

Securities and Exchange Board of India



Price Discovery and Volatility on NSE Futures Market

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* The views expressed in the study are those of the authors and they do not reflect the views of SEBI. This paper has been reviewed independently by a referee.

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Foreword

It has been the endeavor of SEBI to make Indian capital market more efficient. Towards this direction several steps have been initiated. Introduction of trading in financial derivatives is one of them. Stock index futures, index options, stock options and single stock futures have been permitted for trading in the Indian stock exchanges. Members of National Stock Exchange of India Limited (NSE) and The Stock Exchange, Mumbai (BSE) have been allowed to trade in index futures from June 2000 and later on in all the other three products. It has been over two and a half years since trading in index futures started and therefore, an evaluation of the impact of index futures on the underlying market is in order. Derivatives are effective instruments in the hands of investors. These can be used to hedge and / or to speculate. Past experiences in other countries reveal that mostly derivatives have important role to play in the market place. By virtue of linkages between derivatives and spot market the information is expected to flow from one market to another. Some of the studies in other countries reveal that price discovery takes place first in derivatives market and it impacts cash market. This is a very useful information for regulators as well as for market participants. Any recognizable regularity such as this is an indication of predictability in the financial markets. Predictability provides opportunities for potential extra profits. Regulators and policy makers try to initiate regulations so that the predictability disappears or at least becomes uneconomical.

Volatility is yet another area of interest both for regulators and for market participants. Regulators and market participants prefer less volatility to more volatility. Financial derivatives are expected to reduce volatility in the spot market as speculators move away from spot market to financial futures market. However, empirical studies conducted across markets provide differing evidence. Therefore, it has become necessary, from time to time, to conduct empirical studies to measure the impact of financial derivatives, in our case index futures, on volatility of spot market. In order to measure both the important characteristics: price discovery and volatility SEBI has undertaken this research project internally. The results are quite encouraging. The price discovery in our market appears to have taken place simultaneously in both the markets, in entire sample period and it occurs first in the futures market in the latter period. Introduction of index futures appears to have impacted reduction in volatility of the spot market. Both these findings are very useful though they second with the findings of some of the studies conducted overseas. But these are useful in the Indian context. I heartily congratulate the officers of the Research Department for taking up this project and bringing out the results to the public domain.

**G. N. BAJPAI
Chairman
Securities and Exchange Board of India**

**March 2003
Mumbai**

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Securities and Exchange Board of India

The Securities and Exchange Board of India (SEBI) was constituted on 12 April 1988 as a non-statutory body through an Administrative Resolution of the Government for dealing with all matters relating to development and regulation of the securities market and investor protection and to advise the government on all these matters. SEBI was given statutory status and powers through an Ordinance promulgated on January 30 1992. SEBI was established as a statutory body on 21 February 1992. The Ordinance was replaced by an Act of Parliament on 4 April 1992. The preamble of the SEBI Act, 1992 enshrines the objectives of SEBI – to protect the interest of investors in securities market and to promote the development of and to regulate the securities market. The statutory powers and functions of SEBI were strengthened through the promulgation of the Securities Laws (Amendment) Ordinance on 25 January 1995, which was subsequently replaced by an Act of Parliament.

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Abstract

This paper studies price discovery and volatility in the context of introduction of Nifty futures at the National Stock Exchange (NSE) in June 2000. Cointegration and Generalised AutoRegressive Conditional Heteroscedasticity (GARCH) techniques are used to study price discovery and volatility respectively. The major findings are that the futures market (and not the spot market) responds to deviations from equilibrium; price discovery occurs in both the futures and the spot market, especially in the later half of the study period. The results also show that volatility in the spot market has come down after the introduction of stock index futures.

Price discovery and volatility on NSE futures market

1 Introduction

The temporal relation between stock Index and Index futures has been and continues to be of interest to regulators, academicians and practitioners alike for a number of reasons such as market efficiency, volatility and arbitrage. In perfectly efficient markets profitable arbitrage should not exist as prices adjust instantaneously and fully to new information. Hence, new information disseminating into the market place should be immediately reflected in spot and futures prices by triggering trading activity in one or both markets simultaneously so that there should be no systematic lagged responses. However, there is yet another reason that futures markets potentially provide an important function of price discovery to help improve efficiency of the market. If so, then futures prices and movements thereof should contain useful information about subsequent spot prices beyond that already embedded in the current spot price.

One of the purposes of this paper is to examine price discovery between the S&P CNX Nifty and its corresponding futures since inception of Index futures at NSE using cointegration analysis which offers several advantages. First, cointegration analysis measures the extent to which two markets have achieved long run equilibrium. Another distinct advantage of the cointegration technique is that it explicitly allows for divergences from equilibrium in the short run.

The concern over how trading in futures contract affects the spot market in underlying asset has been an interesting subject for investors, academicians, exchanges and regulators. Antoniou and Holmes (1995) found that the introduction of stock Index futures caused an increase in spot market volatility in the short run while there was no significant change in volatility in the long run. The apparent increase in volatility has been attributed to increased information flow in the market through the channel of futures trading. On the other hand, Kamara *et al.* (1992) found no increase in spot market volatility due to introduction of futures trading. 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. 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 and hence increase in volatility.

Since there is theoretical disagreement as to whether futures trading increases or decreases spot price volatility the question needs to be investigated empirically and policy makers in India may also like to know its impact so that future policy changes can be implemented. Another purpose of this study is to examine the effect of introduction of S&P CNX Nifty Index futures on the underlying spot market.

There is an evidence of bi-directional feedback during the day. In order to find out any lead lag information, there is a need to look at high frequency data. Attempts are being made to obtain intra day data so that lead lag relationship, if any, between cash and

futures market can be established. Also, price discovery and volatility in the context of single stock futures is proposed to be studied separately.

This paper is segmented into seven sections. Section two followed by introductory section one, expresses motivation behind the research work. Research studies have their own theoretical backing. Such theoretical pinnings are explained in section three. Some of the more useful and relevant past studies on the topic are referred and summarised in section four. Methodology for the study, selection of appropriate econometric techniques, data and time period is explained in section five. Sections six and seven deal with results, analysis of results and recommendations respectively.

The study finds that Index spot and futures prices are integrated processes. The study also finds a reduction in spot market volatility following the introduction of futures.

2 Motivation

The Indian capital market has witnessed many changes in the past decade. A major reform undertaken by SEBI was the introduction of derivatives products: Index futures, Index options, stock options and stock futures, in a phased manner starting from June 2000. It has been about two and half years since the introduction of Index futures in India mainly as a risk management tool for institutional and for other investors. The two main functions of futures market are price discovery and hedging. Futures markets are also known to have a stabilising effect on the underlying spot market. Price discovery is expected to first take place in the futures market and then it is transmitted to underlying cash market (Pizzi et al, 1998). Since futures market is different from cash market in terms of capital required, cost of transactions and other aspects, it would be a forerunner of the cash market as far as the information discounting is concerned. Thus many small and risk averse investors can trade in the cash market without taking the risk of bouts of volatility. Therefore, this paper makes an attempt to measure price discovery whether actually taking place first in the futures market or not.

A related issue is level of volatility. Introduction of Index futures is expected to reduce volatility in the cash market since speculators are expected to migrate to futures market (Antoniou and Holmes, 1995). Many past studies in other countries measured impact of volatility on the cash market. In India as of now there is no scientific study that used some of the modern econometric techniques to measure volatility in the cash market after the introduction of Index futures. There are some studies which used standard regression and standard deviation techniques. It is proved in India also that volatility is a time varying factor (Thiripal Raju et. al., 2002). Therefore, in this study AutoRegressive Conditional Heteroscedasticity (ARCH) family of techniques are used to capture time varying nature of volatility so that the estimators are more reliable. These are the two important locomotives; price discovery and volatility that worked as drivers of this research study.

3 Theoretical Pinnings

Granger (1987) introduced the concept of cointegration when two variables may move together although they are nonstationary. The rationale behind the concept is that there exists a long run equilibrium relationship between the two variables. In the short run they may deviate from each other but market forces, government intervention etc., will bring

them back together. Engle and Granger (1987) extended this concept and showed that cointegrated series have an error correction representation. With the error correction representation, a proportion of disequilibrium in one period is expected to be corrected in the next period.

The results of 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 due to more highly leveraged and speculative participants in the futures market. The introduction of stock futures causes an increase in volatility in the short run while there is no significant change in volatility in the long-run (Edwards, 1988). With increased volatility, regulatory bodies may interfere in the markets to enact further regulations. While these regulations are certainly costly they may or may not reduce stock price volatility.

An alternative view is that derivative markets reduce spot market volatility, by providing low cost contingent strategies and 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 are expected to have stabilizing influence as it adds more informed traders to the cash market, making it more liquid and, therefore less volatile.

4 Literature Review

Price Discovery

- Kawaller et.al. (1987) examined the intra day price relationship between S&P 500 Index and the S&P 500 Index futures. Their results show that both S&P 500 spot and futures markets are simultaneously related on a minute to minute basis throughout the trading day, and that a lead lag relationship also exists. The lead from futures to cash appears to be more pronounced relative to cash to futures markets.
- Stoll and Whaley (1990) investigated causal relationships between spot and futures markets using intra day data for both S&P 500 and the Major Market Index (MMI). Feedback was detected, but the futures lead was stronger than the cash Index lead.
- Chan et.al. (1991) examined the inter dependence in price change. They found much stronger bidirectional dependence between stock Index and stock Index futures price changes.
- Wahab and Lashgari (1993) used daily data and cointegration analysis to examine the temporal causal linkage between Index and stock Index futures prices for both the S&P 500 and the FTSE 100 Index for the period 1988 to 1992. They find that although feedback exists between spot and futures markets for both the S&P 500 and the FTSE 100 indices, the spot to futures lead appears to be more pronounced across days relative to the futures to spot lead.
- Pizzi et.al. (1999) examined price discovery in the S&P 500 spot Index and its three and six month stock Index futures using intra day minute by minute data. Cointegration analysis is used. The results show that both the three and six months

futures markets lead the spot market by at least twenty minutes. There is bidirectional causality but the futures market does tend to have a stronger lead effect.

- Booth et.al. (1999) study intra day price discovery process among stock Index, Index futures and Index options in Germany using DAX Index securities and intra day transactions data. They find that spot Index and Index futures have substantially larger information shares than Index options.
- Roope et.al. (2002) make a comparison of the information efficiencies between the Singapore exchange and the Taiwan futures exchange for Taiwan Index futures listed in both markets. The results provide strong evidence to suggest that price discovery primarily originates from the Singapore futures market.

Volatility

- Edwards (1988) studied whether stock Index futures trading destabilised the spot market in the long run. Using variance ratio F tests for the period June 1973 to May 1987, he concluded that the introduction of futures trading did not induce a change in spot volatility in the long run.
- Harris (1989) examined volatility after introduction of Index futures by comparing daily return volatilities during the pre futures (1975 - 1982) and post futures (1982 - 1987) period between S&P 500 and a non S&P 500 group of stock controlling for differences in firm attributes. He found that increased volatility was a common phenomenon in different markets and Index futures by themselves may not be a cause.
- Chan et.al., (1991) estimated the intraday relationship between returns and returns volatility in the stock Index and stock Index futures. Their study covered both S&P500 and Major Market Index (MMI) futures. Bivariate GARCH models were used to estimate volatility. Their results indicate a strong inter market dependence in volatility of spot and futures returns.
- Kamara (1992) examined 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.
- Antoniou and Holmes (1995) examined the relationship between information and volatility in FTSE 100 Index in the U.K using GARCH technique. They find that introduction of FTSE 100 Index futures has changed volatility in the spot market and attribute this to better and faster dissemination of information flow due to trading in stock Index future.
- Gregory et.al. (1996) examined how volatility of S&P 500 Index futures affects the S&P 500 Index volatility. Their study also examined the effect of good and bad news on the spot market volatility. Volatility was estimated using EGARCH model. They find that bad news increased volatility more than good news and the degree of asymmetry was higher for futures market.

5 Methodology

Methodology deals with selection of econometric techniques, data, calculation of returns, volatility, identification of benchmark Index and other related matters.

Prices in the cash market and futures market are expected to be inter-related. The products traded are similar in nature. Stock index futures value is derived from the value of the cash market price plus interest rate. Any information; economic, political, social and other influences changes in prices either in spot market or in futures market. Since futures market has lesser trading costs, higher liquidity than spot market the information is first expected to be reflected in the prices of futures and then it is expected to flow to cash market (Kawaller et.al., 1987). However, this may not be true in all circumstances. Sometimes it can happen that the information is first discounted in the cash market and then moves on to futures market. Alternatively, information is reflected simultaneously in both the markets. In this paper what is attempted to measure is the speed of the information flow and its early impact on prices.

There are some econometric techniques to measure the direction as well as the intensity of the information flow. Among others, Granger causality, Spectral Analysis and cointegration are more appropriate techniques useful to find out speed of information flow and its intensity on prices. In order to choose an appropriate technique between these, the prices in their levels are tested for cointegration and found to be cointegrated (see end note 1). Therefore the cointegration technique is preferred to Granger causality.

The use of cointegration analysis and error correction models explicitly takes into account non stationarity and enables one to distinguish between short run deviations from equilibrium indicative of price discovery and long run deviations that account for efficiency and stability. If two series (such as futures and spot prices) are non stationary but that a linear combination of the two variables (such as the basis) is stationary so that both are cointegrated then a bivariate dynamic model that uses only first differences (with lags) is misspecified because it ignores interim short run adjustments to long run equilibrium.

The link between cointegration and causality stems from the fact that if spot and futures prices are cointegrated, then causality must exist in at least one direction and possibly in both directions. Cointegration implies that each series be represented by an error correction model that includes last period's equilibrium as well as lagged values of the first differences of each variable, temporal causality can be assessed by examining the statistical significance and relative magnitudes of the error correction coefficients and the coefficients on the lagged variables.

The possibility that one variable in a system of cointegrated series is exogenous (independent) within the error correction process motivates the use of error correction models in evaluating price discovery. The cointegrating vectors define the long run equilibrium while the error correction dynamics characterise the price discovery process, the process whereby markets attempt to find equilibrium. The primary purpose in estimating the error correction model (ECM) is to implement price leadership tests between futures and spot prices. Tests of causality between cointegrated variables should be conducted in an error correction framework because standard tests of causality overlook the reversion to equilibrium channel of causality represented by ϵ (basis). Causality tests in the ECM framework involve testing significance of the coefficients a

and β . If these coefficients are jointly insignificant, then there is no Granger causality and hence there is no price discovery.

In this paper it is proposed to test the impact of introduction of stock index futures on volatility of spot market. Several techniques are available to measure volatility and its level; standard deviation, and ARCH family techniques. ARCH family techniques take into consideration time varying volatility. As has been mentioned already (Thiripal Raju, 2002) Indian stock indices do exhibit time varying volatility property. Therefore, GARCH (1,1) has been used to study the impact of the introduction of stock index futures on spot market volatility.

Econometric Techniques

Price changes in one market influence price changes in the other market so as to bring about a long run equilibrium relationship as given by the equation :

$$F_t - a_0 - \beta_1 S_t = e_t \quad (1)$$

where F_t and S_t are contemporaneous cash and futures prices at time t ; a_0 and β_1 are parameters and e_t is the classical error term (deviation from equilibrium). According to Engle and Granger (1987), if F_t and S_t are non stationary (see end note 2) but the deviations e_t , are stationary, then S_t and F_t are cointegrated (see end note 1) and equilibrium exists between F_t and S_t . For F_t and S_t to be cointegrated, they must be integrated of the first order. Performing unit root test on each univariate price series determines the order of integration. If each series is nonstationary in the levels, but the first differences and deviations e_t , are stationary, the prices are cointegrated of order (1,1), denoted CI(1,1) with β_1 as the cointegrating coefficient. An error correction model exists for each series which is not subject to spurious results. Ordinary least squares (OLS) is inappropriate if futures or spot prices are non stationary because the standard errors are not consistent.

Cointegration implies that each series can be represented by an error correction model that includes last period's equilibrium error as well as lagged values of the first differences of each variable. Hence, temporal causality can be assessed by examining the statistical significance and relative magnitudes of the error correction coefficients and the coefficients on the lagged variables. In this study, the error correction model can be written as :

$$R_{f,t} = a_{0f} + a_{1f}(F_{t-1} - S_{t-1}) + b_{1f}R_{f,t-1} + b_{2f}R_{s,t-1} + e_{ft} \quad (2)$$

$$R_{s,t} = a_{0s} + a_{1s}(F_{t-1} - S_{t-1}) + b_{1s}R_{s,t-1} + b_{2s}R_{f,t-1} + e_{st} \quad (3)$$

where $R_{f,t}$ is Nifty futures returns and $R_{s,t}$ is Nifty Index returns, a_{1f} and a_{1s} are the error correction terms and β_s represent short run effects.

Each of the above two equations is interpreted as having two parts. The first part is the equilibrium error. This measures how the left hand side variable adjusts to the previous period's deviation from long run equilibrium. The remaining portions of the equations are the lagged first differences which represent short run effects of the previous period's change in price. If a_{1f} is statistically insignificant the current period change in the futures price does not respond to last period's deviation from long run equilibrium. If both a_{1f} and

β_{2f} are statistically insignificant then the spot market price does not Granger cause futures market price.

Both the dependent and explanatory variables behaviour varies over time. If both dependent and independent variables are nonstationary then the estimates of simple regression are incorrect and the results will mislead. Therefore, it is necessary to test whether the variables are stationary or not. Some of the most widely used techniques to test stationarity are Dickey Fuller test and Augmented Dickey Fuller test and Phillip Perron test. In this study Augmented Dickey Fuller test has been used to test for the unit root in variables. The results are presented in Table No. 4. The hypothesis of unit root has been rejected at one per cent significant level.

To examine the effect of futures trading on the underlying spot market, there is a need to study pre and post futures period's volatility. This can be done by using standard deviation of daily log returns as a measure of volatility. However, if volatility is time varying, the above technique cannot be used. Hence, in this study, the ARCH family of models are employed to study volatility.

For studying the volatility, the following GARCH (1,1) model is used.

$$R_{s,t} = \mathbf{a}_1 D_{mon} + \mathbf{a}_2 D_{tue} + \mathbf{a}_3 D_{wed} + \mathbf{a}_4 D_{thu} + \mathbf{a}_5 D_{fri} + \mathbf{b}_1 R_{s,t-1} + \mathbf{b}_2 R_{m,t} + \mathbf{e}_{st} \quad (4)$$

$$h_t = \mathbf{a}_6 + \mathbf{a}_7 e^2_{t-1} + \mathbf{b}_3 h_{t-1} + \mathbf{a}_8 D + \mathbf{a}_5 e^2_{t-1} D + \mathbf{b}_4 h_{t-1} D \quad (5)$$

D is a dummy variable that takes the value 0 pre futures and 1 post futures, $D_{mon - fri}$ are dummy variables for returns on Monday – Friday, $R_{s,t}$ is Nifty Index returns and $R_{m,t}$ is BSE100 Index returns, used as a proxy for market wide volatility. The market capitalisation of BSE100 is more than 70 per cent of total BSE market capitalisation as compared to less than 50 per cent for BSE Sensex. Though there are several other indices such as S&P CNX 500, CNX Nifty Junior, BSE-500 and others, all these suffer from one limitation or the other. Capitalization of CNX Nifty Junior is very small while S&P CNX 500 and BSE 500 suffer from the property of stale prices. Attempts are made to remove the influence of factors other than the impact of index futures on volatility. In this process it is identified that market proxy such as a broad index and returns on any one of the week days could also influence volatility. Therefore, week days returns are also used in the model to eliminate likely predictability effect of these on index returns and consequently on volatility. To incorporate weekly returns dummies are used from Monday to Friday one indicating returns of the respective day and zero absence of the day.

Data Source and Time Period

Index futures on S&P CNX Nifty and BSE Sensex started trading on National Stock Exchange (NSE) and on The Stock Exchange, Mumbai (BSE) respectively in June 2000. Volumes traded on BSE are negligible and they account for less than one per cent of the total number of contracts traded on NSE and BSE put together. Therefore, for the purpose of the research study of price discovery only Index futures on S&P CNX Nifty are considered. Daily closing values of Index futures and BSE 100 Index are considered from June 2000 till October 2002. Trading activity slowly picked up in Index futures and peaked in September 2001. Thereafter with some fluctuations the activity has been very

high. Number of contracts traded varied between 1,00,000 to 1,50,000 (Chart 1) per month during September 2001 to October 2002. The study period is divided into two sub periods on the basis of low volumes (June 2000 to August 2001) and high volumes (September 2001 to October 2002). The distinction is made to assess the impact of volume (liquidity) on long run price equilibrium. Returns are calculated as log of ratio of present day's price to previous day's price. Data are obtained from NSE website of NSE and Bloomberg for S&P CNX Nifty and BSE100 respectively.

Second part of this study deals with volatility modelling, assessing its impact on cash market and recommending policy directions. It is intended to measure the impact of introduction of Index futures on the volatility. Past studies (Thiriapl Raju, 2002) have indicated that Indian stock indices have a character of time varying volatility. Therefore, standard regression parameters will not be able to capture volatility correctly. From chart 2 it is vivid that simple measure of volatility i.e. standard deviation will not be able to say much about the impact of Index futures on volatility. Therefore, standard deviation has not been used to measure and explain the impact of Index futures on cash market volatility. ARCH family techniques are expected to capture and model volatility better (Antoniou and Holmes, 1995). There are several variations of ARCH models: ARCH, GARCH, EGARCH, etc. ARCH is found to be inadequate to capture volatility. GARCH is expected to explain sufficiently the time varying volatility behaviour of cash Index. It is essential to eliminate the impact of confounding factors on the volatility of cash market. For this purpose a market wide representative variable, BSE100, has been chosen as a representative Index to capture the influence of the factors other than Index futures.

Some of the other reasons for choosing BSE100 Index are that the other indices constructed and maintained by India Index Services Limited (IISL) do not have required length of past data. BSE100 market capitalization covers roughly about 70 per cent of the total market capitalization of BSE (as on November 14, 2002). Other broader indices such as BSE200 and BSE500 could consist of more stale prices which could lead to negative serial correlation. Negative correlation could in turn lead to biased estimation of parameters. Owing to these reasons BSE100 has been chosen as a surrogate for market Index. For the volatility study data from January 1998 to October 2002, giving 2 ½ years of data pre and post futures are used. BSE100 Index is used as a proxy for market wide volatility.

The contract details for Nifty Index futures are provided in Table 1.

Table 1: Nifty Index futures contract

Date of Inception	June 12, 2000
Underlying	S&P CNX Nifty Index
Trading Cycle	3 months
Expiry	Every month
Contract size	200
Tick size	Re. 0.05

The descriptive statistics for Nifty futures returns and Nifty Index returns are given in Table 2.

Table 2: Descriptive statistics for daily Nifty futures returns and daily Nifty Index returns (June 2000 to October 2002)

Statistic	Nifty Futures	Nifty Index
Minimum	-0.0902	-0.0631
Maximum	0.0599	0.0599
Mean	-0.0007	-0.0007
Standard Deviation	0.0143	0.0145
Skewness	-0.7623	-0.4665
Kurtosis	4.5630	2.2590

First and second moments of both the series are almost identical. The mean is close to zero and the standard deviation is 1.4 per cent.

The monthly Nifty futures volume since inception is shown graphically below in Chart 1.

Chart 1: Nifty futures volume (Number of contracts traded)

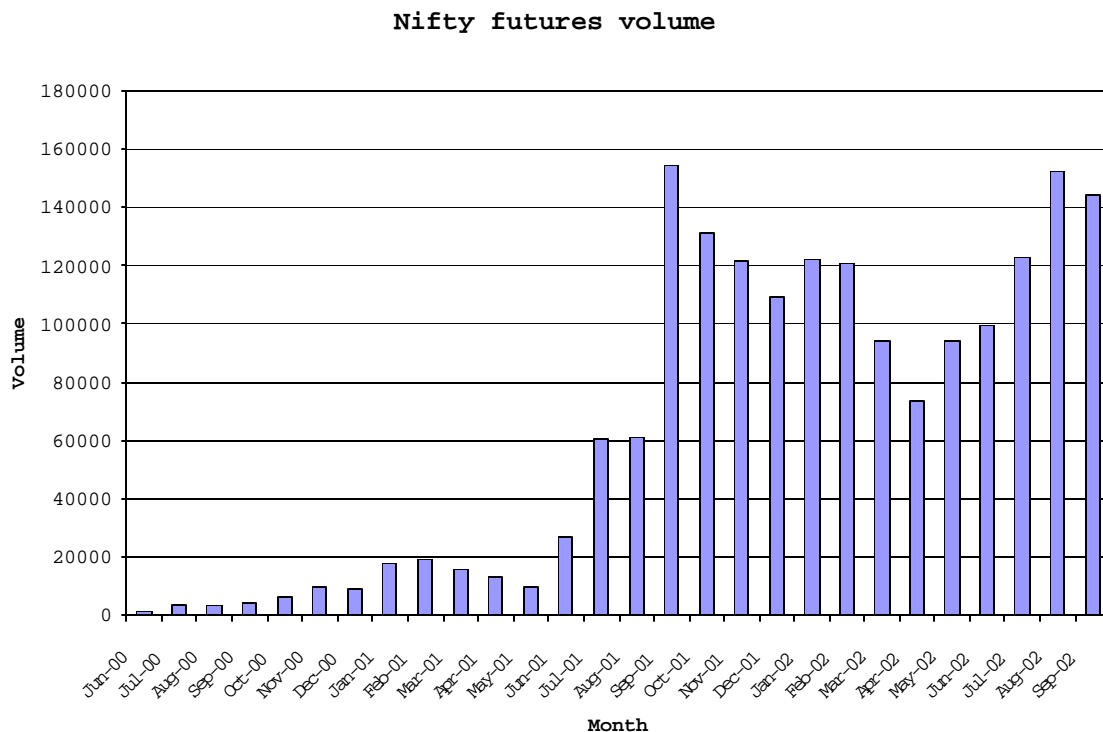


Chart 1 provides information on the total number of contracts traded each month. From the chart it is evident that the volume reached its peak in September 2001 and thereafter

there have been fluctuations in the volume traded. However, towards August – September 2002 again volumes have almost reached its earlier peak.

The volatility measured as standard deviation of daily log returns in per cent is tabulated below for pre futures and futures period.

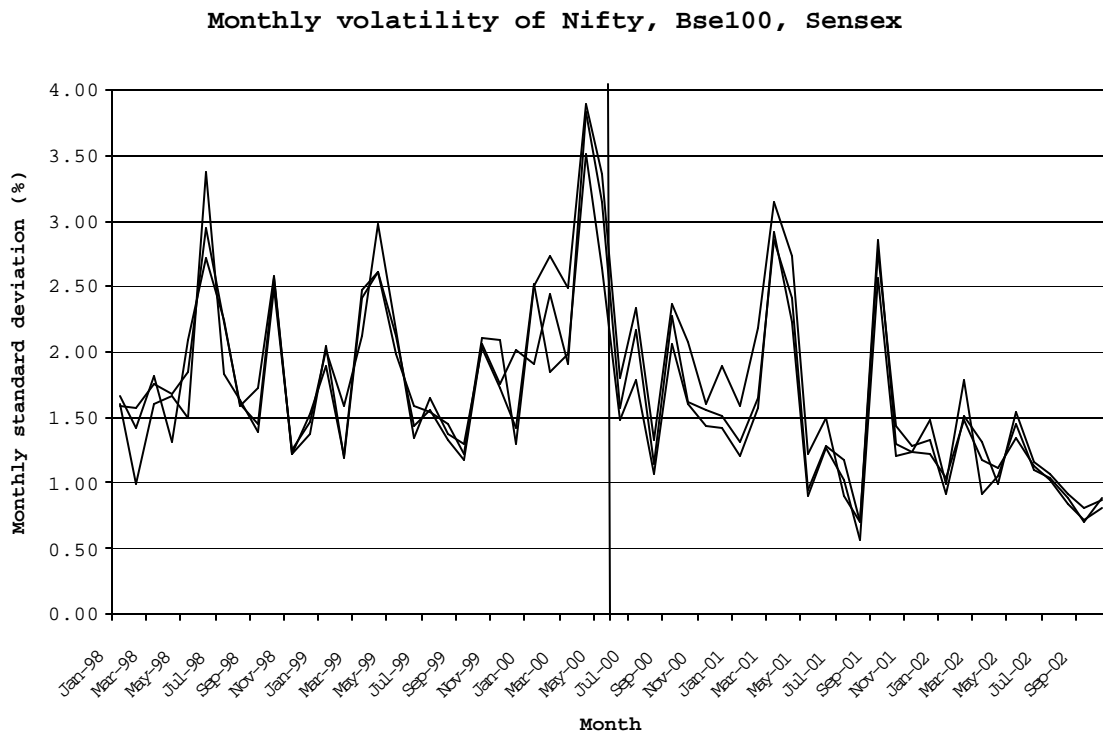
Table 3: Daily Return Volatility (Standard deviation in per cent)

Index	Pre futures (Jan 98–Jun 00)	Futures (Jun 00–Oct 02)
S&PCNX Nifty	1.96	1.45
BSE 100	2.11	1.68
Sensex	2.03	1.54

From the above Table 3 it is clear that volatility has come down after introducing index futures contracts when compared to before the pre introduction period.

The monthly volatility measured as standard deviation of daily log returns in per cent is shown graphically below for pre futures and futures period.

Chart 2: Monthly volatility of Nifty, BSE100 and Sensex



With a naked eye one cannot certainly state whether the volatility fell or rose, as the data moves up and down. Therefore, there is a requirement to go for advanced econometric techniques to judge the behaviour of volatility.

6 Results and Analysis

The results of the unit root tests for Nifty futures and Nifty Index are tabulated below.

Table 4: Unit root test results

Variable	Augmented Dickey-Fuller test statistic	Significance level	Optimal number of lags
Nifty futures	-2.85	0.18	7
Nifty Index	-2.81	0.19	7
Nifty futures returns	-13.30**	0.01	2
Nifty Index returns	-8.84**	0.01	6

** - Significant at 1 per cent level

The above results indicate that Nifty futures and Nifty Index are not stationary at their levels but their returns are stationary.

The results of the cointegration tests for Nifty futures and Nifty Index are tabulated below.

Table 5: Cointegration test results

Cointegration	Nifty futures and Index
Cointegrating vector	-1.02
Engle Granger	5.72**
p-value	0.01
Optimal number of lags	4

** - Significant at 1 per cent level

The above results indicate that Nifty futures and Index are cointegrated of order 1.

The results of the price discovery regression are tabulated below.

Table 6: Price discovery results (Jun 00 – Oct 02)

Coefficient	Value	t-statistic	Significance
a_{0f}	-0.0007	-1.26	0.21
a_{1f}	-0.2109*	-2.22	0.03
β_{1f}	-0.0732	-0.51	0.61
β_{2f}	0.1496	1.06	0.29
a_{0s}	-0.0006	-0.99	0.32
a_{1s}	-0.0062	-0.06	0.95
β_{1s}	0.0197	0.14	0.89
β_{2s}	0.0938	0.65	0.52

* - Significant at 5 per cent level

From the Table 6 above it is clear that for the entire period (June 2000 to October 2002) there is no causality from either futures to spot or vice versa. Also, only the futures market (and not the spot market) responds to a deviation from equilibrium.

Table 7: Price discovery results (Jun 00 – Aug 01)

Coefficient	Value	t-statistic	Significance
a_{0f}	-0.0009	-1.12	0.26
a_{1f}	-0.0549	-0.45	0.65
β_{1f}	-0.3789	-1.16	0.25
β_{2f}	0.4809	1.69	0.09
a_{0s}	-0.0009	-1.05	0.29
a_{1s}	0.1604	1.22	0.22
β_{1s}	0.4101	1.28	0.20
β_{2s}	-0.2894	-0.76	0.45

From the Table 7 above it is clear that for the period (June 2000 to August 2001) there is no causality from either futures to spot or vice versa. Also, neither the futures market nor the spot market responds to a deviation from equilibrium.

Table 8: Price discovery results (Sep 01 – Oct 02)

Coefficient	Value	t-statistic	Significance
a_{0f}	-0.0008	-1.05	0.29
a_{1f}	-0.4788**	-3.65	0.01
β_{1f}	0.4314*	1.96	0.05
β_{2f}	-0.4140*	-2.19	0.03
a_{0s}	-0.0005	-0.71	0.47
a_{1s}	-0.2838*	-2.17	0.03
β_{1s}	-0.6324**	-3.42	0.01
β_{2s}	0.7140**	3.27	0.01

* - Significant at 5 per cent level ** - Significant at 1 per cent level

From the Table 8 above it is clear that for the period (September 2001 to October 2002) there is causality from both futures to spot and vice versa. Also, both the futures market and the spot market respond to a deviation from equilibrium.

The results for the GARCH (1,1) model for the period January 1998 to October 2002 are tabulated below.

Table 9: Volatility results (Jan 98 – Oct 02)

Coefficient	Value	t-statistic	Significance
a ₁	-0.0005	-0.56	0.57
a ₂	-0.0007	-0.74	0.46
a ₃	0.0028**	3.38	0.01
a ₄	0.0004	0.50	0.62
a ₅	-0.0008	-0.84	0.39
β ₁	0.0470	1.71	0.09
β ₂	0.2916**	8.93	0.01
a ₂	0.0167*	2.16	0.03
a ₃	0.0244	1.87	0.06
β ₃	0.9272**	30.43	0.01
a ₄	0.0083	0.84	0.40
a ₅	0.2288**	3.75	0.01
β ₄	-0.2892**	-4.61	0.01

* - Significant at 5 per cent level ** - Significant at 1 per cent level

From the Table 9 above it is clear that volatility has reduced post futures since β_4 is significantly negative. The result is important in light of the significance of β_2 which indicates that market volatility has been accounted for properly. NSE used to follow accounting period settlement (see end note 3) starting from Wednesday and ending on the following Tuesday. Wednesday being the first day it is advantageous for traders to buy / sell and keep the position open till next Tuesday. Investors get longest possible period without full investment. Other major Stock Exchange, BSE used to follow Monday to Friday accounting period settlement. Owing to this different accounting period settlement there were arbitrage opportunities available. It was observed that investors shift their positions from other exchanges to NSE on Wednesday due to the above mentioned reasons (Thiripal Raju et. al., 2003). Therefore, it could be possible that Wednesday returns are found to be positive and significant. The study period vastly comes from accounting period settlement. Therefore, the influence of Wednesday is observed.

The results for the GARCH (1,1) model for the period March 1999 to August 2001 are tabulated below.

Table 10: Volatility results (Mar 99 – Aug 01)

Coefficient	Value	t-statistic	Significance
a ₁	-0.0004	-0.37	0.57
a ₂	-0.0008	-0.66	0.46
a ₃	0.0037**	3.50	0.01

Coefficient	Value	t-statistic	Significance
a ₄	0.0002	0.19	0.62
a ₅	-0.0004	-0.38	0.39
β ₁	0.0249	0.56	0.57
β ₂	0.6049**	11.63	0.01
a ₂	-0.0005	-0.11	0.91
a ₃	-0.0040	-0.21	0.83
β ₃	0.9989**	1414.61	0.01
a ₄	0.0059	1.32	0.19
a ₅	0.1800**	2.74	0.01
β ₄	-0.1883**	-3.50	0.01

* - Significant at 5 per cent level ** - Significant at 1 per cent level

From the Table 10 above it is clear that volatility has reduced post futures since β₄ is significantly negative. The result is important in light of the significance of β₂ which indicates that market volatility has been accounted for properly.

7 Analysis of Results and Recommendations

In the following paras a brief explanation of the results and their implications are discussed.

Price discovery

Tables 5, 6, 7 and 8 present results of co-integration and price discovery results (equations 1, 2 and 3). Table 5 gives information flow from one market to another. Engle and Granger methodology has been used to find out co-integration of futures and cash market. Null hypothesis is that both the markets are independent (not co-integrated). Results indicate (Table 5) null hypothesis is rejected at one per cent level. This means that both the markets are integrated. Information flows from one market to another market. The results are very useful to regulators as well as to market participants. Any regulatory initiative on futures market will have its desired impact on cash market. Therefore, regulators can take actions in the futures market such as reduction in contract size, changes to margins and others which will have their impact on the cash market. Market participant such as investors can use these results to predict impact of shocks to the futures market on cash market.

Tables 6, 7 and 8 present the results of price discovery. Excepting coefficient a_f all other coefficients are found statistically insignificant even at 5 per cent level. This indicates information gets reflected first in the futures market. From the results it is very difficult to say how much time it takes to go to cash market. One of the constraints of the data is that daily close values are used whereas the information might get transmitted much faster. This particular aspect can be stated more authoritatively only if high frequency data is used for this purpose. High frequency data is currently not available for spot market Index in India, therefore they could not be employed in the equation.

Volatility

Tables 9 and 10 provide coefficients, t statistics and significance levels of coefficients for two different periods. First period considers pre and futures period data from January 1998 to October 2002. This has equal windows before and after introduction of futures. The second period which is the sub period of the first one takes into account when Index futures were less popular. This division has been considered to examine whether there is any perceptible change in the volatility due to change in liquidity. Table 9 depicts the data of first period and Table 10 for the second period. From Table 9 it is clear that benchmark Index, BSE100, constant of GARCH model, lag of square of error term, dummy of lag of square of error term, dummy of lag of variance are found significant at five per cent level, in fact the constant is significant at one per cent level also. Since lag of variance has negative significant coefficient that indicates introduction of futures reduced volatility in the cash market. Second period also exhibit identical behaviour. β_4 is negative and significant. Only difference is that the magnitude and reduction of volatility is slightly lower. This could be attributed to some extent to less liquidity that was prevalent in the first period. In other words it can be said that higher liquidity is expected to decrease volatility. Regulator should take all necessary steps to further enhance liquidity in the futures market.

Volatility has been found reduced after the introduction of Index futures. The following suggestions may be implemented to further improve efficiency, liquidity and reduce volatility : a) Futures contracts on more number of indices can be introduced b) Mini size (smaller value contracts) may be permitted c) Efforts may be made to look at margin imposition system and reduce margins without compromising on the integrity of the market and d) Right now institutional participation appear to be negligible in the total turnover, therefore, efforts should be made to enhance their role in derivatives participation.

End Notes

1. Cointegration :

Suppose X_t and Y_t are two non-stationary series. In general we would expect that a combination of X_t and Y_t is also non-stationary. However, a particular combination may be stationary. If such a combination exists, we say that X_t and Y_t are cointegrated. Two cointegrated series will thus not drift far apart overtime eg. futures and spot prices, consumption and income (Ramanathan, 2002). The econometric technique regression assumes that mean values are stationary (do not change much) over any study period. If the mean values of a parameter keep changing from period to period then estimated coefficients will not provide unbiased estimates. Therefore, it is necessary to test the stationarity of the dependent and independent variables.

2. Stationarity :

Broadly speaking a data series is said to be stationary if its mean and variance are constant (non-changing) over time and the value of covariance between two time periods depends only on the distance or lag between the two time periods and not on the actual time at which the covariance is computed (Gujarati, 1995). The correlation between a

series and its lagged values are assumed to depend only on the length of the lag and not on when the series started. This property is known as stationarity and any series obeying this is called a stationary time series. It is also referred to as a series that is integrated of order zero or as $I(0)$ (Ramanathan, 2002).

3. Accounting period settlement

Under accounting period settlement all transactions (purchases and sales) of Wednesday to Tuesday are cleared and settled in a batch mode. Therefore, purchases and sales of day one can be kept open till close hours of following Tuesday without having taken delivery / given delivery. The financial implication of this process are quite different from rolling settlement T+5 or T+3 therefore, stock prices are expected to behave differently on different days.

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