# Effect of Future Trading on Indian Stock Market: A Comparison of Automobiles and Engineering Sector

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## Abstract

***Purpose:*** *This study examines the impact of future trading on efficiency and volatility of stock market. Since the stock future trading is the major contributor in the turnover of derivative market, this research work has been carried out to study the impact of stock future trading on stock market of India.*

***Research Methodology:*** *To evaluate the impact of future trading on efficiency and volatility of stock market, whole period is divided into two parts: pre and post introduction of future trading. This study uses daily closing prices of the stock prices of top 7 companies of two sectors i.e. Automobiles and Engineering listed on NSE to represent Indian stock market. Run test is applied to investigate the impact of future trading on efficiency of stock market. This study also uses ARCH LM to test hetroscedasticity so that EGARCH M model can be applied to test impact of future trading on volatility of stock market.*

***Findings:*** *The run test showed that future trading has mixed effect on efficiency of both the sectors i.e. some stocks has become efficient while other became inefficient after the introduction of future trading. The results also revealed that volatility has increased for most of the stocks of Automobiles and Engineering in post future period.*

***Originality/value:*** *This paper will be useful for both investors and regulators in decision making.*

**Keywords:** Future, Automobiles, Engineering, EGARCH M, Run test

**Classification:** Research Paper

## *1. Introduction*

A future contract is an agreement between parties to buy or sell a specified quantity of an asset at a specified price and at a specified time and place. Future contracts are normally traded on an exchange which sets the certain standardized norms for trading in the future contracts. The important types of financial futures contracts are: Stock Future or equity futures, Stock Index futures, Currency futures, and Interest Rate bearing securities like Bonds, T- Bill Futures. *Futures* contracts are one of the most *important* financial innovations in history. Futures were launched mainly with the twin objective of risk transfer and to increase liquidity thereby ensuring better market efficiency. The futures help to assist the business growth by disseminating effective price signals concerning exchange rates, indices and thereby render both cash and derivatives market more efficient.

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India's tryst with equity derivatives began in the year 2000 on the NSE and BSE. Trading first commenced in Index futures contracts in June 2000, followed by index options in June 2001, options in individual stocks in July 2001 and futures in single stock derivatives in November 2001. Since then, equity derivatives have come a long way.

New products; expanding list of eligible investors; rising volumes and best of risk management framework for exchange traded derivatives have been the hallmark of the journey of equity derivatives so far.

The spectacular growth of the derivative market has brought forth the question of the impact of future trading on efficiency of the stock markets in India and where stock market of India stand in terms of stability after introduction of future trading as compared to the developed nations, with which the country has been trying to integrate its markets.

The futures trading may lead to inefficiency in stock market. The rejection of weak form efficiency will enable investors to predict future prices on the basis of past prices through technical analysis to earn abnormal profit. The inefficiency of stock market will help regulators and authorities to determine the best way to influence stock prices, reduce volatility and evaluate the consequences of different economic policies. The introduction of derivative products may increase volatility in component stocks. This is because stock market and derivative trading is linked through arbitrage. market differs from country to country, not only because of the different structure of these markets but mainly due to the different macroeconomic conditions prevailing in each country.

The present research attempt to find whether Indian stock market is affected by introduction of stock future trading in terms of efficiency and volatility.

## 2. Literature Review

Numerous studies are conducted on efficiency of stock market. But there is little agreement among researchers as to the effect of futures contracts on the underlying ready market. Some of the recent studies are presented in this section.

**Efficiency of stock market**

Srinivasan (2010) investigated random walk hypothesis for Indian equity market by using ADF and PP test. He used daily data for the period 1st June, 2005 to 26th March, 2010. He reported that the Indian stock market is not weak form efficient indicating that there is systematic way to exploit the trading opportunities and acquire excess profits.

Singh et al. (2010) tested weak form efficiency hypothesis for Indian stock market. They used data from 1st April 2005 to 31 st March 2007 for Sensex and Nifty. For BSE prices and individual share price, data for one year from 1st April 2006 to 31st March 2007 was used. Serial correlation, unit root, T test and Run test were used. The result showed that Indian stock market is weak form efficient and price changes follow random walk.

Lazar and Nouroul (2009) examined the weak form efficiency of Indian Capital market by using daily returns of S&P CNX Nifty for the period from 3rd November, 1994 to 30 th June, 2008. Augmented Dickey- Fuller (ADF) and Phillips-Perron (PP) tests were employed. The result s Mittal and Jain (2009) studied random walk hypothesis on Indian stock market for the period of 2007-2008. They used run test, T test, unit root test, serial correlation and ANOVA and found that market is informationally efficient.

Chander et al. (2008) studied the weak form efficiency for Indian stock market by using weekly price data of 145 group A listed stocks of BSE for period July, 1996 to December, 2005. Both parametric and non parametric tests were used to test weak form stock market efficiency. The results reported that market is efficient in weak form

Verma and Rao (2007) examined the weak form efficiency of BSE 100 Index Companies for three years (1998-1999, 1999-2000, and 2000-2001). The sample used for testing hypothesis consists of daily adjusted closing prices.

The inferences drawn from serial correlation and run test exhibited that for the first two years, market is not weak form efficient, but the results of year 2000-2001 indicated that the market is weak form efficient.

Ahmad et al. (2006) studied the Nifty and Sensex for random walk hypothesis by using data for 1994- 2004. They applied non parametric test and found negative autocorrelation at lag 2 indicating over reaction one day after information arrival, followed by a correction on the next day. The result reported that market have become relatively more inefficient in recent periods.

Some of the researchers do not support the existence of weak form efficiency (Kulkarni, 1978; Choudhury, 1991; Poshakwale, 1996; Pant and Bishnoi, 2002; Pandey, 2003; Gupta and Basu, 2007; Mishra, 2009 and Mishra and Pradhan, 2009).

**Volatility of stock market**

Majority of the studies reported reduction in the cash market volatility after introduction of derivatives trading. Debashish (2008) studied the effect of future trading on volatility and operating efficiency by collecting data of Nifty for the period of June 1995 to June 2008. He used paired sample statistic and found that introduction of futures trading in India is associated with both reduction in spot price volatility and reduced trading efficiency in the underlying stock market.

Vipul (2006) used S&P CNX Nifty Index and individual stocks (both derivative and non derivative) to study the impact of derivative trading on the stock market volatility. He applied extreme value measure of volatility and GARCH model and found strong evidence of reduction in Extreme Value and GARCH volatility on the introduction of derivatives for all the underlying (excepting Nifty).

Thenmozhi and Sony (2004) analyzed the relationship between stock index futures and corresponding stock market volatility of the NSE Nifty using the GARCH technique and reported reduction of volatility in the underlying stock market had increased market efficiency.

Hetamsaria and Deb (2004) explored the impact of index futures on the Indian stock market volatility using GARCH model and have shown that the introduction of futures resulted in a reduction in the spot market volatility.

Nath (2003) used the IGARCH model to study the behaviour of stock market volatility after the introduction of futures and concluded that the volatility of Nifty index had fallen in the post future period.

Thenmozhi (2002) used the variance ratio test and Ordinary Least Square Multiple Regression Technique to study the impact of the introduction of Nifty index futures on underlying Nifty index volatility in the Indian markets and concluded that futures trading have reduced the volatility in the spot market.

The alternative proposition is that derivative trading increase the volatility in stock market. Sabri (2008) examined the impact of change in trade volume on volatility of stock prices as expressed by unified Arab Monetary fund stock price index. The study covered a sample of eight out of 15 Arab stock markets included in the Arab Monetary Fund database, using monthly data from 1994 to 2006. He reported increase in both trading volume & stock price volatility.

He also found the correlation between volume and price movement is higher in the stock markets of the oil Arab states compared to the non oil Arab states.

Lee and Ohk (1992) for Japan , UK and USA ; Kamara et al. (1992) for the S&P 500 in USA; Antoniou and Holmes (1995) for the FTSE 100 in UK; Chang et al. (1999) for the Nikkie index in Japan; found support to this proposition.

This study is different from previous studies in three ways: a) None of the studies has been conducted by considering stock futures of different sectors. b) It uses EGARCH-M model to measure volatility which is not done by earlier researchers. c) Most of the studies are conducted outside India.

## 3. Research Methodology

### Data Collection

In India, Derivative trading is permitted on NSE & BSE. Since inception, NSE established itself as the sole market leader in derivative segment in the country and during 2009-2010, it accounted for 99% of the market share. We have considered stock future of National Stock Exchange (NSE) for the study. The data set used in this study is the daily closing prices of the stock prices of top 7 companies of 2 major sectors (Automobiles and Engineering) over the different period. The data set is obtained from the web site of the NSE. To evaluate the impact of future trading on efficiency and volatility of stock market, whole period is divided into two parts: pre and post future period. Table 1 depicts the list of individual securities of Automobiles and Engineering sectors used in the study.

**Table 1: List of Securities used for the study**
**Source:** www.nseindia.com

| S. No. | Security | Launch Date | Pre Future Period | Post Future Period | Whole Period |
|---|---|---|---|---|---|
| | Automobiles | | | | |
| 1. | Apollo Tyres Ltd. | 19-02-10 | 01-04-05 to 18-02-10 | 19-02-10 to 31-03-11 | 01-04-05 to 31-03-11 |
| 2. | Bajaj Auto Ltd. | 26-05-08 | 01-04-03 to 25-05-08 | 26-05-08 to 31-03-11 | 01-04-03 to 31-03-11 |
| 3. | Bharat Forge Ltd. | 20-04-05 | 01-04-00 to 19-04-05 | 20-04-05 to 31-03-10 | 01-04-00 to 31-03-10 |
| 4. | Bosch Ltd. | 30-11-07 | 01-04-02 to 29-11-07 | 30-11-07 to 31-03-11 | 01-04-02 to 31-03-11 |
| 5. | HeroHonda Motors Ltd. | 31-01-03 | 01-04-98 to 30-01-03 | 31-01-03 to 31-03-08 | 01-04-98 to 31-03-08 |
| 6. | Mahindra & Mahindra Ltd. | 02-07-01 | 01-04-96 to 01-07-01 | 02-07-01 to 31-03-06 | 01-04-96 to 31-03-06 |
| 7. | Tata Motors Ltd. | 02-07-01 | 01-04-96 to 01-07-01 | 02-07-01 to 31-03-06 | 01-04-96 to 31-03-06 |
| | Engineering | | | | |
| 1. | BEML Ltd. | 29-12-06 | 01-04-01 to 28-12-06 | 29-12-06 to 31-03-11 | 01-04-01 to 31-03-11 |
| 2. | BHEL Ltd. | 02-07-01 | 01-04-96 to 01-07-01 | 02-07-01 to 31-03-06 | 01-04-96 to 31-03-06 |
| 3. | Crompton Greaves Ltd. | 29-12-06 | 01-04-01 to 28-12-06 | 29-12-06 to 31-03-11 | 01-04-01 to 31-03-11 |
| 4. | Cummins India Ltd. | 20-04-05 | 01-04-00 to 19-04-05 | 20-04-05 to 31-03-10 | 01-04-00 to 31-03-10 |
| 5. | PRAJ Industries Ltd. | 29-12-06 | 01-04-01 to 28-12-06 | 29-12-06 to 31-03-11 | 01-04-01 to 31-03-11 |
| 6. | Patel Engineering Ltd. | 14-05-07 | 01-04-05 to 13-05-07 | 14-05-07 to 31-03-11 | 01-04-05 to 31-03-11 |
| 7. | Larsen & Turbo Ltd. | 15-09-06 | 01-04-04 to 14-09-06 | 15-09-06 to 31-03-11 | 01-04-04 to 31-03-11 |

### Methodology of the Study

We have applied run test to study the impact of future trading on the weak form efficiency of stock market:

**Run test**

It is also called Wald-Wolfowitz test. This test is an appropriate statistical technique to test the weak form market efficiency. A run is defined as a series of consecutive returns of the same sign. "+" stands for a price increase, "-"stands for a price decrease, and "0" stands for no change in price. To test the randomness of distribution, the data whose value is greater than median is marked with + sign, with – sign the data less than the median. Suppose the price changes are independent, the total number of expected runs E(r) can be estimated as for large samples as:

$$E(r) = \frac{2N_1 N_2}{N} + 1$$

Where N is total number of observation $(N_1 + N_2)$
$N_1$ = the number of price changes (+ sign)
$N_2$ = the number of price changes (- sign)

If the number of observation is large (N>30), E(r) has normal distribution. The variance of E(r) $(\sigma_r^2)$ is given by:

$$\sigma_r^2 = \frac{2N_1 N_2 (2N_1 N_2 - 1)}{(N)^2 (N - 1)}$$

$$\text{Prob } (E(r) - 1.96\sigma_r \le R \le E(r) + 1.96\sigma_r) = 0.95$$

Where R is actual number of runs.

The standard normal Z test statistics used to conduct a run test is given by:

$$Z = \frac{(R \pm 0.5) - E(r)}{\sigma_r}$$

R= Actual number of runs
E(r) = Expected number of runs
$\sigma_r$ = Std. error of expected number of runs
The hypotheses for Runs Tests are:
$H_o$: R = E(r)
$H_1$: R ≠ E(r)

The null hypothesis states that the total number of observed runs R is equal to the number of expected runs E(r). The decision rules for this test (at a significance level of = 0.05) is to reject the Ho when |Z| > 1.96. Once this occurs, we can conclude that the price changes are not random.

**Impact of future trading on the volatility of stock market**

We have applied following test to study the impact of future trading on the volatility of stock market:

**1. Arch Lm test**

One of the key assumptions of ordinary regression model is that the errors have the same variance throughout the sample.

If the error variance is not constant, the data are said to be hetroscedastic. In the presence of hetroscedasticity, ordinary regression do not render best linear unbiased estimator (BLUE). We have used ARCH LM method to test the hetroscedasicity in the time series.

Engle (1982) introduced a new approach for modeling heteroscedasticity in a time series. He called it the ARCH (Autoregressive conditional heteroscedasticity) model. The process by which the variances are generated is assumed to be as follows:

$$\sigma_1^2 = \alpha_0 + \alpha_1\mu_{t-1}^2 + \ldots\ldots\ldots + \alpha_p\mu_{t-p}^2$$

This equation is known as $p^{th}$ order ARCH process.

**1. Egarch- M model**

An EGARCH-M model was introduced by Nelson (1991) in order to overcome the limitations of the GARCH and GARCH-M models.

Following is the specification of EGARCH-M model:

Mean equation:

$$R_t = a_0 + a_1 R_{t-1} + a_2 R_{S\&P500-1} + \lambda\sigma_t^2 + \varepsilon_t$$

Where $\alpha_1$ is the coefficient of lagged return, $\alpha_2$ is coefficient of return of S&P500 and $\lambda$ measures the risk premium.

Variance equation:

$$\log(\sigma_t^2) = \omega + a\,\frac{\varepsilon_{t-1}}{\sigma_{t-1}} + \gamma\left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right| + \beta\log(\sigma_{t-1}^2)$$

Where $\alpha$ measures the impact of recent news on the volatility, $\gamma$ estimates the asymmetric effect of news and $\beta$ indicates the persistence of volatility.

## 4. Ordinary Least Square Regression Model

One of the key assumptions of ordinary regression model is that the errors have the same variance throughout the sample. This is also called the homoscedasticity model. Since some of the series in our data is homoscedastic, we have to use ordinary least square method to determine the volatility. Following is the equation of OLS model:

$$R_t = \beta_0 + \beta_1 R_{t-1} + \beta_2 R_{S\&P500-1}$$

Where $\beta_0$ measures the volatility, $\beta_1$ measures the dependence of return on its lagged value; $\beta_2$ depicts dependence of returns on lagged returns of S&P 500.

## 5. Analysis and Discussion

The results are presented sector wise. ADF test was applied to check the stationarity of return and results showed that returns of all companies of Automobiles and Engineering sectors are stationary.

**Descriptive Statistic:** Table 2 shows the descriptive statistic for pre and post future period. The results are analyzed sector wise.

Automobiles: In post future period, average return has increased for all companies except Bharat Forge Ltd. and Bosch Ltd. The standard deviation has decreased for all companies except Bharat Forge Ltd. and Tata Motors Ltd. after introduction of future trading.

The skewness has also decreased for all companies except Bharat Forge Ltd., Mahindra & Mahindra Ltd. and Tata Motors Ltd. in post future period. The value of kurtosis is more than 3 for returns of all the companies in both periods. The Jarque Bera test also rejects the null hypothesis of the normality as p value is less than 0.05 which implies that the series doesn't follow random walk.

Engineering: In post future period, average return has decreased for all companies except BHEL Ltd. and Cummins India Ltd. The standard deviation has decreased for all companies except Patel Engineering Ltd. and Larsen & Turbo Ltd. after introduction of future trading. The skewness has also decreased for all companies except BEML Ltd., BHEL Ltd. and Larsen & Turbo Ltd. in post future period. The value of kurtosis is more than 3 for returns of all the companies in both periods. The Jarque Bera test also rejects the null hypothesis of the normality as p value is less than 0.05 which implies that the series doesn't follow random walk.

**Table 2: Descriptive Statistic**

| S.No. | Security | Mean | | Standard Deviation | | Skewness | | Kurtosis | | Jarque- Bera Test | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Pre | Post | Pre | Post | Pre | Post | Pre | Post | Pre | Post |
| Automobiles | | | | | | | | | | | |
| 1. | Apollo Tyres Ltd. | -0.0013 | 0.0006 | 0.0707 | 0.0289 | -26.124 | 0.4681 | 828.93 | 4.5056 | 3453006 | 36.6746 |
| | | | | | | | | | | (0.0000) | (0.0000) |
| 2. | Bajaj Auto Ltd. | 0.0002 | 0.0004 | 0.0355 | 0.0298 | -17.082 | 0.0806 | 476.50 | 8.1279 | 1213257 | 773.1989 |
| | | | | | | | | | | (0.0000) | (0.0000) |
| 3. | Bharat Forge Ltd. | 0.0016 | -0.0013 | 0.1451 | 0.2276 | -0.0607 | -0.3457 | 116.84 | 56.553 | 686917 | 150471.9 |
| | | | | | | | | | | (0.0000) | (0.0000) |
| 4. | Bosch Ltd. | 0.0004 | 0.0004 | 0.0633 | 0.0189 | -32.313 | 1.43587 | 1157.4 | 24.986 | 7893813 | 16838.78 |
| | | | | | | | | | | (0.0000) | (0.0000) |
| 5. | Hero Honda Motors Ltd. | -0.0009 | 0.0007 | 0.0765 | 0.0225 | -7.1692 | -0.0251 | 178.64 | 4.4827 | 1701708 | 118.9441 |
| | | | | | | | | | | (0.0000) | (0.0000) |
| 6. | Mahindra & Mahindra Ltd. | -0.0008 | 0.0017 | 0.0328 | 0.0315 | -0.1652 | -8.7271 | 4.7705 | 194.45 | 4.7705 | 183874 |
| | | | | | | | | | | (0.0000) | (0.0000) |
| 7. | Tata Motors Ltd. | -0.0001 | 0.0012 | 0.6598 | 0.6681 | 0.0079 | -0.0033 | 4.4311 | 4.4885 | 171.053 | 201.0729 |
| | | | | | | | | | | (0.0000) | (0.0000) |
| Engineering | | | | | | | | | | | |
| 1. | BEML Ltd. | 0.0024 | -0.0003 | 0.0383 | 0.0277 | 0.6311 | 0.3349 | 8.8927 | 7.7674 | 2362.21 | 1015.927 |
| | | | | | | | | | | (0.0000) | (0.0000) |
| 2. | BHEL Ltd. | 0.0003 | 0.0021 | 0.0331 | 0.0245 | 0.0112 | -0.6859 | 4.1094 | 12.735 | 71.4246 | 4808.09 |
| | | | | | | | | | | (0.0000) | (0.0000) |
| 3. | Crompton Greaves Ltd. | 0.0014 | 0.0002 | 0.0529 | 0.0367 | -17.694 | -3.5380 | 523.98 | 59.343 | 1639456 | 141345.9 |
| | | | | | | | | | | (0.0000) | (0.0000) |
| 4. | Cummins India Ltd. | -0.0010 | 0.0013 | 0.0521 | 0.0268 | -23.214 | 0.1285 | 719.98 | 6.2106 | 2727398 | 529.5316 |
| | | | | | | | | | | (0.0000) | (0.0000) |
| 5. | PRAJ Industries Ltd. | 0.0025 | -0.0009 | 0.0861 | 0.0445 | -13.456 | -3.1920 | 359.83 | 52.347 | 7085583 | 108526.9 |
| | | | | | | | | | | (0.0000) | (0.0000) |
| 6. | Patel Engineering Ltd. | 0.0021 | -0.0011 | 0.0318 | 0.0351 | 0.2643 | 0.5135 | 3.6210 | 7.8157 | 15.2717 | 973.9107 |
| | | | | | | | | | | (0.0004) | (0.0000) |
| 7. | Larsen & Turbo Ltd. | 0.0024 | -0.0004 | 0.0226 | 0.0406 | 0.3142 | -9.2167 | 4.5438 | 165.62 | 65.0618 | 1255428 |
| | | | | | | | | | | (0.0000) | (0.0000) |

**Run Test:** Since descriptive statistic and Jarque Bera test rejects the null hypothesis of normality, it will not be suitable to apply parametric test to see impact of future trading on efficiency of the Indian stock market. Therefore, we have applied non parametric test i.e. Run test to check the efficiency. Table 3 shows the result of Run test.

### Table 3: Run test using Median

| S. No. | Security | Test Value | | Cases < Test Value | | Cases >= Test Value | | Total Cases | | Number of Runs | | Z statistic | | Asymp. Sig. (2-tailed) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Pre | Post | Pre | Post | Pre | Post | Pre | Post | Pre | Post | Pre | Post | Pre | Post |
| Automobiles | | | | | | | | | | | | | | | |
| 1. | Apollo Tyres Ltd. | -0.001 | -0.002 | 605 | 140 | 605 | 140 | 1210 | 280 | 585 | 132 | -1.208 | -1.078 | 0.227 | 0.281 |
| 2. | Bajaj Auto Ltd. | 0.001 | -0.000 | 646 | 351 | 646 | 354 | 1292 | 705 | 645 | 334 | -0.111 | -1.469 | 0.911 | 0.142 |
| 3. | Bharat Forge Ltd. | 0.000 | -0.001 | 636 | 629 | 636 | 630 | 1272 | 1259 | 602 | 613 | -1.963 | -0.987 | 0.050 | 0.324 |
| 4. | Bosch Ltd. | 0.001 | -0.000 | 708 | 411 | 709 | 411 | 1417 | 822 | 733 | 398 | 1.249 | -0.977 | 0.212 | 0.328 |
| 5. | Hero Honda Motors Ltd. | 0.000 | 0.000 | 656 | 648 | 659 | 649 | 1315 | 1297 | 689 | 657 | 1.683 | 0.417 | 0.092 | 0.677 |
| 6. | Mahindra & Mahindra Ltd. | -0.002 | 0.002 | 707 | 597 | 707 | 597 | 1414 | 1194 | 694 | 543 | -0.745 | -3.185 | 0.456 | 0.001 |
| 7. | Tata Motors Ltd. | -0.001 | 0.002 | 1002 | 1089 | 1002 | 1089 | 2004 | 2178 | 1228 | 1484 | 10.06 | 16.89 | 0.000 | 0.000 |
| Engineering | | | | | | | | | | | | | | | |
| 1. | BEML Ltd. | -0.001 | -0.001 | 780 | 526 | 781 | 526 | 1561 | 1052 | 792 | 484 | 0.532 | -2.653 | 0.595 | 0.008 |
| 2. | BHEL Ltd. | -0.000 | 0.001 | 696 | 597 | 696 | 597 | 1392 | 1194 | 699 | 588 | 0.107 | -0.579 | 0.915 | 0.563 |
| 3. | Crompton Greaves Ltd. | 0.000 | 0.000 | 721 | 524 | 722 | 528 | 1443 | 1052 | 722 | 516 | -0.026 | -0.678 | 0.979 | 0.498 |
| 4. | Cummins India Ltd. | -0.001 | 0.000 | 634 | 612 | 634 | 613 | 1268 | 1225 | 633 | 623 | -0.112 | 0.543 | 0.911 | 0.587 |
| 5. | PRAJ Industries Ltd. | 0.000 | 0.000 | 650 | 522 | 678 | 530 | 1328 | 1052 | 639 | 528 | -1.412 | 0.064 | 0.158 | 0.949 |
| 6. | Patel Engineering Ltd. | -0.001 | -0.002 | 275 | 482 | 276 | 482 | 551 | 964 | 260 | 443 | -1.407 | -2.578 | 0.159 | 0.010 |
| 7. | Larsen & Turbo Ltd. | 0.002 | 0.001 | 281 | 562 | 281 | 563 | 562 | 1125 | 284 | 524 | 0.169 | -2.356 | 0.866 | 0.018 |

Automobiles: In pre future period, the run test can't reject the null hypothesis of random walk for returns of all companies except Bharat Forge Ltd. and Tata Motors Ltd. In post future period, the run test can't reject the null hypothesis of random walk for returns of all companies except Mahindra & Mahindra Ltd. and Tata Motors Ltd. This implies Bharat Forge Ltd. has become efficient and Mahindra & Mahindra Ltd. became inefficient in post future period.

Engineering: In pre future period, the run test can't reject the null hypothesis of random walk for returns of all companies.

In post future period, run test can't reject the null hypothesis of random walk for returns of all companies except BEML Ltd., Patel Engineering Ltd. and Larsen & Turbo Ltd. This implies that BEML Ltd., Patel Engineering Ltd. and Larsen & Turbo Ltd. became inefficient in weak form after introduction of future trading.

**ARCH LM test:** The impact of future trading on volatility of stock market is evaluated by applying ARCH LM and EGARCH M test. The results of ARCH LM are reported in Table 4. The result showed:

Automobiles: In pre future period, ARCH LM test reject the null hypothesis of homoscedasticity for most of the companies except Apollo Tyres Ltd., Bajaj Auto Ltd. and Bosch Ltd. In post future period, ARCH LM test reject the null hypothesis of homoscedasticity for most of the companies except Apollo Tyres Ltd., Bosch Ltd. and Mahindra & Mahindra Ltd.

Engineering: In pre future period, ARCH LM test reject the null hypothesis of homoscedasticity for most of the companies except Crompton Greaves Ltd., Cummins India Ltd. and PRAJ Industries Ltd. In post future period, ARCH LM test reject the null hypothesis of homoscedasticity for most of the companies except Crompton Greaves Ltd., PRAJ Industries Ltd. and Larsen & Turbo Ltd. ARCH LM test provides mixed results regarding presence of hetroscedasticity in series. This implies that returns of some companies are hetroscedastic while returns of other companies are homoscedastic. EGARCH M test will be applied in hetroscedastic series and OLS regression will be applied in homoscedastic series.

### Table 4: ARCH LM Test

| S. No. | Security | F Statistic | | Observed R Squared | |
|---|---|---|---|---|---|
| | | Pre | Post | Pre | Post |
| **Automobiles** | | | | | |
| 1. | Apollo Tyres Ltd. | 1.5366 | 1.4838 | 1.5382 | 1.4865 |
| | | (0.2157) | (0.2242) | (0.2148) | (0.2227) |
| 2. | Bajaj Auto Ltd. | 0.0082 | 86.9526 | 0.0082 | 77.577 |
| | | (0.9274) | (0.0000) | (0.9274) | (0.0000) |
| 3. | Bharat Forge Ltd. | 119.7414 | 230.2549 | 109.5527 | 194.5567 |
| | | (0.0000) | (0.0000) | (0.0000) | (0.0000) |
| 4. | Bosch Ltd. | $2.26 \times 10^{-5}$ | 1.5044 | $2.27 \times 10^{-5}$ | 1.5053 |
| | | (0.9962) | (0.2203) | (0.9962) | (0.2198) |
| 5. | Hero Honda Motors Ltd. | 38.5638 | 48.8559 | 37.4354 | 47.1499 |
| | | (0.0000) | (0.0000) | (0.0000) | (0.0000) |
| 6. | Mahindra & Mahindra Ltd. | 45.8433 | $2.65 \times 10^{-6}$ | 44.3728 | $2.65 \times 10^{-6}$ |
| | | (0.0000) | (0.9987) | (0.0000) | (0.9987) |
| 7. | Tata Motors Ltd. | 99.2251 | 5.5922 | 92.0908 | 5.5754 |
| | | (0.0000) | (0.0182) | (0.0000) | (0.0182) |
| **Engineering** | | | | | |
| 1. | BEML Ltd. | 119.3775 | 21.7106 | 110.3917 | 21.3105 |
| | | (0.0000) | (0.0000) | (0.0000) | (0.0000) |
| 2. | BHEL Ltd. | 29.6893 | 189.5605 | 29.0806 | 163.7698 |
| | | (0.0000) | (0.0000) | (0.0000) | (0.0000) |
| 3. | Crompton Greaves Ltd. | 0.0009 | 0.0845 | 0.0009 | 0.0847 |
| | | (0.9754) | (0.7713) | (0.9754) | (0.7710) |
| 4. | Cummins India Ltd. | 0.0016 | 10.5075 | 0.0016 | 10.4350 |
| | | (0.9680) | (0.0012) | (0.9679) | (0.0012) |
| 5. | PRAJ Industries Ltd. | 0.0904 | 0.1805 | 0.0905 | 0.1808 |
| | | (0.7637) | (0.6710) | (0.7635) | (0.6706) |
| 6. | Patel Engineering Ltd. | 17.2187 | 144.0455 | 16.7542 | 125.5127 |
| | | (0.0000) | (0.0000) | (0.0000) | (0.0000) |
| 7. | Larsen & Turbo Ltd. | 18.8610 | 0.00429 | 18.3097 | 0.00429 |
| | | (0.00001) | (0.9477) | (0.0000) | (0.9477) |

**EGARCH M test:** The results of mean equation of EGARCH M test are reported in Table 5. The results are analyzed sector wise.

Automobiles: The returns of all the companies are not significantly related to their lagged values in pre future period except Mahindra & Mahindra Ltd. And Tata Motors Ltd. In post future period, returns of Mahindra & Mahindra Ltd. Are significantly related to its lagged value. The returns of all the companies are not significantly related to lagged returns of S&P 500 index in both pre and post future period. The coefficient of risk premium is significant for Tata Motors Ltd. In pre future period.

Engineering: The returns of all the companies are not significantly related to their lagged values in pre future period except Patel Engineering Ltd. While the returns of BEML Ltd. And Patel Engineering Ltd. Are significantly related to their lagged value in post future period. The returns of all the companies are not significantly related to lagged returns of S&P 500 index in pre future period except BEML Ltd.

In post future period, the returns of all the companies are not significantly related to lagged returns of S&P 500 index in post future period. The coefficient of risk premium is not significant for all companies in pre and post future period.

### Table 5: Mean Equation of EGARCH M

| S.No. | Security | $\alpha_0$ | | $\alpha_1$ | | $\alpha_2$ | | $\lambda$ | |
|-------|----------|-----|------|-----|------|-----|------|-----|------|
| | | Pre | Post | Pre | Post | Pre | Post | Pre | Post |
| **Automobiles** | | | | | | | | | |
| 1. | Apollo Tyres Ltd. | - | - | - | - | - | - | - | - |
| | | - | - | - | - | - | - | - | - |
| 2. | Bajaj Auto Ltd. | - | 0.0027 | - | 0.0943 | - | 0.0648 | - | -3.1057 |
| | | - | (0.0834) | - | (0.0567) | - | (0.4894) | - | (0.1409) |
| 3. | Bharat Forge Ltd. | -0.0617 | -0.0025 | 0.0282 | -0.0436 | 0.1461 | 0.0262 | 5.4590 | -0.9561 |
| | | (0.5059) | (0.0193) | (0.7119) | (0.386) | (0.3909) | (0.6777) | (0.503) | (0.6569) |
| 4. | Bosch Ltd. | - | - | - | - | - | - | - | - |
| | | - | - | - | - | - | - | - | - |
| 5. | Hero Honda Motors Ltd. | -0.0037 | -0.0009 | 0.2532 | -0.0228 | 0.1731 | 0.0679 | $6.48 \times 10^{-5}$ | 3.3177 |
| | | (0.4838) | (0.5527) | (0.5469) | (0.4845) | (0.6163) | (0.3638) | (0.9621) | (0.2881) |
| 6. | Mahindra & Mahindra Ltd. | 0.0003 | - | 0.0698 | - | -0.0423 | - | -0.3341 | - |
| | | (0.8458) | - | (0.0253) | - | (0.5495) | - | (0.8462) | - |
| 7. | Tata Motors Ltd. | -0.0094 | -1.5435 | -0.6009 | -0.3487 | -0.0556 | -0.2685 | 0.0348 | 4.3813 |
| | | (0.1398) | (0.0000) | (0.0000) | (0.0000) | (0.8953) | (0.7212) | (0.4545) | (0.0000) |
| **Engineering** | | | | | | | | | |
| 1. | BEML Ltd. | 0.0011 | $-8.87 \times 10^{-5}$ | 0.0385 | 0.1553 | -0.2653 | 0.0314 | 1.0867 | -0.7768 |
| | | (0.4892) | (0.9268) | (0.2329) | (0.0000) | (0.0052) | (0.5254) | (0.3946) | (0.6297) |
| 2. | BHEL Ltd. | 0.0015 | 0.0012 | 0.0372 | 0.0365 | -0.0674 | -0.0103 | -1.0026 | 1.2765 |
| | | (0.478) | (0.3166) | (0.2183) | (0.3071) | (0.3445) | (0.8521) | (0.6403) | (0.6134) |
| 3. | Crompton Greaves Ltd. | - | - | - | - | - | - | - | - |
| | | - | - | - | - | - | - | - | - |
| 4. | Cummins India Ltd. | - | 0.0013 | - | 0.0020 | - | 0.0465 | - | -0.3449 |
| | | - | (0.5079) | - | (0.95) | - | (0.4181) | - | (0.9071) |
| 5. | PRAJ Industries Ltd. | - | - | | - | | - | | - |
| | | - | - | - | - | - | - | - | - |
| 6. | Patel Engineering Ltd. | 0.0146 | -0.0009 | 0.2267 | 0.0881 | -0.0647 | -0.0342 | -13.6566 | -0.4285 |
| | | (0.1013) | (0.4403) | (0.0000) | (0.0302) | (0.7437) | (0.5796) | (0.1382) | (0.7567) |
| 7. | Larsen & Turbo Ltd. | 0.0036 | - | -0.0231 | - | 0.1772 | - | -2.4232 | - |
| | | (0.102) | - | (0.6262) | - | (0.1614) | - | (0.6413) | - |

The results of variance equation of E GARCH M are presented in table 6. The results are analyzed sector wise.

Automobiles: In pre future period, volatility is significantly sensitive to market events for Hero Honda Motors Ltd., Mahindra & Mahindra Ltd. and Tata Motors Ltd. In post future period, volatility is significantly sensitive to market events for Bajaj Auto Ltd., Hero Honda Motors Ltd. and Tata Motors Ltd. This implies that volatility of Mahindra & Mahindra Ltd. insignificantly sensitive to market news and volatility of Bajaj Auto Ltd. became significantly sensitive to market news after introduction of future trading. In pre future period, the good news has greater impact on volatility of Hero Honda Motors Ltd. as compared to bad news which disappeared in post future period. In pre future period, bad news has greater impact on volatility of Mahindra & Mahindra Ltd. as compared to good news which disappeared in post future period. While the volatility of Tata Motors Ltd. became significantly sensitive to bad news as compared to good news in post future period. The persistence of volatility has increased for most of the companies except Tata Motors Ltd.

Engineering: In pre future period, volatility is significantly sensitive to market events for BEML Ltd., BHEL Ltd., Patel Engineering Ltd. and Larsen & Turbo Ltd. In post future period, volatility is significantly sensitive to market events for BEML Ltd., BHEL Ltd., Cummins India Ltd., and Patel Engineering Ltd. This implies that volatility of Cummins India Ltd. is significantly sensitive to market news during post future period while the volatility of Larsen & Turbo Ltd. is insignificantly sensitive to market news during post future period. In pre future period, bad news has greater impact on volatility of BHEL Ltd. which disappeared in post future period. The persistence of volatility has increased for all companies except Larsen & Turbo Ltd.

## Table 6: Variance Equation of EGARCH M

| S. No. | Security | ω | | A | | γ | | β | |
|---|---|---|---|---|---|---|---|---|---|
| | | Pre | Post | Pre | Post | Pre | Post | Pre | Post |
| **Automobiles** | | | | | | | | | |
| 1. | Apollo Tyres Ltd. | - | - | - | - | - | - | - | - |
| | | - | - | - | - | - | - | - | - |
| 2. | Bajaj Auto Ltd. | - | -0.1052 | - | 0.1068 | - | 0.0151 | - | 0.9966 |
| | | - | (0.0224) | - | (0.0003) | - | (0.5803) | - | (0.0000) |
| 3. | Bharat Forge Ltd. | -4.5655 | -0.0606 | 0.2199 | 0.0801 | -0.0043 | -0.0843 | -0.0048 | 0.9978 |
| | | (0.0000) | (0.5589) | (0.781) | (0.2623) | (0.9952) | (0.0534) | (0.9861) | (0.0000) |
| 4. | Bosch Ltd. | - | - | - | - | - | - | - | - |
| | | - | - | - | - | - | - | - | - |
| 5. | Hero Honda Motors Ltd. | -3.3101 | -2.2350 | 1.3849 | 0.4022 | 0.8646 | -0.0368 | 0.5877 | 0.7477 |
| | | (0.0000) | (0.0000) | (0.0084) | (0.0000) | (0.0000) | (0.3681) | (0.0000) | (0.0000) |
| 6. | Mahindra & Mahindra Ltd. | -0.1358 | - | 0.0832 | - | -0.0337 | - | 0.9894 | - |
| | | (0.0335) | - | (0.002) | - | (0.035) | - | (0.0000) | - |
| 7. | Tata Motors Ltd. | -0.1100 | -1.0028 | 0.1230 | -0.0901 | 0.0694 | -0.3382 | 0.9928 | 0.0191 |
| | | (0.0003) | (0.0000) | (0.0003) | (0.0000) | (0.4324) | (0.0000) | (0.0000) | (0.0000) |
| **Engineering** | | | | | | | | | |
| 1. | BEML Ltd. | -0.7374 | -0.5542 | 0.3306 | 0.2918 | -0.0506 | -0.0213 | 0.9250 | 0.9539 |
| | | (0.0001) | (0.0883) | (0.0000) | (0.0012) | (0.1702) | (0.6709) | (0.0000) | (0.0000) |
| 2. | BHEL Ltd. | -1.0376 | -1.0142 | 0.2492 | 0.3026 | -0.0628 | -0.0898 | 0.8767 | 0.8962 |
| | | (0.0001) | (0.0021) | (0.0000) | (0.0002) | (0.0404) | (0.0982) | (0.0000) | (0.0000) |
| 3. | Crompton Greaves Ltd. | - | - | - | - | - | - | - | - |
| | | - | - | - | - | - | - | - | - |
| 4. | Cummins India Ltd. | - | -1.1612 | - | 0.2342 | - | -0.0617 | - | 0.8641 |
| | | - | (0.0041) | - | (0.0000) | - | (0.072) | - | (0.0000) |
| 5. | PRAJ Industries Ltd. | - | - | - | - | - | - | - | - |
| | | - | - | - | - | - | - | - | - |
| 6. | Patel Engineering Ltd. | -0.9125 | -0.5463 | 0.1424 | 0.3259 | -0.0082 | -0.0542 | 0.8854 | 0.9570 |
| | | (0.0651) | (0.0005) | (0.0479) | (0.0000) | (0.7886) | (0.1483) | (0.0000) | (0.0000) |
| 7. | Larsen & Turbo Ltd. | -0.7228 | - | 0.2569 | - | 0.0003 | - | 0.9327 | - |
| | | (0.0063) | - | (0.0001) | - | (0.994) | - | (0.0000) | - |

**Ordinary Least Square Regression Test:** Since some of the series in our data is homoscedastic, we have to use ordinary least square method to determine the volatility. Table 7 shows the results of OLS regression model. The results are analyzed sector wise

Automobiles: In pre future period, the returns of Bajaj Auto Ltd. are significantly related to its lagged value. While the returns of all companies are insignificantly related to their lagged values in post future period. The returns of Bajaj Auto Ltd. are significantly related to lagged returns of S&P 500 index. The coefficient of volatility is insignificant for all the companies.

Engineering: In pre future period, the returns of PRAJ Industries Ltd. are significantly related to its lagged value. In post future period, the returns of all companies are insignificantly related to its lagged value. The returns of Larsen & Turbo Ltd. are significantly related to lagged returns of S&P 500 index in post future period. The coefficient of volatility is insignificant for all the companies.

**Table 7: OLS Regression Model**

| S. No. | Security | $\beta_0$ | | $\beta_1$ | | $\beta_2$ | |
|---|---|---|---|---|---|---|---|
| | | Pre | Post | Pre | Post | Pre | Post |
| **Automobiles** | | | | | | | |
| 1. | Apollo Tyres Ltd. | 0.0003 | 0.0007 | -0.0121 | 0.0961 | 0.1275 | -0.2371 |
| | | (0.7495) | (0.6594) | (0.8008) | (0.1096) | (0.43) | (0.1401) |
| 2. | Bajaj Auto Ltd. | $9.81 \times 10^{-5}$ | - | 0.0997 | - | 0.3481 | - |
| | | (0.9204) | - | (0.0003) | - | (0.0029) | - |
| 3. | Bharat Forge Ltd. | - | - | - | - | - | - |
| | | - | - | - | - | - | - |
| 4. | Bosch Ltd. | 0.0005 | 0.0004 | -0.0114 | 0.0315 | 0.0719 | 0.0114 |
| | | (0.7781) | (0.508) | (0.6687) | (0.5036) | (0.6689) | (0.8319) |
| 5. | Hero Honda Motors Ltd. | - | - | - | - | - | - |
| | | - | - | - | - | - | - |
| 6. | Mahindra & Mahindra Ltd. | - | 0.0016 | - | 0.0519 | - | 0.0348 |
| | | - | (0.0752) | - | (0.0737) | - | (0.6787) |
| 7. | Tata Motors Ltd. | - | - | - | - | - | - |
| | | - | - | - | - | - | - |
| **Engineering** | | | | | | | |
| 1. | BEML Ltd. | - | - | - | - | - | - |
| | | - | - | - | - | - | - |
| 2. | BHEL Ltd. | - | - | - | - | - | - |
| | | - | - | - | - | - | - |
| 3. | Crompton Greaves Ltd. | 0.0015 | 0.0002 | -0.0273 | 0.0290 | 0.0625 | 0.0490 |
| | | (0.286) | (0.8516) | (0.2996) | (0.3481) | (0.6374) | (0.4624) |
| 4. | Cummins India Ltd. | -0.0009 | - | -0.0032 | - | 0.1554 | - |
| | | (0.5099) | - | (0.9098) | - | (0.1924) | - |
| 5. | PRAJ Industries Ltd. | 0.0028 | -0.0010 | -0.0968 | 0.0119 | -0.1322 | 0.1221 |
| | | (0.2386) | (0.4624) | (0.0004) | (0.7003) | (0.5415) | (0.1319) |
| 6. | Patel Engineering Ltd. | - | - | - | - | - | - |
| | | - | - | - | - | - | - |
| 7. | Larsen & Turbo Ltd. | - | -0.0004 | - | 0.0581 | - | 0.1591 |
| | | - | (0.7339) | - | (0.0514) | - | (0.0304) |

## *Conclusion*

This research used time-series data to examine the impact of future trading on volatility and efficiency of stock market. It uses closing prices of top 7 stocks of Automobile and Engineering sectors to compare impact of future trading on different sectors. The study also uses lagged return of S&P 500 index to see spillover effect between Indian market and US market. It applied Run test to see impact of future trading on efficiency of stock market. It also used ARCH LM and EGARCH M model to test impact of future trading on volatility of stock market. The run test showed that future trading has mixed effect on efficiency of both the sectors i.e. some stocks has become efficient while other became inefficient after the introduction of future trading. The results of mean equation of EGARCH M showed that most of the stocks are not significantly related to their lagged returns and lagged returns of S&P500 index. The coefficient of risk premium is insignificant for all the companies of both sectors Tata Motors Ltd. in pre future period. The persistence of volatility has increased for most of the stocks of Automobiles and Engineering in post future period. Therefore, we can conclude that futures trading increased volatility for stocks of both Automobile and Engineering sectors.

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