Available online at www.elixirpublishers.com (Elixir International Journal)

Finance Management

Elixir Fin. Mgmt. 38 (2011) 4187-4195

ISSN: 2229-712X

An investigative study on relative volatility in spot and futures market in selected stock indices in India

Sathya Swaroop Debasish

Department of Business Administration, Utkal University, Vani Vihar, Bhubaneswar-751004, Orissa, India.

ARTICLE INFO

Article history:
Received: 2 July 2011;
Received in revised form:
23 August 2011;
Accepted: 28 August 2011;

Keywords
Volatility,
India,
NSE,
Indices,
Futures market.

ABSTRACT

This study attempts to investigate the change, if any, in the volatility observed in the Indian stock market due to the introduction of futures trading. The change in the volatility is compared in terms of the structure of the volatility. This is done to give insights into the way the futures market is influencing the Indian spot market's volatility. The main objective of the study is to investigate whether there has been significant change in relative volatility of the underlying spot return and futures return. The period of study is from 1st January 2000 to 31st December 2010 for the spot prices. The study used three stock indices of NSE namely Nifty, CNX IT and CNX Bank. The index futures time series analyzed here uses data on the near month contract as they are most heavily traded. The study has used four measures of volatility. The study finds that for the three NSE indices, the study rejects the null hypothesis of 'no significant change in relative inter-day volatility between spot prices and futures prices' over the entire period 2000-2010, but cannot reject the hypothesis fully for all the individual years. There is significant change in relative intra-day volatility between spot prices and futures prices for all the three NSE indices.

Introduction

Derivatives play a very important role in the price discovery process and risk management. It is widely used by mutual funds and institutional investors for risk management purposes. Two main bodies of theories exist in the literature about the relationship between derivatives markets and underlying spot markets. The theoretical literature proposes both a 'destabilizing forces' hypothesis that predicts increased volatility and a 'market completion' hypothesis in which decreased volatility is predicted. For the former hypothesis, it is argued that the inflow and existence of speculation in futures markets may induce destabilizing forces, which among other things create undesirable 'bubbles'.

However, the contrary view is that the introduction of futures trading leads to more complete markets, enhances information flow, and thereby improves the investment choices faced by the investors. Moreover, futures trading may bring more (private) information to the market and allow for a quicker dissemination of information. Further, speculative activity may be transferred from the spot market to the futures market that can dampen spot market volatility.

Since the proposed logical arguments both support and reject the proposition of futures markets having a destabilizing effects on spot markets, it is self-evident that the theoretical debate on how futures markets affect underlying stock markets still remains rather inconclusive. In the Indian scenario, the NSE (national stock exchange) introduced stock index futures and options on the National Stock Exchange's index of 50 stocks (S&P CNX NIFTY) in June 12, 2000 and June 4, 2001 respectively. Subsequently single stock futures were launched at NSE on November 9, 2001. The advent of stock index futures 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.

Any increase in stock market volatility that has followed the onset of futures trading has generally been taken as justifying the traditional view that the introduction of futures markets induces destabilizing speculation. This has led to a necessity for greater regulation to minimise any detrimental effects. An alternative view is that futures markets provide an additional route by which information can be transmitted and therefore, increased spot market volatility may simply be a consequence of the more frequent arrival and more rapid processing of information. Thus, futures trading may be fully consistent with efficiently functioning markets. There has been widespread interest in the effects of futures trading on prices in the underlying spot market. It has been often claimed that the onset of derivative trading will destabilize the associated spot market and thus lead to increase in spot price volatility. Others have argued to the contrary, stating that the introduction of futures trading will stabilize prices and so lead to decrease in price volatility. Why should the introduction of futures trading increase the volatility of cash market? Conventional wisdom suggests, to the contrary, that futures trading should bring more traders to the cash market, making cash market more liquid and therefore, less volatile. The view that futures trading may increase volatility appears to stem from a belief that futures markets bring with them uninformed (or irrational) speculators who then trade in the cash market as well as the futures market. Such speculators, it is argued, drive prices up or down in the quest for short-run 'bandwagon' profits. Economists have analysed this "irrational speculation" argument and have concluded that it would take a considerable number of such speculators to destabilize the cash markets.

Since futures encourage speculation, the debate on the impact of speculators intensified when futures contracts were

Tele:
E-mail addresses: sathyaswaroop2000@yahoo.com

first introduced for trading, beginning with commodity futures and moving on to financial futures. Before further regulations are introduced, it is essential to determine whether in fact there is a causal link between the introduction of futures and spot market volatility. It, therefore becomes imperative that we seek answers to questions like: What is the impact of derivatives upon market efficiency and liquidity of the underlying cash market? To what extent do derivatives destabilize the financial system, and how should these risks be addressed? Can the results from studies of developed markets be extended to emerging markets?

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

Objectives and Hypothesis

This study attempts to investigate the change, if any, in the volatility observed in the Indian stock market due to the introduction of futures trading. The change in the volatility is compared in terms of the structure of the volatility. This is done to give insights into the way the futures market is influencing the Indian spot market's volatility. The main objectives of the study is to investigate whether there has been significant change in relative volatility of the underlying spot return and futures return.

The following null hypotheses were tested for significance:

a) There is no significant change in Relative Inter-Day volatility between spot prices and futures prices.

b) There is no significant change in Relative Intra-Day volatility between spot prices and futures prices.

The above two hypotheses were tested for the three NSE indices.

Literature Review

There is a common belief that stock index futures are more volatile than the underlying spot market because of their operational and institutional properties. The close relationship between the two markets makes possible the transference of volatility from futures market to the underlying spot market. It is, therefore, not surprising that since the inception of index futures contracts in 1982 the issue of volatility of futures contracts relative to the stock market has attracted the attention of researchers world over. In their study, Chu and Bubnys (1990) examined relative volatility using daily returns for the S&P 500 and the NYSE for the period 1982 to 1988. They reported that futures volatility was higher in comparison to the underlying indices. Yadav and Pope (1990) used several volatility measures such as those based on daily close-to-close, open-to-open prices and the Parkinson Extreme Value Estimator to compare FTSE 100 index and futures volatility. They found futures volatility to be higher in comparison to the FTSE index. In one study on the Japanese market, Brenner, Subramanyam and Uno (1990) examined daily closing prices of the Nikkei Futures contract traded on SIMEX. They found that the volatility of the underlying Nikkei Stock index was marginally higher than the futures contracts traded in Osaka but no different from that of SIMEX. In another study, Koutmas and Tucker (1996) reported that the volatility in both the futures and stock markets were persistent. Choudhury (1997) studied the short-run relative volatility on the Hang Seng, the Australian All Ordinaries, and the Nikkei. He reported that with the exception of the Nikkei, the other futures contracts were found to be more volatile than their underlying spot markets.

Several studies have been conducted to examine the behaviour of spot market volatility since the inception of futures trading. Edwards (1988) tried to gather evidence to verify the fact that stock index futures trading have destabilised the spot market in the long run. Using variance ratio F tests from June 1973 to May 1987, he found that the introduction of futures trading has not induced a change in the volatility in the long run. He observed that there was some evidence of futures-induced short-run volatility, particularly on futures contract expiration days, but this volatility did not appear to carry over to longer periods of time. 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 causes 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. Ross (1989) demonstrated that, under conditions of no arbitrage, variance of price change must be equal to the variance of information flow. This implied 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 trading increase the flow of information, then in absence of arbitrage opportunities the volatility of the spot price must change.

Gordon and David (2002) examined the intra-day and intra-week volatility patterns and tests the wait-to-trade hypothesis using 24-hour inter-day returns and 15-minute intraday returns on the Hang Seng Index (HSI) and Hang Seng Index Futures (HSIF). Empirical results showed that for all weekdays, inter-day returns of HSIF are more volatile than those of HSI. An intra-week pattern had existed at 2.45 P.M. for both markets with highest volatility on Monday. For the intraday returns, HSI was found to be significantly more volatile than HSIF for the first 15-30 minutes after the markets open on all weekdays except Monday on which HSI is more volatile for the first one hour. An intra-week pattern exists at 11.30 A.M. for both markets with lowest volatility on Thursday. Through an analysis on the intraday correlations between HSI and HSIF, they argued that the significantly larger open intraday volatility in HSI, which is inconsistent with the wait-to-trade hypothesis, is mainly caused by noise trading unrelated to information arrival.

A study by Bose (2007) examined the characteristics of return volatilities in the equity market and the index futures market in India. Volatility in the NSE Nifty index and that in its futures market were both seen to exhibit features of mean reversion, volatility clustering and a fair degree of volatility persistence, estimates of which give an idea of the impact and duration of a particular information shock to the market. The

returns volatility was found to exhibit significant asymmetric response in times of market retreats and advances, with volatility arising in times of market decline being much sharper and more persistent. The study also provided evidence of volatility linkages between the spot and futures markets. Contemporaneous transmission effects across volatilities of the Indian (NSE) Stock and Index futures markets were tested on daily data, using an asymmetric (threshold) GARCH framework. These results had implications for understanding the pattern of information flows between the two markets. The results indicated that the futures market plays a leading role in assimilating information and thus moderating, though to a small extent, the spot market volatility.

Pati and Kumar (2007) examined the volatility dynamics and investigated the Samuelson Maturity Hypothesis (a source of non-stationary in the volatility of futures price) in the context of the Indian Futures Market by taking Nifty Index Futures traded on NSE. The sample data consisted of daily closing price, volume and open interest of Nifty Index futures from the period January 1, 2002 to December 29, 2005 for near-month contract with 1009 sample data points. They constructed data sample by switching or rolling over to the next maturing contract, four days before the expiration date. For empirical issues, univariate GARCH, E-GARCH family models was employed. The conditional variance was augmented by including open interest and trading volume as exogenous explanatory variables. The empirical evidence suggested that there was time-varying volatility, volatility clustering and leverage effect in the Indian futures market. Their study found a positive contemporaneous relationship between futures price volatility and volume. Their study concluded that time-to-maturity is not a strong determinant of futures price volatility, but the rate of information arrival proxied by volume and open interest are the important sources of volatility.

Bagchi (2007) analyzed the relative impact of volatility measure computed from the four parameters, such as closing, high and low quotes of the day as well as a combination of these three on the stock index return. In addition, various time-steps were also selected for such computation. The study selected a middle capitalization stock index in India called CNX Midcap 200, which represented around 72% of middle order firms listed on the National Stock Exchange (NSE) of India. He used an entropy of volatility to measure information content on various time steps as well as using various pricing parameters. The study used GARCH (1,1) to find out the impact of volatility. Based on the analysis of entropy, the results indicated that there had been a relatively high impact of the volatility computed on high-low-closing prices and the lowest impact is found for volatility computed on high prices of the securities. The above results also confirmed that the entropy of volatility was a valuable indicator for evaluating the performance of the volatility.

Bodla and Kiran (2008) attempted to investigate the impact of equity derivatives on the trading volume of underlying Indian stock market. Their study found a positive impact of expiration of derivatives on trading volume of sample stocks. For this purpose, the daily traded value data of cash market and 22 individual stocks were collected and analyzed by using before-and-after control sample technique. The results of the study also showed that Compound Annual Growth Rate (CAGR) of trading volume had declined slightly after the introduction of derivatives.

Reddy and Sebastin (2008) studied the temporal relationship between the equities market and the derivatives market segments of the stock market using various methods and by identifying lead-lag relationship between the value of a representative index of the equities market and the price of a corresponding index futures contract in the derivatives market. The study observed that price innovations appeared first in the derivatives market and were then transmitted to the equities market. The dynamics of such information transport between stock market and derivatives market were studied using the information theoretic concept of entropy, which captures non-linear dynamic relationship also.

Data and Sources

The study has used data on daily opening, low, high and closing prices of the selected indices and individual stocks traded in the spot market. The futures data include the near-month prices of daily opening, low, high and closing. The spot prices and the one-month futures prices of the selected stocks and indices are taken for the study. The futures time series analyzed here uses data on the near month contract as they are most heavily traded. The study used data on daily opening, low, high and closing prices of the selected indices and individual stocks traded in the spot market. The futures data include the near-month prices of daily opening, low, high and closing.

The spot market volatility of selected NSE indices was studied by a statistical comparison of volatility between pre-futures and post-futures (i.e., after the introduction of futures trading). The two kinds of volatility studied were inter-day volatility and intra-day volatility. The study investigated presence of any significant changes in spot volatility between these sub-periods. The Null hypothesis of 'no significant difference in spot volatility between pre-futures and post-futures period' was tested at 1%, 5% and 10% levels of significance.

The period of study is from 1st January 2000 to 31st December 2010 for the spot prices. The futures trading on most of the individual stocks at NSE commenced from 9th November 2001 and for few at a later period. Hence, the futures data on indices and stocks covers period from their futures trading commencement till 31st May 2007. For the futures data, the trading on stock indices started on 12th June 2000 for NSE Nifty, 29th August 2003 for CNX IT and on 12th June 2005 for CNX Bank. The index futures time series analyzed here uses data on the near month contract as they are most heavily traded. For the futures data, the trading on stock indices started on 12th June 2000 for Nifty, 29th August 2003 for CNX IT and on 13-June-2005 for CNX Bank.

S&P CNX Nifty

S&P (Standard & Poor) NSE Nifty is a well diversified 50 stock index accounting for over 23 sectors of the Indian economy. S&P NSE Nifty is owned and managed by India Index Services and Products Ltd. (IISL), which is a joint venture between NSE and CRISIL. Nifty stocks represent about 59.49% of the total market capitalization as on 31st May, 2007 (i.e., the last date of our study period).

Research Methodology

The study starts with analyzing absolute intra-day and inter-day volatility on spot prices and comparing these during the pre-futures and post-futures period. The study has used four measures of volatility. These are

(a) volatility based upon close-to-close prices,

(b) volatility based upon open-to-open prices,

(c) Parkinson's Extreme Value Estimator (intra-day price range estimator), &
(d) Garman-Klass volatility (GKV) measure.

The null hypothesis of significant difference in volatility in spot prices between pre-futures and spot-futures period is tested using F-test. This is repeated for several sub-periods. Next, the study measure relative volatility between spot prices and futures prices taking half-yearly sub-periods starting from the commencement of futures trading on the concerned indices and stocks. All the above four measures of volatility are again utilized for this purpose and F-test is employed for null hypothesis testing of significant difference in volatility between spot and futures prices during the post-futures period.

In the first place, the daily returns based on spot and futures prices were computed. The price series consisted of open price, low, high, and closing prices for both spot and futures market. The returns for the futures contract and the spot index are defined as $RF_t = \{Ln\ (F_t / F_{t-1})\}$ and $RS_t = \{Ln\ (S_t / S_{t-1})\}$, respectively where F_t and S_t are the futures prices and spot prices on day t, respectively

The study has used four measures of volatility as provided by research studies of Ibrahim, Othman and Bacha (1999). These are (a) the first is based upon close-to-close prices,(b) the second is based upon open-to-open prices, c) Parkinson's High-Low Extreme Value Estimator, and (d) Garman-Klass volatility (GKV) measure.

Close-to-Close Volatility (CCV):

This measure of volatility is based upon close-to-close prices. Close-to-Close Volatility is computed from the variance of close-to close daily return as given by eq.(1):

$$CCV = {}^{T}\Sigma_{t=1}\,(R_t - R_m)^2 / T\text{-}1 \qquad (1)$$

where $R_t = Ln(C_t / C_{t-1})$ (2)

with C_t and C_{t-1} being the closing prices on day t and t-1 respectively; R_m representing the return on day t; representing the mean or average return based on closing prices.

Open-to-Open Volatility (OOV)

This measure of volatility is based upon close-to-close prices. Close-to-Close Volatility is computed from the variance of close-to close daily return as given by eq.(3):

$$OOV = {}^{T}\Sigma_{t=1}\,(R_t - R_m)^2 / T\text{-}1 \qquad (3)$$

where $R_t = Ln(O_t / O_{t-1})$ (4)

with O_t and O_{t-1} being the closing prices on day t and t-1 respectively; R_m representing the return on day t; representing the mean or average return based on opening prices.

Parkinson's High-Low Volatility Estimator (PHLE)

This measure of volatility estimates intra-day volatility. Parkinson's High-Low Volatility Estimator (PHLE) can be computed using eq.(5) as given below. PHLE

$$PHLE = K\sqrt{\frac{\ln(H_t / L_t)\times 2}{N}} \qquad (5)$$

where K=0.601; ln symbolized log; N is the total number of trading days considered; H_t and L_t denote intra-day high and low prices respectively. Beckers (1983) has empirically concluded that Parkinson's high-low estimator contains new information and is an accurate estimator of true volatility

Garman-Klass Volatility (GKV) measure

Garman-Klass Volatility (GKV) uses four intra-day variations of prices namely, daily opening prices, daily highest price, daily lowest prices and daily closing prices. GKV can be computed as given in eq.(6).

$$GKV = \sqrt{1/n\sum[(0.5)[Log(H_t / L_t)]_2 - [2\,Log(2)-1][\log(C_t / O_t)]_2} \qquad (6)$$

where H_t, L_t, C_t , and O_t denote intra-day high, low, close and open prices respectively.

For measuring relative volatility, the study computes the volatility of spot prices and futures prices using each of the 4 volatility measures.

The null hypothesis tested is as follows:

Null Hypothesis: There is no significant difference between the relative volatility of the post market and the futures market i.e., the volatility of the underlying spot market is not significantly different from the volatility of the futures market. In statistical terms, the null and alternative hypothesis is specified as under:

$H_0 : \sigma\ (spot) = \sigma\ (futures)$

$H_1 : \sigma\ (spot) \neq \sigma\ (futures)$

where H_0 and H_1denote the null and alternative hypothesis , respectively; is the standard deviation (measure of volatility); 'spot' represent the spot market ; 'after' denote the futures market.

The volatility is computed for yearly periods after the introduction of futures trading, ie. from year 2001 to year 2010 and the entire post-futures period of 2001-2010.This is because for most of the selected Nifty indices , the futures trading started after year 2000. For NSE Nifty, the volatility is computed from year 2000 since futures started on Nifty on 12th June,2000. But for other two indices namely CNX IT and CNX Bank, the volatility is computed after futures introduction in year 2003 and 2005, respectively. The relative volatility of the two markets (futures and spot) have been studied on a contemporaneous basis and tested for statistical significance by using F-Test.

Analysis and Findings

Inter-day Relative Volatility in Spot and Futures Market for Selected NSE Stock Indices

Table-1 presents the inter-day volatility of spot and futures market year-wise for the three selected NSE indices. For NSE Nifty, the volatility is higher for futures market for all the individual years under study. Further, the inter-day volatility of NSE Nifty futures is 0.0152 in comparison 0.0143 for spot market over the entire period of 2000-2010. Only for year 2004, the relative inter-day volatility of Nifty is statistically significant with futures volatility higher at 0.0196 and spot volatility at 0.0176. For CNX-IT and CNX-Bank, the futures volatility is relatively higher than spot inter-day volatility for all the years.

During the period 2000-2010, the inter-day volatility of CNX-IT for spot and futures was found to be 0.0167 and 0.0175 respectively, and for CNX-Bank the volatilities were 0.0174 and 0.0184 for spot and futures market, respectively. Thus, the futures market volatility is lesser than that of spot volatility for the three indices. Further, it is observed that the values of inter-day spot volatility of all the three indices consistently decreased from year 2001 to year 2010. This indicates a stabilizing effect of futures introduction on spot volatility for the selected NSE indices.

Table-2 presents the open-to-open prices based inter-day volatility for the three selected NSE indices in spot and futures market over the period 2000-2010. The spot volatility of NSE Nifty is relatively higher than that of futures market for all the years under study, and this has decreased from 0.0157 in 2001 to 0.0148 in 2010.Over the entire period, the spot volatility of NSE Nifty is lesser (0.0142) than futures market (0.0166) with statistical significance at 1% level. Spot volatility was found to be highest in year 2004 (0.0178) while highest futures volatility was observed in year 2001 (0.0208). For CNX-IT, highest spot

volatility was in year 2006 (0.0272) and lowest in year 2004 (0.0146). For all the individual years under study, futures volatility is found to be relatively higher than spot market with highest value in year 2006 (0.0283) significant at 5% level, and lowest in year 2005 (0.0186) without any statistical significance. For CNX-Bank, highest spot volatility was in year 2000 (0.0232) and lowest in year 2007 (0.0164). For all the years, futures volatility is relatively higher than spot market. Over the entire study period 2000-10, the spot volatility of CNX-Bank was lower (0.0145) than futures market (0.0163) with statistical significance.

Thus, from table 2 and table 3, we can reject the null hypothesis of "no significant change in Relative Inter-Day volatility between spot prices and futures prices" over the entire period 2000-2007 , but we could not reject the hypothesis fully for all the individual years.

Intra-day Relative Volatility in Spot & Futures for Selected NSE Stock Indices

Table-3 presents the intra-day (high-low) volatility of spot and futures market for the NSE indices. It is observed that for all the three indices, the relative volatility of futures market is lower than the corresponding spot volatility with statistical significance. For the period 2000-10, futures market volatility of NSE Nifty is lower (0.0952) than spot volatility (0.1023) and this difference is significant at 1 % level. For CNX-IT, the spot volatility is highest in year 2000 (0.1455) and lowest in year 2006 at 0.1049 (post- futures). This supports our view that intra-day spot volatility has stabilized after futures introduction. The relative intra-day volatility of CNX-IT over period 2000-10 is lesser for futures market (0.1204) than spot market (0.1429) but with statistical significance. Highest futures volatility of CNX-IT was observed during year 2005 (0.1564) and lowest futures volatility during year 2003 (0.0941). Similarly for CNX-Bank, the futures volatility in all the individual years is significantly lower than spot volatility. Highest intra-day futures volatility for CNX- Bank was witnessed during year 2006 (0.1540) and lowest during year 2005(0.0781). Over the entire period, the intra-day volatility of CNX-Bank is relatively lower for futures market (0.1131) than spot market (0.1275).

Table-4 depicts the intra-day GKV volatility of spot and futures market for the NSE indices over the period 2000-10. For NSE Nifty, the spot volatility was higher than futures volatility during the years 2001, 2002, 2003 and 2007, and the opposite for the remaining years under study. Over the entire study period, there was significant difference between spot (0.0011) and futures (0.0017) volatility in NSE Nifty. For CNX-IT, the intra-day spot volatility was higher than futures volatility for all the years with spot volatility being highest in year 2001 (0.0382) and lowest in year 2007(0.0192). Highest futures volatility of CNX-IT was observed during year 2003 (0.0209) and lowest futures volatility during year 2005 (0.0148). There was evidence of difference between spot and futures intra-day volatility tested statistically significant at various levels for all the years under study. Similarly, for CNX-Bank, the intra-day futures volatility was lesser than spot volatility for all the years under study. Highest intra-day futures volatility for CNX- Bank was witnessed during year 2005 (0.0201) and lowest during year 2007 (0.0167). Over the period 2000-10, the volatility is found to be lower in futures market (0.0015) than spot market (0.0023) with the difference being significant at 1% level. The intra-day spot volatility is always found to be higher than futures volatility for most of the individual years under study period.

Thus, from table 3 and table 4, we can reject the null hypothesis of "No significant change in Relative Intra-Day volatility between spot prices and futures prices" for all the three selected NSE indices.

Conclusion

For the three NSE indices, the study rejects the null hypothesis of 'no significant change in relative inter-day volatility between spot prices and futures prices' over the entire period 2000-2010, but cannot reject the hypothesis fully for all the individual years.

There is significant change in relative intra-day volatility between spot prices and futures prices for all the three NSE indices. Another area of research could be a study on stock market volatility before and after the introduction of index futures trading in multi-county scenario, using models that account for movements in the world market portfolio, asynchronous data and conditional heteroskedasticitv.

Scope for Further Research

There is still scope for further research. Few of the potential areas of research are mentioned below.

a) An extension to our study is an empirical analysis examining the role of certain non-price variables, namely open interest and trading volume, from the stock option market in determining the price of underlying shares in cash market.

b) A potentially allied area of research having much practical utility could be a study on designing an optimum portfolio of stocks for maximizing return.

c) Another area of research could be a study on stock market volatility before and after the introduction of index futures trading in multi-county scenario, using models that account for movements in the world market portfolio, asynchronous data and conditional heteroskedasticitv.

d) Forecasting futures prices of stocks and indices using Neural Network analysis is another potential area of further research.

e) An area of further research could be a study on intra-day return dynamics between the cash and futures market.

f) Yet another area of research could be the study on measuring the effect of futures trading on the stability of stock index returns across various nations.

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Table-1 Relative Inter-day Volatility of Spot and Futures market using Close-to-close prices (CTCP) in NSE Stock Indices

Year	Type of Market / Test Measure	Relative volatility using CTCP: Standard Deviation (S.D.) – Indices		
		NSE Nifty	NSE CNX-IT	NSE CNX-BANK
2000	Spot	0.0156	0.0241	0.0214
	Futures	0.0160	N.A.	N.A.
	F-test Prob.	0.7929		
2001	Spot	0.0163	0.0213	0.0206
	Futures	0.0167	N.A.	N.A.
	F-test Prob.	0.7264		
2002	Spot	0.0106	0.0209	0.0198
	Futures	0.0102	N.A.	N.A.
	F-test Prob.	0.5523		
2003	Spot	0.0123	0.0197	0.0194
	Futures	0.0126	0.0218	N.A.
	F-test Prob.	0.7193	0.0714***	
2004	Spot	0.0176	0.0189	0.0186
	Futures	0.0196	0.0213	N.A.
	F-test Prob.	0.0904***	0.023**	
2005	Spot	0.0111	0.0175	0.0185
	Futures	0.0121	0.0189	0.0211
	F-test Prob.	0.1732	0.1392	0.0329**
2006	Spot	0.0165	0.0171	0.0179
	Futures	0.0181	0.0188	0.0197
	F-test Prob.	0.1470	0.0781***	0.0429**
2007	Spot	0.0151	0.0165	0.0170
	Futures	0.0167	0.0176	0.0182
	F-test Prob.	0.3211	0.0211**	0.0391**
2008	Spot	0.0107	0.0162	0.0155
	Futures	0.0101	0.0193	0.0188
	F-test Prob.	0.5631	0.1671	0.1121
2009	Spot	0.0118	0.0162	0.0181
	Futures	0.0127	0.0191	0.0266
	F-test Prob.	0.1711	0.0021*	0.1391
2010	Spot	0.0151	0.0161	0.0172
	Futures	0.0183	0.0188	0.0189
	F-test Prob.	0.1513	0.0742***	0.0995***
2000-2010	Spot	0.0143	0.0167	0.0174
	Futures	0.0152	0.0175	0.0184
	F-test Prob.	0.0114**	0.0023*	0.046**

Note: F-test Prob. denotes the probability of the F-test on the two sub-periods, called pre-futures and post-futures. * ,** and *** denote significance at 1%, 5% and 10% levels , respectively.
N.A.- Not applicable; Futures trading in NSE CNX –IT and NSE CNX-Bank commenced on 29th August 2003 and 13th June,2005, respectively. Futures trading on NSE Nifty started on 12th June,2000.

Table- 2 : Relative Inter-day Volatility of Spot and Futures market using Open-to-Open prices (OTOP) in NSE Stock Indices

Year	Type of Market / Test Measure	Relative volatility using OTOP: Standard Deviation (S.D.) – Indices		
		NSE Nifty	NSE CNX-IT	NSE CNX-BANK
2000	Spot	0.0157	0.0257	0.0232
	Futures	0.0201	N.A.	N.A.
	F-test Prob.	0.0039*		
2001	Spot	0.0164	0.0187	0.0172
	Futures	0.0208	N.A.	N.A.
	F-test Prob.	0.0002*		
2002	Spot	0.0106	0.0182	0.0173
	Futures	0.0109	N.A.	N.A.
	F-test Prob.	0.6028		
2003	Spot	0.0125	0.0193	0.0174
	Futures	0.0132	0.0222	N.A.
	F-test Prob.	0.4230	0.0315**	
2004	Spot	0.0178	0.0191	0.0291
	Futures	0.0191	0.0214	N.A.
	F-test Prob.	0.2724	0.3710	
2005	Spot	0.0112	0.0146	0.0192
	Futures	0.0123	0.0186	0.0205
	F-test Prob.	0.1249	0.1291	0.0842***
2006	Spot	0.0167	0.0272	0.0178
	Futures	0.0198	0.0283	0.0183
	F-test Prob.	0.0076*	0.0419**	0.1494
2007	Spot	0.0152	0.0182	0.0164
	Futures	0.0171	0.0191	0.0167
	F-test Prob.	0.2423	0.1891	0.1275
2008	Spot	0.0124	0.0172	0.0181
	Futures	0.0135	0.0209	0.0197
	F-test Prob.	0.1115	0.2281	0.1855
2009	Spot	0.0169	0.0141	0.0169
	Futures	0.0184	0.0179	0.0198
	F-test Prob.	0.0071*	0.2345	0.1932
2010	Spot	0.0148	0.0255	0.0119
	Futures	0.0201	0.0271	0.0132
	F-test Prob.	0.0039*	0.1921	0.1291
2000-2010	Spot	0.0142	0.0156	0.0145
	Futures	0.0166	0.0171	0.0163
	F-test Prob.	0.0000*	0.0011**	0.0000*

Note: F-test Prob. denotes the probability of the F-test on the two sub-periods, called pre-futures and post-futures. * ,** and *** denote significance at 1%, 5% and 10% levels , respectively.

N.A.- Not applicable; Futures trading in NSE CNX –IT and NSE CNX-Bank commenced on 29th August 2003 and 13th June,2005, respectively. Futures trading on NSE Nifty started on 12th June,2000

Table-3 : Relative Intra-day Volatility of Spot and Futures market using High-Low prices (HLP) in NSE Stock Indices

Year	Type of Market / Test Measure	Relative Intra-day volatility using HLP: Standard Deviation (S.D.) – Indices		
		NSE Nifty	NSE CNX-IT	NSE CNX-BANK
2000	Spot	0.1274	0.1455	0.1287
	Futures	0.0848	N.A.	N.A.
	F-test Prob.	0.0001*		
2001	Spot	0.1265	0.1370	0.1287
	Futures	0.0898	N.A.	N.A.
	F-test Prob.	0.0000*		
2002	Spot	0.1057	0.1182	0.1202
	Futures	0.0680	N.A.	N.A.
	F-test Prob.	0.0000*		
2003	Spot	0.1145	0.1089	0.1124
	Futures	0.0780	0.0941	N.A.
	F-test Prob.	0.0000*	0.0315**	
2004	Spot	0.1243	0.1391	0.1288
	Futures	0.0879	0.1123	N.A.
	F-test Prob.	0.0000*	0.0811***	
2005	Spot	0.1098	0.1722	0.0945
	Futures	0.0776	0.1564	0.0781
	F-test Prob.	0.0000*	0.0419**	0.0216**
2006	Spot	0.1244	0.1049	0.1902
	Futures	0.0880	0.0912	0.1540
	F-test Prob.	0.0000*	0.0029*	0.0091*
2007	Spot	0.1197	0.1238	0.1390
	Futures	0.0824	0.1194	0.1176
	F-test Prob.	0.0000*	0.0011*	0.0761***
2008	Spot	0.1199	0.1055	0.0911
	Futures	0.0979	0.0977	0.0799
	F-test Prob.	0.0000*	0.0435**	0.2345
2009	Spot	0.1001	0.1262	0.1891
	Futures	0.0799	0.1198	0.1654
	F-test Prob.	0.0000*	0.0931**	0.1932
2010	Spot	0.1231	0.1693	0.1299
	Futures	0.0899	0.1614	0.1199
	F-test Prob.	0.0000*	0.0345**	0.1203
2000-2010	Spot	0.1023	0.1049	0.1275
	Futures	0.0952	0.0912	0.1131
	F-test Prob.	0.0000*	0.0021*	0.0003*

Note: F-test Prob. denotes the probability of the F-test on the two sub-periods, called pre-futures and post-futures. * ,** and *** denote significance at 1%, 5% and 10% levels , respectively.
N.A.- Not applicable; Futures trading in NSE CNX –IT and NSE CNX-Bank commenced on 29th August 2003 and 13th June,2005, respectively. Futures trading on NSE Nifty started on 12th June, 2000.

Table- 4: Relative Intra-day GKV Volatility of Spot and Futures market in NSE Stock Indices

Year	Type of Market / Test Measure	Relative Intra-day GKV volatility : Standard Deviation (S.D.) – Indices		
		NSE Nifty	NSE CNX-IT	NSE CNX-BANK
2000	Spot	0.0201	0.0245	0.0289
	Futures	0.0203	N.A.	N.A.
	F-test Prob.	0.0000*		
2001	Spot	0.0211	0.0382	0.0319
	Futures	0.0200	N.A.	N.A.
	F-test Prob.	0.0016*		
2002	Spot	0.0137	0.0287	0.0217
	Futures	0.0117	N.A.	N.A.
	F-test Prob.	0.0003*		
2003	Spot	0.0162	0.0245	0.0271
	Futures	0.0153	0.0209	N.A.
	F-test Prob.	0.1548	0.0142**	
2004	Spot	0.0222	0.0211	0.0288
	Futures	0.0228	0.0192	N.A.
	F-test Prob.	0.0440**	0.0023*	
2005	Spot	0.0146	0.0187	0.0212
	Futures	0.0148	0.0148	0.0201
	F-test Prob.	0.3763	0.0091*	0.0154**
2006	Spot	0.0217	0.0199	0.0187
	Futures	0.0221	0.0183	0.0172
	F-test Prob.	0.6374	0.0814***	0.0021*
2007	Spot	0.0183	0.0192	0.0181
	Futures	0.0170	0.0188	0.0167
	F-test Prob.	0.0012*	0.0491**	0.0619***
2008	Spot	0.0213	0.0203	0.0201
	Futures	0.0237	0.0171	0.0198
	F-test Prob.	0.0341**	0.0034*	0.0177**
2009	Spot	0.0139	0.0179	0.0182
	Futures	0.0149	0.0155	0.0178
	F-test Prob.	0.4310	0.0083*	0.0033*
2010	Spot	0.0222	0.0192	0.0177
	Futures	0.0234	0.0188	0.0171
	F-test Prob.	0.5961	0.0935***	0.0554***
2000-2010	Spot	0.0011	0.0012	0.0015
	Futures	0.0017	0.0011	0.0023
	F-test Prob.	0.0000*	0.0012*	0.0001*

Note: F-test prob. denotes the probability of the F-test on the two sub-periods, called pre-futures and post-futures. * ,** and *** denote significance at 1%, 5% and 10% levels , respectively.

N.A.- Not applicable; Futures trading in NSE CNX –IT and NSE CNX-Bank commenced on 29th August 2003 and 13th June,2005, respectively. Futures trading on NSE Nifty started on 12th June,2000.