International Research Journal of Finance and Economics
ISSN 1450-2887 Issue 99 October, 2012

http://www.internationalresearchjournaloffinanceandeconomics.com

Impact of Single Stock Futures on the Volatility of Underlying Indian Stocks

Rakesh Gupta
Department of Accounting, Finance and Economics
Griffith Business School, Griffith University, Nathan Campus QLD 4111, Australia
E-mail: r.gupta@griffith.edu.au
Tel: +61737357593; Fax: +617 37353719

Thadavillil Jithendranathan
Department of Finance, Opus College of Business, University of St Thomas, 2115 Summit Avenue, MCH316, St. Paul, MN 55105, USA
E-mail: T9jithendran@stthomas.edu
Tel: +16519625123; Fax: +16519625093

Abstract

This study aims to test the influence of the introduction of derivative contracts on the volatility of the underlying asset. This study uses the introduction of single stock futures (SSF) listed on the National Stock Exchange of India to test the influence on the volatility of the underlying stock returns. An interesting aspect of the Indian SSF market is that for many of the stocks the volume traded on the SSF market is higher than that of the underlying stock market. Results support the hypothesis that introduction of single stock futures reduce the volatility of the returns of the underlying stock. Results of the study are statistically significant. We make important contributions to the understanding of the impact of introduction of stock futures on the behavior of underlying asset by using single stock futures in the Indian market.

I. Introduction

The main focus of this paper is to address the issue of identifying the role, if any of derivatives in influencing the volatility of emerging stock markets? In the recent years equity index based derivative securities have been introduced in several emerging markets and there are some studies that look into the impact of these derivatives on the volatilities of the underlying stocks[1]. Since the index futures are based on a basket of individual stocks, it is difficult to interpret the results of these studies at an individual stock level as the change in the volatility of the underlying index returns may be because of the change in the volatilities of the constituent assets of the index and not because of the introduction of the derivative. This study uses the Single Stock Futures (SSFs) where the underlying asset is a single stock to study the impact of these contracts on the volatility of the underlying stock.

Introduction of a derivative contract can reduce the volatility of the underlying asset by allowing the speed at which new information is incorporated into the underlying asset price[2]. The

1 Kan (1997), Pok and Poshakwale (2004), Ryoo and Smith (2004), Zhong, Darrat and Otero (2004), Drimbetas, Sariannidis, and Porfiris (2007), Kasman and Kasman (2008).

2 In the context of equity markets in India, in its recommendations LC Gupta committee argued that by introduction of derivative instruments speculative transactions that took place in the spot market will get transferred to the derivative market thereby reducing the volatility of the spot market.

volatility-reducing effect of SSFs should also be greatest in markets where there are little or no short-sales. A study by Bris, Goetzmann and Zhu (2007) find that majority of the emerging markets do not allow short-sales or the short-sales are severely restricted. When short-selling is limited or outright banned the market participants are denied an opportunity to capitalize negative information into prices quickly and in a cost effective way. As pointed out by Weller and Yano (1987), futures contracts may complete the markets and thereby reduce the spot market volatility.

When it comes to using equity derivatives as a vehicle to incorporate information the general perception as expressed by Fratzscher (2006) is that "…equity derivatives have usually reduced volatility and strengthened liquidity in equity markets, enhanced returns to institutional investors such as mutual or pension funds, and reduced the cost of equity listings for firms." However, introduction of derivative contracts can lead to destabilization of the spot market due to the speculative trading in the derivative market. However, while the primary motive for derivatives usage is to reduce volatility the research appears to be mixed. Previous studies tend to be of two categories; theoretical and empirical.

Several studies such as Baldauf and Samoni (1991), Antoninon and Foster (1992), Pinceli and Kaoutnous (1997), Galloway and Miller (1997), Dennis and Sim (1999), and Rahmen (2001) generally confirmed the assertion that speculative traders in futures markets stabilize or even reduce spot market volatility. These theoretical explanations are similar to Harris (1989) in that an increase in well informed speculative traders decreases spot volatility. In comparison, relatively few papers suggest that speculation, sometimes referred to as "excess speculation", in futures leads to destabilization in spot markets, e.g. Lee and Ohk (1992) and Antonu and Holmes (1995).

There is a long history of studies on the effect of derivatives on the commodity markets such as Kaldor (1939), Stein (1961), Peck (1976), Turnovsky (1983), Kawai (1983) and Weller and Yano (1987). Likewise, there have also been many studies of the effects of derivatives on the pricing and volatility of financial assets. Among these studies are Froewiss (1978), and Figlewski (1981) all of which were on GNMA securities. Studies done on T-bills include Simpson and Ireland (1985). A study on T-Bonds was done by Bortz (1984). And in the area of derivative effects on S&P 500 index volatility, studies include Edwards (1988) and Harris (1989). One empirical paper that happened to be on SSFs effects on stock volatility was Dennis and Sim (1999) that dealt with stocks on the Sydney Exchange.

India is a unique market to study the effect of introduction of derivatives on the underlying assets. The SSF contracts have become popular in the Indian market and the trading volume on these contracts as a percentage of total derivatives volume is much higher when compared with other major markets in the world. The volume of SSF's on NSE accounts for approximately 50% of the derivatives trade. Uniqueness of the Indian derivatives market provides a good test case as any change found in the volatility of the underlying asset is more likely to be an influence of the introduction of the derivative stock and not because of other factors. Furthermore, law in India specifically provides derivatives to be used for hedging purposes only and to that effect most derivative traders in India describe themselves as hedgers (Sarkar, 2006).

Studies of the influence of futures contracts on the spot market have been numerous; e.g. Thenmozhi (2002), Gupta (2002), Raju and Karnde (2003) find decline in volatility after the introduction of the derivatives and Shengagaram (2003) find no change in spot market volatility after the introduction of the derivative contracts. The studies thus far on tests of influence of the derivatives on the spot market volatility are based on the underlying index and not the individual stocks. The test of change of volatility of the index with the introduction of the derivative products may not be optimal for several reasons. Firstly, the index represents the diversified portfolio of the market, so the introduction of the derivative on the index may not influence the volatility of the index significantly as we are looking at the diversified portfolio of stocks. Secondly, the derivatives (single stock futures) on individual stocks are introduced at different times in the market place; as such it gives an opportunity to see if the change in volatility of the underlying is because of the introduction of the futures contract

of because of other market factors. Lastly, we look at the data for two years prior to the introduction of the futures contract and two years after the introduction of the futures contract.

Derivatives markets in India have existed since 1875. Bombay Cotton Trade Association started futures trading in 1875 and by the 1900s was a major futures market in the world. In 1952 Indian government banned cash settlements and the trading derivatives moved to informal market. Following recommendations of the Kabra Committee appointed in 1993, the Forwards Contracts (Regulation) Act of 1952 was amended and derivative trading in commodities were allowed in early 2000[3].

Currently the law recognizes derivatives as securities and as such can be traded but only if the derivatives are traded on exchanges. Index futures were introduced for trading at NSE in June 2000, followed by index options in June 2001, options and futures on individual securities in July 2001. From the beginning, volumes of derivatives on stock indexes and individual stocks have grown rapidly especially single stock futures.

The rest of the paper is organized as follows. Section 2 describes the empirical methodology, Section 3 details the data, Section 4 analyzes the results and Section 5 concludes this paper.

II. Empirical Methodology

Introduction of SSFs can have an effect on the trading volume of the underlying stock by shifting some of the trading activity away from the spot market. This shift may also be an indication of high level of speculative activity in the futures market, where the cost of transaction is lower compared to the spot market. The effect of introduction of SSF on the trading volume of the underlying stock is tested using the following regression equation.

$$v_{it} = \alpha_1 + \beta_1 t + \beta_2 D + \varepsilon_t \quad (1)$$

where v_t is the log of trading volume in the NSE market, t is the time trend and D is a dummy variable with a value of 0 when there is no futures contract and 1 for those days when there is futures trading. A study by Chae (2005) shows that the distribution of daily volume is non-normal, with high skewness and kurtosis and hence ordinary least squared method cannot be used on the level of volume. To alleviate this problem in this study we use a log function of the volume as suggested by Ajinkya and Jain (1989).

Following Antoniou and Holmes (1995)[4], the conditional mean and conditional volatility of all stocks are estimated as follows:

$$R_{it} = a_0 + a_1 R_{Mt} + \varepsilon_t \quad (2)$$

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1} + \gamma D \quad (3)$$

where R_{it} is the return of the i^{th} stock, R_{Mt} is the return of the market and D is a dummy variable that has a value of 0 for the pre-futures period and 1 for the post-futures period. If the dummy variable is significant, then it can be assumed that the introduction of the futures contract has a significant effect on the volatility of the underlying asset.

The unconditional variance of the stock return can be calculated as $\alpha_0 / (1 - \alpha_1 - \beta_1)$. An increase in the unconditional variance would suggest that greater information is transmitted to the market as a result of the futures trading.

The log likelihood function to maximize in GARCH setup is given by:

$$L = -\frac{T}{2}\log(2\pi) - \frac{1}{2}\sum_{t=1}^{T}\log(\sigma_t^2) - \sum_{t=1}^{T}(y_t - \mu - \emptyset y_{t-1})^2 / \sigma_t^2 \quad (4)$$

3 Prior to the introduction of the formal derivatives contract in the Indian market, there was a form of futures trading referred to as 'badla' which allowed carrying forward of a buy/sale contract to a next settlement period on payment of carry forward charges thus creating a semi-derivative product that allowed short-sales.

4 Pok and Poshakwale (2004) also use similar methodology for their study of the Malaysian market.

The computer maximizes the function and generates parameter values that maximizes the log likelihood function and will also construct their standard errors.

Conditional mean and conditional volatility of the stock returns after the introduction of futures contract is given by the following GARCH (1,1) model.

$$R_{it} = a_0 + a_1 R_{Mt} + \varepsilon_t \quad (5)$$

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1} \quad (6)$$

where R_{it} is the return of the i^{th} stock, R_{Mt} is the return of the market, and h_t is the volatility. This model is used to estimate the conditional volatility after the introduction of the futures contract for the full sample period.

Conditional mean and conditional volatility of the stock returns after the introduction of futures contract is estimated as per the following model. In this case we also include ratio of volume of stock trading and trading of futures contracts.

$$R_{it} = a_0 + a_1 R_{Mt} + \varepsilon_t \quad (7)$$

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1} + \beta_2 TR_t \quad (8)$$

where R_{it} is the return of the i^{th} stock, R_{Mt} is the return of the market, h_t is the volatility, and TR_t is the ratio of futures volume/stock volume at time t.

Stocks are shown to exhibit asymmetries in returns and to address this issue we also estimate a model that allows for asymmetries in asset returns[5]. Equation (8) can be rewritten with an asymmetric term.

$$R_{it} = a_0 + a_1 R_{Mt} + \varepsilon_t \quad (9)$$

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1} + \beta_2 TR_t + \beta_3 S_{t-1} \varepsilon_{t-1}^2 \quad (10)$$

where R_{it} is the return of the i^{th} stock, R_{Mt} is the return of the market, and h_t is the volatility, TR_t is the ratio of futures volume/stock volume at time t, and S_{t-1} is a binary variable with a value of 1 if ε_{t-1} is negative and zero otherwise.

Research has also argued that the ratio of futures volume to the open interest may have some information content. Increase in volume relative to open interest may suggest speculative trading. We also include this ratio to determine if the trading in futures market is information driven or it is speculative. Following model is estimated including all variables

$$R_{it} = a_0 + a_1 R_{Mt} + \varepsilon_t \quad (11)$$

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1} + \beta_2 TR_t + \beta_3 OP_t + \beta_4 S_{t-1} \varepsilon_{t-1}^2 \quad (12)$$

where R_{it} is the return of the i^{th} stock, R_{Mt} is the return of the market, and h_t is the volatility, TR_t is the ratio of futures volume/stock volume at time t, OP_t is the ratio of futures volume/open interest, and S_{t-1} is a binary variable with a value of 1 if ε_{t-1} is negative and zero otherwise.

III. Data

This study covers 28 SSFs that are traded in the NSE market and their underlying stocks that are traded in the NSE market. The effects of the introduction of the SSF on the underlying stock volatility is studied by comparing the volatility of the stock two years prior to and two years after the introduction

5 Studies in the Indian context that analyse the impact of derivatives contract are based on index futures (e.g. Shenbagaraman, 2003; Bandivadekar and Ghosh, 2003; Rao, 2007; Sarangi and Patnaik, 2007). There are only two studies that look at the impact of single stock futures derivative on the underlying (Nath, 2003 and Vipul, 2006). However these studies assume symmetry in the response of volatility to information. Our study differentiates itself from former studies as it is based on the single stock futures. And also considers models with symmetry and asymmetry to address the weaknesses that may arise by assuming symmetrical response to information. Furthermore, we also consider a control sample.

of the SSF. This resulted in a sample of 28 stocks[6] covering different periods as the futures on the stocks were introduced at different times. The details of these SSFs are given in Table 1 with the industry classification and to control sample[7]. The daily price and volume of the SSFs and underlying stocks are obtained from NSE. Table 2 details the growth trends in the ratio of futures trading volume to stock trading volume. Results indicate that the trading in the futures market has grown at a much faster pace than that of the volume in the spot market. This may indicate that some of the trading activity could have transferred from the spot market to the derivative market.

Table 1: Stocks with Single Stock Futures and the Control Sample of Stocks without Single Stock Futures

Name of the Company	Ticker symbol of underlying stock	Date of SSF introduction	Industry Classification	Company with no futures contract
ACC Cements	ACC	November 9, 2001	Cement & Cement Products	India Cements
ABB	ABB	April 20, 2005	Electrical Equipment	Havells
BHEL	BHEL	November 9, 2001	Electrical Equipment	Crompton Greaves
BPCL	BPC	November 9, 2001	Refineries	Zuari Agro
Cipla Ltd	CIP	November 9, 2001	Pharmaceuticals	Glaxo
Gail	GAI	September 26, 2003	Gas	Suppetro
Grasim	GRA	November 9, 2001	Cement & Cement Products	GNFC
HDFC	HDF	November 9, 2001	Finance – Housing	LIC Housing
HDFC Bank	HDB	August 29, 2003	Banks	J & K Bank
Hindalco	HINDALCO	November 9,2003 2001	Aluminium	Tube Investment
Hindustan Lever	HIL	November 9, 2001	Diversified	Voltas
ICICI Bank	ICICIBANK	January 31, 2003	Banks	Kotak Bank
Infosys Technologies	INF	November 9, 2001	Computers - Software	INFOTCENT
ITC Ltd	ITC	November 9, 2001	Cigarettes	Godfrey Philipps
Mahindra & Mahindra	MAM	November 9, 2001	Automobiles 4 wheels	Ashok Leyland
National Aluminium	NAT	January 31, 2003	Aluminium	Jindal Steel
ONGC	ONGC	January 31, 2003	Oil Exploration/Production	Chennai Petro
Ranbaxy Ltd	RAN	November 9, 2001	Pharmaceuticals	Zhandu Pharma
Reliance Capital	RELCAPITAL	April 20, 2005	Finance	SRTRANFIN
Reliance Ltd	REL	November 9, 2001	Refineries	Essar Oil
SAIL	SAI	September 15, 2006	Steel & Steel Products	GUJNRECOKE
SBI Bank	SBI	November 9, 2001	Banks	Corporation Bank
Siemens	SIEMENS	April 20, 2005	Electrical Equipment	Laxmi Machines
Sun Pharma	SUN	April 20, 2005	Pharmaceuticals	Elder Pharmaceuticals
Tata Motors	TATAMOTORS	November 9, 2001	Automobiles 4 Wheel	Escorts
Tata Power	TATAPOWER	November 9, 2001	Power	CESC
Tata Steel	TATASTEEL	November 9, 2001	Steel & Steel Products	Mahendra Seamless
Wipro Ltd	WIP	January 31, 2003	Computer Software	ROLTA

6 Gazprom SSFs were also introduced in 2001, but since there was not enough data on the underlying stock prior to that it was not included in the study. Another SSF that is not included in this study is the SSF of United Energy Systems which was broken into several separate firms in 2008.

7 Control sample is a stock that did not have a futures contract introduced during the period of study and belong to same industry group and have similar characteristics.

Table 2: Growth trends in the ratio of futures trading volume to stock trading volume
In this table the growth trends in the ratio of futures trading volume to stock trading volume is estimated using the following regression:

$$v_t = \alpha + \beta_1 t + \beta_2 t^2 + \varepsilon_t$$

Where v_t is the ratio of the Indian rupee trading volume of the futures and stocks, and *t* is the time trend.

Firm	α (t-stat)	β_1 (t-stat)	$\beta_2 x100$ (t-stat)	R^2 (F-stat)	Mean of dependent variable (std. dev)
ABB	2.1492 (13.8233)*	0.0048 (6.9329)*	-0.0006 (9.2791)*	0.1296 (76.8002)*	2.4888 (1.7698)
ACC	0.1497 (1.6594)***	0.0077 (34.9066)*	-0.0003 (34.0724)*	0.3927 (609.832)*	2.8412 (1.6732)
BHEL	0.4881 (5.2998)*	0.0047 (21.1783)*	-0.0002 (21.1783)*	0.2010 (237.849)*	1.9988 (1.4890)
BPCL	1.0946 (6.9426)*	0.0018 (4.7731)*	-0.0001 (4.0749)*	0.0133 (13.7861)*	1.8751 (2.2943)
CIPLA	-0.4742 (5.9061)*	0.0053 (27.0005)*	-0.0002 (23.3760)*	0.3109 (425.873)*	1.7351 (1.3980)
GAIL	1.0588 (9.2015)*	0.0067 (18.0805)*	-0.0005 (20.2437)*	0.2394 (223.440)*	2.3922 (1.6516)
GRASIM	0.7234 (5.6493)*	0.0039 (12.4436)*	-0.0001 (11.0823)*	0.0818 (84.9030)*	2.2881 (1.9313)
HDFC	-0.1961 (6.1608)*	0.0019 (25.3206)*	-0.0001 (20.5497)*	0.3212 (446.634)*	0.6904 (0.5585)
HDFCBANK	0.6617 (10.4915)*	0.0019 (9.3761)*	-0.0001 (7.6504)*	0.0764 (60.2991)*	1.3082 (0.8272)
HINDALCO	-0.8213 (7.8998)*	0.0061 (24.1994)*	-0.0002 (18.2276)*	0.3507 (509.691)*	2.1644 (1.8647)
HINDUNILVR	-0.2264 (2.9631)*	0.0048 (25.6848)*	-0.0002 (22.5794)*	0.2825 (371.873)*	1.7345 (1.3038)
ICICIBANK	0.2033 (1.8849)*	0.0087 (27.7476)*	-0.0005 (28.9878)*	0.3475 (420.973)*	2.4550 (1.7657)
INFOSYSTCH	0.4431 (11.6076)*	0.0015 (16.1500)*	-0.0001 (10.8049)*	0.2515 (317.445)*	1.2519 (0.6376)
ITC	0.1860 (3.9077)*	0.0025 (22.0708)*	-0.0001 (18.2830)*	0.2530 (319.902)*	1.3154 (0.7961)
M&M	2.2915 (19.5161)*	0.0032 (11.3682)*	-0.0002 (15.3911)*	0.1876 (218.488)*	2.6808 (1.8829)
NATIONALUM	-0.0129 (0.0516)	0.0096 (13.1867)*	-0.0004 (10.4840)*	0.1394 (128.743)*	3.6988 (3.5683)
ONGC	1.1352 (16.6475)*	0.0020 (10.3075)*	-0.0001 (9.2978)*	0.0661 (56.8566)*	1.8135 (0.9332)
RANBAXY	0.5310 (6.2951)*	0.0030 (14.5916)*	-0.0001 (11.7350)*	0.1384 (152.341)*	1.8981 (1.3134)
RELCAPITAL	1.1719 (8.6574)*	0.0150 (24.4799)*	-0.0016 (28.0932)*	0.4709 (454.039)*	3.1582 (1.9764)
RELIANCE	0.0876 (1.5994)	0.0041 (31.0184)*	-0.0001 (25.0465)*	0.4191 (680.306)*	1.9655 (1.0381)
SAIL	2.0776 (20.6144)*	0.0039 (5.5869)*	-0.0007 (7.4192)*	0.1241 (47.9934)*	2.2640 (0.9222)
SBIN	0.0639 (0.6798)	0.0062 (27.1776)*	-0.0002 (22.7404)*	0.3332 (471.664)*	2.7787 (1.6644)
SIEMENS	1.2138 (9.0669)*	0.0086 (14.3416)*	-0.0009 (16.5771)*	0.2389 (160.839)*	2.3410 (1.6297)

Table 2: Growth trends in the ratio of futures trading volume to stock trading volume - continue

SUNPHARMA	1.2946 (6.9062) *	0.0074 (8.7226) *	-0.0008 (10.6590) *	0.1303 (77.2875) *	2.0934 (2.1348)
TATAMOTORS	2.3380 (21.6655) *	0.0032 (12.3271) *	-0.0002 (15.1516) *	0.1435 (158.777) *	2.9732 (1.6853)
TATAPOWER	1.2084 (11.3323) *	0.0046 (17.7824) *	-0.0002 (19.5507) *	0.1756 (201.671) *	2.4805 (1.6975)
TATASTEEL	0.3579 (3.5735) *	0.0064 (26.0854) *	-0.0002 (22.8010) *	0.2916 (388.567) *	2.9877 (1.7198)
WIPRO	0.4539 (5.9415) *	0.0040 (18.0134) *	-0.0002 (14.8639) *	0.2138 (215.479) *	1.9394 (1.1393)

* Significant @1%, ** Significant @5%, *** Significant @10%

IV. Results

The effect of introduction of stock futures on the volatility of the underlying stock is studied in this study by estimating GARCH volatility of the underlying asset. Study estimates the volatility of the asset for the period two years preceding the introduction of the futures contract and after the introduction of the futures contract. A dummy variable is introduced that takes a value of zero for the period prior to introduction of the futures contract and 1 after the introduction of the introduction. If the coefficients of the dummy variable are statistically significant it is inferred that the introduction of the futures contract has influenced the volatility of the underlying asset. Empirical results of effects of futures contract on stock volatility are presented in Table 3. Results show largely that the introduction of futures contracts has minor impact on underlying stock's volatility. It is also evidence that the lag volatility of same underlying stock has significant influence on current volatility.

Table 3: Effect of Futures Contract on Stock Volatility

Conditional mean and conditional volatility of each of the stocks in this study are estimated using the following GARCH(1,1) model:

$$R_{it} = a_0 + a_1 R_{Mt} + \varepsilon_t$$

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1} + \gamma D$$

where R_{it} is the return of the i^{th} stock, R_{Mt} is the return of the market, h_t is the volatility and D is a dummy variable that has a value of 0 for the pre-futures period and 1 for the post-futures period.

Firm	**a_0 (t-stat)**	**a_1 (t-stat)**	**α_0 (t-stat)**	**α_1 (t-stat)**	**β_1 (t-stat)**	**γ×100 (t-stat)**
ABB	0.0011 (2.0479)**	0.6592 (16.116) *	0.0001 (3.1697) *	0.1516 (3.7745) *	0.5559 (4.7824) *	-0.0041 (-2.3852) **
Havells	0.0021 (2.6176)*	0.7619 (14.7845)*	0.0000 (2.9335)*	0.0961 (3.8585)*	0.7931 (15.3670)*	0.0013 (1.1833)
ACC	0.0001 0.2016	1.0300 20.8334*	0.0000 2.5862*	0.07504 3.7835*	0.8721 27.2760*	-0.0031 - 2.3671*
India Cements	-0.0013 (-1.6032)***	1.0589 (16.5112)*	0.0000 (2.7897)*	0.0801 (3.9621)*	0.8601 (23.8228)*	-0.0043 (-2.4555)*
BHEL	0.8910 (1.3559)	0.8910 (15.7433)*	0.0001 (1.1567)	0.0687 (1.8381)***	0.8074 (5.6818)*	-0.0093 (-1.1621)
Crompton Greaves	0.0003 (0.3528)	0.8983 (13.4189)*	0.0003 (3.6283)*	0.1933 (3.8901)*	0.4893 (4.2747)*	0.0036 (0.8283)
BPCL	-0.0003 (0.4373)	0.8688 (15.1380)*	0.0007 (6.7512)*	0.9699 (9.2670)*	0.0345 (0.8877)	-0.0392 (-4.1248)*
Zuari Agro	-0.0003 (-0.3139)	0.7224 (10.0942)*	0.0001 (3.0990)*	0.0931 (4.5842)*	0.8334 (24.7934)*	-0.0036 (-1.7928)***
CIPLA	-0.0003 (-0.5896)	0.5202 (11.5481)*	0.0000 (1.9906)**	0.0632 (3.4719)*	0.8902 (25.8177)*	-0.0018 (-1.5965)

Table 3: Effect of Futures Contract on Stock Volatility - continue

Glaxo	0.0000 (0.1030)	0.4993 (12.6384)*	0.0001 (4.1219)*	0.2387 (4.9482)*	0.4761 (5.5226)*	-0.0067 (-2.9192)*
GAIL	0.0008 (1.6527)***	0.9660 (17.5716)*	0.0000 (3.1910)*	0.1402 (5.0532)*	0.7989 (21.7217)*	0.0000 (0.1447)
SUPPETRO	-0.0001 (-0.1204)	1.0216 (15.1035)*	0.0000 (2.4977)*	0.1390 (4.7372)*	0.8415 (30.0949)*	-0.0005 (-0.4206)
GRASIM	0.0008 (1.4501)	0.6953 (13.3099)*	0.0002 (3.3902)*	0.1815 (3.2019)*	0.6065 (6.3267)*	-0.0145 (-3.1215)*
GNFC	0.0011 (1.4676)	0.8191 (12.7304)*	0.0000 (3.2690)*	0.0532 (4.8378)*	0.9290 (67.6229)*	-0.0012 (-2.3572)*
HDFC	0.0009 (1.6348)	0.2851 (6.6758)*	0.0001 (3.0076)*	0.2481 (4.3993)*	0.6115 (7.0673)*	-0.0080 (-2.6614)*
LICHSGFIN	0.0011 (2.0064)**	0.5397 (14.1727)*	0.0000 (3.6164)*	0.0993 (5.1331)*	0.8545 (34.5727)*	0.0029 (3.4823)*
HDFCBANK	-0.0002 (-0.4952)	0.6917 (12.6520)*	0.0000 (2.3599)**	0.1942 (3.2292)*	0.4589 (2.7665)*	-0.0012 (0.8383)
J&KBANK	0.0009 (1.2758)	0.8592 (13.6363)*	0.0000 (2.2141)**	0.1283 (3.9788)*	0.8045 (14.7149)*	0.0005 (0.5732)
HINDALCO	0.0003 (0.5366)	0.4355 (10.3081)*	0.0000 (3.2315)*	0.1348 (3.4777)*	0.7141 (9.2957)*	-0.0054 (-3.1039)*
TUBEINVEST	.0002 (0.3137)	0.3859 (6.7560)*	0.0000 (2.1478)**	0.0689 (5.3539)*	0.9200 (77.9010)*	-0.0001 (-0.2697)
HINDUNILVR	-0.0006 (-1.2381)	0.8412 (21.7723)*	0.0000 (1.9191)**	0.0840 (3.6858)*	0.8335 (14.5555)*	-0.0028 (-1.7994)***
VOLTAS	0.0011 (1.4780)	0.6044 (10.5558)*	0.0000 (2.3440)*	0.0749 (5.0145)*	0.9015 (48.4724)*	-0.0008 (-1.2772)
ICICIBANK	0.0003 (0.5506)	0.8522 (17.8209)*	0.0000 (2.9821)*	0.1635 (4.7620)*	0.7218 (11.7812)*	-0.0035 (-2.0996)**
KTKBANK	-0.0005 (-0.6813)	0.8596 (13.4747)*	0.0001 (4.4085)*	0.2916 (5.3700)*	0.6477 (15.6696)*	-0.0006 (-0.2582)
INFOSYSTCH	-0.0030 (-3.8492)*	1.8349 (32.5307)*	0.0003 (4.8748)*	0.7909 (7.4710)*	0.2107 (3.0145)*	-0.0082 (-1.3352)
INFOTCENT	-0.0023 (-1.6301)***	1.8143 (17.5616)*	0.0009 (11.0103)*	-0.0048 (-5.7066)*	0.6180 (29.1611)*	-0.0052 (0.5956)
ITC	-0.0002 (-0.5212)	0.6573 (15.8083)*	0.0000 (1.5475)	0.1439 (1.8919)***	0.7401 (5.2058)*	-0.0054 (-1.5356)
GODFRYPHLP	-0.0006 (-0.7884)	0.4023 (6.3243)*	0.0007 (3.5291)*	0.1332 (3.5409)*	0.2194 (1.1518)	-0.0445 (-3.4096)*
M&M	0.0004 (0.6588)	1.1438 (19.5505)*	0.0000 (1.5753)	0.0552 (2.5834)*	0.9232 (28.3882)*	-0.0012 (-1.4800)
ASHOKLEY	0.0010 (1.1351)	0.8054 (12.2267)*	0.0000 (1.9801)*	0.0591 (3.2588)*	0.9067 (29.8024)*	-0.0019 (-1.7054)***
NATIONALUM	0.0012 (1.4601)	-0.0296 (-0.5340)	0.0001 (2.9704)*	0.2347 (4.4058)*	0.6753 (9.6041)*	-0.0068 (-2.3048)**
JINDALSTEL	0.0022 (2.3369)*	-0.0375 (-0.6994)	0.0000 (3.7496)*	0.1630 (5.4641)*	0.7663 (21.7273)*	-0.0003 (-0.2156)
ONGC	0.0000 (0.6457)	0.8324 (17.5871)*	0.0000 (3.2085)*	0.1803 (4.8204)*	0.7794 (19.8269)*	-0.0024 (-2.4384)***
CHENNPETRO	0.0000 (0.0945)	0.8925 (14.3236)*	0.0001 (5.1220)*	0.2143 (4.4970)*	0.4973 (6.4116)*	0.0212 (4.1405)*
RANBAXY	0.0007 (1.1417)	0.7396 (15.9168)*	0.0001 (3.1905)*	0.1063 (3.3891)*	0.7284 (11.1856)*	-0.0063 (-2.8420)*
ZANDUPHARM	-0.0009 (-1.7115)***	0.4447 (9.4745)*	0.0001 (3.7211)*	0.2557 (5.4329)*	0.5312 (6.5932)*	-0.0051 (-2.1695)**

Table 3: Effect of Futures Contract on Stock Volatility - continue

RELCAPITAL	0.0002 (0.3111)	1.3175 (25.8604)*	0.0000 (5.2453)*	0.0830 (4.7185)*	0.8394 (82.4974)*	0.0006 (1.6617)***
SRTRANFIN	0.0010 (1.2718)	0.5745 (10.5013)*	0.0000 (4.1175)*	0.1856 (5.5923)*	0.7196 (17.0587)*	0.0005 (0.3229)
RELIANCE	0.0004 (0.8343)	1.0266 (28.3588)*	0.0000 (3.5636)*	0.1967 (5.6230)*	0.6539 (11.1482)*	-0.0018 (-1.9112)***
ESSAROIL	-0.0020 (-1.8128)***	0.7877 (9.7974)*	0.0010 (7.6452)*	0.2631 (5.2576)*	0.0707 (0.9386)	0.0085 (0.7814)
SAIL	0.0001 (-0.1540)	1.3670 (30.0645)*	0.0002 (1.3687)	0.1496 (2.4667)*	0.4384 (1.3079)	0.0031 (1.1630)
GUJNRECOKE	-0.0060 (-7.9552)*	1.1233 (19.8644)*	0.0006 (5.6851)*	3.0168 (8.2180)*	0.0000 (0.1086)	0.0048 (0.3759)
SBIN	0.0000 (1.6223)	0.8534 (22.3600)*	0.0000 (2.1937)**	0.0592 (3.4086)*	0.9108 (32.8151)*	-0.0006 (-1.8453)***
CORPBANK	0.0004 (0.6802)	0.7571 (13.3905)*	0.0000 (3.3508)*	0.1551 (5.3268)*	0.7617 (17.0289)*	-0.0036 (-2.4765)*
SIEMENS	0.0015 (2.5991)*	0.8372 (16.5532)*	0.0001 (4.0450)*	0.1566 (3.9611)*	0.5256 (5.5912)*	0.0000 (0.0432)
LAXMIMACH	0.0024 (3.7492)*	0.4624 (8.9011)*	0.0001 (3.1587)*	0.1642 (3.8215)*	0.30983 (1.7482)***	0.0112 (2.7847)**
SUNPHARMA	0.0012 (2.4927)*	0.5771 (15.5653)*	0.0002 (3.9943)*	0.2329 (4.4571)*	0.3064 (2.1476)**	-0.0143 (-3.7047)*
ELDERPHARM	0.0007 (0.8983)	0.8748 (13.9559)*	0.0000 (2.0364)*	0.0957 (3.0966)*	0.8646 (19.2778)*	-0.0156 (-1.4833)
TATAMOTORS	0.0011 (1.5306)	1.1137 (19.8263)*	0.0000 (2.2011)**	0.0354 (2.6641)*	0.9429 (45.2697)*	-0.0019 (-2.2189)**
ESCORTS	-0.0007 (-0.8974)	1.0036 (16.3706)*	0.0000 (2.1431)**	0.0623 (3.7439)*	3.7439	
(39.5727)*	-0.0010 (-1.3390)					
TATAPOWER	0.0000 (1.3497)	0.9188 (19.4458)*	0.0000 (3.0062)*	0.0361 (3.5631)*	0.9363 (59.0491)*	-0.0021 (-2.9861)*
CESC	-0.0004 (-0.4442)	0.7695 (11.1543)*	0.0004 (3.9285)*	0.1066 (3.1954)*	0.4123 (3.1366)*	0.0382 (3.0825)*
TATASTEEL	0.0012 (2.0971)**	1.0177 (20.8608)*	0.0000 (2.4591)*	0.1141 (3.6520)*	0.8128 (15.1061)*	-0.0026 (-2.2216)**
MAHSEAMLES	0.0005 (0.8683)	0.2082 (3.9363)*	0.0000 (1.4913)	0.1630 (6.2656)*	0.8340 (32.7949)*	0.0029 (0.4048)
WIPRO	-0.0006 (-0.9034)	1.4917 (23.4729)*	0.0001 (3.1303)*	0.1399 (4.6230)*	0.7440 (13.5528)*	-0.0064 (-2.6317)*
ROLTA	-0.0008 (-0.7952)	-0.0828 (-1.220)	0.0003 (4.6069)*	0.2131 (4.9905)*	0.6107 (10.1589)*	-0.0206 (-3.4902)*

* Significant @1%, ** Significant @5%, *** Significant @10%

Shaded rows show the results for the control sample (control sample is the company from same industry group that has no futures contract during the period of study).

Results in Table 4 convincingly support the hypothesis that the introduction of the futures contract reduces the volatility of the underlying stock by providing a means of low cost transactions for incorporating the news impact in the asset prices. In most cases, more than 90 percent of variation in volatility is explained by lag coefficients of square residuals and volatility. Table 5 results present the impact of stock/futures volume ratio on conditional volatility of the stock returns (in the case of symmetrical model). Results indicate that the volatility of underlying stock is mostly explained by its own lag square residuals and volatility. This study found that the coefficient of futures/stock volume

ratio is statistically significant for 16 firms; however its influence on underlying stock volatility is negligible.

Table 4: Conditional Volatility of the Stock Returns after the Introduction of Futures Contracts
Conditional mean and conditional volatility of each of the stocks in this study are estimated using the following GARCH(1,1) model:

$$R_{it} = a_0 + a_1 R_{Mt} + \varepsilon_t$$

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1}$$

where R_{it} is the return of the i^{th} stock, R_{Mt} is the return of the market, and h_t is the volatility.

Firm	a_0 (t-stat)	a_1 (t-stat)	α_0 (t-stat)	α_1 (t-stat)	β_1 (t-stat)	$\alpha_1+\beta_1$
ABB	0.00034 (0.5510)	0.83865 (23.8825)*	0.00002 (2.5680)**	0.11444 (4.0553)*	0.82220 (18.4107)*	0.93664
ACC	0.00028 (0.7284)	0.84926 (29.4895)*	0.00001 (3.1056)*	0.07631 (5.3710)*	0.89639 (45.0403)*	0.97270
BHEL	0.00098 (2.3840)**	1.02809 (34.6561)*	0.00003 (3.3017)*	0.10060 (4.8133)*	0.79975 (17.7379)*	0.90035
BPCL	-0.00005 (0.0984)	0.71961 (19.5291)*	0.00003 (2.6495)*	0.08756 (3.9126)*	0.86767 (24.2826)*	0.95523
CIPLA	-0.00008 (0.2046)	0.59887 (20.8520)*	0.00010 (5.5630)*	0.15193 (5.3534)*	0.54505 (7.9435)*	0.69698
GAIL	0.00134 (2.5461)**	0.74844 (25.6625)*	0.00016 (4.4029)*	0.60970 (7.5816)*	0.33830 (4.4114)*	0.94800
GRASIM	0.00055 (1.2868)	0.80438 (30.6806)*	0.00001 (2.4412)**	0.04648 (4.8012)*	0.93702 (62.5897)*	0.98350
HDFC	0.00069 (1.5911)	0.81371 (24.8545)*	0.00002 (2.3497)**	0.08725 (4.2220)*	0.87181 (0.8718)	0.95906
HDFCBANK	0.00035 (0.6334)	0.90636 (35.9360)*	0.00008 (3.2731)*	0.16172 (4.3111)*	0.60832 (6.4317)*	0.77004
HINDALCO	-0.00045 (1.0535)	0.89680 (27.3907)*	0.00002 (3.6632)*	0.11060 (6.4831)*	0.85300 (35.3961)*	0.96360
HINDUNILVR	-0.00051 (1.3324)	0.63631 (24.7270)*	0.00004 (3.5839)*	0.12830 (5.2797)*	0.73557 (13.4871)*	0.86387
ICICIBANK	0.00001 (0.0224)	1.14503 (35.4624)*	0.00000 (1.7402)***	0.04022 (3.4207)*	0.94981 (57.2975)*	0.99003
INFOSYSTCH	0.00023 (0.5961)	0.85295 (32.1266)*	0.00000 (1.4512)	0.03443 (2.8556)*	0.96136 (66.8259)*	0.99579
ITC	0.00029 (0.7283)	0.65893 (25.8142)*	0.00002 (3.6184)*	0.08203 (4.4344)*	0.84394 (25.1666)*	0.92597
M&M	0.00066 (1.3121)	0.98754 (33.8828)*	0.00001 (2.5767)*	0.06721 (4.9492)*	0.90895 (44.5890)*	0.97616
NATIONALUM	-0.00011 (0.2009)	1.02515 (27.5978)*	0.00002 (3.4805)*	0.10105 (5.9605)*	0.87423 (40.3721)*	0.97528
ONGC	-0.00029 (0.8020)	0.99630 (41.1080)*	0.00000 (1.8327)***	0.04800 (5.3857)*	0.94710 (84.1969)*	0.99510
RANBAXY	0.00007 (0.1471)	0.61987 (23.3649)*	0.00000 (1.0735)	0.02636 (4.8056)*	0.97335 (157.108)*	0.99971
RELCAPITAL	0.00016 (0.2014)	1.76145 (50.1822)*	0.00008 (1.3380)	0.21115 (2.4994)**	0.70887 (4.8969)*	0.92001
RELIANCE	0.00035 (1.2506)	1.06694 (60.8853)*	0.00002 (3.0035)*	0.11859 (4.6426)*	0.79799 (16.5280)*	0.91658
SAIL	0.00138 (1.3604)	1.38857 (28.1236)*	0.00003 (1.3231)	0.04975 (2.1540)**	0.90794 (17.8745)*	0.95768

Table 4: Conditional Volatility of the Stock Returns after the Introduction of Futures Contracts - continue

SBIN	0.00039 (0.9438)	1.05894 (39.5793) *	0.00001 (2.7199) *	0.04803 (4.4637) *	0.92393 (49.5667) *	0.97196
SIEMENS	0.00051 (0.7344)	0.98181 (24.1265) *	0.00016 (4.1879) *	0.37611 (4.6677) *	0.45419 (5.3513) *	0.83030
SUNPHARMA	0.00020 (0.3574)	0.53617 (14.2001) *	0.00003 (1.9157) ***	0.22445 (3.2254) *	0.73323 (8.5074) *	0.95767
TATAMOTORS	-0.00018 (0.4519)	1.09956 (39.6307) *	0.00000 (1.2924)	0.03525 (4.7048) *	0.96204 (100.387) *	0.99729
TATAPOWER	0.00024 (0.5953)	0.98381 (38.5082) *	0.00002 (3.8431) *	0.13480 (6.4940) *	0.81590 (29.2022) *	0.95070
TATASTEEL	0.00016 (0.3904)	1.24185 (41.7442) *	0.00000 (1.7225) *	0.04329 (3.8392) *	0.95122 (67.9958) *	0.99451
WIPRO	-0.00052 (1.2493)	1.07752 (37.5047) *	0.00001 (2.2404) **	0.11046 (4.5705) *	0.86496 (26.5077) *	0.97542

* Significant @1%, ** Significant @5%, *** Significant @10%

Table 5: Symmetrical Model of Conditional Volatility of the Stock Returns after the Introduction of Futures Contracts with Stock/Futures Volume Ratio

Conditional mean and conditional volatility of each of the stocks in this study are estimated using the following GARCH(1,1) model:

$$R_{it} = a_0 + a_1 R_{Mt} + \varepsilon_t$$

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1} + \beta_2 TR_t$$

where R_{it} is the return of the i^{th} stock, R_{Mt} is the return of the market, h_t is the volatility, and TR_t is the ratio of futures volume/stock volume at time t.

Firm	**a_0 (t-stat)**	**a_1 (t-stat)**	**α_0 (t-stat)**	**α_1 (t-stat)**	**β_1 (t-stat)**	**β_2x100 (t-stat)**	**$\alpha_1+\beta_1$**
ABB	0.00032 (0.5312)	0.83838 (24.7926) *	0.00002 (2.2222) **	0.11719 (4.0931) *	0.82018 (18.8325) *	0.00004 (0.2353)	0.93737
ACC	0.00026 (0.6594)	0.84700 (30.5299) *	0.00002 (2.7811) *	0.08120 (5.6151) *	0.88210 (37.6841) *	-0.00016 (1.7193) ***	0.96330
BHEL	0.00101 (2.4595) **	1.02754 (37.6375) *	0.00004 (3.2393) *	0.10358 (5.0030) *	0.77870 (14.9384) *	-0.00033 (2.3040) **	0.88228
BPCL	-0.00005 (0.1026)	0.71970 (19.5798) *	0.00004 (2.4790) **	0.09140 (4.1031) *	0.86090 (23.9464) *	-0.00023 (0.7895)	0.95230
CIPLA	-0.00013 (0.3053)	0.59310 (21.2418) *	0.00008 (4.3927) *	0.13890 (4.8081) *	0.58100 (8.6829) *	0.00084 (1.8185) ***	0.71990
GAIL	0.00099 (2.0035) **	0.77680 (24.1850) *	0.00024 (3.1582) *	0.51980 (4.9596) *	0.30580 (1.9378) ***	-0.00146 (6.4284) *	0.82560
GRASIM	0.00053 (1.4167)	0.80670 (33.7288) *	0.00001 (2.6634) *	0.04970 (4.1202) *	0.93020 (51.4428) *	-0.00014 (2.1133) **	0.97990
HDFC	0.00066 (1.4662)	0.81690 (25.1470) *	0.00002 (2.2498) **	0.09040 (4.3059) *	0.86450 (24.0550) *	-0.00045 (0.9208)	0.95490
HDFCBANK	0.00043 (0.9350)	0.90400 (35.7680) *	0.00015 (6.8222) *	0.16800 (4.9450) *	0.52190 (6.6561) *	-0.00291 (9.3952) *	0.68990
HINDALCO	-0.00046 (1.0705)	0.89430 (26.6346) *	0.00002 (3.2366) *	0.10820 (5.9491) *	0.85430 (35.5081) *	0.00011 (0.9191)	0.96250
HINDUNILVR	-0.00052 (1.1413)	0.63610 (26.1343) *	0.00004 (3.2113) *	0.12800 (5.3430) *	0.73680 (13.4095) *	0.00009 (0.3566)	0.86480
ICICIBANK	-0.00008 (0.1421)	1.15038 (34.4874) *	0.00002 (1.5059)	0.05056 (2.6773) *	0.91329 (22.6311) *	-0.00027 (1.3882)	0.96385
INFOSYSTCH	0.00022 (0.5782)	0.85950 (30.8738) *	0.00001 (1.4415)	0.04410 (3.3767) *	0.94620 (52.9277) *	-0.00021 (1.0803)	0.99030

Table 5: Symmetrical Model of Conditional Volatility of the Stock Returns after the Introduction of Futures Contracts with Stock/Futures Volume Ratio - continue

ITC	0.00025 (0.6940)	0.65459 (24.7700) *	0.00001 (1.9785) **	0.07444 (3.8699) *	0.86747 (27.1340) *	0.00033 (1.6644) ***	0.94191
M&M	0.00068 (1.6509)	0.98840 (37.9902) *	0.00001 (2.5554) **	0.06800 (5.0771) *	0.90540 (44.9942) *	-0.00007 (1.0166)	0.97340
NATIONALUM	-0.00005 (0.0850)	1.02370 (28.0710) *	0.00001 (1.1534)	0.09426 (5.2139) *	0.88351 (39.2473) *	0.00027 (2.6010) *	0.97776
ONGC	-0.00025 (0.6744)	0.99150 (43.9194) *	0.00000 (1.2204)	0.03150 (3.4875) *	0.96690 (98.9800) *	0.00018 (2.0266) **	0.99840
RANBAXY	0.00005 (0.1169)	0.62290 (23.1757) *	0.00000 (1.2879)	0.02400 (5.0433) *	0.97610 (181.371) *	0.00010 (2.3666) **	1.00010
RELCAPITAL	-0.00002 (0.0223)	1.74695 (49.8956) *	0.00023 (2.3395) **	0.30694 (3.8077) *	0.49170 (3.2875) *	-0.00158 (1.8040) ***	0.79864
RELIANCE	0.00037 (1.3351)	1.06333 (61.6847) *	0.00003 (3.4398) *	0.12987 (5.0168) *	0.75460 (14.3276) *	-0.00040 (2.6621) *	0.88447
SAIL	0.00133 (1.3428)	1.38984 (28.4516) *	0.00007 (1.2168)	0.06076 (2.0716) **	0.85774 (10.1773) *	-0.00085 (0.8449)	0.91850
SBIN	0.00039 (1.0753)	1.05781 (40.5608) *	0.00001 (1.9783) **	0.04631 (4.2798) *	0.92762 (50.0388) *	0.00004 (0.9000)	0.97393
SIEMENS	0.00042 (0.6342)	0.98230 (25.0846) *	0.00027 (4.7059) *	0.30110 (3.6850) *	0.43010 (4.2534) *	-0.00270 (5.3384) *	0.73120
SUNPHARMA	0.00016 (0.2992)	0.52780 (16.3148) *	0.00005 (3.3003) *	0.23300 (4.3743) *	0.70460 (11.1060) *	-0.00043 (3.5103) *	0.93760
TATAMOTORS	-0.00018 (0.4544)	1.09942 (39.9434) *	0.00000 (0.2894)	0.03475 (4.4875) *	0.96332 (98.0623) *	-0.00018 (0.4679)	0.99807
TATAPOWER	0.00025 (0.5980)	0.97980 (32.3465) *	0.00004 (3.2779) *	0.14220 (6.6303) *	0.79480 (25.8310) *	-0.00032 (1.7139) ***	0.93700
TATASTEEL	0.00020 (0.4840)	1.24339 (43.4459) *	0.00000 (0.3650)	0.03530 (2.9948) *	0.96140 (81.5649) *	0.00008 (2.1537) **	0.99670
WIPRO	-0.00050 (1.2060)	1.07515 (37.5098) *	0.00002 (2.2470) **	0.12226 (5.1315) *	0.83885 (22.6848) *	-0.00043 (1.6308)	0.96112

* Significant @1%, ** Significant @5%, *** Significant @10%

Table 6 reports the results of asymmetrical model of conditional volatility of the stock returns. Result evidences that the ratio of futures/stock volume has minor influence on underlying stock volatility. The coefficient of binary variable also show a small impact on the volatility except in the case of GAIL where it has significant influence on volatility (0.37). In the case of asymmetric model also we found that the underlying asset volatility is majorly influenced by its own lag square residual and lag volatility. Therefore, it is understood from both the models of symmetrical and asymmetrical that the underlying stock volatility is determined by its own previous characteristics. In addition to this, we further explored determinants of underlying asset volatility by adding additional explanatory variable in the asymmetrical model. Results from Table 7 shows that both the coefficients of futures/stock volume ratio and futures volume/open interest ratio have statistical significance in most cases. It is identified that the ratio of futures/stock volume has negative impact on volatility (mostly) and ratio of futures volume/open interest has largely positive influence on volatility. We also found that when the lag residuals take the value of zero or negative then it has some impact on underlying asset volatility. It is important to observe in this result that when we introduce ratio of futures volume/open interest into this model, we found that these results are significantly different from those of Tables 5 and 6 where underlying stock volatility is explained by its own past characteristics. From these results we can infer that the introduction of futures contract has dramatically reduced the volatility of the return of underlying stock.

Table 6: Asymmetrical Model of Conditional Volatility of the Stock Returns after the Introduction of Futures Contracts with Stock/Futures Volume Ratio

Conditional mean and conditional volatility of each of the stocks in this study are estimated using the following GARCH(1,1) model:

$$R_{it} = a_0 + a_1 R_{Mt} + \varepsilon_t$$

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1} + \beta_2 TR_t + \beta_3 S_{t-1} \varepsilon_{t-1}^2$$

where R_{it} is the return of the i^{th} stock, R_{Mt} is the return of the market, and h_t is the volatility, TR_t is the ratio of futures volume/stock volume at time t, and S_{t-1} is a binary variable with a value of 1 if ε_{t-1} is negative and zero otherwise.

Firm	a_0 (t-stat)	a_1 (t-stat)	α_0 (t-stat)	α_1 (t-stat)	β_1 (t-stat)	β_2x100 (t-stat)	β_3 (t-stat)	$\alpha_1+\beta_1$
ABB	0.00032 (0.5498)	0.84010 (23.6788)*	0.00003 (1.8677)	0.12080 (4.1025)*	0.81380 (17.7020)	0.00002 (0.1486)	-0.01880 (0.4707)	0.93460
ACC	0.00025 (0.6531)	0.84670 (30.3462)*	0.00002 (1.7492)***	0.08070 (5.1673)*	0.88270 (35.7596)*	-0.00015 (1.2683)	0.00547 (0.1841)	0.96340
BHEL	0.00101 (2.1727)**	1.02742 (33.7424)*	0.00004 (2.6387)**	0.10324 (4.5432)*	0.77934 (14.9612)*	-0.00033 (2.1178)**	0.00204 (0.0500)	0.88258
BPCL	0.00007 (0.1365)	0.71380 (20.8786)*	0.00007 (2.8795)*	0.10620 (4.1316)*	0.8345 (18.6469)*	-0.00025 (0.7491)	-0.07240 (2.7363)*	0.94070
CIPLA	-0.00014 (0.3445)	0.5989 (28.1037)*	0.00014 (3.8903)*	0.16280 (4.9392)*	0.47730 (5.7761)*	0.00076 (1.3086)	-0.14390 (2.2454)**	0.64010
GAIL	0.00023 (0.4190)	0.84210 (24.1941)*	0.00031 (7.8408)*	0.43620 (4.8749)*	0.01690 (0.3956)	-0.00145 (8.2779)*	0.37410 (4.9421)*	0.45310
GRASIM	0.00049 (1.2775)	0.81000 (40.5937)*	0.00000 (0.8518)	0.04390 (4.4289)*	0.93960 (61.2774)*	-0.00010 (1.6978)***	0.02500 (1.5175)	0.98350
HDFC	0.00062 (1.3287)	0.81760 (25.0239)*	0.00002 (1.6921)***	0.08920 (4.3812)*	0.86670 (24.0356)*	-0.00042 (0.8396)	0.01170 (0.4950)	0.95590
HDFCBANK	0.00046 (1.0606)	0.90500 (35.1630)*	0.00016 (4.5837)*	0.17510 (4.5459)*	0.53240 (5.2686)*	-0.00295 (4.2175)*	-0.11030 (1.9650)**	0.70750
HINDALCO	-0.00046 (1.1219)	0.89560 (27.2208)*	0.00001 (1.5154)	0.10770 (5.9347)*	0.85380 (35.3535)*	0.00012 (1.0830)	0.02600 (1.1173)	0.96150
HINDUNILVR	-0.00052 (1.3550)	0.63600 (24.8497)*	0.00004 (2.7103)*	0.12790 (4.9932)*	0.73690 (13.1806)*	0.00009 (0.3537)	0.00077 (0.0188)	0.86480
ICICIBANK	-0.00011 (0.2234)	1.14856 (32.4049)	0.00001 (3.0641)*	0.03964 (4.8627)*	0.93759 (96.7858)*	-0.00015 (2.2175)**	0.02687 (1.3837)	0.97723
INFOSYSTCH	-0.00004 (0.1194)	0.83996 (34.3874)*	-0.00001 (25.2722)*	-0.00155 (2698.50)*	1.00092 (5486.31)*	-0.00000 (220.732)*	0.05572 (23.2093)*	0.99937
ITC	0.00021 (0.5618)	0.65379 (24.9412)*	0.00001 (1.2432)	0.07770 (4.1190)*	0.85775 (24.0821)*	0.00031 (1.3808)	0.03949 (1.2423)	0.93545
M&M	0.00069 (1.6681)***	0.98880 (35.2277)*	0.00002 (2.2371)**	0.06920 (4.8296)*	0.90370 (42.9936)*	-0.00009 (1.1226)	-0.01500 (0.8104)	0.97290
NATIONALUM	0.00008 (0.1571)	1.01723 (26.4708)*	0.00002 (2.1080)**	0.09038 (5.0296)*	0.89669 (42.2113)*	0.00025 (2.7448)*	-0.04310 (2.2538)**	0.98707
ONGC	-0.00019 (0.4486)	0.98880 (39.8330)*	0.00000 (0.4137)	0.02590 (2.8728)*	0.97390 (96.8882)*	0.00020 (2.6401)*	-0.01700 (0.8574)	0.99980
RANBAXY	0.00002 (0.0357)	0.62260 (22.3854)*	0.00000 (1.6804)***	0.02430 (4.5953)*	0.97500 (156.461)*	0.00010 (2.2096)**	0.00998 (1.1914)	0.99930
RELCAPITAL	-0.00008 (0.1086)	1.75322 (48.5861)*	0.00018 (2.0708)**	0.30250 (4.0242)*	0.50560 (3.7249)*	-0.00138 (1.7997)***	0.10960 (1.8545)***	0.80810
RELIANCE	0.00031 (1.1032)	1.06372 (61.7045)*	0.00002 (2.4888)**	0.12644 (4.8535)*	0.77009 (15.1446)*	-0.00032 (2.2115)*	0.05403 (1.8419)***	0.89653
SAIL	0.00118 (1.1610)	1.38904 (30.2854)*	0.00002 (0.3670)	0.04461 (1.6128)	0.90937 (12.3030)*	-0.00019 (0.2271)	0.04174 (0.8442)	0.95398
SBIN	0.00021 (0.5185)	1.07319 (31.3358)*	0.00011 (9.0160)*	0.13111 (4.8465)*	0.53690 (11.5978)*	-0.00098 (20.2887)*	0.09150 (2.1533)**	0.66801
SIEMENS	0.00039 (0.5556)	0.98290 (22.6823)*	0.00026 (4.1898)*	0.29600 (3.8636)*	0.43580 (4.6634)*	-0.00264 (5.3933)*	0.03070 (0.5170)*	0.73180
SUNPHARMA	0.00018 (0.3309)	0.52890 (15.2278)*	0.00005 (3.2174)*	0.23000 (4.0841)*	0.70800 (11.1336)*	-0.00043 (4.1290)*	-0.00665 (0.1464)	0.93800
TATAMOTORS	-0.00025 (0.5402)	1.10005 (36.5090)*	-0.00001 (1.5724)	0.03267 (4.2224)*	0.96726 (99.2990)*	0.00005 (1.2387)	0.02565 (1.8043)***	0.99993
TATAPOWER	0.00029 (0.7744)	0.98080 (32.7176)*	0.00004 (3.2321)*	0.14230 (6.2314)*	0.79530 (24.6519)*	-0.00035 (1.7814)***	-0.02260 (0.8891)	0.93760

Table 6: Asymmetrical Model of Conditional Volatility of the Stock Returns after the Introduction of Futures Contracts with Stock/Futures Volume Ratio - continue

TATASTEEL	0.00019 (0.4452)	1.24330 (38.2986) *	0.00000 (0.4003)	0.03578 (3.0239) *	0.96077 (64.8514) *	0.00008 (1.8266) ***	0.00318 (0.2359)	0.99655
WIPRO	-0.00084 (1.8183) ***	1.06673 (35.7447) *	0.00001 (1.0364)	0.11608 (4.9614) *	0.83435 (22.3692) *	-0.00047 (1.8059) ***	0.09429 (2.9055) *	0.95042

* Significant @1%, ** Significant @5%, *** Significant @10%

Table 7: Asymmetrical Model of Conditional Volatility of the Stock Returns after the Introduction of Futures Contracts with Stock/Futures Volume Ratio and Ratio of Futures Volume/Open Interest

Conditional mean and conditional volatility of each of the stocks in this study are estimated using the following GARCH(1,1) model:

$$R_{it} = a_0 + a_1 R_{Mt} + \varepsilon_t$$

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1} + \beta_2 TR_t + \beta_3 OP_t + \beta_4 S_{t-1} \varepsilon_{t-1}^2$$

where R_{it} is the return of the i^{th} stock, R_{Mt} is the return of the market, and h_t is the volatility, TR_t is the ratio of futures volume/stock volume at time t, OP_t is the ratio of futures volume/open interest, and S_{t-1} is a binary variable with a value of 1 if ε_{t-1} is negative and zero otherwise.

Firm	a_0 t-stat)	a_1 t-stat)	α_0 t-stat)	α_1 t-stat)	β_1 t-stat)	β_2x100 t-stat)	β_3x100 t-stat)	β_4 t-stat)	$\alpha_1+\beta_1$
ABB	-0.00111 1.8944)***	0.82741 42.4772) *	0.00021 5.0261) *	0.11208 3.1835) *	-0.05473 0.7262)	-0.01446 11.5443) *	0.03016 9.0503) *	0.01424 0.2639)	0.05735
ACC	0.00007 0.1854)	0.77630 50.6171) *	0.00018 8.5317) *	0.09330 5.1486) *	-0.08980 2.1329) **	-0.01113 15.3623) *	0.02602 24.1976) *	0.05700 1.7135) ***	0.00350
BHEL	-0.00050	1.00313*	0.00000	0.10468	0.06011	-0.00454	0.03523	0.09507	0.16479
	1.3879)	56.1378)	0.1324)	3.9948) *	1.6809) ***	8.4143) *	17.2809) *	3.0042) *	
BPCL	-0.00172 3.5738) *	0.67470 36.4712) *	0.00021 7.0513) *	0.11876 5.6319) *	-0.05179 1.5151)	-0.01154 6.6418) *	0.06196 16.7013) *	-0.10344 3.0614) *	0.06696
CIPLA	0.00003 0.0828)	0.53270 36.1098)	-0.00002 3.7336)	0.04040 1.8220)	0.05310 3.0741)	-0.00051 1.2631)	0.05224 31.3879)	0.09450 2.9791)	0.09350
GAIL	-0.00043 0.8636)	0.84564 38.1581) *	0.00021 5.8202) *	0.27096 6.6834) *	0.03561 0.6544)	-0.01588 11.8936) *	0.03989 10.3614) *	0.13687 3.4068) *	0.30658
GRASIM	-0.00053 1.4788)	0.77660 52.3796) *	0.00010 6.3705) *	0.15060 6.3792) *	0.04650 1.0901)	-0.00852 10.6951) *	0.04357 13.3264) *	0.06160 1.7313) ***	0.19710
HDFC	-0.00106 1.6871)	0.34960 58.2739) *	0.00019 9.5021) *	0.39460 6.7544) *	-0.19530 0.4879)	0.00600 0.8544)	0.02521 0.3413)	0.01010 0.0333)	0.19930
HDFCBANK	0.00041 0.9454)	0.92197 51.6425) *	0.00009 3.7266) *	0.14620 6.4732) *	-0.18986 5.5275) *	-0.00480 3.3663) *	0.05025 11.6614) *	0.10075 2.1569) **	-0.04365
HINDALCO	-0.00070 4.1525) *	3.07435 44.3376) *	0.00013 5.5001) *	0.22140 10.1432) *	-0.25455 0.0704)	-0.00203 28.4562) *	-0.00517 0.0233)	0.09855 5.5412) *	-0.03315
HINDUNILVR	-0.00180 5.1170) *	0.50890 40.4686) *	0.00000 0.1736)	0.12220 6.7869) *	-0.15000 3.8413) *	0.00102 2.3006) **	0.05485 19.6205) *	0.14250 4.3149) *	-0.02780
ICICIBANK	-0.00170 3.4835) *	1.13192 51.0926) *	0.00009 3.3132) *	0.06269 2.6658) *	0.08264 1.3301)	-0.00824 5.8220) *	0.04376 11.2613) *	0.08335 2.2187) **	0.14534
INFOSYSTCH	0.00009 0.2047)	0.74850 44.0398) *	0.00014 11.8591) *	0.15270 5.9685) *	-0.12550 7.4296) *	-0.00844 10.6172) *	0.02005 11.3873) *	0.10780 2.7560) *	0.02720
ITC	-0.00097 2.9816) *	0.63400 43.6786) *	0.00001 0.5944)	0.07804 4.4396) *	-0.15397 3.0655) *	-0.00226 2.1815) **	0.04597 17.2678) *	0.04327 1.3942)	-0.07593
M&M	0.00005 0.1230)	0.98180 60.9588) *	0.00011 6.6276) *	0.22290 8.1352) *	0.44680 10.0735) *	-0.00661 11.4338) *	0.00770 8.3373) *	0.00895 0.3255)	0.66970
NATIONALUM	-0.00005 0.1029)	1.00059 38.3446) *	-0.00002 2.4653) **	0.10820 8.3554) *	0.86021 55.5004) *	0.00182 5.6426) *	0.00551 4.7809) *	-0.00811 0.4803)	0.96841
ONGC	-0.00003 0.0708)	0.93562 55.0724) *	0.00014 6.0213) *	0.03192 2.9224) *	-0.27565 4.7733) *	-0.01064 9.0626) *	0.04241 17.7738) *	0.09754 2.7619) *	-0.24373
RANBAXY	-0.00170 4.8815) *	0.63170 38.6995) *	-0.00003 2.6381) *	0.22570 8.9246) *	-0.03190 2.0070) **	0.00022 0.2899)	0.05950 23.1200) *	0.01810 1.0220)	0.19380

Table 7: Asymmetrical Model of Conditional Volatility of the Stock Returns after the Introduction of Futures Contracts with Stock/Futures Volume Ratio and Ratio of Futures Volume/Open Interest - continue

RELCAPITAL	-0.00008 0.0965)	1.43649 42.4706)*	0.00040 4.3504)*	0.13330 4.7611)*	-0.21838 7.5429)*	-0.01941 6.0065)*	0.03383 9.1478)*	0.08892 1.8118)***	-0.08508
RELIANCE	-0.00036 1.2036)	1.12799 85.8958)*	0.00006 4.4137)*	0.04116 3.0597)*	-0.28893 3.8355)*	-0.00135 1.8820)***	0.01792 18.0251)*	-0.10207 2.4582)**	-0.24777
SAIL	-0.00024 0.2454)	1.17800 28.9895)*	0.00022 2.6471)*	0.08177 1.9941)**	0.28838 42.4914)*	-0.01973 3.5677)*	0.03289 6.2991)*	-0.00702 0.0878)	0.37015
SBIN	-0.00084 2.5861)*	1.06975 70.4664)*	0.00021 8.0058)*	0.02827 3.9137)*	-0.44670 6.8579)*	-0.00825 5.7739)*	0.02272 23.9081)*	0.04278 0.9854)	-0.41843
SIEMENS	-0.00135 2.2862)**	0.94202 34.9878)*	0.00002 0.6883)	0.12267 3.0720)*	0.14025 2.9763)*	-0.01239 10.0784)*	0.05750 15.0058)*	0.17086 5.1687)*	0.26292
SUNPHARMA	-0.00019 0.3984)	0.51750 24.2715)*	0.00008 4.0671)*	0.29630 6.2551)*	0.27170 4.6106)*	-0.00734 9.7822)*	0.03794 9.3252)*	0.04200 1.0187)	0.56800
TATAMOTORS	-0.00035 0.8640)	1.12985 66.8979)*	0.00010 6.2581)*	0.13499 6.9071)*	0.72288 24.8218)*	-0.00591 6.8574)*	0.00144 3.2482)*	0.00570 0.2020)	0.85787
TATAPOWER	-0.00061 1.5359)	0.92120 51.7089)*	0.00010 6.0399)*	0.23260 6.8747)*	0.20280 3.7975)*	-0.00839 11.5145)*	0.02386 15.9906)*	0.05270 2.3349)**	0.43540
TATASTEEL	-0.00096 2.2670)**	1.09938 51.6370)*	0.00006 2.4567)**	0.14086 5.8595)*	0.21239 6.9015)*	-0.00639 5.1805)*	0.02716 13.8857)*	0.07048 2.1274)**	0.35324
WIPRO	-0.00085 1.9774)**	1.05904 53.2671)*	0.00002 1.5914)	0.13300 7.4898)*	0.79091 30.9133)*	-0.00194 2.9983)*	0.00037 0.6982)	0.10515 3.4117)*	0.92390

* Significant @1%, ** Significant @5%, *** Significant @10%

V. Conclusion

In this study, we examined the influence of the introduction of derivative contracts on the volatility of the underlying asset. We use 28 single stock futures (SSF) that are listed on the National Stock Exchange of India to investigate their influence on the volatility of the underlying stock returns. We employed symmetrical and asymmetrical GARCH (1, 1) models to see the impact of introduction of stock futures on the underlying stock volatility. Empirical results show that the introduction of the futures contract has significantly reduced the impact on the volatility of underlying stock return. Both symmetrical and asymmetrical models yield similar results we found that the underlying asset volatility is significantly influenced by its own lagged squared residuals and lagged volatility. We also explored this by adding an explanatory variable of futures volume/open interest ratio to the volatility model. Results suggest that the ratio of futures volume/open interest has further reduced the influence on volatility of the underlying asset return.

References

[1] Ajinkya, B. B., Jain, P. C., 1989, The behavior of daily stock market trading volume. Journal of Accounting and Economics 11, 331–359.

[2] Antoniou, A. and Foster, A. J. (1992) The effect of futures trading on spot price volatility: evidence for Brent crude oil using GARCH, Journal of Business Finance & Accounting, 19, 473–84.

[3] Antoniou, A. and Holmes, P. (1995) Futures trading and spot price volatility: evidence for the FTSE-100 stock index futures contract using GARCH, Journal of Banking and Finance, 19, 117–29.

[4] Baldauf, B. and Santoni, G. J. (1991) Stock price volatility: some evidence from an ARCH model, Journal of Futures Markets, 11, 191–200.

[5] Bandivadekar, S. and Ghosh, S. (2003) Derivative and Volatility on Indian Stock Markets, Reserve Bank of India Occasional Papers, 23, 187-201

[6] Board, J. Sandman, G. and Suicliffe, C. (2002). The Effect of Futures Market Volume on Spot Market Volatility. Journal of Business Finance and Accounting, 28, 799-819.

[7] Bortz, G. (1984). Does the treasury-bond futures market destabilize the treasury-bond cash market? Journal of Futures Markets, 4, 25-38.

[8] Bris A. Goetzman, W. Zhu, N. (2007) Efficiency and the Bear: Short Sales and Markets Around the World. Journal of Finance. June 2007;62(3):1029-1079.

[9] Chae, J., 2005. Trading volume, information asymmetry, and timing information. The Journal of Finance 60, 413-442.

[10] Dennis, S. A. and Sim, A. B. (1999) Share price volatility with the introduction of individual shares futures on the Sydney futures exchange, International Review of Financial Analysis, 8, 153–64.

[11] Evangelos Drimbetas, Nikolaos Sariannidis, and Nicos Porfiris (2007). The effect of derivatives trading on volatility of the underlying asset: evidence from the Greek stock market. Applied Financial Economics, 2007, 17, 139–148.

[12] Edwards, F. R. (1988) Does futures trading increase stock market volatility?, Financial Analysts Journal, 44(1), 63–9.

[13] Robert W. Faff; Michael D. McKenzie. The Impact of Stock Index Futures Trading on Daily Returns Seasonality: A Multicountry Study. The Journal of Business, Vol. 75, No. 1. (Jan., 2002), pp. 95-125.

[14] Figlewski, S. (1981) Futures trading and volatility in the GNMA market, Journal of Finance, 36, 445–57.

[15] Fratzscher, Oliver, 2006, "Emerging Derivative Markets in Asia," EAP Flagship on Asian Financial Market Development (Washington: World Bank).

[16] Froewiss, K. (1978). GNMA Futures: Stabilizing or Destabilizing? Federal Reserve Bank of San Francisco, Economic Review, 20-29.

[17] Galloway, T. M. and Miller J. M. (1997) Index futures trading and stock return volatility: evidence from the introduction of MidCap 400 Index Futures, Financial Review, 32, 845–66.

[18] Gupta O P, Kumar M : Impact of Introduction of Index Futures on Stock Market Volatility: The Indian Experience, 2002, (http://www.pbfea2002.ntu.edu.sg/papers/2070.pdf).

[19] Harris, L. (1989) S & P 500 spot stock price volatilities, Journal of Finance, 44, 1155–75

[20] Kawai, M. (1983). Spot and Futures Prices of Nonstorable Commodities Under Rational Expectations. The Quarterly Journal of Economics, Vol. 98, No. 2 (May, 1983), pp. 235-254.

[21] Nicholas Kaldor, Speculation and Economic Stability, The Review of Economic Studies, Vol. 7, No. 1 (Oct., 1939), pp. 1-27

[22] Kan, C. V. (1999) The effect of index futures trading on volatility of HIS constituent stocks, Pacific-Basin Finance Journal, 5, 105–14.

[23] Kasman, A. Kasman, S. (2008). The impact of futures trading on volatility of the underlying asset in the Turkish stock market. Physica A: Statistical Mechanics and its Applications. Volume 387, Issue 12, 1 May 2008, Pages 2837-2845

[24] Lee, S and Ohk, K, 1992, "Does Futures Trading Increase Stock Market volatility? The US, Japan, the UK and Hong Kong", The Review of Futures Markets, 11, 253-288

[25] Nath, G.C. (2003) Behaviour of Stock Market Volatility after Derivatives, NSE occasional paper, available at http://nse-india.com/content/press/nov2003a.pdf accessed on 2nd November 2009

[26] Peck, A.E. 1976, `Futures markets, supply response, and price stability', Quarterly Journal of Economics, vol. 90, no. 3, pp. 407-464.

[27] Pericli, A. and Koutmos, G. (1997) Index futures and options and stock market volatility, Journal of Futures Markets, 17, 957–74.

[28] Pok, W. C. and Poshakwale, S. (2004) The impact of the introduction of futures contracts on the spot market volatility: the case of Kuala Lumpur stock exchange, Applied Financial Economics, 14, 143–54.

[29] Rahman, S. (2001) The introduction of derivatives on the Dow Jones industrial average and their impact on the volatility of component stocks, Journal of Futures Markets, 21, 633–53.

[30] Raju M T, Karande K: Price discovery and volatility of NSE futures market, SEBI Bulletin, Vol 1(3) p. 5-15

[31] Rao, S.V.R. (2007) Impact of Financial Derivative Products on Spot Market Volatility: A Study of Nifty, The ICFAI Journal of Derivatives Markets, 4, 7-16

[32] Ryoo, H.-J. and Smith, G. (2004) The impact of stock index futures on the Korean stock market, Applied Financial Economics, 14, 243–51.

[33] Sarangi, S.B. and Patnaik, U.S. (2007) A Study on the Impact of Futures and Options on Spot Market Volatility: A Case of S&P CNX Nifty Index, The ICFAI Journal of Applied Finance, 13, 58-72

[34] Sarkar, A. (2006) Indian Derivative Market. In Oxford Companion to Economics in India (Ed.), Basu, K. New Delhi, Oxford University Press

[35] Shebangaraman, P. (2003) Do Futures and Options Trading increase Stock Market Volatility?, NSE working paper, http://www.nse-india.com/content/research/Paper60.pdf viewed on 2nd November 2009

[36] Simpson, W. and Ireland, T. (1985). The Impact of Financial Futures on the Cash Market for Treasury Bills. The Journal of Financial and Quantitative Analysis 20, 371-379.

[37] Jerome L. Stein, "Destabilizing Speculative Activity Can be Profitable," The Review of Economics and Statistics, XLIII (August I96I), 30I-302.

[38] Turnovsky, S. The Determination of Spot and Futures Prices with Storable Commodities, Econometrica, Vol. 51, No. 5 (Sep., 1983), pp. 1363-1387

[39] Thenmozhi M : Futures Trading, Information and Spot Price Volatility of NSE-50 Index Futures Contract, NSE Working Paper, 2002, http://www.nseindia.com/content/research/Paper59.pdf

[40] Vipul, (2006) Impact of introduction of Derivatives on Underlying Volatility: Evidence from India, Applied Financial Economics, 16, 687-97

[41] Paul Weller and Makoto Yano. Forward Exchange, Futures Trading, and Spot Price Variability: A General Equilibrium Approach. Econometrica, Vol. 55, No. 6 (Nov., 1987), pp. 1433-1450.

[42] Zhong M, Darrat A F and Otero R (2004), Price discovery and volatility spillovers in index futures markets: Some evidence from Mexico Journal of Banking & Finance 28, 3037-3054