Do Futures and Options trading increase stock market volatility?

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Abstract

The objective of this study is to assess the impact of introducing index futures and options contracts on the volatility of the underlying stock index in India. Numerous studies on the effects of futures and options listing on the underlying cash market volatility have been done in the developed markets. The empirical evidence is mixed and most suggest that the introduction of derivatives do not destabilize the underlying market. The studies also show that the introduction of derivative contracts improves liquidity and reduces informational asymmetries in the market. In the late nineties, many emerging and transition economies have introduced derivative contracts, raising interesting issues unique to these markets. Emerging stock markets operate in very different economic, political, technological and social environments than markets in developed countries like the USA or the UK. This paper explores the impact of the introduction of derivative trading on cash market volatility using data on stock index futures and options contracts traded on the S & P CNX Nifty (India). The results suggest that futures and options trading have not led to a change in the volatility of the underlying stock index, but the nature of volatility seems to have changed post-futures. We also examine whether greater futures trading activity (volume and open interest) is associated with greater spot market volatility. We find no evidence of any link between trading activity variables in the futures market and spot market volatility. The results of this study are especially important to stock exchange officials and regulators in designing trading mechanisms and contract specifications for derivative contracts, thereby enhancing their value as risk management tools

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I. Introduction

In the last decade, many emerging and transition economies have started introducing derivative contracts. As was the case when commodity futures were first introduced on the Chicago Board of Trade in 1865, policymakers and regulators in these markets are concerned about the impact of futures on the underlying cash market. One of the reasons for this concern is the belief that futures trading attracts speculators who then destabilize spot prices. This concern is evident in the following excerpt from an article by John Stuart Mill (1871):

> "The safety and cheapness of communications, which enable a deficiency in one place to be, supplied from the surplus of another render the fluctuations of prices much less extreme than formerly. This effect is much promoted by the existence of speculative merchant. Speculators, therefore, have a highly useful office in the economy of society".

Since futures encourage speculation, the debate on the impact of speculators intensified when futures contracts were first introduced for trading; beginning with commodity futures and moving on to financial futures and recently futures on weather and electricity. However, this traditional favorable view towards the economic benefits of speculative activity has not always been acceptable to regulators. For example, futures trading was blamed by some for the stock market crash of 1987 in the USA, thereby warranting more regulation. However before further regulation in introduced, it is essential to determine whether in fact there is a causal link between the introduction of futures and spot market volatility. It therefore becomes imperative that we seek answers to questions like: What is the impact of derivatives upon market efficiency and liquidity of the underlying cash market? To what extent do derivatives destabilize the financial system, and how should these risks be addressed? Can the results from studies of developed markets be extended to emerging markets?

This paper seeks to contribute to the existing literature in many ways. This is the first study to examine the impact of financial derivatives introduction on cash market volatility in an emerging market, India. Further, this study improves upon the methodology used in prior studies by using a framework that allows for generalized auto-regressive conditional heteroskedasticity (GARCH) i.e., it explicitly models the volatility process over time, rather than using estimated standard deviations to measure volatility. This estimation technique enables us to explore the link between information/news arrival in the market and its effect on cash market volatility. The study also looks at the linkages in ongoing trading activity in the futures market with the underlying spot market volatility by decomposing trading volume and open interest into an expected component and an unexpected (surprise) component. Finally this is the first study to our knowledge that looks at the effects of both stock index futures introduction as well as stock index options introduction on the underlying cash market volatility.

The results of this study are crucial to investors, stock exchange officials and regulators. Derivatives play a very important role in the price discovery process and in completing the market. Their role in risk management for institutional investors and mutual fund managers need hardly be overemphasized. This role as a tool for risk management clearly assumes that derivatives trading do not increase market volatility and risk. The results of this study will throw some light on the effects of derivative introduction on the efficiency and volatility of the underlying cash markets.

The study is organized as follows. Section II discusses the theoretical debate and summarizes the empirical literature on derivative listing effects, Section III details the model and the econometric methodology used in this study, Section IV outlines the data used and discusses the main results of the model and finally Section V concludes the study and presents directions for future research.

II. Theoretical foundations and survey of the empirical literature.

The introduction of equity index futures markets enables traders to transact large volumes at much lower transaction costs relative to the cash market. The consequence of this increase in order flow to futures markets is unresolved on both a theoretical and an empirical front. Stein (1987) develops a model in which prices are determined by the interaction between hedgers and informed speculators. In this model, opening a futures market has two effects; (1). The futures market improves risk sharing and therefore reduces price volatility, and (2). If the speculators observe a noisy but informative signal, the hedgers react to the noise in the speculative trades, producing an increase in volatility.

In contrast, models developed by Danthine (1978) argue that the futures markets improve market depth and reduce volatility because the cost to informed traders of responding to mispricing is reduced. Froot and Perold(1991) extend Kyle's(1985) model to show that market depth is increased by more rapid dissemination of market-wide information and the presence of market makers in the futures market in addition to the cash market. Ross (1989) assumes that there exists an economy that is devoid of arbitrage and proceeds to provide a condition under which the no-arbitrage situation will be sustained. It implies that the variance of the price change will be equal to the rate of information flow. The implication of this is that the volatility of the asset price will increase as the rate of information flow increases. Thus, if futures increase the flow of information, than in the absence of arbitrage opportunity, the volatility of the spot price must change. Overall, the theoretical work on futures listing effects offer no consensus on the size and the direction of the change in volatility. We therefore need to turn to the empirical literature on evidence relating to the volatility effects of listing index futures and options.

The first stock index futures contract introduced in the world was the Value line contract, introduced by the Kansas City Board of Trade in 1982 in the USA. Since then we have seem numerous markets all over the world launching new derivative contracts every year. Following the introduction of derivative contracts in developed markets like the US and UK, researchers have sought to analyze the impact of derivatives introduction on the volatility and efficiency of the underlying cash market. The empirical evidence is however quite mixed. Most studies summarize that the introduction of derivatives does not destabilize the underlying market; either there is no effect or perhaps only a very small decline in volatility[1]. The impact however, seems to vary depending on the time period studied and the country studied. For example, in a study of 25 countries, Gulen and Mayhew (2000) find that futures trading is associated with increased volatility in the United States and Japan. In some countries, there is no robust, significant effect, and in many others, volatility is lower after futures have been introduced.

Nathan Associates (1974) was the first to study the impact of listing options on the Chicago Board of Exchange. He reported that the introduction of options seemed to have helped stabilize trading in the underlying stocks. This result has been supported by Skinner (1989) and also by other authors for the UK, Canada, Switzerland and Sweden. More recent work by Lamoureux and Pannikath (1994), Freund, McCann and Webb (1994) and Bollen (1998) have found that the direction of the volatility effect is not consistent over time. After 1987, the residual variance of both optioned stocks and stocks in a matched control group increased at the time of the option listing. This might be interpreted in two ways; viz. perhaps the listing has no true impact on volatility and there is some common unknown factor that is driving the magnitude of the idiosyncratic risk for different stocks. Or perhaps, there are spill over effects associated with listing options for some stocks, such that the dynamics of other stocks also changes (Detemple and Jorion, 1990, and Cao 1999).

In looking at the effect on liquidity, Nathan Associates (1974) found that the trading volume did not change with option introduction. However, later studies like Kumar, Sarin and Shastri (1995) have found that the volume in the underlying stock does increase after the introduction of stock options. Studies have also found that after the introduction of options, prices tend to reflect new information more quickly, bid-ask spreads narrow, and the adverse selection component of the spread becomes smaller. Relatively few authors have studied the impact of stock index options listing on volatility in the cash market. Evidence reported by Chatrath, Kamath, Chakornpipat and Ramchander (1995) indicates that S&P 100 stock index options trading had a stabilizing effect on the

[1] For a detailed summary of this literature, see surveys by Hodges (1992), Damodaran and Subrahmanyam (1992), Stucliffe (1997) and Mayhew (1999).

underlying stock index. Studies of volatility effects of individual equity options have also reported mixed results; some find that volatility is unchanged, while some report a small decrease in volatility. Only one paper Wei, Poon and Zee (1997) report an increase in volatility for options on OTC stocks in the USA. However no consensus result emerges, which probably a result of different data and time-periods studied, as also the inherent endogenously of the option listing decision[2].

III. Model and Methodology

One of the key assumptions of the ordinary regression model is that the errors have the same variance throughout the sample. This is also called the homoscedasticity model. If the error variance is not constant, the data are said to be heteroscedastic. Since ordinary least-squares regression assumes constant error variance, heteroscedasticity causes the OLS estimates to be inefficient. Models that take into account the changing variance can make more efficient use of the data. There are several approaches to dealing with heteroscedasticity. If the error variance at different times is known, weighted regression is a good method. If, as is usually the case, the error variance is unknown and must be estimated from the data, one can model the changing error variance. In the past, studies of volatility have used constructed volatility measures like estimated standard deviations, rolling standard deviations, etc, to discern the effect of futures introduction. These studies implicitly assume that price changes in spot markets are serially uncorrelated and homoscedastic. However, findings of heteroskedasticity in stock returns are well documented (Mandelbrot 1963), Fama (1965), Bollerslev (1986). Thus the observed differences in variances from models assuming homoscedasticity may simply be due to the effect of return dependence and not necessarily due to futures introduction. The GARCH model assumes conditional heteroscedasticity, with homoscedastic unconditional error variance. That is, the model assumes that the changes in variance are a function of the realizations of preceding errors and that these changes represent temporary and random departures from a constant unconditional variance, as might be the case when using daily data. The advantage of a GARCH model is that it captures the tendency in financial data for volatility clustering. It therefore enables us to make the connection between information and volatility explicit, since any change in the rate of information arrival to the market will change the volatility in the market. Thus, unless information remains constant, which is hardly the case, volatility must be time varying, even on a daily basis. A model with errors that follow a GARCH (p,q) process is represented as follows:

[2] In a recent working paper, Mayhew and Mihow (2000) explicitly model the exchanges 'option listing choice using a logit model to account for this endogeniety.

$$Y_t = a_0 + a_1 X_t + e_t, e|\Psi_{t-1} \sim N(0, h_t)$$

$$h_t = a_0 + \sum_{i=1}^{p} a_i e_{t-1}^2 + \sum_{j=1}^{q} b_j h_{t-j}$$

Equation 1a and 1b

where Equation 1a is the conditional mean equation and 1b is the conditional variance equation.

In studying the links between information, cash market volatility and derivatives trading, two issues are interesting. First, how the initial introduction of derivative contracts impact cash market volatility. Second, whether the existence of futures trading affects daily volatility in the cash market. To address the first issue, we introduce a dummy variable into the conditional variance equation. Equation (1) thus becomes:

$$Y_t = a_0 + a_1 X_t + e_t, e|\Psi_{t-1} \sim N(0, h_t)$$

$$h_t = a_0 + \sum_{i=1}^{p} a_i e_{t-1}^2 + \sum_{j=1}^{q} b_j h_{t-j} + gDF$$

Equation 2

where DF is a dummy variable taking the value of 0 before futures introduction and 1 after. If the coefficient on the Dummy is statistically significant then the introduction of futures has an impact on the spot market volatility. To address the second issue, we divide the sample into the pre-futures and post- futures sub-sample and a GARCH model is estimated separately for each sub-sample. This allows us to compare the nature of volatility before and after the onset of futures trading. Further, we also incorporate the contract volume and open interest in the futures market in the conditional variance equation in the post-futures sub sample.

The impact of stock index futures and option contract introduction in the Indian market is examined using a univariate GARCH (1,1) model[3]. The time series of daily returns on the S&P CNX Nifty Index is modeled as a univariate GARCH process. Following Pagan and Schwert (1990) and Engle and Ng (1993), we need to remove from the time series any predictability associated with lagged world returns and/or day of the week effects. Further, we need to control for the effect of market wide factors, since we are interested in isolating the unique impact of the introduction of the futures/options contracts. Fortunately for the Indian stock market we have another index, the Nifty Junior, which comprises stocks for which no futures contracts are traded. As such, it serves as a perfect control variable for us to isolate market wide factors and thereby concentrate on the residual volatility in the Nifty as a direct result of the introduction of the index derivative contracts. We therefore introduce the return on the Nifty Junior index as an additional independent variable. The following conditional mean equation is estimated:

[3] Alternative GARCH models were estimated, the GJR-GARCH, EGARCH AND TGARCH, but we find the GARCH (1,1) model to provide the best fit for the data in this study.

$$R_{nifty,t} = a_0 + a_1 R_{sp500,t-1} + a_2 R_{niftyjunior,t} + \sum_{j=2}^{5} a_j DAY_j + u_t \qquad \textbf{\textit{Equation 3}}$$

where $R_{nifty,t}$ is the daily return on the S&P CNX Nifty Index calculated as the first difference of the log of the index, $R_{sp500,t-1}$ is the lagged S&P500 index return, and DAY_j are day-of-the-week dummy variables for Tuesday to Friday. The lagged S&P500 index return is used as an independent variable to remove the effects of worldwide price movements on the volatility of the Nifty Index return. For example, if the Indian market is influenced by US markets, this will be reflected through the lagged S&P500 return.

In GARCH, the residuals $\{u_t\}$ from Equation 3 are assumed to be distributed $N(0, h_t)$ where the conditional volatility h_t is given by the following equation:

$$h_t = g_0 + g_1 e_{t-1}^2 + g_2 h_{t-1} + g_3 D_t \qquad \textbf{\textit{Equation 4}}$$

where D_t is a dummy variable that takes on a value of zero before the options/futures were introduced and a value of one after. A significant positive value for g_3 would indicate that derivatives introduction increases the volatility of the underlying index.

Section IV. Data and Results

Daily closing prices for the period 5th Oct 1995 to 31st Dec 2002 for the SNX Nifty and the Nifty Junior were obtained from the CD-ROMs provided by NSE and the NSE website. Data on Nifty futures contract volume and open interest were downloaded from the NSE website. Data on the S&P500 index were obtained from Reuters Inc. All estimations in this study are done using SAS. The SNX Nifty is an index of 50 stocks traded on the National Stock Exchange and represents approximately 50% of the total market capitalization of the market. Nifty Junior is an index of the next most liquid 50 stocks. The first index future in India was introduced on the SNX Nifty on June 12, 2000. The first index options contract was introduced on 4th June, 2001.

Table 1 provides summary statistics for the Nifty and Nifty Junior indices. All returns are calculated as the first difference of the log of the index daily close price and Chart 1 graphs the returns on the Nifty index over time. As seen in Table 1, the overall sample has 1805 time series observations. The mean return on the Nifty is 0.003% per day with a standard deviation of 1.67% per day. The mean daily return on the Nifty Junior is 0.007% with a standard deviation of 1.95%. If we divide the sample period into pre-futures vs. post-futures using the June 12, 2000 cutoff date, the mean daily return on the Nifty is a positive 0.029% before and a negative 0.044% after the futures was introduced. A similar pattern in Nifty Junior returns is also apparent. The average daily standard deviation for the Nifty return pre-futures is 1.79% and 1.42% post-futures. However, the daily standard deviation for the Nifty Junior, for which no index futures were traded, pre-futures is 2% and post futures is 1.7%. A very similar pattern emerges when one examines the pre-options and post-option sub-sample means and standard deviations.

As stated in the previous section, it is important to remove market-wide influences on Nifty returns, if we are to isolate the impact of futures introduction. In order to do this we need a proxy that is not associated with any futures contract, and yet captures market-wide influences in India. For example, information news releases relating to economic conditions like, inflation rates, growth forecasts, exchange rates, etc are likely to affect the whole market. It is necessary to remove the effects for all these factors on price volatility. Since the Nifty Junior has no futures contracts traded on it, we use it as a proxy to capture market-wide information effects. Following Pagan and Schwert (1990) and Engle and Ng (1993), we also need to remove from the time series any predictability associated with lagged world market returns and day-of-the-week effects. The lagged return on the S&P500 index is used as a proxy for the world market return to remove any worldwide price movements on volatility in the Nifty return. We introduce day of the week dummies for Tuesday to Friday. Table 3 examines the Nifty returns for the presence of any ARCH/GARCH effects and finds that there exists substantial ARCH effects in the residuals and therefore a model that accounts for these effects would describe the data better.

Having demonstrated the need to use some type of GARCH model to model the Nifty returns, we conducted tests to see which form of the GARCH model fits the returns data best. We tested the GARCH (1,1) model, the EGARCH model of Nelson (1991), the GARCH model with t-distribution and the GJR-GARCH model of Glosten, Jagannathan and Runkle (1993). We find that the GARCH (1,1) and the EGARCH model both seem to fit the data better than the GJR-GARCH and the TGARCH models. However, forecasting the multi-period error variance is easier in the GARCH (1,1) model relative to the EGARCH model, and hence in the interest of practicality, we use the GARCH (1,1) model in this study.

As mentioned earlier, in order to estimate the impact of the introduction of the futures and options contracts, we introduce a Dummy variable in the conditional volatility equation. A significant positive co-efficient would indicate and increase in volatility, a significant negative coefficient would indicate a decrease in volatility. The results of the estimation for the impact of futures introduction are presented in Table 4. The coefficient on the futures dummy g_3, is not significantly different from zero, indicating no impact on volatility. There appears to be significant day-of-the-week effects as evidenced by the coefficients on the dummies for Tuesday and Friday. g_1 can be viewed as a "news" coefficient, with a higher value implying that recent news has a greater impact on price changes. It relates to the impact of yesterday's news on today's price changes. In contrast, g_2 reflects the impact of "old news', i.e. it is picking up the impact of prior news on yesterdays variance and as such indicated the level of persistence in the information effect on volatility. Table 5 presents the results of the model with an Options dummy. Index options were introduced on June 4th, 2001. The Dummy-Options is zero before and 1 on/after June 4th 2001. The introduction of options has had no statistically discernable effect on spot market volatility.

The results thus far suggest that the introduction of futures and options has had no effect on spot market volatility, at least none that is statistically significant. However, in reality, one might expect a lot of uncertainty in the market leading up to the introduction of the derivative contracts, which our cut-off dates are unable to capture in the model. Table 2 presents some basic statistics on the means and standard deviations of the returns for the six months leading up to the introduction of the futures contracts in June 2000. The standard deviation of nifty returns up until Dec 1999 was 1.7%. Between Jan 2000 and June 2000, the standard deviation rose to 2.5% and then after June 2000 dropped back to 1.4%. Interestingly, a similar patter emerges for the Nifty Junior returns, even though no underlying futures contracts were being introduced for stocks in this index. This was also an extremely volatility period in world stock markets, especially the US stock markets. The increase in volatility in the Indian market might have been a consequence of increased volatility in the US markets. This effect is picked up by the lagged return on the S&P 500 index in our model. In conclusion, we find little evidence that the spot market volatility changed significantly as a result of futures or options introduction.

Chart 2 plots the GARCH model predicted conditional error standard deviation over time. Clearly, the model is able to capture the temporary increase in the volatility leading up to the introduction of the futures contracts in the first six months of 2000. Further, one can see that if we ignore this 6 month period, the volatility has not changed much before and after the futures introduction. Chart 3 depicts the actual Nifty returns and the Model predicted returns. A casual observation of this graph shows that the model does a decent job of capturing the time varying conditional volatility in the Nifty returns and thereby increases the efficiency with which our model parameters are estimated.

It is interesting to explore further whether the nature of the GARCH process was altered as a result of the futures introduction. We therefore estimate the GARCH model separately for the pre-futures and the post-futures period separately. Table 6 presents the results of this estimation. The first point to note in comparing the results before and after futures introduction is that the onset of futures trading has altered the nature of the volatility. Before futures, the Arch and the GARCH effects are significant, suggesting that both recent news and old news had a lingering impact on spot volatility. The results also show the presence of day-of-the-week effects for Tuesday and Friday. After the futures introduction, the day-of-the-weeks effects are no longer statistically significant. Also the coefficient on the GARCH variable is no longer significant, suggesting that old news has no impact on today's spot price changes. However our sample period post futures is fairly small, only 597 observations, so we must treat these results with some caution. The results are similar when we analyze the GARCH effects pre and post options introduction in Table 7.

We have thus far, tested whether there appears to be any structural change in the underlying spot market volatility at the time of futures and options introduction. It is interesting to see if there has been any structural change in the mean equation pre and post futures/options introduction. In order to test for parameter stability in the mean equation, assuming constant unconditional variance, we conduct a Chow test for structural change. The Chow test is a formal test to evaluate the stability of the regression coefficients. The sample is divided into two parts at the specified break-point, and the fit of the model in the two parts is compared to test whether both sub samples are consistent with the same model. The Null Hypothesis is that the coefficients in both sub-samples are equal, conditional on the same error variance. Under the Null, the Chow test statistic has an F-distribution with K and (n1+n2-2k) degrees of freedom where k is the number of coefficients. Using June 12, 2000 as our first break point for futures introduction, the value of the F-stat (7, 1661) df is 3.63 and is highly significant at the 1% level. This suggests that the coefficients are not the same before and after futures introduction. Using June 3, 2001 as our breakpoint for options introduction, the F-stat (7, 1661) df is 1.20 and we are unable to reject the null that the coefficients are the same.

Now we test to see if there is any relationship, after the futures are introduced, between the level of futures trading activity and the volatility of the spot market return. We follow Bessembinder and Sequin (1992) and using an ARIMA (p,q) model, decompose the time series of the futures trading volume and open interest into expected and unexpected components. The expected component represents a threshold level (or average) of futures trading, and the unexpected component picks up any sudden increase in trading volume as a result of unexpected price changes. Bessembinder and Sequin find that spot market volatility in the US market is positively related to the unexpected components of volume and open interest, and negatively related to the expected component, suggesting an increase in volatility due to unexpected information , but an otherwise stabilizing influence of futures trading activity.

Using an ARIMA (1,1) model for the contracts volume and an ARIMA (2,2) model for the Open Interest, we decompose each series into an expected and an unexpected component. We then insert these components as additional variables in the conditional variance equation:

$$h_t = \gamma_0 + \gamma_1 h_{t-1} + \gamma_2 e_{t-1}^2 + \gamma_3 D_t + \gamma_4 CONTex + \gamma_5 CONTunex + \gamma_6 OIex + \gamma_7 OIunex$$

The results of this estimation are presented in Table 8. None of the coefficients on the trading activity variables are statistically significant. This however, may be an artifact of the rather low sample size in the post futures period. As more data becomes available, it will be interesting to re-estimate this model to evaluate the impact of continuing trading activity in the futures and/or options market on the underlying spot market. Also, in decomposing the volume indicator variables, no adjustment was made to remove any seasonal effects like contract expiry months, etc. An interesting topic for further research would be to see if adjusting for this seasonality will have a significant impact on the decomposition of the permanent and temporary components of trading activity.

V. Conclusion

In this study, we have examined the effects of the introduction of the Nifty futures and options contracts on the underlying spot market volatility using a model that captures the heteroskedasticity in returns that characterize stock market returns. The results indicate that derivatives introduction has had no significant impact on spot market volatility. This result is robust to different model specifications.[4] However, futures introduction seems to have changed the sensitivity of nifty returns to the S&P500 returns. Also, the day-of-the-week effects seem to have dissipated after futures introduction.

We then estimated the model separately for the pre and post futures period and find that the nature of the GARCH process has changed after the introduction of the futures trading. Pre-futures, the effect of information was persistent over time, i.e. a shock to today's volatility due to some information that arrived in the market today, has an effect on tomorrow's volatility and the volatility for days to come. After futures contracts started trading the persistence has disappeared. Thus any shock to volatility today has no effect on tomorrow's volatility or on volatility in the future. This might suggest increased market efficiency, since all information is incorporated into prices immediately. However, we prefer to treat our results here with caution since we are estimating the GARCH model with only two and a half years of data.

Next, using a procedure inspired by Bessembinder and Sequin (1992), we find that after the introduction of futures trading, we are unable to pick up any link between the volume of futures contracts traded and the volatility in the spot market. As more data becomes available, it will be interesting to explore this link once more.

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[4] In the interest of brevity, the estimation results of the various GARCH specifications are not presented. All the models showed no effect of futures or options introduction on spot market volatility.

It is important to emphasize that although we have sought to analyze the impact of the introduction of futures/options on spot market volatility, in reality the listing of index derivative contracts is hardly an exogenous event. The listing is usually preceded by many decisions made by regulators and stock exchange officials, who in turn may be reacting to world developments. Further, it is quite possible that the introduction of futures and options has different impact on spot volatility depending on the trading mechanisms, contract designs and regulatory environments. This might explain the rather mixed results reached by researchers in different markets. Further research needs to explore the relationship between these factors and the nature of spot market volatility before and after derivatives trading began. As more data becomes available in the Indian market, such a study would be immensely beneficial to investors, institutional traders and regulators alike.

Further, it should be noted that a relatively long time series[5], is required to obtain reliable GARCH parameter estimates. For the model estimated over the entire sample period, Oct 1995-Dec 2002, this might not be a problem. However in our estimations for the post futures period, clearly this is affects the reliability of our estimates. Unfortunately, the only solution is patience and persistence. In summary, we find little evidence that the introduction of new stock index futures or options contracts in emerging markets like India will destabilize stock markets. On the contrary, it appears that the stock markets become more efficient and information is incorporated into prices a lot faster.

[5] Engle and Mezrich (1995) suggest using at least eight years of daily data for proper GARCH estimation.

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CHART 1: Return on the SNX Nifty return

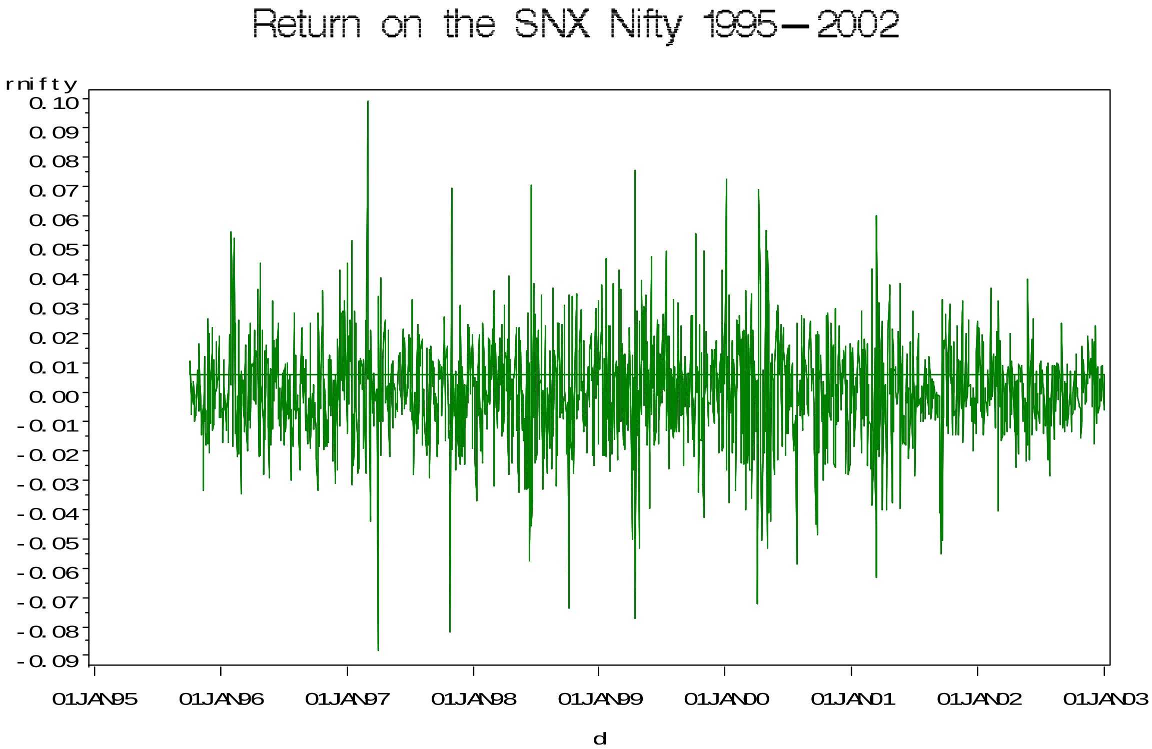


CHART 2: Estimated error standard deviation from the GARCH (1,1) model

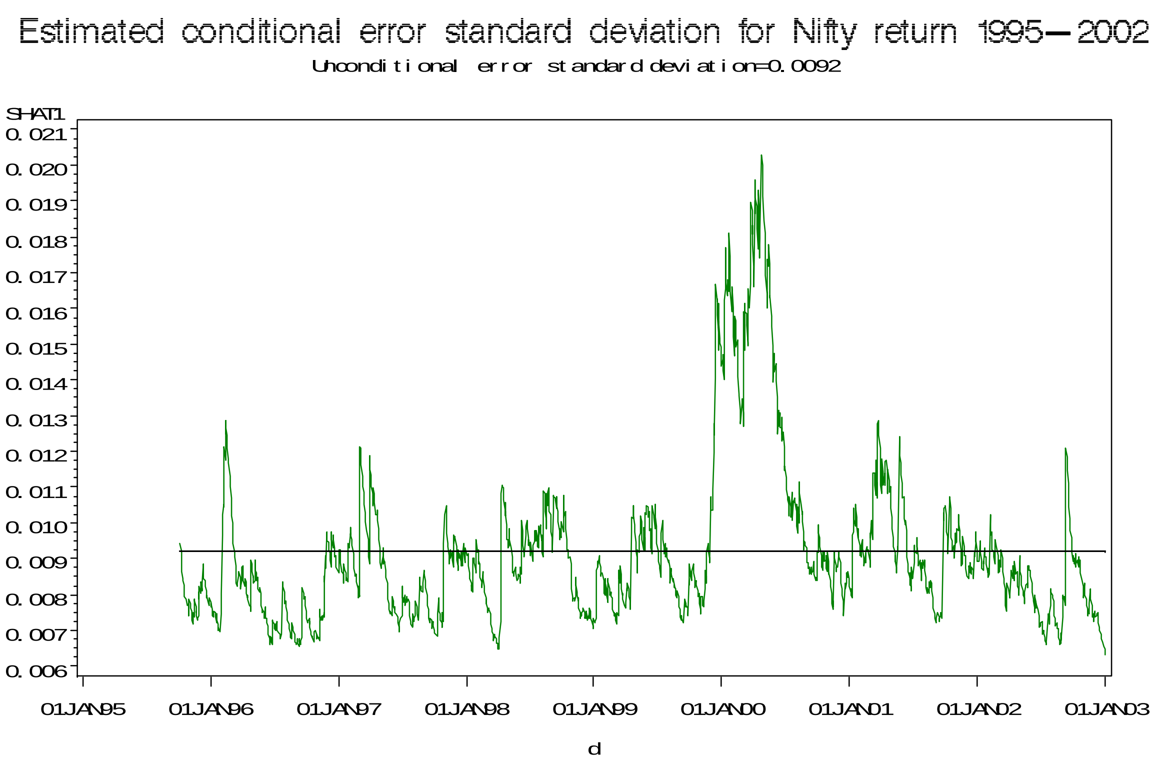
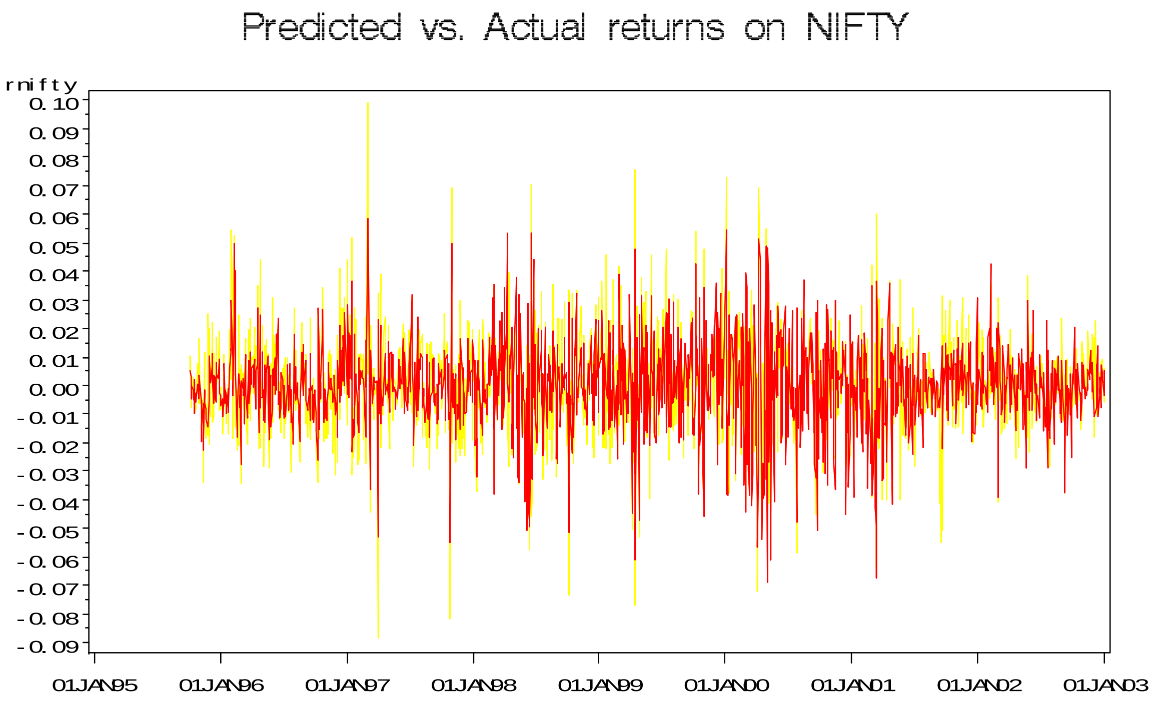


CHART 3: Model forecasts of returns compared to actual returns



Red* : *Predicted returns
Yellow:* *Actual returns

Table 1: Descriptive Statistics

Means and standard deviations of first differences of the log of the Nifty and the Nifty Junior daily price indices, Oct 1995 to Dec 2002

Period	NOB	Nifty		Nifty Junior	
		Mean	Std.Deviation	Mean	Std.Deviation
1995-2002	1805	0.00003	0.01674	0.00007	0.01952
Pre-Futures	1163	0.00029	0.01795	0.00066	0.02036
Post-Futures	642	-0.00044	0.01429	-0.00099	0.01788
Pre-Options	1410	0.00007	0.01785	0.00018	0.02080
Post-Options	395	-0.00011	0.01199	-0.00033	0.01405

Futures contracts were introduced on June 12, 2000 and Options contracts on June 4, 2001.

Table 2: Descriptive Statistics

Means and standard deviations of Index returns for sub-periods

Period	NOB	Nifty		Nifty Junior	
		Mean	Std.Deviation	Mean	Std.Deviation
1995-1999	1054	0.00033	0.01712	0.00111	0.01793
Jan00-Jun00	109	-0.00008	0.02465	-0.00363	0.03613
Jun00-2002	641	-0.00042	0.01429	-0.00096	0.01787

Table 3: Q and LM Tests for ARCH Disturbances in Nifty Return

Order	Q	Pr > Q	LM	Pr > LM
1	55.8488	<.0001	55.8149	<.0001
2	73.7657	<.0001	64.6203	<.0001
3	81.6025	<.0001	67.2248	<.0001
4	83.4541	<.0001	67.3591	<.0001
5	108.5446	<.0001	87.4193	<.0001
6	117.9494	<.0001	89.3290	<.0001
7	132.0676	<.0001	94.8906	<.0001
8	135.0817	<.0001	94.8963	<.0001
9	135.3960	<.0001	95.0414	<.0001
10	136.1184	<.0001	95.0416	<.0001
11	141.6768	<.0001	98.2314	<.0001
12	145.0954	<.0001	98.4892	<.0001

Table 4: Estimates of the GARCH(1,1) model with Futures dummy

$$R_{nifty,t} = a_0 + a_1 R_{niftyjunior,t} + a_2 R_{sp500,t-1} + \sum_{j=2}^{5} a_j DAY_j + u_t$$

$$h_t = g_0 + g_1 e_{t-1}^2 + g_2 h_{t-1} + g_3 D_t$$

where D is a dummy variable that takes a value of 1 after June 12th 2000 and 0 before.

a_0	Intercept	-0.00116 *	-2.69
a_1	NiftyJunr return	0.75360 *	77.25
a_2	Lagged S&P500	0.10380 *	7.02
a_3	Dummy-Tue	0.00142 *	2.19
a_4	Dummy-Wed	0.00110	1.69
a_5	Dummy-Thur	0.00008	1.36
a_6	Dummy-Fri	0.00175*	2.72
g_0	Arch0	0.00000 *	4.03
g_1	Arch1	0.05310*	5.42
g_2	Garch1	0.92200 *	68.97
g_3	Dummy-Futures	0.00000	0.10

* Statistically significant at the 5% level.
Total R-square= 0.6741
N=1675
Unconditional variance=0.00008427

Table 5: Estimates of the GARCH(1,1) model with Options dummy

$$R_{nifty,t} = a_0 + a_1 R_{niftyjunior,t} + a_2 R_{sp500,t-1} + \sum_{j=2}^{5} a_j DAY_j + u_t$$

$$h_t = g_0 + g_1 e_{t-1}^2 + g_2 h_{t-1} + g_3 D_t$$

where D is a dummy variable that takes a value of 1 after June 4th 2001 and 0 before.

a_0	Intercept	-0.00116 *	-2.69
a_1	NiftyJunr return	0.75250 *	77.86
a_2	Lagged S&P500	0.10370 *	6.94
a_3	Dummy-Tue	0.00142 *	2.19
a_4	Dummy-Wed	0.00110	1.70
a_5	Dummy-Thur	0.00085	1.36
a_6	Dummy-Fri	0.00175*	2.73
g_0	Arch0	0.00000 *	3.90
g_1	Arch1	0.05335*	5.42
g_2	Garch1	0.92170 *	68.21
g_3	Dummy-Options	0.00000	0.01

* Statistically significant at the 5% level.
Total R-square= 0.6742
N=1675
Unconditional variance=0.00008486

Table 6: Estimates of the GARCH(1,1) model before and after futures introduction.

$$R_{nifty,t} = a_0 + a_1 R_{niftyjunior,t} + a_2 R_{sp500,t-1} + \sum_{j=2}^{5} a_j DAY_j + u_t$$

$$h_t = g_0 + g_1 e_{t-1}^2 + g_2 h_{t-1}$$

		BEFORE		AFTER	
		Estimate	t-stat	Estimate	t-stat
a_0	Intercept	-0.00148 *	-2.89	-0.00058	-0.78
a_1	Nifty junior return	0.86490 *	64.49	0.60740*	34.57
a_2	Lagged S&P500	0.13380 *	6.87	0.08580 *	3.49
a_3	Dummy-Tue	0.00189 *	2.51	0.00159	1.45
a_4	Dummy-Wed	0.00040	0.53	0.00070	0.67
a_5	Dummy-Thur	0.00100	1.37	0.00122	1.13
a_6	Dummy-Fri	0.00191*	2.51	0.00146	1.30
g_0	Arch0	0.00000 *	3.14	0.00006 *	16.36
g_1	Arch1	0.07680*	5.52	0.07940	1.43
g_2	Garch1	0.90610 *	56.01	0.00000	0.00
Total R-square		0.6744		0.6370	
N		1078		597	
Unconditional variance		0.000097		0.000071	

* Statistically significant at the 5% level.

Chow test: F=3.63 Pr>F=.0007

Df=7, 1661

Table 7: Estimates of the GARCH(1,1) model before and after options introduction.

$$R_{nifty,t} = a_0 + a_1 R_{niftyjunior,t} + a_2 R_{sp500,t-1} + \sum_{j=2}^{5} a_j DAY_j + u_t$$

$$h_t = g_0 + g_1 e_{t-1}^2 + g_2 h_{t-1}$$

		BEFORE		AFTER	
		Estimate	t-stat	Estimate	t-stat
a_0	Intercept	-0.00131 *	-2.67	-0.00089	-1.05
a_1	NiftyJunr return	0.79120 *	71.67	0.60560*	26.24
a_2	Lagged S&P500	0.11710 *	6.59	0.08070 *	2.73
a_3	Dummy-Tue	0.00168 *	2.30	0.00113	0.89
a_4	Dummy-Wed	0.00075	1.04	0.00126	0.95
a_5	Dummy-Thur	0.00074	1.04	0.00166	1.34
a_6	Dummy-Fri	0.00201*	2.75	0.00169	1.32
g_0	Arch0	0.00000 *	3.46	0.00006 *	13.26
g_1	Arch1	0.05770*	5.20	0.04400	0.56
g_2	Garch1	0.92410 *	67.67	0.00000	0.00
Total R-square		0.6866		0.5247	
N		1309		366	
Unconditional variance		0.000094		0.000059	

* Statistically significant at the 5% level.

Chow test: F=1.20 Pr>F=0.2969

Df=7,1661

Table 8: Estimates of the AUGMENTED GARCH (1,1) model after futures introduction.

$$R_{nifty,t} = a_0 + a_1 R_{niftyjunior,t} + a_2 R_{sp500,t-1} + \sum_{j=2}^{5} a_j DAY_j + u_t$$

$$h_t = g_0 + g_1 e_{t-1}^2 + g_2 h_{t-1}$$

		Estimate	t-stat
a_0	Intercept	-0.00009	-1.16
a_1	NiftyJunr return	0.59920 *	33.24
a_2	Lagged S&P500	0.07160 *	2.83
a_3	Dummy-Tue	0.00202	1.82
a_4	Dummy-Wed	0.00104	0.95
a_5	Dummy-Thur	0.00158	1.39
a_6	Dummy-Fri	0.00179	1.58
g_0	Arch0	0.00006 *	2.20
g_1	Arch1	0.09050*	1.64
g_2	Garch1	0.00088	0.00
g_3	Cont-expected	0.00002	1.39
g_4	Cont-unexpected	-0.00000	-0.00
g_5	OI-expected	0.00000	0.00
g_6	OI-unexpected	0.00000	0.00
Total R-square		0.6430	
N		594	
Unconditional variance		0.000069	

* Statistically significant at the 5% level.

Cont=change in the log of the total number of contracts traded for all expiry for the nifty futures.
OI=change in the log of the open interest for all expiry horizons for nifty futures contracts.
An ARIMA (1, 1) is used to decompose contracts series into expected and unexpected components.
An ARIMA (2, 2) model is used to decompose the OI series into expected and unexpected components.