	0.9982	0.9959
HINDPETRO	0.9943	0.9956	0.9960	0.9882	0.5619	0.9889
HINDUNILEVER	0.9732	0.9894	0.9832	0.9899	0.9975	0.9835
INFOSYS	0.9933	0.9993	0.9986	0.9924	0.9998	0.9950

Name	Inception	Pre-Fin. Crisis	Fin. Crisis	Recovery	Growth	Reforms
ITC	0.9933	0.9668	0.9840	0.9934	0.9959	0.9809
M&M	0.9795	0.9965	0.9855	0.9983	0.9975	0.9995
RELIANCE	0.9851	0.9955	0.9996	0.9148	0.9956	0.9872
SBIN	0.9956	0.9738	0.9965	0.9969	0.9950	0.9973
TATAMOTORS	0.9963	0.9964	0.5956	0.9931	0.9986	0.9974
TATASTEEL	0.9937	0.9985	0.9990	0.9982	0.9967	0.7825

Source: Computation of the researchers

Through the analysis of sub periods, it is found that all companies except Hindustan Petrolium Corporation Ltd. and Tata Steel Ltd. are have hedging effectiveness more than 98 percentage in the growth and reforms period respectively. From the robustness analysis using sub periods, it is clear that all selected companies provide perfect hedging opportunity for its investors in the Indian equity futures market in the recent period and the company ITC Ltd. has got the perfect hedge ratio with a hedging effectiveness of 99.56 percentage. Hedging effectiveness is highest for Mahindra and Mahindra Ltd. and its optimal Hedge ratio is 0.9968 which is near to perfect hedging. The results of the study are similar to the results of Anjaly Prasad (2009) which demonstrated that hedging effectiveness is highest for those companies having better optimal hedge ratios.

CONCLUSION:

From the analysis, it is clear that Indian equity futures market provide hedging opportunity for the investors in Indian equity market, even though the hedging effectiveness varies for the companies during the various sub periods. The companies ITC Ltd., Mahindra and Mahindra Ltd., Hindustan Unilever Ltd., State Bank of India Ltd., Tata Motors Ltd. and Tata Steel Ltd. provide the satisfactory hedging opportunity for its investors and among these companies Mahindra and Mahindra Ltd., State Bank of India Ltd. and ITC Ltd. provide almost perfect hedging opportunities. The companies ITC Ltd., Mahindra and Mahindra Ltd., Hindustan Unilever Ltd., State Bank of India Ltd., Cipla Industries Ltd., Grasim Industries Ltd., Hindalco Industries Ltd. and Reliance Industries Ltd. provide the satisfactory hedging effectiveness for its stocks and among these companies Mahindra and Mahindra Ltd., State Bank of India Ltd., ITC Ltd. and Reliance Industries Ltd. provide highest hedging effectiveness during all time periods. Among all the selected companies Mahindra and Mahindra Ltd., State Bank of India Ltd. and ITC Ltd. have got highest and consistent optimal hedge ratio and hedging effectiveness and therefore hedging with futures contracts on the stocks of these companies provides maximum variance reduction and hedging effectiveness for the investors in the Indian equity market.

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APPENDIX:

Table No A1: Descriptive Statistics of the Futures Returns of the Sub periods

Name	Mean	Median	SD	Skewness	Kurtosis	Jarque Bera	Prob.	Observation
Panel A - Inception Period								
BPCL	265.68	265.58	59.03	0.56	2.86	28.78	0.00	538
CIPLA	954.67	951.10	155.31	-0.06	2.32	10.77	0.00	538
DRREDDY	987.69	960.73	152.90	0.71	3.44	49.01	0.00	538
GRASIM	415.65	320.73	190.11	1.72	4.76	335.15	0.00	538
HDFC	537.44	591.93	123.99	-0.43	1.61	60.34	0.00	538
HINDALCO	736.50	701.80	201.63	1.51	4.83	279.03	0.00	538
HINDPETRO	283.83	292.23	68.62	-0.35	2.92	11.31	0.00	538
HINDUNILEVER	186.02	181.48	24.90	0.41	2.69	17.59	0.00	538
INFY	3887.42	3838.20	626.83	0.21	2.45	10.63	0.00	538
ITC	710.66	683.73	88.36	1.39	4.48	223.07	0.00	538
M&M	143.20	110.75	77.58	1.78	4.93	366.94	0.00	538
RELIANCE	319.78	295.48	73.71	1.45	4.13	216.87	0.00	538
SBIN	302.11	274.13	94.42	0.89	2.41	78.27	0.00	538

Name	Mean	Median	SD	Skewness	Kurtosis	Jarque Bera	Prob.	Observation
TATAMOTORS	186.52	156.38	87.92	1.60	4.45	277.80	0.00	538
TATASTEEL	165.89	136.15	83.30	1.62	4.52	286.91	0.00	538
Panel B - Pre-financial Crisis Period								
BPCL	382.35	370.80	52.95	0.47	2.42	51.77	0.00	1017
CIPLA	366.83	260.80	290.06	2.47	7.87	2036.90	0.00	1017
DRREDDY	871.29	761.80	255.56	1.37	3.69	336.54	0.00	1017
GRASIM	1870.08	1431.60	825.43	0.77	2.41	115.94	0.00	1017
HDFC	1238.52	1122.20	617.26	1.08	3.64	216.52	0.00	1017
HINDALCO	606.19	189.60	533.94	0.43	1.28	157.18	0.00	1017
HINDPETRO	317.86	313.20	61.25	1.29	5.11	472.17	0.00	1017
HINDUNILIVER	185.53	190.00	42.71	0.16	2.21	31.07	0.00	1017
INFY	2554.13	2162.50	1099.94	1.73	4.88	658.28	0.00	1017
ITC	630.26	191.10	560.02	0.58	1.73	125.67	0.00	1017
M&M	596.45	567.60	148.07	0.39	2.12	58.32	0.00	1017
RELIANCE	1050.17	794.40	656.49	1.48	4.52	468.91	0.00	1017
SBIN	962.71	871.50	477.32	1.48	4.81	511.74	0.00	1017
TATAMOTORS	628.31	642.80	177.49	0.23	1.69	81.99	0.00	1017
TATASTEEL	470.10	431.10	155.04	1.24	4.10	314.21	0.00	1017
Panel C - Financial Crisis Period								
BPCL	357.83	362.10	49.80	-0.49	3.12	12.99	0.00	319
CIPLA	206.93	206.90	18.71	0.06	2.14	10.06	0.00	319
DRREDDY	538.82	543.35	88.34	0.05	1.91	15.97	0.00	319
GRASIM	1865.96	1798.00	596.98	0.30	2.03	17.28	0.00	319
HDFC	2046.05	2096.35	490.93	0.06	1.76	20.75	0.00	319
HINDALCO	112.13	121.65	57.16	0.10	1.38	35.28	0.00	319
HINDPETRO	246.86	248.40	30.77	-0.23	2.42	7.26	0.02	319
HINDUNILIVER	235.73	238.45	16.43	-0.84	3.48	40.57	0.00	319
INFY	1480.64	1465.85	227.94	0.22	1.94	17.70	0.00	319
ITC	187.48	187.35	16.40	0.39	2.66	9.41	0.00	319
M&M	488.97	523.50	141.57	-0.26	1.65	27.78	0.00	319
RELIANCE	1894.83	2021.40	518.87	-0.18	1.56	29.10	0.00	319
SBIN	1422.91	1336.05	335.65	0.96	3.38	50.65	0.00	319
TATAMOTORS	382.22	394.05	209.21	0.28	1.61	29.80	0.00	319
TATASTEEL	481.76	530.35	262.50	0.07	1.37	35.76	0.00	319
Panel D – Recovery Period								
BPCL	531.20	530.73	55.05	-0.11	2.44	4.23	0.12	276
CIPLA	302.00	313.03	35.39	-0.47	2.17	18.13	0.00	276
DRREDDY	1044.05	1109.33	225.61	-0.14	1.90	14.76	0.00	276
GRASIM	2499.83	2569.85	298.96	-0.83	3.12	32.05	0.00	276
HDFC	2586.15	2624.00	192.05	-0.32	2.32	10.10	0.00	276
HINDALCO	134.12	138.23	31.55	-0.28	1.99	15.31	0.00	276
HINDPETRO	349.23	348.05	29.22	0.20	2.42	5.79	0.05	276
HINDUNILIVER	255.44	260.15	18.82	-0.08	1.90	14.17	0.00	276
INFY	2335.69	2409.95	351.70	-0.66	2.32	25.10	0.00	276
ITC	244.86	250.50	26.20	-0.66	3.14	20.07	0.00	276
M&M	833.80	843.83	202.23	-0.12	1.75	18.67	0.00	276
RELIANCE	1537.54	1121.10	516.98	0.15	1.13	41.13	0.00	276
SBIN	2045.10	2093.70	234.96	-0.34	1.83	21.08	0.00	276
TATAMOTORS	611.82	670.10	173.63	-0.52	1.92	26.12	0.00	276
TATASTEEL	522.44	522.30	86.54	-0.06	2.12	8.99	0.01	276

Panel E – Growth Period								
BPCL	617.19	643.98	182.51	0.03	2.33	34.83	0.00	1830
CIPLA	463.01	417.10	128.93	0.34	1.72	160.10	0.00	1830
DRREDDY	2438.44	2425.38	760.04	0.38	2.12	103.31	0.00	1830
GRASIM	2738.33	2740.08	947.41	-0.19	2.74	15.99	0.00	1830
HDFC	1044.69	900.40	421.83	2.11	9.98	5082.00	0.00	1830
HINDALCO	145.05	137.25	44.93	0.55	2.66	99.77	0.00	1830
HINDPETRO	471.49	411.20	219.91	1.27	4.43	647.70	0.00	1830
HINDUNILIVER	645.77	605.28	256.99	0.25	2.18	69.86	0.00	1830
INFY	2257.80	2417.18	935.08	-0.16	1.73	131.13	0.00	1830
ITC	280.83	293.60	62.16	-0.40	2.00	125.74	0.00	1830
M&M	1029.25	975.98	267.42	-0.02	1.48	176.93	0.00	1830
RELIANCE	950.64	929.40	167.51	1.64	6.75	1896.50	0.00	1830
SBIN	1441.50	1770.73	1023.00	-0.10	1.40	199.31	0.00	1830
TATAMOTORS	499.00	422.58	284.29	1.52	4.31	835.53	0.00	1830
TATASTEEL	426.45	410.03	119.32	0.35	2.46	60.70	0.00	1830
Panel F – Reforms Period								
BPCL	479.96	485.08	33.79	-0.24	1.90	5.94	0.05	98
CIPLA	597.36	602.38	20.58	-1.12	3.71	22.51	0.00	98
DRREDDY	2287.27	2281.03	125.09	0.21	1.91	5.59	0.06	98
GRASIM	1155.94	1141.63	51.04	0.32	2.16	4.53	0.10	98
HDFC	1775.63	1777.48	78.28	0.53	2.51	5.63	0.05	98
HINDALCO	248.96	249.90	17.61	-0.39	2.44	3.86	0.14	98
HINDPETRO	400.06	411.15	27.43	-0.47	2.20	6.29	0.04	98
HINDUNILIVER	1326.27	1329.68	37.62	-0.27	2.19	3.92	0.14	98
INFY	1078.12	1089.75	79.08	-0.13	1.42	10.48	0.00	98
ITC	264.75	264.10	6.58	0.48	2.65	4.22	0.12	98
M&M	968.84	758.30	320.56	0.75	1.61	17.18	0.00	98
RELIANCE	924.25	923.73	21.09	0.28	2.87	1.39	0.50	98
SBIN	298.15	307.45	28.19	-0.59	2.10	9.12	0.01	98
TATAMOTORS	396.48	404.60	33.29	-0.51	2.03	8.04	0.01	98
TATASTEEL	692.19	697.58	53.93	-0.37	2.72	2.59	0.27	98

Source: Computation of the researcher

Table No A2: Descriptive Statistics of the Spot Returns of the Sub periods

Name	Mean	Median	SD	Skewness	Kurtosis	Jarque Bera	Prob.	Observation
Panel A - Inception Period								
BPCL	264.86	264.65	59.01	0.57	2.91	28.99	0.00	538
CIPLA	950.68	945.60	154.47	-0.05	2.33	10.44	0.00	538
DRREDDY	984.58	957.88	151.42	0.71	3.52	51.81	0.00	538
GRASIM	414.09	320.05	189.02	1.72	4.75	333.05	0.00	538
HDFC	537.16	593.60	123.45	-0.43	1.61	59.76	0.00	538
HINDALCO	734.25	699.68	199.41	1.52	4.85	283.06	0.00	538
HINDPETRO	282.66	291.18	68.65	-0.33	0.95	10.03	0.00	538
HINDUNILEVER	185.96	181.05	24.65	0.46	2.83	19.99	0.00	538
INFY	3881.72	3828.45	621.61	0.19	2.42	10.80	0.00	538
ITC	709.03	683.05	87.60	1.38	4.49	221.25	0.00	538
M&M	142.67	110.15	77.08	1.77	4.91	362.52	0.00	538
RELIANCE	319.78	295.48	73.71	1.45	4.13	216.87	0.00	538
SBIN	300.39	270.50	93.69	0.88	2.39	78.17	0.00	538
TATAMOTORS	185.98	155.75	87.22	1.61	4.46	280.03	0.00	538

Name	Mean	Median	SD	Skewness	Kurtosis	Jarque Bera	Prob.	Observation
TATASTEEL	165.22	135.68	82.60	1.62	4.51	286.20	0.00	538
Panel B - Pre-financial Crisis Period								
BPCL	383.22	371.75	52.51	0.48	2.44	52.82	0.00	1017
CIPLA	366.23	260.30	289.16	2.47	7.88	2044.20	0.00	1017
DRREDDY	870.52	761.50	255.11	1.37	3.68	335.45	0.00	1017
GRASIM	1868.19	1425.45	821.99	0.76	2.38	114.68	0.00	1017
HDFC	1238.65	1126.15	615.45	1.08	3.63	213.52	0.00	1017
HINDALCO	606.11	188.10	534.20	0.43	1.27	157.55	0.00	1017
HINDPETRO	317.61	313.55	60.87	1.31	5.15	485.99	0.00	1017
HINDUNILIVER	185.69	189.55	42.76	0.15	2.18	32.33	0.00	1017
INFY	2553.71	2163.70	1102.16	1.73	4.85	651.71	0.00	1017
ITC	631.05	190.80	561.09	0.58	1.73	125.51	0.00	1017
M&M	596.28	577.50	147.12	0.38	2.11	57.35	0.00	1017
RELIANCE	1046.32	793.55	652.72	1.47	4.48	458.62	0.00	1017
SBIN	959.24	869.10	474.11	1.48	4.80	506.27	0.00	1017
TATAMOTORS	628.04	641.05	176.90	0.22	1.67	83.64	0.00	1017
TATASTEEL	470.10	431.05	155.04	1.24	4.10	314.21	0.00	1017
Panel C - Financial Crisis Period								
BPCL	357.90	360.65	50.05	-0.39	3.03	7.99	0.01	319
CIPLA	206.69	206.95	18.56	0.05	2.14	9.95	0.00	319
DRREDDY	538.94	541.70	88.80	0.06	1.94	15.23	0.00	319
GRASIM	1866.29	1800.45	594.62	0.29	2.03	16.97	0.00	319
HDFC	2042.93	2085.50	489.91	0.07	1.77	20.44	0.00	319
HINDALCO	112.10	121.35	57.11	0.09	1.38	35.23	0.00	319
HINDPETRO	246.55	248.20	30.95	-0.19	2.41	6.48	0.03	319
HINDUNILIVER	236.10	238.30	15.74	-0.80	3.58	38.60	0.00	319
INFY	1480.80	1467.90	229.54	0.25	1.97	17.48	0.00	319
ITC	187.53	187.10	16.46	0.38	2.64	9.24	0.00	319
M&M	489.99	522.85	141.25	-0.27	1.66	27.90	0.00	319
RELIANCE	1891.34	2018.55	517.49	-0.17	1.56	28.91	0.00	319
SBIN	1425.39	1335.20	334.63	0.96	3.38	51.10	0.00	319
TATAMOTORS	385.20	397.00	209.66	0.26	1.59	29.98	0.00	319
TATASTEEL	482.14	526.35	262.47	0.07	1.36	36.21	0.00	319
Panel D – Recovery Period								
BPCL	530.49	530.33	54.61	-0.13	2.48	3.94	0.13	276
CIPLA	301.41	312.58	35.30	-0.48	2.20	18.20	0.00	276
DRREDDY	1042.72	1108.15	225.32	-0.14	1.91	14.66	0.00	276
GRASIM	2500.28	2581.10	299.67	-0.88	3.17	35.71	0.00	276
HDFC	2585.62	2615.18	193.00	-0.32	2.35	9.62	0.00	276
HINDALCO	134.04	138.13	31.45	-0.28	1.99	15.36	0.00	276
HINDPETRO	348.47	347.68	29.11	0.17	2.42	5.24	0.07	276
HINDUNILIVER	255.79	259.68	18.56	-0.07	1.97	12.49	0.00	276
INFY	2336.49	2410.05	353.28	-0.66	2.31	25.17	0.00	276
ITC	244.97	250.30	26.41	-0.59	3.09	15.91	0.00	276
M&M	833.87	841.98	202.21	-0.11	1.76	18.13	0.00	276
RELIANCE	1535.19	1121.30	516.12	0.16	1.13	41.16	0.00	276
SBIN	2046.41	2092.98	235.84	-0.32	1.82	20.77	0.00	276
TATAMOTORS	614.99	672.73	173.88	-0.55	1.95	26.48	0.00	276
TATASTEEL	523.61	522.43	86.25	-0.03	2.13	8.73	0.01	276

Panel E – Growth Period								
BPCL	615.69	642.83	182.40	0.03	2.34	33.91	0.00	1830
CIPLA	461.56	415.50	128.68	0.34	1.72	161.36	0.00	1830
DRREDDY	2432.26	2411.98	758.46	0.38	2.12	103.66	0.00	1830
GRASIM	2730.67	2722.10	944.08	-0.19	2.74	15.93	0.00	1830
HDFC	1042.36	895.70	421.35	2.12	10.02	5124.96	0.00	1830
HINDALCO	144.60	136.80	44.82	0.55	2.66	100.38	0.00	1830
HINDPETRO	470.69	412.43	219.86	1.28	4.45	657.41	0.00	1830
HINDUNILIVER	644.51	604.95	256.65	0.25	2.18	70.32	0.00	1830
INFY	2254.00	2415.35	933.13	-0.16	1.73	130.93	0.00	1830
ITC	280.00	292.80	61.91	-0.41	2.00	126.51	0.00	1830
M&M	1027.09	975.43	266.82	-0.01	1.47	177.77	0.00	1830
RELIANCE	950.64	929.40	167.51	1.64	6.75	1896.59	0.00	1830
SBIN	1439.19	1767.00	1021.44	-0.10	1.40	199.32	0.00	1830
TATAMOTORS	498.43	421.08	285.05	1.53	4.33	845.11	0.00	1830
TATASTEEL	425.86	409.00	118.98	0.35	2.44	61.45	0.00	1830
Panel F – Reforms Period								
BPCL	481.74	488.80	32.81	-0.37	2.18	4.99	0.08	98
CIPLA	595.89	601.30	20.59	-1.08	3.57	20.33	0.00	98
DRREDDY	2280.47	2275.63	124.81	0.25	1.93	5.74	0.05	98
GRASIM	1152.89	1139.88	50.88	0.33	2.15	4.72	0.09	98
HDFC	1772.44	1768.85	79.17	0.49	2.43	5.17	0.07	98
HINDALCO	248.24	249.65	17.40	-0.40	2.44	3.94	0.13	98
HINDPETRO	400.40	410.68	26.82	-0.59	2.45	6.97	0.03	98
HINDUNILIVER	1323.38	1325.90	38.53	-0.32	2.25	3.95	0.13	98
INFY	1076.95	1089.45	79.51	-0.15	1.45	10.21	0.00	98
ITC	264.11	263.23	6.68	0.54	2.72	5.10	0.07	98
M&M	966.49	757.08	319.92	0.76	1.62	17.16	0.00	98
RELIANCE	922.01	921.08	21.69	0.30	2.92	1.52	0.46	98
SBIN	297.34	306.43	28.06	-0.60	2.10	9.12	0.01	98
TATAMOTORS	395.46	403.63	33.24	-0.51	2.02	8.19	0.01	98
TATASTEEL	691.16	694.43	53.89	-0.37	2.77	2.43	0.29	98

Source: Computation of the researcher

Table No A3: Results of Stationarity Tests of 15 Companies for the sub periods

Name	Inception	Pre-Fin. Crisis	Fin. Crisis	Recovery	Growth	Reforms
Panel A - ADF t-statistics of the spot returns						
BPCL	22.94***	30.65***	17.108***	17.119***	43.054***	9.534***
CIPLA	20.95***	30.88***	9.2633***	17.427***	43.473***	9.736***
DRREDDY	17.55***	32.15***	13.856***	15.436***	37.735***	8.129***
GRASIM	4.72***	32.41***	17.763***	10.379***	42.774***	9.540***
HDFC	25.08***	8.714***	9.7248***	8.3994***	43.687***	8.878***
HINDALCO	20.84***	32.00***	16.852***	16.065***	43.70***	10.11***
HINDPETRO	22.05***	12.06***	8.7905***	16.314***	41.307***	10.45***
HINDUNILEVER	22.28***	30.29***	14.10***	16.277***	20.583***	9.548***
INFOSYS	20.69***	32.47***	9.589***	11.087***	42.415***	7.653***
ITC	17.65***	31.57***	13.691***	9.5928***	23.189***	9.458***
M&M	3.37***	30.28***	15.982***	16.591***	13.646***	9.581***
RELIANCE	23.45***	6.992***	16.291***	16.364***	42.685***	4.777***
SBIN	5.87***	22.92***	15.552***	15.94***	25.712***	10.52***
TATAMOTORS	8.81***	30.57***	17.702***	16.186***	7.716***	10.98***
TATASTEEL	9.99***	23.04***	17.108***	17.021***	43.021***	9.140***

Panel B - ADF t-statistics of the future returns						
BPCL	22.786***	29.949***	17.002***	17.083***	17.119***	4.3642***
CIPLA	21.08***	30.771***	9.07045***	17.351***	17.427***	9.7340***
DRREDDY	11.062***	32.227***	13.775***	15.865***	15.436***	8.1728***
GRASIM	4.5576***	6.7029***	18.048***	10.515***	10.379***	9.3822***
HDFC	24.631***	6.2017***	9.5946***	8.2785***	8.3994***	8.4905***
HINDALCO	20.57***	-31.78***	20.572***	16.255***	16.065***	10.295***
HINDPETRO	21.753***	8.0058***	17.409***	16.610***	16.314***	7.1296***
HINDUNILEVER	21.477***	31.071***	9.9255***	12.293***	16.277***	9.252***
INFOSYS	20.548***	32.53***	14.200***	14.302***	11.087***	5.0760***
ITC	17.572***	31.743***	4.1393***	13.293***	9.5928***	9.4622***
M&M	3.4324**	30.598***	14.608***	16.807***	16.591***	9.6327***
RELIANCE	23.580***	7.0587***	16.196***	16.46***	16.364***	4.697***
SBIN	5.9889***	11.513***	16.782***	16.483***	15.942***	10.44***
TATAMOTORS	8.6492***	31.690***	15.589***	16.197***	16.186***	10.955***
TATASTEEL	21.752***	30.919***	18.289***	10.627***	17.021***	9.1664***
Panel C - PP t-statistics of the spot returns						
BPCL	22.94***	30.665***	17.105***	17.144***	43.24***	9.533***
CIPLA	20.85***	30.958***	18.854***	17.502***	43.488***	9.7359***
DRREDDY	21.39***	32.151**	19.771***	15.608***	37.671***	8.1690***
GRASIM	19.81***	32.410***	17.916***	15.76***	42.774***	9.5406***
HDFC	25.19***	30.921***	15.262***	17.227***	43.680***	8.8763***
HINDALCO	20.89***	32.007***	16.801***	16.066***	43.839***	10.114***
HINDPETRO	22.03***	28.587***	21.494***	16.362***	41.283***	11.204***
HINDUNILEVER	22.27***	30.274***	17.319***	16.295***	43.740***	9.5985***
INFOSYS	20.79***	32.537***	20.354***	14.809***	42.414***	8.6745***
ITC	23.00***	31.576***	13.473***	17.90***	42.684***	9.7833***
M&M	20.46***	30.252***	15.919***	16.592***	43.926***	9.5803***
RELIANCE	23.45***	29.978***	16.169***	16.4118***	42.773***	8.4427***
SBIN	23.23***	29.50***	15.555***	15.951***	40.91***	10.595***
TATAMOTORS	23.03***	30.55***	17.703***	16.201***	40.816***	10.945***
TATASTEEL	22.16***	29.928***	17.105***	17.019***	43.021***	9.1404***
Panel D - PP t-statistics of the future returns						
BPCL	22.783***	29.904***	16.959***	17.121***	17.144***	9.9752***
CIPLA	21.08***	30.82***	19.099***	17.396***	17.502****	9.7336***
DRREDDY	21.694***	32.227***	13.856***	16.002***	15.608***	8.213***
GRASIM	19.475***	32.726***	18.157***	15.992***	15.765***	9.382***
HDFC	24.685***	30.958***	15.135***	17.117***	17.227***	8.485***
HINDALCO	20.53***	31.78***	20.53***	16.256***	16.066***	10.28***
HINDPETRO	21.734***	29.480***	17.485***	16.652***	16.36***	10.53***
HINDUNILEVER	21.417***	31.071***	21.236***	15.722***	16.295***	9.267***
INFOSYS	20.402***	32.585***	17.542***	10.729***	14.809***	8.868***
ITC	22.841***	-31.74***	20.239***	17.552***	17.908***	9.531***
M&M	20.576***	30.580***	14.471***	16.808***	16.592***	9.632***
RELIANCE	23.58***	30.453***	16.15***	16.518***	16.411***	8.596***
SBIN	23.459***	30.702***	16.694***	16.490***	15.951***	10.507***
TATAMOTORS	23.10***	-31.70***	15.595***	16.196***	16.201***	10.937***
TATASTEEL	21.812***	30.934***	18.283***	17.587***	17.019***	9.1664***

*** denotes level of significance at 1%

Source: Computation of the researcher

Table No A4: List of Companies Selected for the Study

Sl. No.	Symbol / Abbreviation	Name of the Company
1	BPCL	Bharat Petroleum Corporation Ltd.
2	CIPLA	CIPLA industries Ltd.
3	DRREDDY	Dr. Reddy's Laboratories Ltd.
4	GRASIM	Grasim Industries Ltd.
5	HDFC	The HDFC Bank Ltd.
6	HINDALCO	Hindalco Industries Ltd.
7	HINDPETRO	Hindustan Petroleum Corporation Ltd.
8	HINDUNILEVER	Hindustan Unilever Ltd.
9	INFOSYS	Infosys Ltd.
10	ITC	ITC Ltd.
11	M&M	Mahindra & Mahindra Ltd.
12	RELIANCE	Reliance Industries Ltd.
13	SBIN	The State Bank of India Ltd.
14	TATAMOTORS	Tata Motors Ltd.
15	TATASTEEL	Tata Steel Ltd.

Source: www.nseindia.com
