Futures Trading, Information and Spot Price Volatility of Nse-50 Index Futures Contract

Dr.(Ms.) M.Thenmozhi*

Abstract

The purpose of the study is to examine if there is any change in the volatility of Nifty index due to the introduction of Nifty futures and whether movements in the futures price provide predictive information regarding subsequent movements in the index prices. The study shows that inception of futures trading has reduced the volatility of spot index returns. The information flow is higher in the post futures period resulting in decline in spot index volatility in the post futures period. The lead lag analysis shows that futures have little or no memory effect and infrequent trading is virtually absent in futures market. The study also shows that futures market transmits information to cash market and futures market is faster than spot market in processing information. The futures returns lead the spot index returns by one day and this relationship is robust. It is also shown that the cash index returns do not lead the futures returns.

* Associate Professor, Indian Institute of Technology, Chennai. The views expressed and the approach suggested are of the authors and necessarily of NSE.

The advent of stock index futures and options has profoundly changed the nature of trading on stock exchanges. The concern over how trading in futures contracts affects the spot market for underlying assets has been an interesting subject for investors, market makers, academicians, exchanges and regulators alike. These markets offer investors flexibility in altering the composition of their portfolios and in timing their transactions. Futures markets also provide opportunities to hedge the risks involved with holding diversified equity portfolios. As a consequence, significant portion of cash market equity transactions are tied to futures and options market activity. In the Indian context, derivatives were mainly introduced with a view to curb the increasing volatility of the asset prices in financial markets; bring about sophisticated risk management tools leading to higher returns by reducing risk and transaction costs as compared to individual financial assets. However, it is yet to be known if the introduction of stock index futures has served the purpose claimed by the regulators.

The launch of derivative products has significantly altered the movement of the share prices in the spot market. The spot and futures market prices are linked by arbitrage, i.e., participants liquidating positions in one market and taking comparable positions at better prices in another market, or choosing to acquire positions in the market with the most favourable prices. If, for example, the observed futures price is above (below) the theoretical futures price, arbitrageurs sell (buy) futures and buy (sell) the underlying security, driving down (up) the price of the futures and driving up (down) the prices of security. This raises important questions about the effect that index derivatives have on volatility of the spot market. While there is still disagreement as to whether futures trading increases or decreases the volatility of spot prices, the question is still an empirical one. However, if one market reacts faster to information, and the other market is slow to react, a lead-lag relation is observed. The lead-lag relation between price movements of stock index futures and the underlying cash market illustrates how fast one market reflects new information relative to the other, and how well the two markets are linked. Hence, this study attempts to examine the lead – lag relationship between the futures and the underlying spot market.

LITERATURE REVIEW

The literature review pertaining to volatility of stock index futures and the lead lag relationship are discussed separately in the following paragraphs.

a. Volatility of futures and spot market

Several studies have attempted to examine the behaviour of spot market volatility since the inception of futures trading. Edwards (1988) tries to gather evidence to verify the fact that stock index futures trading has destabilised the spot market in the long run. Using variance ratio F tests from June 1973 to May 1987, Edwards concludes that the introduction of futures trading has not induced a change in the volatility in the long run. He observes that there is some evidence of futures-induced short-run volatility, particularly on futures contract expiration days, but this volatility does not appear to carry over to longer periods of time.

Harris (1989) observes increased volatility after the introduction of index futures by comparing daily return volatilities during the pre-futures (1975-1982) and post-futures (1982-1987) between S&P 500 and a non S&P 500 group of stocks controlling for differences in firm attributes (beta, price-level, size and trading frequency). He notes that increase in volatility is a common phenomenon in different markets and index futures by themselves may not bear the sole responsibility. He points out other index-related instruments and developments such as growth in index funds and increase in foreign ownership of equity as possible explanations of higher volatility in stock markets.

Ross (1989) demonstrates that, under conditions of no arbitrage, variance of price change must be equal to the variance of information flow. This implies that the volatility of the asset price will increase as the rate of information flow increases. If this is not the case, arbitrage opportunities will be available. It follows, therefore, that if futures increase the flow of information, then in absence of arbitrage opportunities the volatility of the spot price must change.

Herbst et. al., (1990) document expiration day volatility of the stock index futures and the "special" Friday opening. Volatility is measured by the standard deviation of returns. It is seen that there is a fall in the triple witching hour due to change in settlement procedure from the third Friday to preceding Thursday.

Hodgson et. al., (1991) study the impact of All Ordinaries Share Index (AOI) futures on the Associated Australian Stock Exchanges over the All Ordinaries Share Index. The study spans for a period of six years from 1981 to 1987. Standard deviation of daily and weekly returns is estimated to measure the change in volatilities of the underlying index. The results indicate that the introduction of futures and options trading has not affected the long-term volatility, which reinforces the findings of the previous U.S. studies. However, there was a problem of confounding variables such as floating of Australian dollar in late 1983, deregulation of stock exchanges, foreign bank ownership and mutual fund investment rules during 1984.

Kalok Chan et.al., (1991) estimate the intraday relationship between returns and returns volatility in the stock index and stock index futures. The study covers both S&P500 and Major Market Index futures. The intraday patterns of volatility are estimated using autocorrelation and cross correlation patterns of the intraday returns. Bivariate GARCH model is used to estimate the volatility. Results indicate a strong intermarket dependence in the volatility of the cash and futures returns. It is also shown that the intraday volatility patterns that originate either in stock or futures market demonstrate predictability in the other market.

Bessembinder and Seguin (1992) examine whether greater futures trading activity (volume and open interest) is associated with greater equity volatility. Their findings are consistent with the theories predicting that active futures markets enhance the liquidity and depth of the equity markets. They provide additional evidence suggesting that active futures markets are associated with decreased rather than increased volatility.

Herbst et.al., (1992) examine the informational role of the end-of-day returns in the stock index futures for the period 1982 to 1988. Volatility is estimated from the standard deviation of the returns. It is shown that the end of day return volatility is positively correlated to the next day's spot returns.

Kamara et.al., (1992) observe the stability of S&P 500 index returns with the introduction of S&P 500 index futures. They also assess the change in the volatility of S&P 500 index due to the introduction of futures trading for the period 1976 to 1987. The changes in the volatilities are examined using parametric and non-parametric tests. The variance ratio F-tests used by Edwards (1988 a,b) are sensitive to the underlying assumption of normally distributed stock returns. Apart from F-tests, Kolmogorov-Smirnov two-sample test and Wilcoxon Rank sum test are used to find out if the dispersion is significantly high in the post-futures period. The results show that the daily returns volatility is higher in the post futures period while the monthly returns remain unchanged. He concludes that increase in volatility of daily return in the post-futures period is necessarily not related to the inception of futures trading.

James. T.W., (1993) study the impact of price discovery by futures market on the cash market volatility. The study is conducted using Garbade and Silber model to estimate the price discovery function of the futures market. The results affirm that futures market is beneficial with respect to cash market as it offers better efficiency, liquidity and also lowers the long-term volatility of the spot market.

Jegadeesh and Subrahmanyam (1993) compare the spread in NYSE before and after the introduction of futures on S&P 500 index as volatility can also be measured in terms of individual stock bid-ask spread. They find that average spread has increased subsequent to the introduction of futures trading. When they repeat their test by controlling for factors like price, return variance, and volume of trade, they still find higher spreads during the post-futures period. Overall results of Jegadeesh and Subrahmanyam (1993) suggest that introduction of index futures did not reduce spreads in the spot market, and there is weak evidence that spreads might have increased in the post futures period.

Hong Choi et.al., (1994) examine the impact of futures trading on the volatility and liquidity (as measured by bid-ask spread) of the spot market. Intraday data of S&P 500 and Major Market Index is used for a period of one year. The results indicate that the average intraday day bid-ask spread in post Major Market Index futures has increased while there is no significant change in the volatility. The trading volume has registered a rise in both S&P 500 and Major Market Index. Information asymmetry also has posted an increase due the introduction of futures trading.

Hung-Gay Fung et.al., (1994) examine the dependency in intra-day (minute-to-minute) stock index futures for the period 1987 - 1988. The dependency of intraday futures price is estimated using various models such Auto Regressive Fractionally Integrated Moving Average, Re-scaled range test, Variance ratio test and Autocorrelation functions. It is shown that futures price do not appear to have long-term memory and that the price changes in futures market are not a random walk.

Darrat et.al., (1995) examines if futures trading activity has caused stock price volatility. The study is conducted on S&P 500 index futures for a period of 1982 - 1991. The study also examines the influence of macro-economic variables such as inflation, term structure rates on the volatility of the S&P 500 stock returns. Granger causality tests are applied to assess the impact on stock price volatility due to futures trading and other relevant macro-economic variables. The results indicate that the futures trading have not caused any jump volatility (occasional and sudden extreme changes in stock prices). Term structure rates and OTC index have caused the stock price volatility while, inflation and risk premium have not influenced the volatility of stock prices.

Antoniou and Holmes (1995) examined the relationship between information and volatility in FTSE-100 index in the U.K. using GARCH technique. Although they find that introduction of FTSE-100 index futures has changed volatility in the spot market, they attribute this to better and faster dissemination of information flow due to trading in stock index futures.

Gregory et. al., examine (1996) how volatility of S&P 500 index futures affects the S&P 500 index volatility. The study also examines the effect of good and bad news on the spot market volatility. The change in the correlation between the index and futures before and after October 1987 crash is also examined. Volatility is estimated by EGARCH model. It is shown that the bad news increases the volatility than the good news and the degree of asymmetry is much higher for the futures market. The correlation between the S&P 500 index futures and S&P500 index declines during the October 1987 crash.

Butterworth investigates the effect of futures trading in the FTSE Mid 250 index on the underlying spot market using symmetric and asymmetric GARCH methods. The results reported for the Mid 250 index indicate that while the existence of futures trading had made little impact on the underlying level of volatility, as measured by the standard deviation, it has altered significantly the structure of the spot market volatility.

The two most likely explanations for changes in volatility of stock returns are microeconomic and macroeconomic factors. Harris (1989) investigates the former and Kamara (1992) investigates the latter. Harris notes that increase in volatility is a common phenomenon in different markets and index futures by themselves may not bear the sole responsibility. He points out other index related instruments and developments such as growth in index funds and increase in foreign ownership of equity as possible explanations of higher volatility in stock markets. Kamara (1992) examines the influence of innovations in the rate of productive activity, unanticipated changes in the default risk premium, unanticipated changes in discount rate, unanticipated price level changes and changes in expected inflation on the volatility for the pre-future and post-future period. The results indicate that the increase in volatility in the post futures period cannot be completely attributed to the introduction of futures trading.

It is seen that the results on the effect of index futures on the underlying spot market volatility are mixed. One view is that derivative securities increase volatility in the spot market caused by more highly levered and speculative participants in the futures market. The introduction of stock index futures cause an increase in volatility in the short run while there is no significant change in volatility in the long-run (Edwards 1988). This is because futures markets result in uninformed (irrational) speculators trading in both futures and cash markets, shocking prices in search of short-term gains. Hodgson and Nicholls (1991) quote that increased market volatility may increase real interest rates and the cost of capital, leading to a reduction in the value of investments and loss of confidence in the market. In turn, this can lead to a flow of capital away from equity markets. Secondly, with increased volatility, regulatory bodies may interfere in markets to enact further regulations. While these regulations are certainly costly and may or may not reduce stock price volatility.

However, another view is that derivative markets reduce spot volatility; by providing low cost-contingent strategies, enabling investors to minimize portfolio risk by transferring speculators from spot markets to futures markets. The low margins, low transaction costs and the standardized contracts and trading conditions attract risk-taking speculators to futures. Hence, futures have a stabilizing influence as it adds more informed traders to the cash market, making it more liquid and, therefore, less volatile. It is seen that increased spot volatility from futures markets may not be undesirable if induced by objective new information. In general, the quicker and more accurate prices reflect new information, the more efficient should be the allocation of resources.

It is seen from the literature that the volatility of the spot market is compared before and after introduction of futures and also tested for variations in volatility due to flow of market information. The impact of information content on the underlying markets is tested and is found to have strong correlation with the volatility of the underlying markets. Besides, standard deviations of daily returns, bid-ask spreads for all stocks, GARCH models have been used as a measure for volatility. GARCH models have been used when the data spans over a long time period to accommodate heteroskedasticity in the returns. In the event of short run analysis of time series of data, standard deviation of daily returns have been used as a measure of volatility.

b. Lead -Lag Relation between Futures and Spot Market

Several studies have examined the temporal relationship between futures and cash returns. Most of the empirical evidences support the lead effect more than the lag effect.

Koch and Koch (1987, 1988) estimate the lead-lag relation between S&P 500 index futures and S&P 500 index. They probe the lead-lag effects using simultaneous equation model estimated by three stage least squares regression. Based on the minute-to-minute changes in both the index and the futures prices, a model was constructed to describe the dynamic intraday price relationship between the index and futures prices.

Finnerty and Park (1987) also discover a significant lead-lag relationship between futures and spot prices. Herbst, McCormak, and West (1987) too observe that the S&P 500 and Value Line futures lead the spot index between 0 to 16 minutes.

Stoll and Whaley (1990) use ARIMA model and ordinary least squares to estimate the lead-lag between S&P 500 index futures, Major Market Index futures and the underlying spot market. The results indicate that S&P 500 and Major Market Index futures lead the cash market by 10 minutes and they attribute this to faster dissemination of information into futures market. The findings are consistent with the evidence gathered by Koch and Koch (1987), MacKinlay and Ramasamy (1988).

Schwarz et.al., (1991) examine the price leadership of index futures over the spot market and test the dynamic efficiency of index futures as a price discovery vehicle. However, they use Garbade & Silber model to quantify the price discovery function of the futures market. The study is done on the Major Market Index for the sample period 1985 to 1988. The results show that the spot and futures are integrated such that average mispricing leading to arbitrage is eliminated within one to seven days.

Chan (1992) estimate the lead-lag relation between Major Market Index and Major Market Index futures under conditions of good and bad news, different trading intensities and under varying market wide movements. ARMA models are used as proposed by Stoll (1990). It is seen that the futures market leads the spot again attributed to faster information processing by the futures market. However, under bad news it is the cash index that leads over the futures market while, there is no effect on the lead-lag relation during different trading intensities. The findings are in line with the earlier studies of Koch and Koch (1987), Stoll and Whaley (1990).

Tang, Mak and Choi (1992) studied the causal relationship between stock index futures and cash index prices in Hong Kong, which revealed that futures prices cause cash index prices to change in the pre-crash period but not vice versa. In the post-crash period, they found that bi-directional causality existed between the two variables.

Evidence from other markets also postulates a lead-lag relationship. Tse(1995) examines the behaviour of prices in the Nikkei index and the corresponding SIMEX traded futures contract and found that lagged changes of the futures price affect the short-term adjustments of the futures price.

Abhyankar (1995) investigates the lead-lag relationship between hourly returns in the FT-SE 100 stock index futures and the underlying cash index using hourly data for the period 1986 - 1990. They test the lead-lag relation for periods of differential transactional costs, good and bad news (measured by the size of returns), spot volume and spot volatility. The results revealed that when transaction costs for the underlying asset fell (post "big Bang"), the futures lead of the spot index reduced, implying that transaction cost differential is the major driver for the lead-lag relationship. It was found that the futures lead over spot was insensitive to variations is spot transaction volume. An AR (2) - EGARCH (1,1) model was then fitted to spot and futures returns to give a time series of estimated volatilities, and it was observed that during periods of high volatility, futures markets led spot market returns. Support is also found for the hypotheses that lower transactions and entry costs in the stock index futures market is one of the reasons why traders with market wide information prefer to use the futures markets. This causes the arbitrageurs to step in quickly to bring the cost-of-carry relationship into alignment.

Wahab and Lashgari (1993) studied daily data from January 1988 to May 1992 using error correction methodology. Their results revealed bi-directional causality between spot and futures returns.

Teppo et.al., (1995) study the two-way causality between the Finnish stock index futures and the stock index for a period of one year from 1989 - 1990. Granger Causality tests are applied on the daily returns due to non-availability of intra-day data. The results indicate that the futures market provides predictive information for both frequent and infrequently traded stocks while the reverse causality is found to be weak.

Abhyankar (1998) revisited the relationship using 5-minute returns by regressing spot returns on lagged spot and futures returns, and futures returns on lagged spot and futures returns using EGARCH. It was found that the futures returns led the spot returns by 15 - 20 minutes.

Chris et.al., (2001) estimate the lead-lag relation between the FTSE 100 stock index futures and the FTSE 100 index. Based on the results obtained, they develop a trading strategy based on the predictive abilities of the futures market. The study is conducted using Co-integration and Error Correction model, ARMA model and vector auto-regressive model. The results indicate that futures lead the spot market attributable to faster flow of information into futures market mainly due to lower transaction costs. It is shown that the error co-integration model predicts the correct direction of the spot returns 68.75% of the time. Ghosh (1993) also observed a similar lead-lag relationship for the U.S. market following the use of an error correction model.

The literature on the lead-lag relation between the index futures and the index indicate that futures market is the main source of market wide information and the futures lead the spot market. There is very little evidence of spot index leading the futures market. Most of the studies use simultaneous equation modeling solved by ordinary least squares method to examine the lead-lag relationship between the futures and the spot market. Serial correlation tests and ARIMA models are used to eliminate effects of infrequent trading and bid-ask price effects. It is shown that trading frequency cannot account for the observed lead rather, it is the speed of price adjustment to information in futures markets that makes investors to trade in futures first as they receive new market wide information. Support is also found from the earlier studies that lower transactions and entry costs in the stock index futures market is one of the reasons why traders with market wide information prefer to use the futures markets. Hence, this results in the arbitrageurs to step in quickly to bring the cost-of-carry relationship into alignment (Abhyankar 1995, 1998).

OBJECTIVES OF THE STUDY

The purpose of the study is to investigate the empirical relationship between the NSE 50 futures and the NSE 50 Index. The primary objective is to determine if there is any change in the volatility of the underlying index due to the introduction of NSE 50 index futures and whether movements in the futures price provide predictive information regarding subsequent movements in the index. Hence, the objectives of the study are:

1. To examine the volatility of spot market before and after introduction of the stock index futures.
2. To examine the lead-lag relationship between stock index futures and spot index returns.

DATA AND SAMPLE

The data for the study has been collected from the National Stock Exchange (NSE) website. The main data for the study is the returns of the S&P CNX Nifty index futures and spot Nifty index. In order to estimate the impact of futures trading on the volatility of Nifty, daily closing price returns of NSE-50 Index is considered for the period 15th June 1998 to 26th July 2002. The returns series comprises 1037 observations, of which 503 observations relate to the period prior to the introduction of futures trading and the remaining 534 observations to the period after the introduction of futures trading. During the sample period, the Nifty index futures trades from 9:55 A.M. to 3:30 P.M. The index futures time series analyzed here uses data on the near month contract as they are most heavily traded. The closing price returns of futures index from 15th June 2000 to 25th July 2002 comprising 531 observations has been considered for the analysis. Though it would be better to consider using higher frequency of data rather than daily prices, the daily closing prices are taken due to non-availability of intra-day data (hourly or minute by minute data). The returns for the futures contract and the spot index are defined as $R_{F,t}$ = {Ln(F_t/F_{t-1})*100 + 10} and $R_{S,t}$ = {Ln(S_t/S_{t-1})*100 + 10}, respectively. The returns are added with 10 to standardise the data series, which eliminates the negative returns series. The data has been analysed using SPSS package version 9.5.

METHODOLOGY

In analyzing the relationship between spot price volatility and the impact of futures trading, three issues need to be addressed. First, does the existence of futures trading in itself have any effect on volatility? Second, and perhaps more important, if the existence of index futures trading does affect volatility, what is the relationship between information and volatility following the onset of futures trading? Third, what is the extent to which futures trading influence the volatility of Nifty index ignoring the other market wide information? Since, many events have occurred in the recent past other than the introduction of futures trading, it is essential to distinguish the impact of volatility due to the introduction of futures trading from that of the others.

The impact on the volatility of the spot Nifty is assessed by comparing the Nifty volatility before and after the introduction of futures trading. Volatility has been measured using standard deviation (Hodgson et. al., 1991, Herbst et. al., 1992) and GARCH model has also been a preferred measure of volatility by many researchers (Kalok Chan et. al., 1991, Antoniou and Holmes, 1995, Gregory et. al., 1996, Butterworth, University of Durham) to accommodate for heteroskedasticity in the observed returns. The problem of heteroskedasticity does not exist as the data spans for a short period of two years and GARCH is not relevant for measuring volatility for a short time-span. Hence, in this study, volatility has been measured by computing the standard deviation of the daily returns.

As there might be other factors responsible for changes in observed volatility, other factors with potential to influence volatility is taken into account. Hence, in order to determine whether the onset of futures trading has had any impact on underlying spot market volatility it is necessary to separate the volatility arising from market wide factors from the volatility which is specific to futures trading. Previous studies have sought to filter out the factors that lead to market wide volatility by regressing spot market returns against a proxy variable for which there was no related futures contract (Antoniou and Holmes, 1995, Kamara et.al., 1992, Gregory et. al., 1996, Darren Butterworth). For the purpose of this study, the spot market volatility is regressed with the Nifty Junior Index returns (which essentially capture the market wide volatility) and a dummy variable. The dummy assumes the value of 1 for the post futures period and 0 before the introduction of the futures trading. If the dummy variable is significantly different from zero it is considered to have influenced the spot market volatility. The sign of the dummy signifies a fall or rise in the volatility with the inception of futures trading. The data has been analysed using ordinary least squares multiple regression technique. F-test is performed on the sample returns to examine the equality of variance before and after the introduction of futures trading. The normality of the data is tested using the standard error of kurtosis and skewness measures.

In order to empirically measure the impact of futures trading on the volatility of the spot market, volatility before and after the introduction of the index futures is compared. The following model is used for examining the impact:

$$VS_t = \beta_0 + \beta_1 VM_t + \beta_2 D_t + E_t$$

Where, VS_t is a constructed measure of volatility in the spot market under investigation in period t;

VM_t is a proxy measure of market wide volatility in period t, that is, volatility unrelated to the onset of trading in futures contract on the spot asset under investigation;

D_t is a dummy variable, which takes a value of 1 if t is a post futures time period, 0 for pre futures;

β_0, β_1 and β_2 are regression parameters and E_t is the error term.

The parameters of the above equation are estimated and if β_2, coefficient of the dummy variable turns out to be significantly different from zero it is taken as an evidence for different volatilities in the two sub-periods, before and after futures. In the case of index futures, VS_t is the volatility measure for the index on which futures contracts are defined and VM_t is the volatility of another stock market indicator that does not include the component securities in the original index.

The lead-lag relationship has been examined by using the following steps:

First, univariate time series properties of the stock index and futures returns series are observed to account for the infrequent trading and bid-ask price effects. The effect of infrequent trading and bid-ask bounce is examined by running the serial correlation tests on the daily price returns series of the index and futures markets to determine if past price has an effect on the futures price.

A further examination of the influence of the past closing prices on the current returns is estimated using AR (2) model to determine the bid-ask spread. Auto Regression of the order 2 has been used as the higher order correlation coefficients are close to zero. This model explains the extent by which the stale prices or poor trading frequency affects the current market returns which in turn might be a cause for the possible lead/lag between the index and futures markets.

In the next step, cross-correlation tests are run between the index and futures return series. This test helps in determining the extent to which the two markets are correlated to each other and the length of the lead/lag is also determined from the cross-correlation coefficients of the spot index and futures markets.

Finally, the lead/lag coefficients are determined by regressing the spot market returns with the current and lagged futures returns and vice versa using simultaneous equation modeling - ordinary least squares and two-stage least squares regression technique (Kawaller Koch and Koch, 1987).

Following Stoll and Whaley (1990) and Chan (1992), the following regression (Simultaneous Equation Modeling, two stage least squares) is estimated to examine the nature of lead-lad relationship between returns in the cash and the futures markets.

$$\mathbf{R_{S,t} = \alpha + \sum_{k=-n}^{k=n} \beta_k R_{F,t-k} + \varepsilon_t}$$

$$\mathbf{R_{F,t} = \alpha + \sum_{k=-n}^{k=n} \beta_k R_{S,t-k} + \varepsilon_t}$$

$R_{S,t}$ and $R_{F,t}$ are the daily spot and futures returns at time t, n denotes the number of leads/lags used and ε_t denotes the error term.

A look at the futures trading volume since its inception to March 2001 as shown in Fig.1 indicates that there is an increase in the futures contracts from October 2000 onwards and the initial few months had very low volumes. Moreover, after the September 11 terrorist attack, the stock market also underwent a drastic change. Hence, the lead- lad analysis is done separately for the period between October 2000 and September 2001 as the futures trading has registered consistent rise in its volumes since October 2000 contract onwards. The volume of trading as observed from Fig 2 and the value of trading from Fig 3 shows that the volume and value of contracts traded in futures market has undergone a drastic change from October 2001. Hence, the lead-lag analysis has been done separately for the period October 2001 to July 2002. Thus, the analysis is done separately for different time periods to account for the changes in volume of trading and the occurrence of certain events. The lead lag analysis has been done for the periods 12/6/2000 to 10/9/2001, 27/10/2000 to 10/9/2001, 1/10/2001 to 25/7/2002, 12/11/2001 to 25/7/2002 and 12/6 2000 to 25/7/2002.

RESULTS

Descriptive Statistics

The descriptive statistics as given in Table 1 indicate that the Nifty and Nifty Junior return series follow a normal distribution as given by the measures of skewness and kurtosis. It is seen that the measures of standard error of skewness and kurtosis are well within the range of -2 to +2 complying with the normal distribution pattern. A comparison of the population variance of the Nifty is estimated both before and after the introduction of Nifty futures. A casual observation of Nifty volatility as measured by standard deviation shows that the volatility in the post futures (1.5191) period is less than the volatility before the introduction of futures (2.0113) volatility. ANOVA results comparing the pre and post futures Nifty returns shows that there is a statistically significant difference in the volatility before and after the introduction of futures at 0.05 level of significance. Thus, there is a clear indication that the volatility of the spot market is subject to change as measured by standard deviation with the introduction of futures trading and the volatility has reduced in the post-futures period.

However, inferences cannot be drawn from these figures and further investigation is required. In order to examine whether the differences in the volatility in the spot market is due to the introduction of the futures, the change in the volatility of another index, i.e., Nifty Junior index returns is also examined.

Table 1 Descriptive Statistics of Nifty and Nifty Junior returns (Non-standardised data)

Column1	Pre-introduction		Post-introduction		Overall	
	Nifty	Nifty Jr.	*Nifty*	Nifty Jr.	*Nifty*	Nifty Jr.
Mean	0.0820	0.1362	(0.0734)	(0.1100)	0.0002	0.0117
Standard Deviation	2.0113	2.4869	1.5191	1.8930	1.7759	2.2040
Sample Variance	4.0454	6.1848	2.3075	3.5833	3.1537	4.8577
Kurtosis	1.7698	0.9960	1.9528	2.0298	2.1762	1.5407
Standard error of kurtosis	.306	.274	.306	.274		
Skewness	(0.0159)	(0.3863)	(0.4426)	(0.6812)	(0.1152)	(0.4489)
Standard error of Skewness	.153	.138	.153	.138		
Range	15.2493	16.4052	12.3056	14.0792	15.2493	16.4052
Minimum	(7.7099)	(9.0327)	(6.3095)	(8.3465)	(7.7099)	(9.0327)
Maximum	7.5394	7.3724	5.9960	5.7327	7.5394	7.3724
Count	503	503	534	534	1037	1037

As observed from the Table 1, the measures of standard error of skewness and kurtosis for the Nifty Junior returns are within the range of -2 to +2 complying with the normal distribution pattern. It is also seen that the volatility of Nifty Junior returns as measured by standard deviation has taken a dip from 2.4869 in the pre-futures period to 1.8930 in the post-futures period. The volatility of Nifty index has reduced by 24.47% while the volatility in Nifty index junior has reduced by 23.38%. Probably, the extent to which index-futures trading has caused a dip in the spot market volatility can be better explained by capturing the "news coefficient" or "market-wide information" in the subsequent section.

	27/10/2000-8/03/2001		9/03/2001-10/9/2001		12/09/2001-26/07/2002	
	Nifty	Nifty Junior	Nifty	Nifty Junior	Nifty	Nifty Junior
Mean	0.1016	-0.1610	-0.1528	-0.2926	-0.0041	0.1077
Standard deviation	1.4547	2.1632	1.6562	1.8042	1.3824	1.5941
count	91	91	127	127	217	217

The volatility of Nifty index and Nifty Junior returns have been compared during post futures period considering two events – ban on short sales from 8 /03/2001 and the U.S. terrorist attack on 11/9/2001. The volatility of Nifty index has increased after the ban on short sales from 1.457 to 1.6562 while it decreased to 1.3824 in the post terrorist attack period. However, the Nifty Junior volatility declined from 2.1632 to 1.8042 and then to 1.5941 during the same period. The decline in the volatility over different time periods is lower for Nifty than for Nifty Junior.

NIFTY JUNIOR

	12/6/00 to 29/9/00	3/10/00 to 7/3/01	9/3/01 to 1/6/01	5/6/01 to 29/6/01	3/7/01 to 8/11/01	12/11/01 to 25/7/02
N	78	109	59	19	89	176
Range	11.59	10.62	13.01	4.48	11.95	10.89
Minimum	3.17	4.10	1.65	7.08	1.77	4.84
Maximum	14.56	14.73	14.66	11.56	13.72	15.73
Mean	9.8409	9.8412	9.6872	9.4252	9.8448	10.1286
Std.dev.	**2.2057**	**2.1925**	**2.5132**	**1.3260**	**1.5957**	**1.4497**
Variance	4.865	4.807	6.316	1.758	2.544	2.102
Skewness Std. error	-.281	-.52	-.865	-.069	-.985	.089
	.272	.231	.311	.524	.255	.183
Kurtosis Std. error	.586	.027	1.353	-1.118	8.569	1.887
	.538	.459	.613	1.014	.506	.364

The volatility has been analysed for different periods considering the introduction of index options , stock

	12/6/00 to 29/9/00	3/10/00 to 7/3/01	9/3/01 to 1/6/01	5/6/01 to 29/6/01	3/7/01 to 8/11/01	12/11/01 to 25/7/02
N	78	109	59	19	89	176
Range	5.77	8.10	12.31	5.01	8.65	7.89
Minimum	.03	6.12	3.69	7.73	4.50	5.95
Maximum	5.79	14.22	16.00	12.74	13.15	13.85
Mean	1.1428	10.0135	9.7987	9.9091	9.8896	9.9986
Std. Deviation	**1.1171**	**1.5037**	**2.2539**	**1.2278**	**1.5161**	**1.1909**
Variance	1.248	2.261	5.080	1.507	2.298	1.418
Skewness Std.error	1.768	-.194	-.140	.431	-1.204	.288
	.272	231	.311	.524	.255	.183
Kurtosis std. error	3.921	-.063	.678	.499	3.612	1.065
	.538	.459	.613	1.014	.506	.364

options & stock futures apart from considering the ban on short sales and the September terrorist attack..

NIFTY

The period considered here for comparison are

- 12/6/00 to 29/9/00 – initial period of introduction of index futures where the volumes were very low
- 3/10/00 to 7/3/01 – period when volumes were steady and upto introduction of ban on short sales
- 9/3/01 to 1/6/01 –period after introduction of ban on short sales upto introduction of index options
- 5/6/01 to 29/6/01-period after introduction of index options upto introduction of stock options
- 3/7/01 to 8/11/01-period after introduction of stock options upto intorduction of stock futures
- 12/11/01 to 25/7/02 –period after introduction of stock futures upto 25th july 2002

The analysis shows that the volatility has increased and decreased at different periods of time and the trend in Nifty and Nifty junior index is similar though the percentage change is different.

period	Nifty Junior std.deviation	% change
12/6/00 to 29/900	2.2057	
3/10/00 to 7/3/01	2.1925	-0.59845
9/3/01 to 1/6/01	2.5132	14.62714
5/6/01 to 29/6/01	1.326	-47.2386
3/7/01 to 8/11/01	1.5957	20.33937
12/11/01 to 25/7/02	1.4497	-9.14959

Nifty Futures

period	std.deviation	% change
12/6/00 to 29/900	1.6029	
3/10/00 to 7/3/01	1.4924	-7.40418
9/3/01 to 1/6/01	2.1434	30.37231
5/6/01 to 29/6/01	1.0736	-99.6461
3/7/01 to 8/11/01	1.6007	32.92934
12/11/01 to 25/7/02	1.1265	-42.095

Market-Wide Information and Spot Returns

The change in volatility of spot price due to Nifty futures can be measured by using a regression model. But, the spot price volatility may also be due to market wide information flow and as such the actual effects due to index futures have to be measured separately. Hence, in order to remove market-wide influences on spot price change, a proxy variable is incorporated which is not associated with the futures contract. NSE-50 Junior Index is used as a proxy to capture market-wide influences on price volatility. Besides, Nifty Junior contains securities that are not included in the NSE-50 Index. Hence, the following regression equation is used to determine the extent to which "market wide" information can be captured.

$$\mathbf{R}^{N}_{t} = a_0 + a_1 \mathbf{R}_{t}^{NJ} + e_t$$

$\mathbf{R}^{N}_{t}$: NSE-50 index returns

$\mathbf{R}_{t}^{NJ}$: Nifty junior returns

a_0 : Constant

a_1 : Coefficient of Nifty Junior returns

α_1 (information coefficient) relates to the impact of market specific information that affects the prices (i.e. returns) of Nifty. If α_1 is statistically significant, it implies that "market-wide" information has been captured.

Assuming that markets are more efficient, then these price changes are due to arrival of information in the market, which are specific to the pricing of NSE-50 Junior index. Hence, α_1 relates to the impact of market-specific price changes on price changes at time t. As α_1 relates to the arrival of information, it can be viewed as a "news" coefficient and higher value of the coefficient implies that recent news has a greater impact on price changes. The regression results as given in Table 2 and Table 3 clearly indicate the extent to which information is being impounded into the markets. It is seen that the α_1 "information coefficient" in the post futures period (0.654) is more than that in the pre-futures period (0.648). The t-value of the news coefficient for the pre-futures period is 29.874 while it is 32.446 for the post futures period. Both of them are statistically significant at 0.01 level of significance. An increase in R^2 from 0.641 (pre-futures period) to 0.666 (post-futures period) clearly states that the increase in the information flow has influenced in deciding the market returns in the post-futures period. The goodness of the fit of the models in the pre and post futures period is reaffirmed, as the F-statistic is significant at 0.01 level of significance. Hence, an increase in α_1 in the post futures period suggests that information is being impounded in spot prices more quickly due to the introduction of futures trading.

With the information now flowing into the markets at a faster rate with the introduction of futures trading, it is expected that the spot market volatility be altered (Ross, 1989). Hence, the spot market has to be tested for change in volatility with the inception of futures trading in the next section.

Table 2: Market Wide Information And Spot Index Returns In Pre-Futures Period

Coefficients

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
Model		B	Std. Error	Beta		
1	(Constant)	3.517	.227		15.526	.000
	pre nifty junior standardised returns	.648	.022	.801	29.874	.000

a Dependent Variable: pre futures nifty standardised returns

Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
.801	.641	.641	1.1979

a Predictors: (Constant), pre futures nifty junior standardised returns

Table 3 Market Wide Information And Spot Index Returns In Post-Futures Period

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	3.458	.203		17.024	.000
standardised nifty junior returns	.654	.020	.816	32.446	.000

R	R Square	Adjusted R Square	Std. Error of the Estimate
.816	.666	.665	.8789

Impact of futures trading on Spot market volatility

Having shown that there is an increase in the flow of information, an analysis is done to examine if the spot market volatility has undergone a structural change due to futures trading in place by regressing the spot market volatility with Nifty futures and Nifty Junior returns series as independent variables. The effect of introduction of Nifty futures is introduced as a dummy variable, which assumes the value of 0 for the pre-futures period and 1 for the post-futures period.

The following regression model is used to assess the impact of futures trading on the spot market volatility.

$$\mathbf{SD^{N}_{t} = \beta_0 + \beta_1 SD^{NJ}_{t} + \beta_2 D_t + E_t}$$

SD^{N}_{t} is the standard deviation of Nifty return series

SD^{NJ}_{t} is the standard deviation of Nifty Junior return series

D_t is the dummy variable (0 for pre-futures and 1 for post-futures)

β_1, β_2 are regression coefficients.

If the coefficient of β_2 is statistically different from zero, it is an indication of a change in the volatility of the spot market with the inception of futures trading. The sign of the coefficient of the dummy variable β_2 determines the rise or fall in the volatility due to futures trading.

A regression analysis of the spot market volatility and Nifty Junior returns as shown in Table 4 shows that the F-statistic is significant at 0.001 level of significance and hence the model is a good fit. The coefficient of standard deviation of Nifty Junior returns is 0.607. The t-value is 33.073 at 0.01 level of significance. Nifty Junior returns volatility explain 51.4% of the variation in Nifty index volatility.

A regression analysis introducing futures trading as a dummy variable shows that explanatory power R^2 has slightly improved from 51.4% in the absence of the dummy variable to 51.9% during the presence of the dummy variable and thus futures trading explains 0.5% of the variation in spot price volatility. The coefficient of the dummy is -0.179. The t-value of the dummy coefficient is –3.457 and is significant at 0.01 level of significance. This shows that the volatility in spot index has reduced due to the introduction of futures.

Table 4: Spot Volatility And Futures Trading Without Dummy Variable

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	.359	.037		9.633	.000
Standard Deviation of Nifty Junior returns	.607	.018	.717	33.073	.000

R	R Square	Adjusted R Square	Std. Error of the Estimate
.717	.514	.513	.8275

a Predictors: (Constant), Standard Deviation of Nifty Junior returns

b Dependent Variable: Standard deviations of nifty returns

Coefficients

Hence, the fact that the introduction of futures trading does influence the spot volatility is reinforced as the dummy variable turns out to be significantly different from zero. A negative β_2 clearly indicates that the volatility has been brought down with the onset of futures trading which is in line with the findings from the volatility as measured by standard deviation for pre and post futures period. The study conforms to the findings of Bessembinder and Seguin (1992) and it can be inferred that trading in index futures affect spot market volatility as the presence of futures market provides additional 14% explanatory power on the spot market volatility.

Table 5: Spot Market Volatility And Futures Trading With Dummy Variable

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	.466	.048		9.644	.000
Standard	.597	.018	.705	32.296	.000

Deviation of Nifty Junior returns					
dummy 0-prefutures, 1-post futures	-.179	.052	-.075	-3.457	.001

R	R Square	Adjusted R Square	Std. Error of the Estimate
.721	.519	.518	.8232

a Predictors: (Constant), dummy 0-prefutures, 1-post futures, Standard Deviation of Nifty Junior returns

b Dependent Variable: Standard deviations of nifty returns

REASONS FOR LEAD-LAG BETWEEN SPOT AND FUTURES PRICES

From a practical perspective, it is generally agreed that the two phenomena of market sentiment and arbitrage trading are the major determinants linking stock index futures and the stock market. Conventional wisdom amongst professional traders suggests that movements in the futures price should reflect expected future movements in the underlying cash price. The futures price should quickly reflect all available information regarding events that may affect the underlying and respond quickly to new information. The index should respond in a similar fashion, but for the index to react to the new information completely the underlying stocks must all be re-valued, i.e. every constituent stock must re-evaluate the new information and adjust accordingly. Consider a trader with news just arrived to the market that is bullish – the trader has two options.

1. Buy underlying stocks of the Nifty.
2. Purchase the Nifty futures.

In this scenario, the futures trade can be executed immediately with little initial cash outlay, as futures are a levered instrument, compared to trading actual underlying stocks, which would require a greater up-front investment and a probable longer implementation time because of stock selection and numerous underlying stock transactions. This transaction preference for futures may explain why the lead-lag relationship in many markets. Trading futures also has the advantage of a highly liquid market, easily available short positions, low margins, leverage positions and rapid execution. Such trading would move the futures price first then ‘lead’ the stock index when arbitrageurs respond to the deviations from the cost of carry relationship. Futures pricing thus may provide sentiment indicator for changes in stock prices and hence the Nifty index.

It is also possible that cash index price changes lead changes in the futures prices. If the index were to decline or rise for whatever reason, the price change might induce a change in sentiment that would be reflected in subsequent declines or increases in the futures price. As long as the basis (absolute difference between the futures and spot price) lies within the no arbitrage range, changes in the market sentiment would affect both the futures price and the index in the same direction. The arbitrage bound is essentially the futures to cash price differential, which normally falls within boundaries determined by financing costs and dividend yield. In situations where the bound is breached, arbitrageurs would be able to make riskless profits until the prices traded back within the no-arbitrage band.

The theoretical relationship between the price of an index futures contract and the price of the underlying index is given by the following expression (MacKinlay and Ramaswamy, 1988):

$$F_t = S_t e^{(r-d)(T-t)} \qquad \textbf{(1)}$$

F_t is the index futures price at a time t

S_t is the index price at time t

r-d is the net cost of carrying the underlying stocks in the index i.e. the rate of interest cost 'r' less the rate at which dividend yield accrues to the stock index portfolio holder 'd'.

T is the expiration date of futures contract, so T-t is the time remaining in the futures contract life

Index arbitrage opportunities exist if the value of the index futures contract deviates from the cost of buying the individual stocks that make up the index, and then holding them to maturity. When the futures price is above the level implied by right-hand side of (1), a riskless arbitrage profit can be earned. This profit is equal to the difference between the futures price and the index price plus the cost of carry (F_t - $S_t e^{(r-d)(T-t)}$). This profit can be earned by selling the futures contract and buying the stock index portfolio, financing the stock purchase with riskless borrowings. On the other hand, when the futures price falls below the right-hand side of (1), a short arbitrage profit of ($S_t e^{(r-d)(T-t)}$ - F_t) can be earned by buying the futures and selling the portfolio of stocks, investing the proceeds of the sale of stock at the riskless rate of interest. The use of a single, computer-generated order to buy or sell an entire portfolio of stocks is known as "program trading".

In perfectly efficient and continuous futures and stock markets absent transaction costs, riskless arbitrage profit opportunities should not appear and hence the cost of carry relation (1) should be satisfied at every instant *t* during the futures contract life. In such a case, the instantaneous rate of price appreciation in the stock index equals the net cost of carry of the stock portfolio plus the instantaneous relative price change of the future contract i.e.:

$$\mathbf{R_{S,t} = (r\text{-}d) + R_{F,t}} \qquad \textbf{(2)}$$

$R_{S,t} = Ln(S_t / S_{t-1})$ and $R_{F,t} = Ln(F_t / F_{F,t-1})$

Several implications follow from (2) under the assumption that the short-term interest rate and the dividend yield rate of the stock index are constant and that the index futures and stock markets are efficient and continuous:

1. The expected rate of price appreciation on the stock index portfolio $E(R_{S,t})$ equals the net cost of carry (r-d) plus the expected rate of return on the futures contract $E(R_{F,t})$.

2. The standard deviation of the rate of return on the futures contract equals the standard deviation of the rate of return of the underlying stock index.

3. The contemporaneous rates of return of the futures and the cash are perfectly, positively correlated while the non-contemporaneous rates of return are uncorrelated and no lead-lag relationship would exist.

It has been shown, however, that (1) does not hold exactly at every instant of time. Stoll and Whaley (1986) report frequent violations of cost-of-carry relation in excess of transaction costs using hourly S&P 500 index and index futures data during the period April 1982 through December 1985. The frequency of violation is nearly 80 percent for the June 1982 futures contract while it falls below 15 percent for more recent contract maturities. MacKinlay and Ramaswamy (1988) report similar results for S&P 500 futures contracts expiring in September 1983 through June 1987. Using 15-minute price data, they find that the cost-of-carry relation is violated 14.4 percent of the time, on average.

However, if interest rates and dividend yields were nonstochastic, contemporaneous price changes in the two markets would be perfectly correlated and no lead-lag relation would exist between them. However, there are several reasons why, in the presence of market imperfections, there may be a lead-lag relationship between the index futures and cash market returns. Violations of the cost-of-carry relation may appear for a variety of reasons- infrequent trading, differences in transaction costs, liquidity, flow of market wide or firm specific information, information processing speed and margin for trading.

Hence, this study aims to examine the possible lead/lag relation between the spot and futures market and also explore the reasons that cause the lead/lag between the cash and futures market.

Estimating Infrequent Trading & Bid-Ask Price Effects

In order to estimate the empirical relation between index futures returns and the returns of the underlying index, it is necessary to consider the univariate time series properties of the observed stock index return series to account for the infrequent trading and bid-ask price effects. The serial correlation, bid-ask spread and effects of infrequent trading are examined.

The autocorrelation structure of the daily returns of NSE-50 Index is presented in Table 6. A look at the serial correlation coefficients of the Index returns shows that only first lag is reasonably high (0.096) and significant (at 0.05 Significance Level) with lingering, less significant serial correlation at lags 2 and 3. The lag two and three serial correlation coefficient of Nifty returns is very small and lag 2 is negative. The apparent negative serial dependence is probably due to individual stock bid/ask spreads. However, the problem of bid-ask bounce is not severe in the case of Nifty's component stocks as the impact cost on Rs.4 million of the full S&P CNX Nifty is a mere 0.2%. That is, if Nifty is quoting at 1000, a buy order goes through at 1002 and sell order gets 998. Besides, for a stock to qualify for possible inclusion into the Nifty, it has a market impact cost of below 1.5% when doing Nifty trades of half a crore rupees. NSE has a reasonably high trading intensity (reducing stale prices) and their bid-ask spreads are the tightest (reducing bid-ask bounce). This is assisted by the fact that the NSE tick size is Rs.0.05 for all stocks, which encourages tight bid-ask spreads. Hence, observed index returns are reasonable accurate reflections of "true" index returns because of less significant higher order autocorrelation coefficients. The findings are consistent with the evidence in Chan (1992), Stoll and Whaley (1990). This implies that there is less non-synchronous trading of component stocks.

Table 6 Autocorrelation pattern of Index Returns

Lag	Auto Correlation Coefficient	Standard Error	Box-Ljung Statistic	Probability
1	0.096	0.043	4.900	0.027
2	-0.065	0.043	7.187	0.028
3	0.000	0.043	7.187	0.066
4	0.092	0.043	11.718	0.020
5	0.083	0.043	15.429	0.009
6	-0.038	0.043	16.202	0.013

A look at the autocorrelation coefficients of the index futures returns (Table 7) is worthwhile. The serial correlation of futures returns are relatively small and none of the lags from one through sixteen are significant. The difference in the serial correlation of the Nifty Index and Futures returns may be due to nonsynchronous trading of component stocks within the NSE-50 Index. It may also be due to slow dissemination of market wide information in the cash market. Lower autocorrelation coefficients of Nifty futures returns indicates that futures absorbs information faster as they arrive in the market thereby giving no room for the past information to affect the current futures returns. Since the futures returns are for a single financial instrument rather than a portfolio of securities, no positive serial dependence due to infrequent trading should appear. This conforms to the fact that futures returns appear to have little or no memory virtually. The findings are consistent with the evidence in Stoll and Whaley (1990), Chan (1992) and Abhyankar (1995).

Table 7 Autocorrelation patterns of futures returns

Lag	Auto Correlation Coefficient	Standard Error	Box-Ljung Statistic	Probability
1	0.074	0.043	2.958	0.085
2	-0.023	0.043	3.252	0.197
3	0.035	0.043	3.895	0.273
4	0.061	0.043	5.877	0.209
5	0.077	0.043	9.030	0.108
6	-0.005	0.043	9.045	0.171

Bid-Ask Spread

The distance between the best buy and the best selling price is called the *bid-ask* spread. Liquidity is ultimately about being able to transact at a price which is very close to the current market price which in turn means the tightest possible bid-ask spread. For example, the securities like Reliance, the bid-ask spread is typically five to ten paisa. Hence, the lesser the bid-ask spread, greater is the liquidity for the component stocks.

The effect of infrequent trading and bid-ask spread have been shown to cause observed portfolio returns to follow an ARMA (p,q) process. Table 8 indicates the parameter estimates for the fitted ARIMA model at 95% confidence levels estimated by Cochrane-Orcutt Iterative Least Squares (COILS) method (Stephen). The results for Nifty Index show that the coefficients of the ARIMA is significantly different from zero only for lag 1, that is, the current closing price of the index could be influenced by the previous day's closing price. For lags beyond two, the coefficients are close to zero and hence reinforces the fact that serial correlation problems do not persist in the Nifty returns. However, R^2 value of 0.37 indicates that the variations in the observed index returns are less explained by the past returns. This reflects the fact that there was considerable trading activity in the stock market during the sample period under consideration. It is seen that only the previous day's closing price is significant as indicated by the t-value of 2.25 at 0.05 level of significance. The results obtained here conform to the findings from the serial correlation coefficients that higher order lags are less significant in determining the current index returns.

Table 8 Parameter estimates of daily Nifty returns from the fitted AR model

PROB.	B	SEB	T-RATIO	APPROX.
INDEXR1	.0986720	.04378408	2.25360	.02463600
INDEXR2	-.0691917	04403883	-1.57115	.11675449
INDEXR3	.0203661	.04418874	0 .46089	.64507087
INDEXR4	.0714886	.04426651	1.61496	.10692511
INDEXR5	.0681355	.04425523	1.53960	.12426428
INDEXR6	-.0388400	.04427534	-.87724	.38076160
INDEXR7	-.0325623	.04429926	-.73505	.46263782
INDEXR8	-.0296999	.04422809	-.67152	.50218951
INDEXR9	.0286338	.04402625	.65038	.51573339
CONSTANT	9.9324067	.07404565	134.13896	.00000000

Rho -.26615083

Multiple R .61473998

R-Squared .37790524

Adjusted R-Squared .37554435

The results Nifty Futures fitted to the AR (4) as in Table 9 shows that none of the lag coefficients are statistically significant. This follows the fact that Nifty futures have a tighter bid/ask spread (tick size being Rs.0.05). It can be inferred from the model that the effects of infrequent trading is virtually absent.

Thus the analysis shows that the past returns of Nifty do not tamper the current returns thereby eliminating the problems of infrequent trading and poor liquidity of the component stocks.

Table 9 Parameter estimates of daily Nifty futures returns from the fitted AR model

	B	SEB	T-RATIO	APPROX. PROB.
AR1	.0706027	.04378665	1.61242	.10747514
AR2	-.0318347	.04389508	-.72524	.46862789
AR3	.0405714	.04393915	.92335	.35625046
AR4	.0541104	.04404942	1.22840	.21985038
AR5	.0746872	.04398091	1.69817	.09007220
AR6	-.0132760	.04405454	-.30135	.76326469
AR7	-.0127815	.04402495	-.29032	.77168395
AR8	-.0347245	.04402056	-.78882	.43057355
AR9	-.0323427	.04395362	-.73584	.46216115
CONSTANT	9.9316359	.07281117	136.40263	.00000000

Rho	-.24814587
Multiple R	.60905996
R-Squared	.37095403
Adjusted R-Squared	.36856676

LEAD LAG ESTIMATES OF THE INDEX AND FUTURES RETURNS

In order to estimate the lead/lag relation between the Nifty and futures return series, it is necessary to determine the length of the lead/lag coefficients. The choice of lead-lag is based on the cross correlation coefficients between index and futures returns for 4 lead/lags as indicated in the Table10. Positive value of the coefficients at lags at k = 1,2,3 would indicate that returns in the futures market tend to lead those in the stock market, and positive values for the coefficients at leads k = -1, -2, -3 would indicate that the stock market tends to lead the futures market. Hence, the coefficients with negative subscripts are the lead coefficients and the positive subscripts are the lag coefficients. If the lead coefficients are significant then the cash leads the futures and, if the lag coefficients are significant, the cash index lags the futures. Apart from giving a preliminary look at the lead-lag relation between the two markets, it suggests the number of leads, and lags to be used in the later regression analysis.

The contemporaneous correlation is 0.559 suggesting that the two time series are moderately correlated thought not perfectly correlated. The lagged futures returns seem to have forecast power in explaining current spot index returns as the lag 1 coefficient is 0.319. The serial correlation between the current spot and future futures returns is quite low. The subsequent lead/lag coefficients are diminishing and the results suggest that cross-correlation coefficients at longer leads/lags are not significant. The serial correlation coefficients indicate that the current spot returns is correlated to the current future returns and one lead/lag futures returns. Thus, the coefficient of the lead/lag is estimated by regressing the spot market returns to the current and one lead/lag of futures returns. Similarly, the futures market returns are regressed against the current and one lead/lag of cash market returns.

Table10 Cross correlation coefficients between the Nifty and Nifty futures returns

Lag	Cross-Correlation
-4	0.093
-3	-0.013
-2	0.041
-1	**0.147**
0	**0.559***
1	**0.319***
2	0.014
3	-0.022
4	0.037

* Significant

Lead-Lag Relationship

The lead lag relationship between spot and index futures are estimated using Simultaneous equation model (ordinary least squares and two stage least squares regression). The spot as a function of futures and the futures market as a function of spot market is assessed. The lead lag results for different time periods are discussed below.

a) Lead-Lag Relationship for the Period 12/6/2000 to 10/9/2001

The results of the regression are given in Table 11 and 12. The adjusted R^2 of 0.795 and a high value of F-Statistic (408.017 at 0.01 level of significance) indicate the goodness of fit of the regression model.The contemporaneous coefficient β_0 is 0.825, and is the largest among all coefficients, suggesting that two markets react simultaneously to much of the information. High positive T-values of coefficients β_0, β_1, β_2 at 0.01 level of significance show that the regression coefficients are statistically significant. The coefficient of lag 1(0.110) futures is higher than the lead 1 futures (0.101), which indicate that futures market, lead the cash index. It is interesting to note that the coefficients of one-lead/lag futures do not differ largely. It may be due the returns taken on a daily basis. The difference would have been prominent had the lag/lead been in minutes or on hourly basis. Nevertheless, the futures lag coefficient is still high enough as against the lead one futures coefficient, which is a clear indication of futures market leading the cash market. On examining the predictive effect of lag stock index returns on current futures returns, it is found that the model is deemed fit, as the F-statistic (353.132) is statistically significant at 0.01 level of significance

Table 11 Results of the lead-lag estimates of Nifty futures returns

(12/06/2000 to 10/09/2001)

$$R_{S,t} = a + \sum_{k=-n}^{k=n} b_k R_{F,t-k} + e_t$$

	Description	Coefficients(β)	T Ratio	Sig.
β_{-1}	LEADS(FUTRET,1)	0.101	4.230	0.000
β_0	Spot futures returns	0.825	34.416	0.000
β_1	LAGS(FUTRET,1)	0.110	4.544	0.000

a. Predictors: (Constant), spot futures returns, LAGS (FUTRET, 1), LEADS (FUTRET,1)

b. Dependent Variable: post futures spot index returns

Model Summary

R	R Square	Adjusted R Square	Standard Error of Estimate
.893	.797	.795	7.154E-03

It is seen from the regression results (presented in Table 12) that none of the lead/lag coefficients of index returns are significant. Only the spot index returns coefficient (0.881) is statistically significant and much of the adjusted R^2 (0.77) is explained single-handedly by the current index returns. The evidence suggests that movements in the index do not provide any information about the upcoming futures prices. However, the possibility of any information transmission from the index to the futures could be verified by pruning the length of the lead/lag to intra-day returns ranging from minute-by-minute to hourly returns as studied by Abhyankar(1995), Chan (1992), Stoll and Whaley(1990).

Table 12 Results of the lead-lag estimates of Nifty returns (12/06/2000 to 10/09/2001)

$$\mathbf{R_{F,t} = a + \sum_{k=-n}^{k=n} b_k R_{S,t-k}} + e_t$$

	Description	Coefficients(β)	T Ratio	Sig.
β_{-1}	LEADS(INDXRET, 1)	-0.003	-0.110	0.913
β_0	Spot Index returns	0.881	31.924	0.000
β_1	LAGS(INDXRET, 1)	-0.010	-0.382	0.702

a. Predictors: (Constant), LEADS (INDXRET, 1), LAGS (INDXRET, 1), spot index returns

b. Dependent Variable: spot futures returns

Model Summary

R	R^2	Adjusted R^2	Standard Error of Estimate
.879	.772	.770	8.061E-03

(b) Lead-Lag Relationship for the Period October 2000 to September 2001

The regression analysis is carried out for the period between October 2000 and September 2001 as the futures trading has registered consistent rise in its volumes since October 2000 contract onwards. The model is considered a good fit as the F-statistic(Table 13) (171.846), is significant at 0.01 level of significance. The results are a clear indication that the futures market tends to lead the cash market as the lag one futures coefficient is 0.124 (0.01 level of significance) is significant while the lead one futures coefficient is a mere 0.072 (0.05 level of significance). The clear distinction between the lead and lag coefficients vindicates the fact that futures markets are the ones that transmit the information to cash market.

From the above analysis it is reinforced that the futures market tend to the lead spot market due to lower transaction costs and the absence of infrequent trading and poor liquidity problems.

Table 13 Results of the lead-lag estimates of Nifty returns (27/10/2000 to 10/09/2001)

$$R_{S,t} = a + \sum_{k=-n}^{k=n} b_k R_{F,t-k} + e_t$$

	Description	Coefficients(β)	T Ratio	Sig.
β_{-1}	LEADS(FUTRET,1)	0.072	1.908	0.058
β_0	Spot futures returns	0.800	21.108	0.000
β_1	LAGS(FUTRET,1)	0.124	3.296	0.000

a. Predictors: (Constant), spot futures returns, LAGS (FUTRET, 1), LEADS (FUTRET,1)

b. Dependent Variable: post futures spot index returns

Model Summary

R	R Square	Adjusted R Square	Standard Error of Estimate
.840	.706	.702	8.4326E-03

c) Lead-Lag Relationship for the Period October 2001 to July 2002

The lead lag relation may be affected by the intensity of trading activity in the two markets. Lower trading activity implies that the securities are less frequently traded and thus observed prices lag true 'value more. Moreover, information dissemination may related to the intensity of trading activity. Admati and Pfleinderer(1988) shows that , in general, traders of both discretionary liquidity traders and informed traders cluster, with each group preferring to trade when the market is thick. The clustering of trade causes more information to be released when trading activity is higher. Therefore, the lead-lag relation is expected to vary with the relative intensity of trading activity in the two markets. Stephan and Whaley(1990) study the intra-day relation between the stock market and the stock option market. They find that not only do price changes of stocks lead price changes of options , but that trading activity (proxied by the number of transactions and trading volume) in the two markets also bears the same kind of lead – lag relation. This provides evidence that price discovery and trading activity are related.

As observed from Fig.2 and Fig 3 , the volume of contracts traded in Nifty futures and the value of contracts traded in Nifty futures is on an increasing trend from October 2001, particularly the aftermath of September 11 incident. Hence the lead- lag relationship has been examined separately from October 1 2002 to July 25, 2002. The results as given in Table 14 and 15 show that the current returns of index is not significantly correlated to the current futures returns and current futures returns is not significantly influencing the current index returns during this period of analysis. However the most significant variable influencing Futures is lead 1 of Nifty and the most significant variable influencing spot index is lag 1 of futures. Thus, the results show that futures leads the spot market returns. The model is considered a good fit as the F-statistic is significant at 0.01 level of significance.

Table 14 Results of the lead-lag estimates of Nifty futures (10/2001 to 07/2002)

Multiple R .88645

R Square .78580

Adjusted R Square .78260

Standard Error .54051

F = 245.78999 Signif F = .0000

Variable	B	SE B	Beta	T	Sig T
NIFTY	-.005044	.031440	-.005237	-.160	.8727
LAGN1	-.005876	.031337	-.006134	-.188	.8514
LEDN1	.851018	.031418	.885987	27.087	.0000
(Constant)	1.622245	.560194		2.896	.0042

Dependent variable.. FUTURE

Table 15 Results of the lead-lag estimates of Nifty index (10/2001 to 07/2002)

Multiple R .90026

R Square .81046

Adjusted R Square .80762

Standard Error .52918

F = 285.06288 Signif F = .0000

Variable	B	SE B	Beta	T	Sig T
FUTURE	.006259	.031978	.006027	.196	.8450
LAGFU1	.934488	.032013	.903815	29.191	.0000
LEDFU1	.044292	.032284	.042470	1.372	.1716
(Constant)	.141716	.585206		.242	.8089

Dependent variable.. NIFTY

d) Lead-Lag Relation for the Period 12 June 2000 to 25 July 2002

The lead lag relationship considering the entire period from 12th June 2000 to 25th July 2002 has been examined and the results are given in Table 16 and Table 17. The results show that the current index returns is significantly influencing the current future returns (.47) apart from lead 1 of Nifty (.39). Thus, the results show that futures leads the spot market returns. The model is considered a good fit as the F-statistic is significant at 0.01 level of significance.

Table 16 Lead – lag estimates of Nifty index returns (12/06/2000 to 25/7/2002)

Multiple R .65035

R Square .42296

Adjusted R Square .41967

Standard Error 1.13319

F = 128.51644 Signif F = .0000

Variable	B	SE B	Beta	T	Sig T
STD_NIFT	.463469	.032745	.473434	14.154	.0000
LAG_NI_1	.042801	.032661	.043730	1.310	.1906
LED_NI_1	.390406	.032631	.399210	11.964	.0000
(Constant)	1.029827	.539367		1.909	.0568

Dependent variable.. STD_FUT

The results as given in Table 17 shows that the current spot returns is influenced by current futures returns and past futures returns i.e. lag 1 futures returns. It may be inferred that the futures lead the spot and the previous day futures returns also influences the current spot index returns.

Table 17 Lead – lag estimates of Nifty futures returns(12/06/2000 to 25/7/2002)

Multiple R .65596

R Square .43028

Adjusted R Square .42703

Standard Error 1.15126

F = 132.17036 Signif F = .0000

Variable	B	SE B	Beta	T	Sig T
STD_FUT	.493103	.033843	.482714	14.570	.0000
LAG_FU_1	.415352	.033785	.406273	12.294	.0000
LED_FU_1	.036211	.033814	.035391	1.071	.2847
(Constant)	.548326	.559402		.980	.3274

Dependent variable is STD_NIFTY

e) Lead-Lag Relation for the Period 12 November 2001 to 25 July 2002

The analysis has been done separately after the introduction of stock futures in November 2001 and the results are given in Table 18 and 19. The results show that even during this period futures lead the spot and there is weak evidence of spot leading the futures. However, the influence of spot futures returns seems to be higher than the lag futures as the beta coefficient is very high for spot returns.

Table 18 Lead – lag estimates of Nifty returns considering volume of trading (12/11/2001 to 25/7/2002)

Multiple R .95099

R Square .90438

Adjusted R Square .90270

Standard Error .37324

F = 535.98484 Signif F = .0000

Variable	B	SE B	Beta	T	Sig T
NIF_FUT	1.004607	.025107	.950111	40.013	.0000
LAG_FU_1	.068281	.025247	.064325	2.705	.0075
LED_FU_1	-.021905	.025142	-.020720	-.871	.3848
(Constant)	-.523016	.457088		-1.144	.2541

Dependent variable.. NIF_RE

Table 19 Lead – lag estimates of Nifty futures returns considering volume of trading (12/11/2001 to 25/7/2002)

Multiple R .95075

R Square .90393

Adjusted R Square .90224

Standard Error .35383

F = 533.20056 Signif F = .0000

Variable	B	SE B	Beta	T	Sig T
NIF_RE	.897641	.022500	.949128	39.895	.0000
NIF_LE_1	.054139	.022543	.057217	2.402	.0174
NIF_LA_1	-.027166	.022656	-.028569	-1.199	.2322
(Constant)	.765796	.407043		1.881	.0616

Dependent variable.. NIF_FUT

f) Lead-Lag Relation for the Period 12 June 2000 to 25 July 2002 considering volume of trading

The volume of trading being a significant factor in determining the lead lag relationship, the volume of contracts traded in the futures market is also considered in establishing the lead lag relationship by introducing the variable as a dummy variable. The period with low volume of contracts - 12/2/2000 to 30/9/2001 is given the dummy value 0 and the period with high volume of contracts – 1/10/2001 to 25/7/2002 is given the dummy value 1. The results of the two stage regression analysis considering the volume of contracts as a dummy variable is given in Table 20 and Table 21. The results show that the beta coefficient of the dummy variable is very low (.004 and .005) and is not significant at .01 level of significance. The coefficient seems to be very close to zero and thus volume of contracts does not have any significant influence either on the spot or on the futures returns.

Table 20 Lead –lag estimates of Nifty index returns considering volume of trading (12/06/2000 to 25/7/2002)

Multiple R .65598

R Square .43030

Adjusted R Square .42595

Standard Error 1.15234

F = 98.94705 Signif F = .0000

Variable	B	SE B	Beta	T	Sig T
STD_FUT	.492857	.033923	.482473	14.529	.0000
LAG_FU_1	.415032	.033899	.405961	12.243	.0000
LED_FU_1	.035904	.033921	.035091	1.058	.2903
DUMVOLUM	.014070	.103606	.004507	.136	.8920
(Constant)	.551568	.560434		.984	.3255

Dependent variable.. STD_NIFT

Table 21 Lead – lag estimates of Nifty futures returns considering volume of trading (12/06/2000 to 25/7/2002)

Multiple R 65038

R Square 42299

Adjusted R Square 41860

Standard Error .13423

F = 96.21678 Signif F = .0000

Variable	B	SE B	Beta	T	Sig T
LAG_NI_1	.042414	.032769	.043335	1.294	.1961
LED_NI_1	.390090	.032713	.398887	11.925	.0000
STD_NIFT	.463166	.032823	.473124	14.111	.0000
DUMVOLUM	.017418	.101763	.005708	.171	.8642
(Constant)	1.033085	.540201		1.912	.0564

Dependent variable.. STD_FUT

FINDINGS

This study in particular addresses the impact of introduction of futures trading on the volatility of spot market by separating the possible effects of market wide information.

(i) Volatility of spot index in the pre futures and post futures period:

A comparison of Nifty volatility as measured by standard deviation shows that the volatility in the post futures period is less than the volatility before the introduction of futures volatility. Though the explanatory power due to introduction of futures is low, there seems to be statisitically significant difference between the volatility before and after introduction of futures. The volatility of Nifty in the post futures period has been in the declining trend when examined at different time periods except during the 9/3/2001 to 10/9/2001 , i.e after the ban on short sales

(ii) Market-Wide Information and Spot Returns:

The change in volatility of spot price may be due to other factors apart from futures. Introducing a proxy variable, which is not associated with the futures contract, eliminates the market-wide influences on spot price changes. NSE-50 Junior Index is used as a proxy to capture market-wide influences on price volatility as it is not very highly correlated with NSE-50 Index. It is seen that the "information coefficient" in the post futures period is more than that in the pre-futures period. An increase in R^2 from 0.641 (pre-futures period) to 0.666 (post-futures period) shows that there is a possibility of increase in the information flow that has influenced the market returns in the post-futures period.

(iii) Spot market volatility and futures trading:

A regression analysis done to examine if the spot market volatility has undergone a structural change due to futures trading by introducing futures trading as a dummy variable shows that the futures trading explains 0.5% of the variation in spot price return. The coefficient of the dummy variable is different from zero and is negative indicating that Nifty index volatility reduces in the post futures period.

The study reveals that there is a fall in volatility since the inception of futures trading which may be attributed to increased trading in cash markets, due to faster dissemination of information, making cash markets more liquid and, therefore, less volatile. It could also be due to shift of speculators from cash to futures market due to low transaction costs and high leveraging in the futures market. This shift can be attributed to low margins, low transaction costs and the standardised contracts and trading conditions prevalent in the futures market (Butterworth, Antoniou et. al., (1995)). The finding that the volatility of the spot market has decreased with the introduction of futures trading and the explanatory power of index futures on spot market volatility support the introduction of derivatives trading and validates the financial sector reforms in the country.

(iv) Lead lag relationship between spot and futures returns

Uncovering lead and lag relations in price changes raises an interesting possibility that the futures and cash markets are not equal in their capacity to discover new information about asset prices. In this backdrop, the study examines the lead-lag relation between the daily futures and cash index prices over the sample period, June 2000 through July 2002.

(a) Autocorrelation Function

A look at the serial correlation coefficients of the Index returns shows that only first lag is large and significant (at 0.01 Significance Level) with lingering, less significant serial correlation at lags 2, 3, and 4. Since the futures returns are for a single financial instrument rather than a portfolio of securities, no positive serial dependence due to infrequent trading should appear. This conforms to the fact that futures returns appear to have little or no memory virtually.

(b) Bid-Ask Spread

The effect of infrequent trading and bid-ask spread have been shown to follow an ARIMA (p,q) process. The results for Nifty Index show that the coefficients of the ARIMA is significantly different from zero only for lag 1, that is, the current closing price of the index could be influenced by the previous day's closing price. For lags beyond two, the coefficients are close to zero and hence reinforce the fact that serial correlation problems do not persist in the nifty returns. R^2 value of 0.37 indicates that the variations in the observed index returns are less explained by the past returns. This reflects the fact that there was considerable trading activity in the stock market during the sample period under consideration. The results obtained here conform to the findings from the serial correlation coefficients that higher order lags are less significant in determining the current index returns. The results for Nifty Futures fitted to the ARIMA shows that none of the lag coefficients are statistically significant. R^2 of 0.37 indicates that futures returns are not influenced by infrequent trading and bid/ask price effects.

(c) Lead-Lag Length

Correlation between the current Nifty returns and one lead and one-lag futures returns are significant with subsequent lead/lag coefficients diminishing. The lagged one futures return seem to have forecast power in explaining current spot index returns with a higher cross correlation coefficient. The results suggest that cross-correlation coefficients at longer leads/lags are not significant. The choice of lead-lag is based on the cross correlation coefficients between index and futures returns and thus one lead / lag is considered for subsequent analysis.

(d) Lead-Lag relation for the Period 12/06/2000 to 10/09/2000

The contemporaneous coefficient β_0 is 0.825, and is the largest among all coefficients, suggesting that two markets react simultaneously to much of the information. The coefficient of lag 1(0.110) futures is higher than that lead 1 futures (0.101), which indicate that futures market, lead the cash index. It is interesting to note that the coefficients of one-lead/lag futures do not differ largely. It may be due the returns taken on a daily basis. The difference would have been prominent had the lag/lead been in minutes or on hourly basis. Nevertheless, the futures lag coefficient is still greater than the lead one futures coefficient, which is a clear indication of futures market leading the cash market. The results indicate that much of the information is transferred from the futures to the spot market than from spot to futures market.

(e) Lead-Lag relation for the period 27/10/2000 to 10/9/2001

The clear distinction between the lead and lag coefficients vindicates the fact that futures markets are the ones that transmit the information to cash market. However, during this period the lag one futures coefficient 0.124 (0.01 level of significance) is much higher than the lead one futures coefficient which is a mere 0.072 (0.05 level of significance).The results are a clear indication that the futures market tends to lead the cash market.

(f) Lead-Lag relation for the period 1/10/2001 to 25/7/2002

The findings are similar to the other time periods that futures lead the spot market returns but interestingly, during this period there seems to be very insignificant relationship between the current returns of index and current futures returns. However, the most significant variable influencing Futures is lead 1 of Nifty and the most significant variable influencing spot index is lag 1 of futures. The coefficient of the lagged returns is highest and the other coefficients are insignificant.

(g) Lead-Lag Relation for the Period 12 November 2001 to 25 July 2002

The findings are similar and the results show that futures lead the spot and there is weak evidence of spot leading the futures. However, the influence of spot futures returns seems to be hi gher than the lag futures as the beta coefficient is very high for spot futures returns.

(h) Lead-Lag relation for the period 12/6 2002 to 25/7/2002

The results show that that the futures lead the spot and the previous day futures returns also influen ces the current spot index returns. Interestingly, the influence of current price returns and lag returns is more or less equal (.48 and .40) compared to the other time periods.

Thus, the lead lag analysis shows that the futures returns leads the spot market returns and beta coefficient of the lagged futures returns has been increasing from .110 to.124 to .903 while the lead futures returns has been decreasing from .101 to .072 to .042. . The influence of current futures price on spot index returns h as been declining from 88 to .80 to.006. However, considering the post futures period, the influence of current futures returns and lag one futures returns are more significant and equal while the lead futures returns is insignificant in determining the spot index price.

(h) Lead-Lag relation for the period 12/6 2002 to 25/7/2002 considering volume of contracts

The regression analysis considering volume of contracts as a dummy variable shows that volume of contracts do not have any significant effect in the lead lag relationship. However, as discussed above, it was observed from the lead lag analysis done for the period when volume of contracts is high- 1/10/2001 to 25/7/2002, that the coefficient of the lagged futures returns is the highest and t he other coefficients (current futures returns and lead one futures returns) are insignificant in influencing the spot index returns.

From the above analysis, it is reinforced that the futures market tend to the lead spot market and the index futures market serves as a primary market of price discovery. This is attributed to the ease at which the information is absorbed by the index futures contracts due to lower transaction costs and high leveraging in the futures market. These results are plausible given that transaction and entry costs in the stock index futures are lower than the spot markets and probably due to the absence of infrequent trading and poor liquidity problems. It is also shown that the cash index does not lead the futures returns. Though the futures lead the spot market returns by one day, the exact time by which the futures lead the spot market returns is not identified as the study is conducted using daily returns due to lack of data in terms of minute-by-minute or hourly returns.

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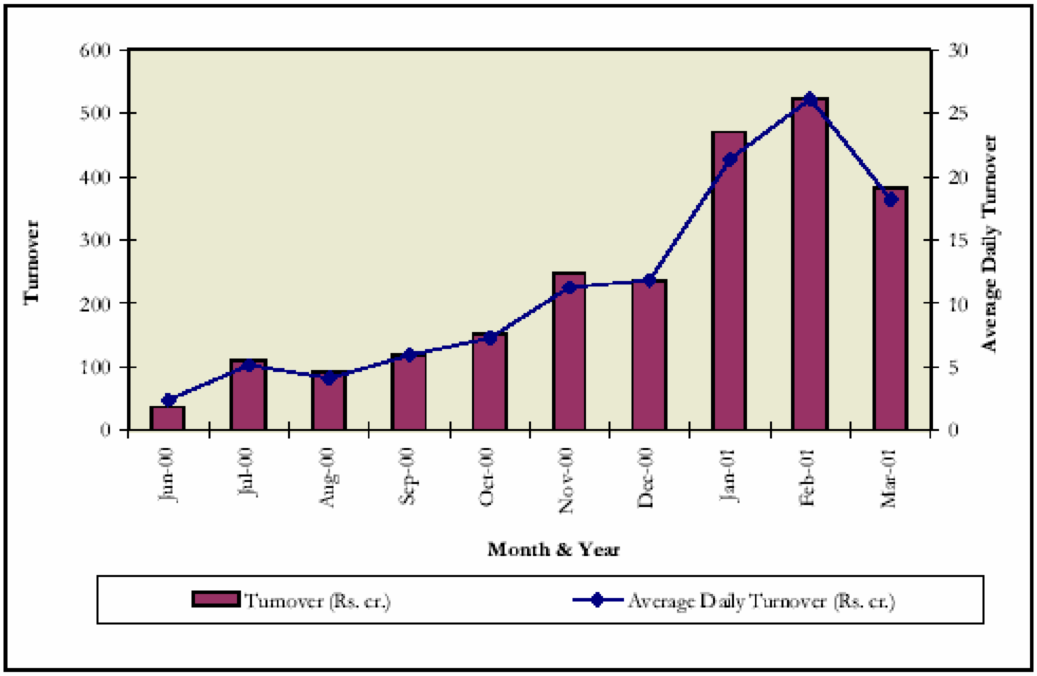
Fig. 1 Average daily turnover of futures contracts for the period June 2000 to March 2001



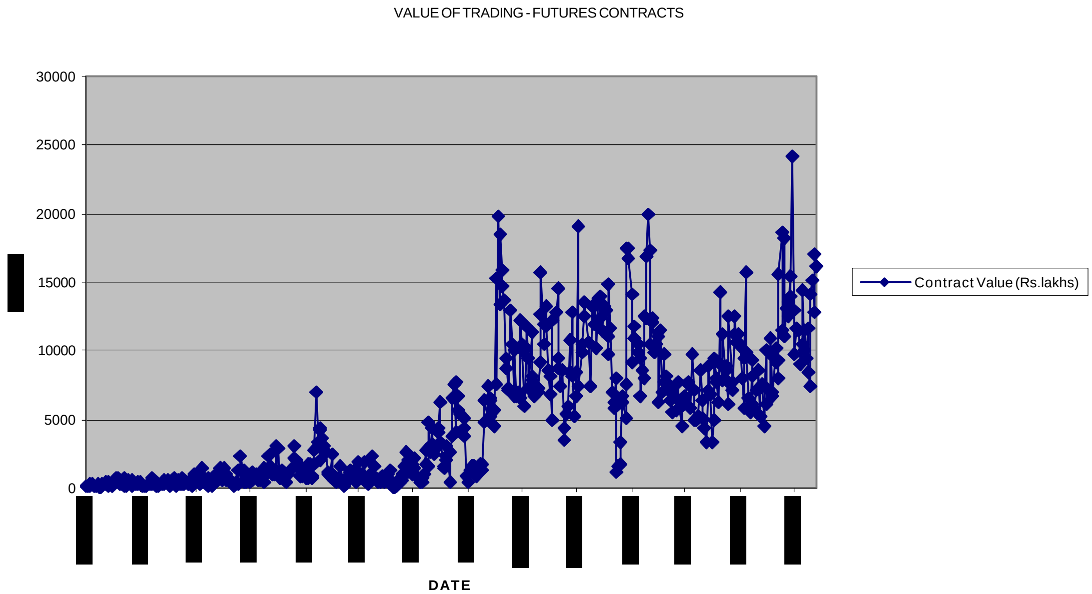
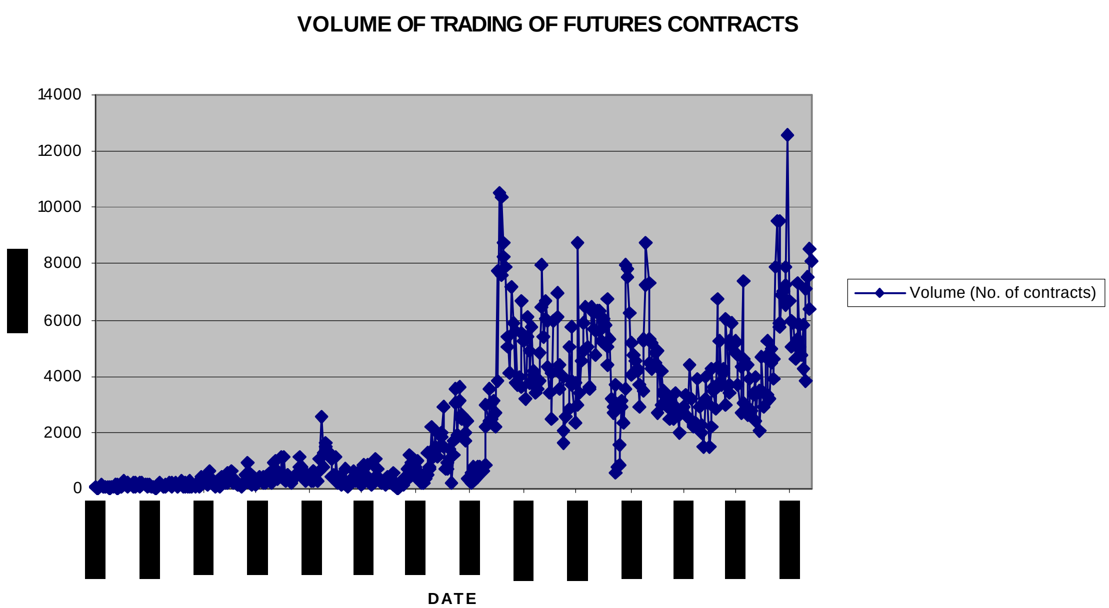

VALUE OF TRADING - FUTURES CONTRACTS
30000
25000
20000
15000
10000
5000
0
Contract Value (Rs.lakhs)
DATE

Fig 2

Fig. 3


VOLUME OF TRADING OF FUTURES CONTRACTS
14000
12000
10000
8000
6000
4000
2000
0
Volume (No. of contracts)
DATE