*Reserve Bank of India Occasional Papers*
*Vol. 24, No. 3, Winter 2003*

# *Derivatives and Volatility on Indian Stock Markets*

**Snehal Bandivadekar and Saurabh Ghosh ***

Derivative products like futures and options on Indian stock markets have become important instruments of price discovery, portfolio diversification and risk hedging in recent times. This paper studies the impact of introduction of index futures on spot market volatility on both S&P CNX Nifty and BSE Sensex using ARCH/GARCH technique. The empirical analysis points towards a decline in spot market volatility after the introduction of index futures due to increased impact of recent news and reduced effect of uncertainty originating from the old news. However, further investigation also reveals that the market wide volatility has fallen during the period under consideration. Surrogate indices like BSE 200 and Nifty Junior are introduced to evaluate whether the introduction of index futures *per se* has been instrumental in reducing the spot market volatility or the volatility has fallen in line with general fall in market wide volatility. The results using these surrogate indices show that while the 'futures effect' plays a definite role in the reduction of volatility in the case of S&P CNX Nifty, in the case of BSE Sensex, where derivative turnover is considerably low, its role seems to be ambiguous.

JEL Classification: G1, G14, G15

Key words: Derivatives, index futures, stock markets, volatility, ARCH-GARCH

## Introduction

A derivative is financial instrument whose value is 'derived' from another underlying security or a basket of securities. Traders can assume highly leveraged positions at low transaction costs using these extremely flexible instruments. Derivative products like index futures, stock futures, index options and stock options have become

∗ Snehal Bandivadekar and Saurabh Ghosh are Research Officers in the Department of Economic Analysis and Policy, Reserve Bank of India. The authors are thankful to Dr. Sunando Roy, Shri Indranil Sen Gupta and to an anonymous referee for comments on the earlier drafts. The usual disclaimer applies.

important instruments of price discovery, portfolio diversification and risk hedging in stock markets all over the world in recent times. With the introduction of all the above-mentioned derivative products in the Indian markets a wider range of instruments are now available to investors. Introduction of derivative products, however, has not always been perceived in a positive light all over the world. It is, in fact, perceived as a market for speculators and concerns that it may have adverse impact on the volatility of the spot market are neither new nor understudied. Recent research, however, strengthens the argument that introduction of these products have not only deepened the markets but have also been instrumental in reduction of volatility in the spot markets.

The index futures were introduced in the Indian stock markets in June 2000 and other products like index options, stock futures and options and interest rate futures followed subsequently. The volumes in derivative markets, especially in the case of National Stock Exchange (NSE), has shown a tremendous increase and presently the turnover in derivative markets is much higher than the turnover in spot markets.

This article makes an effort to study whether the volatility in the Indian spot markets has undergone any significant change after the introduction of index futures in June 2000. It also attempts to evaluate whether such volatility change is due to unrelated macroeconomic reasons or it could be attributed to the derivative products introduced in the Indian stock markets. This article is organised as follows: Section I presents the literature survey, Section II assesses the available data presents the methodology and evaluates the results of the empirical exercise and Section III draws conclusions from the study.

## Section I

## Literature Survey

The effect of introduction of derivatives on the volatility of the spot markets and in turn, its role in stabilising or destabilising the

cash markets has remained an active topic of analytic and empirical interest. Questions pertaining to the impact of derivative trading on cash market volatility have been empirically addressed in two ways: by comparing cash market volatilities during the pre-and post-futures/ options trading eras and second, by evaluating the impact of options and futures trading (generally proxied by trading volume) on the behaviour of cash markets. The literature is, however, inconclusive on whether introduction of derivative products lead to an increase or decrease in the spot market volatility.

One school of thought argues that the introduction of futures trading increases the spot market volatility and thereby, destabilises the market (Cox 1976; Figlewski 1981; Stein, 1987). Others argue that the introduction of futures actually reduces the spot market volatility and thereby, stabilises the market (Powers, 1970; Schwarz and Laatsch, 1991 *etc*.). The rationale and findings of these two alternative schools are discussed in detail in this section.

The advocates of the first school perceive derivatives market as a market for speculators. Traders with very little or no cash or shares can participate in the derivatives market, which is characterised by high risk. Thus, it is argued that the participation of speculative traders in systems, which allow high degrees of leverage, lowers the quality of information in the market. These uninformed traders could play a destabilising role in cash markets (Chatrath, Ramchander and Song, 1995). However, according to another viewpoint, speculation could also be viewed as a process, which evens out price fluctuations.

The debate about speculators and the impact of futures on spot price volatility suggests that increased volatility is undesirable. This is, however, misleading as it fails to recognise the link between the information and the volatility (Antoniou and Holmes, 1995). Prices depend on the information currently available in the market. Futures trading can alter the available information for two reasons: first, futures trading attract additional traders in the market; second, as transaction costs in the futures market are lower than those in the

spot market, new information may be transmitted to the futures market more quickly. Thus, future markets provide an additional route by which information can be transmitted to the spot markets and therefore, increased spot market volatility may simply be a consequence of the more frequent arrival and more rapid processing of information.

On the other hand, arguments suggesting that the future and option markets have become important mediums of price discovery in cash markets are equally strong. Several authors have argued that trading in these products improve the overall market depth, enhance market efficiency, increase market liquidity, reduce informational asymmetries and compress cash market volatility (Kumar, Sarin and Shastri, 1995; Antoniou, Holmes and Priestley, 1998).

It has been argued that the introduction of derivatives would cause some of the informed and speculative trading to shift from the underlying cash market to derivative market given that these investors view derivatives as superior investment instruments. This superiority stems from their inherent leverage and lower transaction costs. The migration of informed traders would reduce the information asymmetry problem faced by market makers resulting in an improvement in liquidity in the underlying cash market. In addition, it could also be argued that the migration of speculators would cause a decrease in the volatility of the underlying cash market by reducing the amount of noise trading. This hypothesis would also suggest that the advent of derivatives trading would be accompanied by a decrease in trading volume in the underlying security.

In a recent study, Bologna and Cavallo (2002) investigated the stock market volatility in the post derivative period for the Italian stock exchange using Generalised Autoregressive Conditional Heteroscedasticity (GARCH) class of models. To eliminate the effect of factors other than stock index futures (*i.e.*, the macroeconomic factors) determining the changes in volatility in the post derivative period, the GARCH model was estimated after adjusting the stock return equation for market factors, proxied by the returns on an index

(namely Dax index) on which derivative products are not introduced. This study shows that unlike the findings by Antoniou and Holmes (1995) for the London Stock Exchange (LSE), the introduction of index future, *per se*, has actually reduced the stock price volatility. Bologna and Covalla also found that in the post Index-future period the importance of 'present news' has gone up in comparison to the 'old news' in determining the stock price volatility.

A few studies have been undertaken to evaluate the effect of introduction of derivative products on volatility of Indian spot markets. These studies have mainly concentrated on the NSE, and the evidence is inconclusive in this regard. While Thenmozhi (2002) showed that the inception of futures trading has reduced the volatility of spot index returns due to increased information flow. According to Shenbagaraman (2003), the introduction of derivative products did not have any significant impact on market volatility in India. Raju and Karande (2003) also reported a decline in volatility of S&P CNX Nifty after the introduction of index futures.

In the present study, following Bologna and Cavallo (2002) a GARCH model has been used to empirically evaluate the effects on volatility of the Indian spot market and to see that what extent the change (if any) could be attributed to the of introduction of index futures. We use BSE-200 and Nifty Junior as surrogate indices to capture and study the market wide factors contributing to the changes in spot market volatility. This gives a better idea as to: whether the introduction of index futures in itself caused a decline in the volatility of spot market or the overall market wide volatility has decreased, and thus, causing a decrease in volatility of indices on which derivative products have been introduced. Finally, the studies in the Indian context have evaluated the trends in NSE and not on the Stock Exchange, Mumbai (BSE) for the reason that the turnover in NSE captures an overwhelmingly large part of the derivatives market. However, since the key issue addressed here is the volatility of the cash market as affected or unaffected by the derivative market, the importance of evaluating the trends in BSE as well was felt and the empirical analysis was carried out likewise.

## Section II

## Empirical Analysis

Daily data for BSE Sensex and S&P CNX Nifty have been used for the period January 1997 to March 2003. Alongwith these two series on which derivative products are available, we also consider the volatility on the broad based BSE-200 and Nifty Junior on which derivative products have not been introduced. Though BSE and NSE prices are tightly bound by arbitrage, the derivative turnover differs considerably among these markets (with the NSE recording a maximum turnover in the derivative market). A comparison of fluctuations in volatility between BSE-200/Nifty Junior and Sensex/Nifty may provide a clue to segregate the fluctuations due to introduction of future products and due to other market factors. There are several broad based indices available like BSE-100, BSE-200, BSE-500 and Nifty Junior. However, longer time series is available only for Nifty Junior and BSE 200. These indices also capture 80 to 90 per cent of market capitalisation of the BSE or the NSE and therefore, they are chosen as surrogate indices.

The empirical exercise attempts to evaluate whether the introduction of index futures had any significant impact on the spot stock return volatility. It uses the daily BSE Sensex returns and daily S&P CNX Nifty returns along with returns on BSE-100, BSE-200 and BSE-500 to evaluate the impact of these policy changes on the stock returns volatility. Following Bologna and Cavallo (2002), this paper uses Generalised Autoregressive Conditional Heteroscedasticity (GARCH) framework to model returns volatility.

The GARCH model was developed by Bollerslev (1986) as a generalised version of Engle's (1982) Autoregressive Conditional Heteroscedasticity (ARCH). In the GARCH model the conditional variance at time '*t*' depends on the past values of the squared error terms and the past conditional variances.

The GARCH (p,q) model suggested by Bollerslev (1986) is represented as follows:

$$Y_t = \alpha X + \varepsilon_t$$

$$\varepsilon_t / \varepsilon_{t-1} \sim N(O, h_t)$$

$$h_t = \beta_o + \sum \beta_i \varepsilon^2_{t-i} + \sum \beta_j h_{t-j} \quad \text{where } i=1,2..p \text{ and } j=1,2\ldots q$$

Where $Y_t$ is the dependent variable and Xis a set of independent variable(s). $\varepsilon_t$ is the GARCH error term with mean zero and variance $h_t$.

The GARCH (1,1) framework has been extensively found to be most parsimonious representation of conditional variance that best fits many financial time series (Bollerslev, 1986; Bologna and Cavallo, 2002) and thus, the same has been adopted to model stock return volatility. The model specification is as follows:

$$R_t = \alpha_o + \alpha_1 R_{t-1} + \varepsilon_t$$

$$\varepsilon_t / \varepsilon_{t-1} \sim N(O, h_t)$$

$$h_t = \beta_o + \beta_1 \varepsilon^2_{t-1} + \beta_2 h_{t-1} + \lambda D_f$$

where $R_t$ is the daily return on the BSE Sensex and $R_{t-1}$ is the lagged return. As regards the conditional variance, following Bologna and Cavallo (2002), it has been augmented with a dummy variable $D_t$ which takes value zero for the pre-index-futures period and one for the post-index-futures period. The direction and the magnitude of the dummy variable coefficients are used to infer whether the introduction of index futures could be related to any change in the volatility of the spot market. This exercise also estimates the coefficients of the GARCH model separately for the pre-index future and post-index future period to have a deeper insight in the change in the values of the coefficients and their implications on the stock return volatility. The results of this exercise are presented in Table 1 below.

**Table 1: Changes in Volatility in BSE Sensex after the Introduction of Index Futures**

| $a_0$ | $a_1$ | $b_0$ | $b_1$ | $b_2$ | $l$ |
|---|---|---|---|---|---|
| ***Estimates for the Whole Period*** | | | | | |
| 0.05 | 0.11 | 0.55 | 0.18 | 0.69 | -0.28 |
| (0.19) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |
| ***Before the Introduction of Index Future*** | | | | | |
| 0.10 | 0.09 | 0.44 | 0.12 | 0.76 | |
| (0.12) | (0.02) | (0.01) | (0.00) | (0.00) | |
| ***After the Introduction of Index Future*** | | | | | |
| 0.03 | 0.13 | 0. 32 | 0.26 | 0.61 | |
| (0.53) | (0.00) | (0.00) | (0.00) | (0.00) | |

Note : P-values are reported in parentheses.

The first two rows of the Table 1 present the result for the whole period under consideration for BSE Sensex. It shows the coefficient of the index-futures dummy variable ($l = -0.28$) is significant at one per cent level, which is indicative of the fact that the introduction of index futures might have made a difference in the volatility of BSE Sensex returns. The negative sign of the dummy variable coefficient is suggestive of the reduction in the volatility. This preliminary result supports the hypothesis that the introduction of index future has reduced the volatility in the BSE spot market, even though derivative turnover is quite low in BSE as compared with NSE.

The results reported in Table 1 presents estimate of the GARCH model coefficient for the pre-future trading and post-future trading periods. The coefficients reported in Table 1 support the findings of the Antoniou and Holmes (1995) and Bologna and Cavallo (2002). It shows that in the GARCH variance equation the $b1$ components have gone up and $b2$ components have actually gone down in the post Index-future period and these estimates are significant at one per cent level. The $b1$ component is the coefficient of square of the error term and the $b2$ represents the

coefficient of the lagged variance term in the GARCH variance equation. Both Antoniou and Holmes' (1995) and Bologna and Cavallo's (2002) papers have referred $b_1$ as the effect of 'recent news' and $b_2$ capturing the effect of 'old news'. Thus, in line with the findings in the UK and Italy, the result reported here supports the hypothesis that introduction of index futures have actually increased the impact of recent news and at the same time reduced the effect of uncertainty originating from the old news.

The Index futures were introduced only in the BSE Sensex and not in the other (*e.g.,* BSE-100, BSE-200 and BSE-500) indices available on the BSE. Moreover, futures trading was introduced in most of the scrips included in the BSE Sensex. Thus, if index and stock futures were the only factors instrumental in reducing the spot price volatility then the reduction in volatility is expected to be more in the case of the BSE Sensex in comparison to the other indices available in BSE. In an attempt to evaluate whether the introduction of futures was the only reason behind the reduction of volatility in BSE Sensex, the same GARCH model with the same dummy variable was used to evaluate the changes in volatility for the BSE-100, BSE-200 and BSE-500. Table 2 shows the estimated coefficients of the model where the dummy variable represents the inception of index future.

**Table 2: Changes in Volatility after the Introduction of Index Futures**

| $a_0$ | $a_1$ | $b_0$ | $b_1$ | $b_2$ | $l$ |
|---|---|---|---|---|---|
| ***For BSE-100*** | | | | | |
| 0.07 | 0.13 | 0. 44 | 0.21 | 0.68 | -0.15 |
| (0.05) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |
| ***For BSE-200*** | | | | | |
| 0. 08 | 0.13 | 0. 32 | 0.15 | 0.78 | -0.08 |
| (0.05) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |
| ***For BSE-500*** | | | | | |
| 0. 08 | 0.11 | 0.28 | 0.14 | 0.81 | -0.14 |
| (0.11) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |

Note : P-values are reported in parentheses.

The estimated $\lambda$ coefficients of the modified GARCH model (which were significant at one per cent level) reported in column 6 of Table 2 are indicative of the reduction in volatility in the post-index future period. The GARCH results obtained for BSE-100, BSE-200 and BSE-500 are counterintuitive to the argument of index future being unambiguously responsible for the reduction in the BSE Sensex volatility in the post Index future period and indicative of the fact that it is more likely that the stock market and economy wide factors were responsible for the reduction in volatility of the BSE Sensex in the period under consideration.

In order to address the issue of whether introduction of index future has been the only factor instrumental in reducing volatility, we use the technique of Bologna and Cavallo (2002) where they included the returns from a surrogate index (in our case BSE-200) into GARCH equation to control the additional factors affecting the market volatility. The augmented set of equations is as follows

$$R_t = \alpha_0 + \alpha_1 R_{t-1} + \alpha_2 R_t^{BSE\text{-}200} + \varepsilon_t$$

$$\varepsilon_t / \varepsilon_{t-1} \sim N(O, h_t)$$

$$h_t = \beta_o + \beta_1 \varepsilon^2_{t-1} + \beta_2 h_{t-1} + \lambda D_f$$

The estimation based on the above-mentioned set of equations is provided in Table 3 below. The $\lambda$ coefficient is significant but shows extremely low positive value. It suggests that under the augmented GARCH model, the so called "futures effect" (the reduction in the spot index return volatility after the introduction of future products) has disappeared in the case of BSE Sensex. However, a comparison of the results of the pre-futures and post-futures period in the new model shows that the $\beta_1$ and $\beta_2$ components have followed the same path as before. In particular, the importance of 'recent news' has increased in the post-futures period and the impact of the 'old news' has decreased. Moreover, the most noticeable factor here is that $\beta_2$ coefficient is not significant in the post index future period. This is in line with Antoniou and Holmes' (1995) result, which suggests that the introduction of

futures have improved the quality of information flowing to the spot market. The overall impact of index futures on the spot index volatility is ambiguous. The empirical evidence in this paper however strongly suggests that the stock market volatility in general has gone down during the post future period under consideration.

**Table 3: Changes in the Volatility of BSE Sensex after Introduction of Index Futures (after controlling for movement in BSE-200 Nifty Junior)**

| $a_0$ | $a_1$ | $a_2$ | $b_0$ | $b_1$ | $b_2$ | $I$ |
|---|---|---|---|---|---|---|
| ***Estimates for the Whole Period (after controlling for movement in BSE-200)*** | | | | | | |
| -0.01 | -0.02 | 1.02 | 0.01 | 0.09 | 0.90 | 0.01 |
| (0.29) | (0.01) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |
| **Estimates for the Whole Period (after controlling for movement in Nifty Junior)** | | | | | | |
| -0.08 | -0.01 | 0.66 | 1.36 | 0.11 | 0.03 | 0.05 |
| (0.09) | (0.78) | (0.00) | (0.00) | (0.01) | (0.91) | (0.00) |
| ***Before the Introduction of Index Future*** | | | | | | |
| -0.01 | -0.03 | 1.06 | 0.62 | 0.17 | 0.80 | |
| (0.54) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | |
| ***After the Introduction of Index Future*** | | | | | | |
| -0.07 | 0.03 | 0.82 | 0.30 | 0.22 | 0.01 | |
| (0.01) | (0.11) | (0.00) | (0.00) | (0.00) | (0.92) | |

Note : P-values are reported in parentheses.

It might be noted that the entire period under consideration was marked by subdued trends in the stock market. While the domestic stock markets have remained sluggish after the stock market scam, the international markets also remained depressed after the terrorist attack in US. At the same time, however the domestic markets witnessed rapid progress amidst in market microstructure. All the scrips listed on the BSE and the NSE are now under the orbit of compulsory rolling settlement. The rolling settlement cycle has been reduced to T+3 and further to T+2 for all the scrips in line with the best international practices.

Corporate governance practices have been made more stringent. Against this backdrop, the empirical results confirm that the overall volatility in BSE spot market declined in the post index future period. The extent to which it could be linked to the 'future's effect' however, remains ambiguous.

A number of studies concentrated only on the volatility changes of S&P CNX Nifty in post-futures period (Thenmozhi, 2002; Raju and Karande, 2003). Majority of the studies have concluded that the introduction of derivative products have resulted in reduction in the cash market volatility. In an attempt to evaluate whether the macroeconomic factors were primarily responsible for reduction in volatility in the NSE, which registers maximum turnover in the derivative segment, we consider the volatility changes in S&P Nifty index. Our empirical analysis in the case of S&P CNX Nifty also supports the earlier findings. As reported in Table 4 the coefficient of the dummy variable capturing the effect of the changes in market volatility after introduction of index future had negative sign (-0.30) and was significant at one per cent level. In an attempt to segregate the 'futures effect' from the other factors causing the decline in cash market volatility, BSE-200[1] was once more used as the surrogate index and the results of the augmented GARCH model are presented in Table 4 below.

**Table 4: Changes in Volatility of S&P CNX Nifty after Introduction of Index Futures**

| $a_0$ | $a_1$ | $a_2$ | $b_0$ | $b_1$ | $b_2$ | $l$ |
|---|---|---|---|---|---|---|
| ***Estimates for the Whole Period*** | | | | | | |
| 0.05 | 0.10 | - | 0.49 | 0.12 | 0.74 | -0.30 |
| (0.13) | (0.00) | - | (0.00) | (0.00) | (0.00) | (0.00) |
| ***GARCH Estimate (after controlling for movement in BSE-200)*** | | | | | | |
| 0.02 | 0.14 | 0.86 | 0.01 | 0.03 | 0.96 | -0.01 |
| (0.08) | (0.16) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) |
| **GARCH Estimate (after controlling for movement in Nifty Junior)** | | | | | | |
| 0.05 | 0.10 | 0.02 | 0.50 | 0.12 | 0.75 | -0.28 |
| (0.14) | (0.00) | (0.31) | (0.00) | (0.00) | (0.00) | (0.00) |

Note : P-values are reported in parentheses.

The result shows that the dummy coefficient (-0.01) has taken negative value even after adjusting for the market factors and it is significant even though the magnitude of such effect has gone down considerably. This finding supports the earlier work for S&P CNX Nifty and shows that unlike BSE Sensex, futures trading has a significant role in reducing volatility of S&P CNX Nifty, over and above the market factors.

The empirical findings of this section could be summarised by saying that there has been reduction in the spot market volatility in the recent years (after June 2000), which could be attributed to macroeconomic changes. This is evident from the reduction in volatility documented in BSE-100, BSE-200 and BSE-500 indices where derivative products were not introduced. BSE Sensex also witnessed reduction in volatility. Though derivative products are available on BSE Sensex, the reduction in volatility in the post derivative period fades away when we control for the market movement through a surrogate index. These findings indicate that the change in BSE Sensex spot volatility was mainly due to the market wide changes and not due to the futures effect. However, an analysis in the same framework shows different results for S&P CNX Nifty. Even after controlling for the market movement through surrogate index for S&P CNX Nifty, the volatility in the cash market shows significant signs of reduction, which could be due to the "futures effect". The differences in the empirical finding between these two indices could be because of large turnovers in the derivative segment in the S&P CNX Nifty index as opposed to BSE Sensex, which makes the "futures effect" to be significant in the former index.

## Section III

## Conclusions

Using ARCH/GARCH methodology, this article evaluated the impact of introduction of derivative products on spot market volatility in Indian stock markets. We found that the volatility in both BSE Sensex and S&P CNX Nifty has declined in the period after index future was introduced. Recognising the fact that the decline in volatility is a

function of not only introduction of derivative products, but also certain market wide factors, we evaluated the volatility of BSE-100, BSE-200 and BSE-500 indices (where index futures have not been introduced) which showed a decline and indicated that the other market wide factors might have played an important role in the observed decline in volatility of BSE Sensex and S&P CNX Nifty. In order to control the market-wide factors, we used BSE-200 and Nifty Junior as surrogate indices in the GARCH model. Using this model, we found a reduction in volatility of S&P CNX Nifty even after controlling for market wide factors. The volatility of BSE Sensex, however, showed an increase, which is not in line with the expectations. This result indicates that the decline in volatility of BSE Sensex was mainly due to the overall decline in market volatility. S&P CNX Nifty, however, incorporated the contribution of both the 'market factors' as well as the 'futures effect'. This is due to increased impact of recent news and reduced effect of uncertainty originating from the old news.

In conclusion, the empirical results of this study indicate that there has been a change in the market environment since the year 2000, which is reflected in the reduction in volatility in all the BSE indices and S&P CNX Nifty. The impact of a derivative product, however, on the spot market depends crucially on the liquidity characterising the underlying market. This is evident from the differential results obtained for BSE Sensex and S&P CNX Nifty. It may be added, that turnover in the derivative market of BSE constitutes not only a small part of the total derivative segment, but is miniscule as compared to BSE cash turnover. Thus, while BSE Sensex incorporates only the market effects, the reduction in volatility due to "future's effect" plays a significant role in the case of S&P CNX Nifty.

## Note

[1] We also used Nifty Junior as a surrogate index to capture the effect of macroeconomic factors on the spot price volatility of S&P CNX Nifty. The results reported in the last rows of Table 4 are in confirmation to the result obtained in case of BSE 200.

## References

Antoniou, A and P Holmes (1995): "Futures Trading, Information and Spot Price Volatility: Evidence from FTSE -100 Stock Index Futures Contracts Using GARCH?" *Journal of Banking and Finance*, 19(2), 117-129.

Antoniou, A.P Holmes and R Priestley (1998): "The Effects of Stock Index Futures Trading on stock index volatility: An Analysis of the Asymmetric Response of Volatility to News?" The *Journal of Futures Markets,* 18 (2), 151-166.

Bologna, P and L. Cavallo (2002): "Does the Introduction of Stock Index Futures Effectively Reduce Stock Market Volatility? Is the 'Futures Effect' Immediate? Evidence from the Italian stock exchange using GARCH", *Applied Financial Economics,* 12, 183-192.

Bollerslev T. (1986): "Generalised Autoregressive Conditional Heteroscedasticity" *Journal of Econometrics,* 31, 307-327.

Chatrath, Arjun, Sanjay Ramchander and Frank Song (1995): "Does Options Trading Lead to Greater Cash Market Volatility?" *Journal of Futures Markets,* 15 (7), 785-803.

Cox, C C (1976): "Futures Trading and Market Information" *Journal of Political Economy,* 84, 1215-37.

Engle, R. (1982), "Autorregressive Conditional Heteroskedasticity with Estimates of United Kingdom Inflation", *Econometrica,* 50, 987-1008.

Figlewski, Stephen(1981): "Futures Trading and Volatility in the GNMA Market" *Journal of Finance,* 36, 445-84.

Kumar, Raman, Atulya Sarin and Kuldeep Shastri (1995): "The Impact of the Listing of Index Options on the Underlying Stocks" *Pacific-Basin Finance Journal,* 3, 303-317.

Pericli, A. and G. Koutmos (1997): "Index Futures and Options and Stock Market Volatility" *Journal of Futures Markets,* 17(8), 957-974.

Pizzi, M., A. Andrew, J. Economopoulos and H. O'Neill (1998): "An Examination of the Relationship between Stock Index Cash and Futures Markets: A Cointegration Approach" *Journal of Futures Markets,* 18, 297-305.

Powers M J (1970): "Does Futures Trading Reduce Price Fluctuations in the Cash Markets?" *American Economic Review,* 60, 460-4.

Raju M T and K Karande (2003): "Price Discovery and Voltatility on NSE Futures Market" *SEBI Bulletin,* 1(3), 5-15.

Schwarz T V and F Laatsch (1991): "Dynamic Efficiency and Price Leadership in Stock Index Cash and Futures Markets", *Journal of Futures Markets,* 11, 669-83.

Shenbagaraman P (2003): "Do Futures and Options Trading increase Stock Market Volatility?" *NSE Research Initiative,* Paper no. 20.

Stein J C (1987): "Information Externalities and Welfare Reducing Speculation" *Journal of Political Economy,* 95, 1123-45.

Thenmozhi M (2002): "Futures Trading, Information and Spot Price Volatility of NSE-50 Index Futures Contract" *NSE Research Initiative,* Paper no. 18.