Price Discovery, Volatility and Market Quality

A Study of Equity Derivatives in India

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in
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DECLARATION

I hereby declare that the work presented in this thesis entitled "Price Discovery, Volatility, and Market Quality: A Study of Equity Derivatives in India" has been carried out by me under the supervision of Dr. G. Omkarnath, Department of Economics, University of Hyderabad. I declare to the best of my knowledge that no part of the thesis was earlier submitted for the award of research degree of any other university or institute.

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CERTIFICATE

This is to certify that the study entitled "Price Discovery, Volatility, and Market Quality: A Study of Equity Derivatives in India" is the bona fide work of Ash Narayan Sah, carried out under my supervision at Department of Economics, University of Hyderabad. I recommend his thesis for submission for the award of the degree of Doctor of Philosophy in Economics.

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Abbreviations

ADF Test	Augmented Dickey-Fuller Test
ADRs	American Depositary Receipts
AEX	Australian Exchange
AOI	All Ordinary Index
AR(1)	Autoregressive of order one
AR(p)	Autoregressive of order p
ARCH	Autoregressive Conditional Heteroscadasticity
ARMA(p,q)	Autoregressive moving average of order p and q
BDS Test	Brock-Dechert-Scheinkman Test
BHEL	Bhart Heavy Electricals Limited
BIS	Bank for International Settlement
BSE	Bombay Stock Exchange
CAPM	Capital Asset Pricing Model
CBOE	Chicago Board Options Exchange
CBT	Chicago Board of Trade
CFTC	Commodity Futures Trading Commission
CME	Chicago Mercantile Exchange
DF Test	Dickey-Fuller Test
ECM	Error Correction Model
EGARCH	Exponential Genalized Autoregressive Conditional Heteroscadasticity
EMH	Efficient Market Hypothesis
EOE	European Exchange
EWMA	Exponentially Weighted Moving Average
F&O	Futures & Options
FRA	Forward Rate Agreement
GARCH	Genalized Autoregressive Conditional Heteroscadasticity
GARCH-M	Genalized Autoregressive Conditional Heteroscadasticity in Mean
GDRs	Global Depositary Receipts
GJR	Glosten-Jagannathan-Runkle Model

HE	Hedging Effectiveness
HR	Hedge Ratio
I(1)	Integrated of order one
ICICI Bank	The Industrial Credit and Investment Corporation of India Limited Bank
IFRs	Impulse Function Responses
IID	Identical Independently Distributed
IMF	The International Monetary Fund
IMM	International Monetary Market
IRS	Interest Rate Swap
ISMR	Indian Securities Market Review
KCBT	Kansas City Board of Trade
LB Test	Ljung-Box Test
LIFFE	London International Financial Futures and Options Exchange
LM Test	Lagrange Multiplier Test
LMSW	Llorente-Michaely-Saar-Wang Model
LSE	London Stock Exchange
MVHR	Minimum Variance Hedge Ratio
NASDAQ	National Association of Securities Dealers Automated Quotations
NSCC	National Securities Clearing Council
NSDL	National Securities Depositary Limited
NSE	National Stock Exchange
NYSE	New York Stock Exchange
OLS	Ordinary Least Squares
ONGC	Oil and Natural Gas Corporation
OTC	Over-the-Counter
PACF	Partial Autocorrelation Functions
RBI	The Reserve Bank of India
SAP	Structural Adjustment Programme
SACF	Sample Autocorrelation Functions
SAIL	Steel Authority of India Limited
SBI	State Bank of India
SCRA	Securities Contracts Regulation Act
SEBI	Securities and Exchange Board of India
SEC	Securities and Exchange Commission

SPI	Share Price Index
TARCH	Threshold Autoregressive Conditional Heteroscadasticity
UTI	Unit Trust of India
VAR	Vector Autoregerssion
Var(H)	Variance of Hedged
Var(U)	Variance of Unhedged
VDCs	Variance Decompositions
VECM	Vector Error Correction Model

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Chapter – I
Introduction

1.1 Background

Risk is inherent in human affairs and affects all economic agents in the economy. The word ‘risk’ refers to the possibility of loss, damage, or any other undesirable event. Risk can be measured and managed. Some risk such as damages due to fire or theft can be handled by paying premium to the insurance companies. Risk can be also reduced to a larger extent by diversification. However, the risk arising from macroeconomic fluctuation that affects all the participants in the economy can neither be insured nor diversified away. In this context, derivatives have become increasingly important to manage risk by various financial institutions like banks, corporate firms, asset management companies, governments and investor round the world.

Derivative markets were small until the 1970s. However, with the breakdown of Bretton Woods system in 1973, there was a sudden increase in the volatility of exchange rates and interest rates thereby making it necessary for firms and investors to find ways to reduce these risks. Besides, the publication of Black and Scholes (1973) option pricing model brought a revolution in the financial markets and laid the basis for the spectacular growth in derivatives markets. Other developments in the economic environment such as ongoing globalization process, the deregulation of several industries and the spectacular growth in international trade and finance, advancement in telecommunication and information technology in recent years have also increased the demand for derivative products.

On the domestic front, there has been a paradigm shift in policy stance of the government with regard to resource allocation in the economy since 1980s. The direct influences on resource allocation by the State were diminished and a greater role has been given to the market. One of the main aspects of these reforms has been the development of the financial markets as an alternative vehicle to determine the allocation of capital in the economy. The financial sector of India and in particular securities markets attracted sharp attention from policy makers in the aftermath of Harshad Mehta Scam of 1992. This led to some initiatives with respect to the equity and debt markets in the following years.

Financial sector liberalization in the strict sense started in India since the early 1990s after the balance of payments crisis of 1991. *Narasimham Committee Report on Financial System* submitted its report in September 1992, which laid the foundation of these far-reaching reforms. Financial market reform was an integral part of financial sector reform that brought gradual improvement in the functioning of the Indian stock markets. These reforms were aimed at enhancing competition, transparency, and efficiency in the Indian financial market. The reform of the Indian stock market has brought paradigm shift in the functioning and structure of the market. These reforms were guided by two broad themes – structural transformation and speedy access to information. On the one hand, massive institutional reforms were undertaken to improve the functioning of the market that resulted in greater participation by not only individual but also by institutional investors. On the other hand, advances in information technology facilitated computerization on large scale and internet trading facilitated trading from any part of the country.

Few notable developments in this direction were permission to the private sector to enter into the mutual fund industry earlier dominated by Unit Trust of India (UTI) since 1992-93; since September 1992 foreign institutional investors (FIIs) were permitted to invest in the Indian capital market based on the recommendations of *Narasimham Committee Report on Financial System*; Indian companies were also allowed to raise funds abroad through GDRs and ADRs. The Indian capital market integrated more with the world market since 1999 when companies based in India started to list on foreign stock exchanges, especially in the NASDAQ. Besides this, certain institutional reform such as setting of the National Stock Exchange and Securities and Exchange Board of India (SEBI), introduction of on-line trading system by NSE for the first time in the country in June 1994 in debt segment and in November 1994 in equity segment, establishment of National Securities Clearing Corporation (NSCC) and National Security Depository Limited (NSDL) in 1996, abolition of ‘Badla’ transaction and introduction of rolling settlement of ‘T+5’in January, 1998 which subsequently become ‘T+2’ to improve cash market operation. All these developments have considerably changed the functioning of the Indian stock market.

As a part of ongoing capital market reforms, derivatives trading started in India in June 2000 after the securities market regulator of India, Securities and Exchange Board of India (SEBI) approved trading of derivatives products in May 2000. SEBI allowed two premier stock exchanges in the country viz. the National Stock Exchange (NSE) and the Bombay Stock Exchange (BSE), and their clearing house/corporation to commence trading and settlement in approved derivative contracts. Based on the recommendation of L.C. Gupta Committee Report on Derivatives who recommended phased introduction of derivatives in the Indian market, SEBI first approved trading in index futures contracts based on S&P CNX Nifty Index and BSE Sensex Index. This was followed by trading in options based on these two indices and options on individual securities. The trading in index options commenced in June 2001 and those in options on individual securities commenced in July 2001. Futures contracts on individual stock were launched in November 2001.

The driving force behind introducing futures and options instruments was that they will enhance the functioning of the capital market. In general, the volume of cash market, its volatility and efficiency and liquidity are greatly enhanced with trading of these products. This led to the development of the overall economy because the association between financial deepening and economic growth is a well established fact in economics.

1.2 Financial Development and Economic Growth

The relation between financial development and economic growth is not difficult to comprehend. Economic historians cite the case of England, United States and Japan as prime examples to lay emphasis on the significance of finance for development. Stiglitz (1998) describes the financial sector as ‘the brain of the economy’. The significance of the financial system is evident from the function it performs. The financial system offers various financial services -wholesale, retail, formal and informal - to consumers, businesses, and other financial institutions in an economy. The financial system embraces not only banking system and securities markets but also insurers, credit unions, microfinance institutions and moneylenders. The development of the financial system is critical for the growth and development of the economy.

Financial development means various things. It may mean improvement in the efficiency and competitiveness of the financial sector. It may also refers to increase in the availability of the range of financial services in the market. Another meaning of financial development is increase in the type of financial institutions, which operate in the system. In addition, it is also increase in intermediation through the financial sector and increase in allocation of capital by private financial institutions to private sector enterprises. Financial development also meant to move towards financial liberalization from regulated interest rate regime, improvement in the regulation and stability of the financial system and gaining access to financial services by increasing numbers of the population.

Economists like Gurley and Shaw (1955), Goldsmith (1969), and McKinnon (1973) have emphasized the relationship between finance and growth. According to these economists finance is central to the economic activity and hypothesized that difference in the quantity and quality of services provided by financial institutions partially explains differences in growth rates across countries. McKinnon (1973) in his celebrated work observed that less developed countries depend heavily on self-financing. Little household savings goes to organized business activities. Capital markets are underdeveloped and fragmented. Banks are heavily regulated in order to serve rural areas through compulsory directed lending to the priority sectors. Rest of the economy is financed by moneylenders, pawnbrokers, and cooperatives, a phenomenon defined as financial repression. McKinnon maintains that financial repression is associated with substantial costs in the form of loss of economic prosperity and advocate financial liberalization that can help in breaking the confines of self-finance and channel the external funds to its most efficient use. The increase in efficiency of bank lending is a necessary condition, according to MacKinnon, to enlarge the real size of monetary system which alleviates financial repression. The reform of monetary system can stimulate growth by raising saving propensities and the quality of capital formation.

The debate about whether financial development follows or induces growth has been replaced by an almost consensual belief that sustained economic growth follows from financial development (Wachtel, 2001). Also, according to the World Bank financial development 'contributes significantly to growth', 'is central to poverty reduction, directly benefits the poorer segments of society' and 'is associated with improvements in income distribution' (World Bank, 2001). Nevertheless, the view fostered by the World Bank on the nature of relationship and on the direction of causality is not supported by a large part of empirical literature.

Theoretical and empirical works on the relationship between finance and development along with performance of emerging market economies in neighbourhood such as Malaysia, Indonesia, South Korea, Singapore, Hong Kong, Thailand provided thrust to financial liberalization program in India. The beginning of economic reforms in 1991 under the Structural Adjustment Programme (SAP) heralded a new era in the economic history of this country. Before 1991, the heavy hand of the government was omnipresent in economic life of this country. A paradigm shift in policy stance of the Government was noticed in the wake of severe balance of payment crisis. The need for economic reform in India had become apparent much earlier in the light of East Asian experience which achieved high rate of growth by following policies that emphasized export orientation and the encouragement of the private sector. In the 1980's, India made a move in this direction, but it was not until 1991 when balance of payment crisis hit the country which provided real thrust for a paradigm shift from government's regulated regime to a more open economy with a bigger role for the private sector; more reliance on market forces and a restructuring of the role of the government.

From the very beginning, reform of the financial sector was recognized, as an integral part of the economic reforms initiated in 1991. Reform of the financial sector was on agenda even before the onset of economic reforms in 1991. In 1991, the Government of India appointed a high level Committee on the Financial System to make comprehensive recommendations for reforms. This Committee on the Financial System under the chairmanship of M. Narasimham submitted its report in November, 1991. A number of recommendations were made in the report for reform in the banking sector and also in the capital market. A second report was also submitted by Mr. M. Narasimhan in the year 1997 that signaled the need for the second phase of Financial and Banking Sector Reforms in India.

Equity derivatives in India was started as a part of capital market reforms to hedge price risk resulted from greater financial integration between nations in the 1990's. Introduction of derivatives in India was recommended by the L.C. Gupta Committee Report on Derivatives in 1997 in a phased manner.

1.3 Statement of the Problem

Since 1990, the Indian financial system has become increasingly global in nature. It was exposed to the global financial market through channels of financial integration, development in information technology and telecommunication. The growing link among the financial markets have genesis in the increased globalization of capital. This phenomenon started in the 1980s and 1990s in the developing countries and the financial markets of these countries increasingly integrated with each other in recent years. Many countries dismantled trade restrictions and liberalized their financial markets that facilitated substantial cross border movement of funds due to foreign direct investment and portfolio investment.

This process of globalization has been accompanied by increasing volatility and uncertainty in prices of many commodities and in financial markets. As a result some business risks like price risk, foreign exchange risk etc., have grown in importance and a new generations of sophisticated risk management techniques and instruments have been developed. Management of these financial and commodity market risks is centered on the use of a new breed of financial instruments called derivatives. Financial derivatives – whose value is derived from the underlying asset, which can be stock, indices of stock – are designed primarily as risk management tools. Through the use of derivatives products, it is possible to partially or fully transfer price risk. Financial derivatives products initially emerged, as hedging devices against fluctuations in commodity prices and commodity-linked derivative remained the sole form of products for almost three hundred years. Trading in derivatives has now become an integral part of global financial markets. Recent decades have seen a singular rise in the growth and development of derivatives markets the world over. The growing financial link among the countries and globalization of finance prepared the ground for the introduction of risk management tools like derivatives in India. The need for derivatives was acknowledged as being necessary by some academicians and financial policy makers in the context of globalization in the early 1990s. Accordingly, derivatives were introduced as a part of capital market reforms to hedge price risk.

The very introduction of derivatives has been debated. One view was that the Indian market is not ripe for highly leveraged products like derivatives, the introduction of which might heighten volatility in the underlying asset market. The other and opposite view is that closer economic integration of the different countries of the world and progressive deregulation of financial sector, together with large fluctuations in real sectors of Indian economy in recent years, have exposed market players to different risks. India would be, according to this view, at a disadvantage unless financial derivatives as risk management tools are introduced. The latter would, it is argued, improve liquidity and efficiency of the market by moderating volatility in the market for underlying assets. Derivatives are also seen as an indirect inducement for raising savings and investment rates in the economy by augmenting market participants who were shy of stock market in absence of risk management products. Further, it was argued that speculative activities[1] shift from cash market to futures segment which can provide leverage to the speculator at low transaction cost. Nevertheless, equity derivatives got a start with introduction of index futures trading on Bombay Stock Exchange (BSE) on 9 June, 2000.

The present state of infancy of financial derivatives in India raises a number of crucial issues for policy and analysis. The very introduction of financial derivatives has been debated. One view is that the Indian market is not ripe for highly leveraged products like derivatives, the introduction of which might heighten volatility in the asset markets turning them into 'casinos'. The other and opposite view is that closer economic integration of the different countries of the world and progressive deregulation of financial sector, together with large fluctuations in real sectors of Indian economy in recent years, have exposed market players to different risks. India would be, according to this view, at a disadvantage unless financial derivatives as risk management tools are introduced. The latter would, it is argued, improve liquidity and efficiency of the market by moderating volatility in the market for underlying assets. Derivatives are also seen as an indirect inducement for raising savings and investment rates in the economy. It may be too early to assess the full impact on the Indian financial system of financial derivatives. Yet, it is of crucial importance for policy and, in particular, for the regulator (Securities and Exchange Board of India) to understand the basic mechanism of this new market and its interrelation with the underlying market. The present study seeks to focus on some of these issues with reference to *equity derivatives* in India.

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[1] Indian stock markets is considered as one of the most speculative markets in the world as pointed out in one of the important studies (Singh, 2001) , 'Tax Financial Speculation', PIRC Briefing Paper, PIRC, New Delhi. The volume of speculative trading in Indian financial markets was extremely high (Gupta, 1992).

1.4 Objectives

The introduction of equity derivatives in India is a nine year old market. Four derivatives instruments viz. index futures, index option, stock futures and stock option are traded on the Indian stock exchanges. The moot question is whether the introduction of these leveraged products in the Indian market performing their basic economic function of price discovery. Besides this, another important issue relating to the introduction of derivatives market is whether it has destabilized the underlying cash market. In other words, whether derivatives are playing their part as risk management tools and how it is befitting the underlying market in terms of pricing efficiency, liquidity and stability through the supposed informational role of derivatives trading. The objectives of this study are:

1. To determine the hedging effectiveness of index futures and stock futures.
2. To study whether futures market are performing their price discovery function.
3. To study whether introduction of futures and options have destabilized the underlying market.
4. To examine whether trading in futures market is done for hedging or speculation.
5. To examine whether market quality in terms of efficiency and liquidity have enhanced after the introduction of derivatives products.

1.5 Data and Variables

To meet the above mentioned objectives, we mainly relied upon data from secondary sources. To test the hedging effectiveness of index futures and stock futures, we collected daily data on S&P CNX Nifty and Nifty from 12 June 2000 to 26 March, 2009. We also collected data on two sectoral indices, namely, Bank Nifty and Bank Nifty Futures and CNXIT and CNXIT futures from 1st January 2007 to 26 March, 2009. Besides this, we also collected data on 10 companies from 1st January 2007 to 26 March 2009. The names of companies are as follows:

1. Bharat Heavy Electricals Ltd
2. Bharti Airtel
3. ICICI Bank
4. ITC Ltd

5. Infosys Technology
6. Oil and Natural Gas Corporation (ONGC)
7. Reliance
8. State Bank of India (SBI)
9. Steel Authority of India Ltd (SAIL)
10. Wipro

Our second objective of the study is to see whether futures market performs its price discovery function. We conducted test at index level as well as firm level. For index level study, we collected data on S&P Nifty index and S&P Nifty futures from 12 June 2000 to 26 March, 2009. Price discovery of two sectoral indices viz. Bank Nifty and Bank Nifty futures and CNXIT and CNXIT futures are also studied. For firm level study, we collected data on 10 companies from 9 November, 2001 to 26 March 2009. To study the impact of futures and options trading on the volatility of the underlying market, we collected data on S&P CNX Nifty from 1st April 2000 to 31 march 2009. To study structure of volatility at firm level, we also collected data on 10 companies from 1st April 2000 to 31 March 2009. To test the fourth objective of our study, that is, whether trading in futures market is done for hedging or for speculation, the same data set for S&P CNX Nifty futures, Bank Nifty futures, CNXIT futures and data on 10 companies are used. For testing fifth objective whether introduction of derivatives have improved the market quality in terms of efficiency and liquidity, we collected data on S&P Nifty from 1 April, 1998 to 31 March, 2006. We also collected data for the above said period to examine efficiency and liquidity of 10 companies.

One of the key variables used is the return of various series. The continuously compounded return, which is, used in this study, is defined as follows:

$$R_t = In(\frac{P_t}{P_{t-1}}) \qquad (1.1)$$

where P_t and P_{t-1} are the natural logarithm of closing prices on day t and t-1 respectively. R_t stand for returns. Return variable will be used to study the hedging effectiveness, price discovery and market efficiency.

Volatility of the market is another important variable. It is measured by computing the standard deviation of the daily returns. The daily returns based on closing prices were calculated by using equation (1). Finally, the daily volatility is computed as the square root of variance of the returns series. The variance is computed by using the following equation:

$$\sigma^2 = \frac{(R_{i,t} - \overline{R})^2}{(n-1)} \qquad (1.2)$$

where $\overline{R}$ is the mean return over the period. Besides this, since the Indian stock markets is exhibiting time-varying volatility (Raju & Ghosh, 2004), we will use GARCH volatility in this study. We also tried with EGARCH and TARCH volatility conditioned upon past five days return which takes into account 'good news' and bad 'news'. We know that stock market views 'good news' and 'bad news' differently and its impact on prices are different.

Another variable used in this study is the liquidity of the underlying market. The liquidity of the stock market refers to the ease with which stocks can be sold and purchased. There are various ways of measuring liquidity such as frequency of trading, volume of trading (*number of shares traded*), annual turnover (*number of shares traded multiplied by price*) and the ratio of total turnover to the market capitalization which can be used to make comparison across different markets or over time. This measure of liquidity is appropriate for our study to make a comparison before and after the introduction of the derivatives trading.

Open interest is a proxy for *market depth* in our study. It refers to the total number of contracts that have not yet been offset by an opposite transaction or fulfilled by delivery of the asset underlying a contract. Although each transaction has both a buyer and a seller, only one side of the transaction is included in open interest statistics. Open interest is a stock concept reflecting the net outcome of transactions on a given date. It is often interpreted as an indicator of the hedging or long-term commitment of traders to a particular contract. Open interest is generally smaller than turnover because a large number of contracts that are bought or sold during the course of the day are reversed before the end of the trading session.

1.6 Methodology

This study makes use of various econometric techniques to test the above mentioned objectives. The objectives of this study are varied and we have used different econometric tools keeping in mind the nature of problem at hand.

1.6.1 VAR and VECM Models

To examine the hedging effectiveness of index futures and stock futures, this study make use of OLS, VAR and VECM model. To study the second objective, we employed the techniques of cointegration and error correction model. We will use Engle-Granger Error correction model as well as Johnston multivariate system.

1.6.2 ARCH and GARCH Models

To examine the destabilizing effect of the introduction of the futures and option on the underlying or spot market, this study makes use of ARCH/GARCH technique. The financial market variables such as price often exhibit time varying volatility which is not accounted by the above mentioned technique. Therefore, we also employed ARCH and GARCH technique to model volatility before and after the introduction of the futures and option markets.

The basic least square model is based on homoscedasticity of the error terms. If this assumption of the classical linear regression model is violated then we confront the problem of heteroscedasticity. The direct consequence of this problem is that the OLS estimates are still unbiased but but the standard errors and confidence intervals estimated by conventional procedures will be too narrow, giving a false sense of precision. Autoregressive conditional heteroskadastic (ARCH) models first introduced by Engle (1982) revolves around this assumption of homoscedasticity. ARCH and GARCH instead of considering heterosceadticity as a problem, it treated heteroscedasticity as a variance to be modeled. As a result, not only are the deficiencies of least squares estimates corrected, but a forecasting is calculated for the variance of each error term.

1.6.3 GARCH-M and BDS Test

For testing whether the introduction of futures and options have enhanced the quality of markets in terms of efficiency, we employed various tests to examine the efficiency of the market before and after introduction of futures and options like random walk model, serial correlation tests, GARCH-M model and finally BDS test.

Random walk model was first found by French Mathematician Louis Bachelier from the study of French commodity. However, this term was popularized by Malkiel (1973) in his celebrated work '*A Random Walk Down Wall Street*.' This hypothesis asserts that the random nature of commodity or stock prices cannot reveal trend and therefore current prices are no guide to future prices. Economists have historically accepted the random walk hypothesis. Nonetheless, there are economists like Lo and Mackinlay (2002) who do not accept this hypothesis. They wrote the book A Non-Random Walk Down Wall Street, which asserts that there are trends in the stock market and they are somewhat predictable.

Randomness of a series is also tested by autocorrelation test. Autocorrelation refers to the correlation of a time series with its own past and future values. Autocorrelation is sometimes called 'serial correlation' which refers to the correlation between members of a series of numbers arranged in time. They are also termed sometimes as 'lagged correlation' and 'persistence'. A guide to persistence in a time series is given by sample autocorrelation function which measures the correlation between observations at different times. We have already discussed foundation of ARCH/GARCH model earlier; GARCH-in-Mean is another model for testing market efficiency. The idea is that if risk premium is time dependent which implies autocorrelation in returns then it s a clear violation of market efficiency. Finally, BDS test which is a non-parametric method is also done to take care of non-linear dependences in data.

1.7 Limitations of the Study

Some limitations of data are worth noting. First, the study uses only National Stock Exchange data and trading on futures and option on BSE is not taken into consideration. NSE account for approximately 99.5% of the total trading on Futures and Options Segment while the BSE account for the rest, which is negligible. Thus, deleting the BSE from the analysis is not going to affect the result adversely. Second, this study has used daily data instead of 'high-frequency' data. The results may alter significantly with 'high-frequency' data. However, this attempt will help to answer some basic question relating to futures trading and its impact on the markets. The findings of the study may help to evolve appropriate policy regarding trading in *futures and option* in India.

It may be observed that the recent turmoil in the global financial market is often associated with a market collapse led by highly leveraged derivatives, especially in advanced economies such as the US. The present study, however, is not concerned with systemic macroeconomic or global forces that led to the crisis. Our purpose is strictly the micro structure and junctioning of the equity derivation in India.

1.8 Chapter Outline

The whole study is divided into seven chapters including introduction, Chapter II deals with 'Derivatives Markets in India: A Survey' which put forward the basic concept relating to derivatives market, common instruments traded in the market, history of these instruments and a brief overview of its trading in India. Chapter III is 'Hedging Effectiveness of Index and Stock Futures Contracts' which tries to assess the risk reducing capability of these index and stock futures contracts. Chapter IV is entitled as 'Price Discovery in Cash and Futures Market' which investigates the price discovery functions of the futures market. Chapter V is 'Derivatives Trading, Information and Stock Market Volatility' which explores the impact of futures and option market on the underlying market. Chapter VI is 'Hedging and Speculation in the F&O Segment of NSE' which studies whether trading volume is generated due to speculative demand or hedging purpose in the futures market. Chapter VII is 'Market Quality' which looks at market quality in terms of efficiency and liquidity' before and after introduction of derivatives trading. Finally, chapter VIII provides summary and conclusion of this study. Some additional information relating to commodity futures and highlights of L.C. Gupta Committee Report and Verma Committee Report are given out in special appendices to the thesis (See Appendix A through Appendix C). The main data set used for the thesis is provided in the Appendix D.

Chapter – II

Derivatives Markets in India: A Survey

2.1 Introduction

This chapter provides definitions of derivatives and derivatives products, market participants and various economic functions performed of the derivatives market. This will not only give certain concepts related to derivative market but also throw light on trading mechanism and market micro-structure of derivatives trading in India. Besides this, it presents an account of different products and their trading process in the F&O segment of NSE. This chapter is intended to help the reader to grasp the contents of subsequent chapters.

2.2 Definition of Derivatives

Derivatives are financial products whose value is derived from the value of an underlying asset. This underlying asset could be a commodity, a security, an index, an interest rate or an event. The International Monetary Fund (IMF), 1993 *System of National Accounts* defines derivatives as: "Financial derivatives are financial instruments that are linked to a specific financial instrument or indicator or commodity, and through which specific financial risk can be traded in their own right. The value of a financial derivative derives from the price of an underlying item, such as an asset or an index. Unlike debt securities, no principal is advanced to be repaid and no investment income accrues." The Securities Laws (amendment) Act, 1999, in India formally defined derivatives to include:

a) a security derived from a debt instrument, share, loan whether secured or unsecured, risk instruments or contracts for differences or any other form of security, and

b) a contract, which derives from the prices, or index of prices, or underlying securities.

Thus, derivative instruments such as forwards, futures, options and swaps derive their value from the underlying asset. Hence, the name derivatives.

2.3 A Brief History of Derivatives

Derivatives have been traded for centuries. Their usefulness is not new. Derivatives have played a role in commerce and finance for thousands of years. The first known evidence of derivatives trading dates to 2000 B.C. when merchants of Bahrain Island in the Arab Gulf, made consignment transactions for goods to be sold in India. Aristotle also discussed some 2,350 years ago a case of market manipulation through the use of derivatives on olive oil press capacity in Chapter 9 of his Politics. Derivatives trading in an exchange environment and with trading rules can be traced back to Venice in the 12th Century. Forward and options contracts were traded on commodities, shipments and securities in Amsterdam after 1595 (See Appendix II.1A for Landmarks in the History of Derivatives).

The Royal Exchange in London seems to be the first exchange for trading derivatives which permitted forward contracting. The first "futures" contract is by and large traced to the Yodoya rice market in Osaka, Japan around 1650. The Chicago Board of Trade (CBT) was established in 1848 and was perhaps the next major event in the history of futures markets. In 1925 the first futures clearinghouse was formed. From that point, futures contracts got its standard form. In 1972, the Chicago Mercantile Exchange (CME) established the International Monetary Market (IMM) which allowed trading in currency futures. In 1982, the Kansas City Board of Trade launched the first stock index futures, a contract on the Value Line Index. The Chicago Mercantile Exchange quickly followed with their highly successful contract on the S&P 500 index. The 1980s marked the beginning of the era of swaps and other over-the-counter derivatives. In 1994 the derivatives world was hit by a series of large losses on derivatives trading announced by some well-known and highly experienced firms, such as Procter and Gamble and Metallgesellschaft.

Emerging market economies are increasingly adopting derivatives to mitigate risk. In recent years, some emerging markets like China, Korea, Taiwan, Malaysia, and India have shown tremendous growth in derivatives trading. In the 1980's, derivatives market was dominated by exchanges in the United States. However, the emerging market exchanges are expected to generate a majority of the world's derivatives trading volume in coming few years. Certain emerging markets like China, Korea, Malaysia, Taiwan and India have made tremendous growth in derivatives trading in recent years (Chance, 1998).

Deerivatives trading is not new to India as commodity futures trading has been in existence since 1953. Certain OTC derivatives such as Forward Rate Agreement (FRAs) and Interest Rate Swaps (IRS) were allowed by the RBI through its guidelines in 1999. The trading of derivatives products based on securities on stock exchanges was permitted only in June 2000. The forerunner to exchange based derivatives in India was a kind of 'forward trading' in securities in the form of call option *(teji)*, put option *(mandi)*, and straddles *(fatak)* etc. These derivatives products were banned by the Securities Contracts Regulation Act, 1956 (SCRA) in 1969. However, as a result of this, volumes on stock markets started declining which compelled the Bombay Stock Exchange in 1972 to start an informal system of 'forward trading'. This system allowed *'Carry forward'* between two settlement periods. However, SEBI was of the view that carry forward transactions should be disallowed and transactions conducted strictly on delivery basis and trading in futures and options should be permitted in separate markets. Consequently, SEBI issued a directive in December 1993 prohibiting the Carry forward transactions. But it was not possible in view of prohibition in the SCRA. It was thought that if these prohibitions were withdrawn, trading in derivatives could commence. The Securities Laws (Amendments) Ordinance, 1995, promulgated on 25th January 1995, lifted the ban by amending its preamble. The markets for derivatives, however, did not take off, as there was no regulatory framework to govern trading of derivatives. SEBI set up a 24-member Committee under the chairmanship of L.C. Gupta in November 1996 to develop appropriate regulatory framework for derivatives trading in India. The Committee submitted its report on March 17, 1998. The Committee strongly favours the introduction of financial derivatives to facilitate hedging in a most cost-efficient way against market risk.

The market went ahead with preparation. It was soon realized that there was no law under which the regulations could be framed for derivatives. SEBI felt that the definition of "*securities*" under SCRA could be expanded by declaring derivatives contracts as securities. It was thought that Government of India could declare derivatives to be securities under its delegated powers. However, amendments to existing law in the matter become imminent.

As the derivatives could not be declared to be "*securities,*" government explored the possibility of amending the SCRA to explicitly define securities to include derivatives. The *Securities Contracts (Regulation) Amendment Bill, 1998* was introduced in the Lok Sabha on 4th July, 1998 proposing to expand the definition of "securities" to include derivatives within its ambit so that trading in derivatives could be introduced and regulated under SCRA. The Lok Sabha passed the Bill on 30th November and the Rajya Sabha on 1st December 1999. It became the Securities Laws (Amendment) Act 1999 on receiving the assent of the President on 16th December 1999. Derivatives were formally defined to include*:(a) a security derived from a debt instrument, share, loan whether secured or unsecured, risk instruments or contracts for differences or any other form of security, and (b) a contract which derives from the prices, or index of prices, or underlying securities*. The Act also ensured that derivatives should be legal and valid only if such contracts are traded on a recognized stock exchange, thus precluding over-the-counter derivatives. The Government also abolished in March 2000 the three-decade-old notification, which prohibited forward trading in securities. Derivatives trading commenced in India in June 2000 after SEBI granted the final approval to this effect in May, 2000. *Index futures* commenced on 9th June, 2000 on BSE and on 12th June on NSE, while trading in *index options* commenced in July 2001 followed by *stock futures* in November 2001 (Saksena, 2002).

2.4 Derivatives Instruments

There are mainly two categories of derivatives instruments, namely, plain vanilla and exotic derivatives instruments categorized into plain vanilla and exotic. Plain vanilla type of derivatives instruments include futures, forwards, options and swaps, and these can be combined with each other or traditional securities and loans to create hybrid instruments. Exotic derivatives are non–standardized contracts, which might appeal to some special class of investors. The simplest and perhaps the oldest derivatives instrument is forward contract. Forward contract can be defined as an agreement between two parties to purchase or sell a specific quantity of a specified item at a predetermined price at a specified time in the future. Forward contracts are traded on over –the- counter market. This market has two main limitations. Since forward contract is not traded on an exchange it suffers from *illiquidity* and *counter-party risk.* Futures contracts are like forward contracts, which obligates one party to buy or sell the underlying assets at a fixed price at a certain time in the future called 'maturity' from a counterparty who is obligated to sell or buy the underlying at that fixed price. However, unlike forward contracts, futures are highly standardized, traded on a recognized exchange and cleared through a clearinghouse. The standardization of contracts of futures contracts facilitates greater trading volume and greater market liquidity. Another popular derivatives product is option. It is a right but not the obligation to buy or sell some assets on a specified date in the future at a stated price in a contract. There are two types of option, namely, *call* option and *put* option. A call option gives the holder the right to buy the underlying asset by a certain date for a certain price. On the other hand, the put option gives the holder the right to sell the underlying asset by a certain date for a certain price. In 1973, Black, Merton and Scholes came up with their famous Black –Scholes formula which revolutionized the financial scene. In April 1973, Chicago Board of Exchange (CBOE) was set up specifically for trading of options contracts. The market of options developed since then and there was no looking back. In 1982, futures on equity and options on bonds made their appearance on stock exchanges. A swap is an agreement to exchange, or swap, a floating price or rate for a fixed price or rate (or vice versa) for an asset at specific time intervals. Interest rate swaps and currency swaps are very popular. Swap contracts, in comparison to forwards, futures and options, are one of the more recent innovations in derivatives contract design.

Both types of derivatives instruments viz. plain vanilla and exotic are used by market participants like businesses, individuals, and governments to achieve a wide variety of objectives. Risk management has been the traditional role of the futures markets and it is the driving force behind the development of futures contracts. Derivatives products are also used to reduce financing costs. There are mainly two ways of financing a project either by issuing shares or debt. However, derivatives products can be used to enhance a firm’s ability to reduce the cost of debt. Businesses can generally use derivatives to reduce their financing costs by engaging in hedging activity which lessen the risk of its venture. To take advantage of differences in interest rates across borders and maturities a firm could issue debt in a country with lower interest rates and use currency swaps to protect itself against foreign exchange risk. Firms can also reduce their interest costs substantially by trading “quality spread," which arises due to differences in interest-rate spreads between fixed-and floating rate in credit markets. Besides this, businesses could use derivatives to capitalize on low interest rates to lock in the financing costs of a future debt issue.

Asset management companies such as mutual funds, pension funds, hedge funds, portfolio managers, insurance companies manage a huge amount of money on daily basis. It is difficult and costly sometimes to alter the portfolio in the spot market. Derivative instrument help to manage risk because of the low transactions costs associated with acquiring derivative instruments such as forwards, futures, options and swaps relative to the spot market instruments.

Derivatives provide businesses tax planning opportunities by taking advantage of differences in the tax structure and the regulatory requirements across various countries or markets. Derivatives products can be used to issue debt in tax-favored jurisdictions or through a tax-favored instrument to replicate the payment stream of a high taxed jurisdiction or security. Derivatives may also be used by some regulated industries to reduce the impact of certain regulatory restrictions and limitations.

Moreover, derivatives markets perform a number of economic functions. One of the important functions of derivatives market is price discovery. Prices in an organized derivatives market reflect the perceptions of market participants about the future and lead the prices of underlying to the perceived future level. The ability of futures markets to provide information about prices is a central theme for the existence of these markets. In order to obtain an optimum allocation of resources in an economy, prices must accurately reflect relative production costs and relative consumption utilities. Futures markets, by providing a mechanism through which information about current and future spot prices can be assimilated and disseminated to all participants in the economy, help to achieve this goal.

Another function of derivatives markets is to provide hedging facility to the economic agents either to reduce or eliminate risk that cannot be insured or diversified away. And, here, lies the rationale behind futures trading everywhere in the world. Hedging is obtained by taking opposite position in the futures market. The significance of hedging in a volatile price environment is not difficult to imagine. To see the demise of an otherwise efficient firm or farmer as a consequence of adverse price fluctuations over which it had no control is really pitiable. This high degree of volatility in prices is seen often in the case of agricultural commodities when a good crop causes harvest prices to fall below a farmer’s cost of production. In fact, it was this very situation that led to establishment of Chicago Board of Trade and the introduction of commodity futures in

1860's. Similar, volatility in prices of financial assets were also observed after the breakdown of Bretton wood system in early 1970's that led to numerous financial innovations like financial futures. This hedging facility provided by the derivatives products reduces the aggregate risk in the economy and influence economic activities and hence it's economic growth. On the other hand it gives some profit to speculators for their aptitude towards risks. In addition to this, one of the benefits of derivatives trading is that the speculative trade shift to a more controlled environment of derivatives markets. In the absence of organized derivatives, speculators trade in the underlying markets. Margining, monitoring and surveillance of the activities of various participants become extremely difficult in these kinds of mixed markets.

2.5 Microstructure of Derivatives Markets

The logistics are very essential for proper functioning of the market. The success of a derivatives exchange largely depends upon its microstructure. This includes the choice of derivatives products which is to be traded, trading mechanisms adopted by the concerned exchange, clearing arrangements and settlement and the regulatory structure governing derivatives transactions.

2.5.1 Products

One of the key features of derivatives trading is the range of products offered by derivatives exchanges. The main categories of products are commodities, interest rates, currencies, bullions, energy derivatives, stock index, individual stocks etc. The traded product should have certain desirable characteristics for successful trading of a derivatives instrument. The underlying product must have high degree of price volatility to attract hedgers, speculators and arbitragers. This is desirable because there should be enough speculators to provide additional liquidity. Derivatives exchanges trade completely standardized products. The exchange defines the traded product, and market participants have no flexibility in altering the terms. All features of the traded product are specified, including the expiration date, date of making delivery, the exact specification of the grade and quantity of the goods, which will be delivered, etc by the exchange. To a large extent, the success of a derivatives exchange will depend on the choice of products to be traded. In India, now there are four products available namely index futures, index option, futures on individual securities (stock futures) and option on individual securities (stock option) for trading on the NSE and BSE.

2.5.2 Trading Mechanism

A derivatives exchange needs a trading system. A trading system is defined by distinct set of rules that regulate the trading process in a derivatives exchange. These rules dictate when and how orders can be submitted, who may see or handle the orders, how orders are processed, and how prices are set. Trading system, therefore, determines how the flows of orders interact and determines volume and price during transactions. Rules of trading determined by a trading system have significant implication for the profitability of trading strategy and thus influence trading behaviour, price formation in the markets and costs of transactions. Depending on the automation and sophistication of the market, trades can be executed either on the floor or through electronic trading. In recent years, increasingly electronic trading is preferred over floor trading. The modern consensus in the securities industry is that liquidity is maximized using the open electronic limit order book market, where trading takes place in anonymity, where individuals all across the country have equal access to the trading floor prices and liquidity are transparent. In India, the derivatives trading system at NSE is called NEAT-F&O trading system. It provides a fully automated screen-based trading for derivatives on a nationwide basis. It supports an anonymous order driven market, which operates on a strict price-time priority.

2.5.3 Clearing and Settlement

One of the important components of derivatives exchange is clearinghouse, which clears trade. Clearing trades normally involves processing of transactions, including reporting to transacting parties; confirmation of trades; and matching of orders. The job of the clearinghouse is to remove or reduce the counterparty credit risk by standardizing and simplifying the processing of transactions. The clearinghouse matches all buy and sales on a daily basis. After all the trades have been matched, the clearinghouse becomes the seller to all buyers and the buyer to all sellers, thereby guaranteeing the contractual obligations of each transaction. Trades are reported to the clearinghouse, and the contracts are written anew, or novated, so that the clearinghouse becomes the counterparty to every contract. In this manner, the clearinghouse assumes the credit risk of every futures contract traded on the exchange. The presence of a clearinghouse in the center of market trading means that every market participant has a creditworthy clearinghouse as counterparty. In India, National Securities Clearing Council performs the job of clearing house.

2.5.4 Monitoring and Control

Regulation of the derivatives trading is major challenge before the governments round the world due to its recent happening. The problem before the policy makers is how to monitor the activities of the exchanges and to set broad parameters for derivatives trading. Ideally, there should be an effort to place minimum standards in areas such as contract design, market surveillance, reporting and record keeping, market transparency, safeguarding customer funds and assets, ensuring the financial integrity of the trading process, and protecting customers from fraud and markets from manipulation and trading abuses. Besides these controls, a derivatives exchange requires to develop the competence to self-regulate by monitoring trading activities, ensuring contract execution, resolving disputes, enforcing rules and sanctions, and promoting professional conduct in order to increase investors' confidence.

The microstructure of derivatives exchanges is critical for several reasons. It tells us how the market is working through an examination of the features of the exchange and of the linkages that allow a disciplined flow of orders and execution of transactions. This also play a vital role in creating and disseminating market information. Both trading activity and price determination are sensitive to institutional arrangements. Moreover, the microstructure ensures the smooth execution of transactions. Finally, market arrangements have implications for the long-term properties of derivatives contracts and the returns on underlying assets.

2.6 F & O Segment of NSE

Derivatives trading started in India in June 2000 after the securities market regulator of India, Securities and Exchange Board of India (SEBI) approved trading of derivatives products in May 2000. SEBI allowed two premier stock exchanges in the country viz. the National Stock Exchange (NSE) and the Bombay Stock Exchange (BSE), and their clearing house/corporation to commence trading and settlement in approved derivative contracts. Based on the recommendation of L.C. Gupta Committee Report on

Derivatives who recommended phased introduction of derivatives in the Indian market, SEBI first approved trading in index futures contracts based on S&P CNX Nifty Index and BSE Sensex Index. This was followed by trading in options based on these two indices and options on individual securities. The trading in index options commenced in June 2001 and those in options on individual securities commenced in July 2001. Futures contracts on individual stock were launched in November 2001.

The index and the stock futures at NSE are traded in monthly series, the expiration date for each series being the last Thursday of the month. At any particular point of time, three contracts are traded. For example, on 12 June, 2000, the series being traded were: the near month series expiring on 29 June, 2000, the next month series expiring on July 27, 2000, and the far month contract expiring on 31 August, 2000. On the expiry of a particular month's series, trading in a new contract for the far month starts on the next day.

Both the stock futures and the index futures are cash settled. This obviates the need for the delivery of physical stocks on the date of expiry of stock futures and hence the undesirable demand and supply pressure on the cash market on that date. Both NSE and BSE, which are the major cash markets for the stocks underlying the derivatives , have the same trading time for both the cash segment and derivatives segment (Monday to Friday; 9:55 a.m. to 3:30 p.m.).

The daily marked-to market margin for futures contracts at NSE is charged at the closing price of the futures contract on the trading day which is weighted average price of the contract during the last half an hour of trading. The final settlement is done on the cash basis at the closing price of the relevant underlying index or security in the equity market segment of NSE on the last trading day of the futures contract. In India, there is no separate exchange for derivatives instruments. It is traded on a segment of NSE and BSE exchanges. Since almost 99% of the trading is accounted by NSE, we will discuss only NSE's F&O segment

The derivatives trading on NSE started in June 2000 with the introduction of index futures on S&P CNX Nifty. Subsequently, index option on S&P Nifty, futures and option on other sectoral indices such as CNX IT, Bank Nifty, futures and option on 118 individual stock and interest rate futures were introduced in the market. The turnover in the F&O

segment has experienced considerable growth since 2000. India ranks first in stock futures trading in terms of number of contracts traded. It is second in Asia in terms of number of contracts traded in equity derivatives.

There are mainly four derivatives products available in the Indian market namely index futures, index option, stock futures and stock option. The underlying indices for index futures and option are S&P CNX Nifty, CNX IT index, CNX Bank index. Futures and option are also available on individual stocks. As of now, there are 118 individual stocks on which stocks and futures are available for trading. Index option is European style which can be exercised only at the time of maturity. However, stock options are American style which can be excursed at any time before maturity of the contract.

On NSE, at any point of time there are only three contract months available for trading, with 1 month, 2 months and 3 months to expiry. These contracts expire on last Thursday of the expiry month and have a maximum of 3-month expiration cycle. A new contract is introduced on the next trading day following the expiry of the near month contract. All the derivatives contracts are presently cash settled.

Appendix II.1A

Landmarks in the History of Derivatives (World)

2000 BC	In India (forward trading by traders and agriculturists).
400 BC	In ancient Greece and Rome (option trading in agriculture products).
12th Century	European trade fair sellers (signs contracts promising future deliveries of trade items).
17th Century (beginning)	Tulip Mania in Holland (1634-1637) (Trader's lost fortunes in a speculative boom in tulip futures burst).
17th Century (late)	Dojima Rice Futures (Japan at Dojima (near Osaka) a futures market in rice developed to protect sellers from bad weather or warfare).
19th Century	Asian Trader's Actively traded (In agriculture, products traded via sea). Chicago Board of Trade (1868). Trading in wheat, pork belly and copper futures starts.
20th Century	Late 1960: Black and Scholes begin collaboration. Fischer Black and Myron Scholes tackle the problem of determining how much an option is worth. Robert Merton joins them in 1970. 1968: SCRA (Securities Contracts Regulation Act) bars use of Derivatives as a security in the formal setup. Leads to derivative instruments moving to unorganized sector. April 1973: Chicago Board Options Exchange opens. May/June 1973: Black-Scholes Model published (*Journal of Political Economy* accepted the model after repeated rejections including once by JPE). 1994: Metallgesellshaft loses $1.5 bn on oil futures. 1995: Baring Bank goes burst (Nick Leeson loses $1.4 bn by speculating them in the Nikkei 225 index of leading Japanese company shares, which did not move from its normal trading range. The Kobe earthquake shattered that assumption on 17th January whereafter Leeson attempted to conceal his losses). 1997: Nobel Prize in Economics awarded to Robert Merton and Myron Scholes. Weather Derivatives Market and Instruments initiated (late 1997). Aquila Energy introduced a weather option embedded in a power contract. 1998: Long-Term credit management bailout (The hedge fund is rescued at a cost of $3.5 bn to secure extensive losses to the world financial system). 1999: The Flaming Ferraris (some traders at CSFB sacked for illegal trades in an attempt to manipulate the Swedish stock market index).
21st Century	2000: India launches derivatives in formal setup (June 2000) in the Bombay Stock Exchange and National Stock Exchange. 2001: Enron goes bankrupt 7th largest company in US and the world's largest energy trader made extensive use of energy and credit derivatives, which built up an accumulated loss leading to bankruptcy. September 11 attack (terrorists made huge profits in Insurance and Airline's industry stocks). A model and a weather derivatives instrument based on water tables for hedging risks against floods, droughts and rainfalls developed by Aman Agarwal (for FSD Dept., The World Bank, USA), *Finance India*, XVI No. 3, September, 2002. 2002: AIB loses $750 mn (John Rusnak uses fictitious option contracts to cover losses on the spot and forward foreign exchange contracts).

Appendix II.1B

Landmarks in the History of Indian Derivatives Market (India)

1991	Liberalization process initiated
14-Dec-95	NSE asked SEBI for permission to trade index futures.
18-Nov-96	SEBI setup L.C.Gupta Committee to draft a policy framework for index futures.
11-May-98	L.C.Gupta Committee submitted report.
07-Jul-99	RBI gave permission for OTC forward rate agreements (FRAs) and interest rate swaps.
24-May-00	SIMEX chose Nifty for trading futures and options on an Indian index.
25-May-00	SEBI gave permission to NSE and BSE to do index futures trading.
09-Jun-00	Trading of BSE Sensex futures commenced at BSE.
12-Jun-00	Trading of Nifty futures commenced at NSE.
25-Sep-00	Nifty futures trading commenced at SGX.
02-Jun-01	Individual Stock Options & Derivatives

Chapter – III

Hedging Effectiveness of Futures Contracts

3.1 Introduction

One of the important functions of the futures market is to provide hedging facility to the market participants. The dictionary meaning of 'hedge' is to protect oneself financially as by buying or selling futures contract as a protection against loss due to price fluctuation. Futures markets provide hedging facilities to the economic agents either to reduce or eliminate risk that cannot be insured or diversified away. And, here, lies the rationale behind futures trading everywhere in the world. Hedging is done by taking opposite position in the futures market. The significance of hedging in a volatile price environment is not difficult to imagine. To see the demise of an otherwise efficient firm or farmer as a consequence of adverse price fluctuations over which it had no control is really pitiable. This high degree of volatility in prices is seen often in the case of agricultural commodities when a good crop causes harvest prices to fall below a farmer's cost of production. In fact, it was this very situation that led to establishment of Chicago Board of Trade and the introduction of commodity futures in 1860's. Similar volatility in prices of financial assets was also observed after the breakdown of Bretton Woods system in early 1970's that led to numerous financial innovations like financial futures. The Indian financial system has also become increasingly global in nature and was exposed to the global financial market through channels of financial integration, development in information technology and telecommunication in recent years. This process of globalization has been accompanied by increasing volatility and uncertainty in prices of many commodities and in financial markets. As a result some business risks like price risk, foreign exchange risk etc., have grown in importance and management of these financial and commodity market risks required the use of financial instruments called derivatives.

Equity derivatives in India was started in June 2000. Four derivatives instruments viz. index futures, index option, stock futures and stock option are traded on the Indian stock exchanges. The moot question is whether the trading of stock index futures in the Indian market performing their basic economic functions of providing effective hedge. A hedge is said to be effective if price movement of the hedged item such as some cash position in the underlying market and the hedging instrument such as stock futures with which hedging is done roughly offset each other. In fact, one of the important factor determining the success of futures contracts in market is its hedging effectiveness. Hedging decisions as how many futures contracts to be used for hedging a cash market position completely is dependent upon finding hedge ratio which is defined as a ratio comparing the value of futures contracts purchased or sold to the value of the cash position being hedged.

Various methods have been adopted for estimating optimal hedge ratio. All the previous studies estimated optimal hedge ratio using simple Ordinary Least Squares (OLS) regression. Two criticisms leveled against using OLS as OLS estimate suffers from the problem of autocorrelation in the OLS residuals and the heteroskedasticity often found in cash and futures prices (Herbst et al., 1993). Another problem arises from the fact that cash and futures prices might be cointegrated and if it is not taken into account, then it can lead to an under-hedged position due to misspecification of the pricing behavior between these markets (Ghosh, 1993). In this connection, Error Correction Models (ECMs) may be more appropriate and numerous studies have used ECMs for estimating hedge ratio (Chou et al., 1996). Others have used both Error correction component as well as time-varying risk structure (e.g. Lien and Tse, 1999). However, all the earlier studies neglected the fact that the joint distribution of spot and futures prices varies over time (Cecchetti et al., 1988). Recent developments in time series econometrics have tried to remove this problem. A multivariate GARCH method has been developed (Bollerslev et al , 1988) to estimate time varying hedge ratio by considering conditional variance and covariance of cash and futures prices. Many studies on the hedging effectiveness have compared the constant and time varying hedge ratio using this approach. This paper focuses on estimating optimal hedge ratio of S&P Nifty futures by various methods and compares its hedging effectiveness.

3.2 Theoretical Background

Using futures contract to hedge a particular position established in the cash market, the market participant must decide on the optimal hedge ratio. Hedging decisions as such clearly depends on the hedge ratio which is the number of units traded in futures market to the number of units traded in the cash market. There are basically three hedging strategy namely traditional one to one; the beta hedge and the minimum variance hedge ratio (MVHR) proposed by Johnson (1960) and Ederington (1979). The traditional hedging strategy involve taking equal and opposite position in the futures market, that is hedge ratio of -1. This strategy will work if the proportional changes in cash price exactly match proportional change in futures price. However, such perfect correlation between spot and futures prices rarely found. Hence, one-to-one strategy is not optimal and hedge ratio that minimizes the variance must different from -1.

Beta hedge ratio refers to portfolio's beta[2]. The objective of beta hedge is similar to traditional 1:1 hedge ratio that involve taking equal and opposite position in the futures market. However, when the cash position is a stock portfolio, the number of futures contracts required to hedge the position completely needs to be adjusted by the portfolio's beta. Very often the portfolio to be hedged will be a subpart of the portfolio underlying the futures contract, and therefore the beta hedge ratio will differ from -1. However, if the futures contracts have perfect correlation with the portfolio to be hedged then the beta hedge will be same as the traditional 1:1 hedge ratio.

Johnson (1960) proposed another hedge ratio called MVHR which is the ratio of covariance of spot and futures price changes to the variance of futures price changes. He applied modern theory of portfolio to the hedging problem and for the first time risk and return in terms of mean and variance of return was used to hedging problem. He assumed that the main goal of hedging as to minimize the risk which is defined as the variance of return on a two-asset hedged portfolio. The hedge ratio is measured as:

$$h = -\frac{X_f}{X_s} = \frac{\sigma_{sf}}{\sigma_f^2} \qquad (3.1)$$

where X_f and X_s are amount invested in futures and spot market respectively. σ_{sf} and σ_f^2 are covariance of spot and futures price changes to the variance of futures price changes respectively. It is to be noted that the minimum variance hedge ratio (MVHR) is the regression coefficient of cash price changes on futures price changes.

[2] Beta measures the sensitiveness of a stock vis-à-vis the market. Portfolio's beta refers to weighted beta of a group of stocks.

A measure of hedging effectiveness was developed by Johnson (1960) also associated with Ederington (1979). It is defined in terms of variance reduction of the hedged position over the variance of the unhedged position as given below:

$$HE = 1 - \frac{Var(h)}{Var(u)} \tag{3.2}$$

Where,

$$\text{var}(u) = \sigma_s^2$$

$$\text{var}(h) = \sigma_s^2 + h^2\sigma_f^2 - 2h\sigma_{sf}$$

If we substitute and rearrange yields,

$$HE = 1 - \frac{X_s^2\sigma_{\Delta s}^2(1-\rho^2)}{X_s^2\sigma_{\Delta s}^2} = \rho^2 \tag{3.3}$$

where ρ^2 is the R^2 i.e. coefficient of determination. Alternately, it is the square of coefficient of correlation. Thus, in the MVHR model R^2 measure the hedging effectiveness of a futures contract.

3.3 Literature Review

Figlewski (1984) was the first to conduct study on hedging effectiveness of S&P 500 stock index futures for the period June 1982 and September 1983. He estimated hedge ratio by OLS and found that MVHRs of out-of sample performance of was better than beta hedge ratio. Junkus and Lee (1985) studied hedging effectiveness of three US stock index futures using different hedging strategy. They found that OLS hedge ratio outperform others methods. Their study also established superiority of MVHR. Holmes (1995) examined ex ante hedging effectiveness of UK index futures contracts using data from 1984 to 1992 and reported that FTSE-100 futures contract is very useful for portfolio mangers for avoiding risk. Chou et al (1996) studied Japan's NSA and NSA index futures contract and compared the hedging effectiveness using different time intervals. They documented that the conventional OLS hedge outperforms the error – correction hedge over the in-sample period. However, in out-of-sample period error-correction performed better than OLS hedge. Park and Switzer (1995a) investigated the hedging effectiveness of three stock index futures namely S&P 500, MMI futures and Toronto 35 index futures. Their results show that bivariate GARCH perform better than

OLS hedge. Lypny and Powalla (1998) examined hedging effectiveness of German stock index DAX futures using bivariate GARCH (1,1) and documented that dynamic model outperform other models. Laws and Thompson (2002) examined the ex ante hedging effectiveness of stock index futures on LIFFE. Butterworth and Holmes (2000) studies hedging effectiveness of FTSE -100 and FTSE Mid 250 index futures contracts. They found FTSE-100 provided effective hedge for portfolio dominated by large firms and FTSE Mid 250 was equally effective for portfolios dominated by small capitalizations stocks. Brailsford et al (2000) estimated hedge ratio by several techniques for the Australian All Ordinary Share Price index futures contract. Yang (2001) showed that M-GARCH dynamic hedge ratios provided largest degree of reduction in variance of returns. Nonetheless some recent studies for example Lien et al (2002) and Moosa(2003) have reported that basic OLS approach outperforms other advanced models of hedge ratio estimation.

In India very few studied were conducted on the hedging effectiveness of the futures contract. Roy and Kumar (2007) studied hedging effectiveness of wheat futures in India. They used conventional OLS method for hedge ratio estimation and found wheat futures contract do not provide effective hedge in avoiding risk. Bhaduri and Durai (2008) examined hedging effectiveness of Nifty Futures. They found OLS based strategy provided better hedge at shorter time horizons. However, at higher time horizons bivariate GARCH clearly dominates. Further, Kumar et al (2008) examined hedging effectiveness of constant and time varying hedge ratio of Nifty Futures, Gold Futures and Soybean futures. Their results showed that the time varying hedge ratio provided greatest variance reduction as compared to other hedges based on constant hedge ratio.

3.4 Methodology

Several methods have been used to estimate optimal hedge ratio such as conventional OLS method, bivariate vector autoregressive model and bivariate vector error correction model. These methods are discussed in detail below:

3. 4.1 Conventional Regression Model

The optimal hedge ratio in conventional regression method is obtained by regressing change in spot price on the changes in futures prices. This model is specified as follows:

$$\Delta S_t = \alpha + \beta \Delta F_t + \mu_t \qquad (3.4)$$

where μ_t is the residual, ΔS_t and ΔF_t are spot and futures price changes. The slope coefficient of the above model provides an estimate of optimal hedge ratio.

3.4.2 Bivariate VAR Model

One problem with the conventional regression model is that there may be possibility of error being autocorrelated. To remove this problem bivariate autoregressive (VAR) model can be preferred over OLS method. The VAR model can be specified as follows:

$$R_{st} = \alpha_s + \sum_{i=1}^{k} \beta_{si} R_{st-i} + \sum_{j=1}^{l} \delta_{Fj} R_{Ft-j} + \mu_{St} \qquad (3.5)$$

$$R_{Ft} = \alpha_F + \sum_{i=1}^{k} \beta_{Fi} R_{Ft-i} + \sum_{j=1}^{l} \delta_{Sj} R_{St-j} + \mu_{Ft} \qquad (3.6)$$

where,

R_{st} = Return on spot prices at time‘t’

R_{ft} = Return on futures prices at time‘t’

α_s = Intercept term of model (3.5)

α_f = Intercept term of model (3.6)

β_{st} = Coefficients lagged return on spot prices in model (3.5)

δ_{ft} = Coefficients lagged return on futures prices in model (3.5)

β_{ft} = Coefficients lagged return on futures prices in model (3.6)

δ_{st} = Coefficients lagged return on spot prices in model (3.6)

μ_{ts} = Error term in model (3.5)

μ_{ft} = Error term in model (3.6)

After estimating the system of equation, optimal hedge ratio is calculated from the residuals of spot and futures returns as follows:

$$H = \frac{\sigma_{SF}}{\sigma^2_F} \qquad (3.7)$$

where,

σ_{SF} = Covariance of μ_{st} and μ_{ft}

$\sigma^2{}_F$ = variance of μ_{ft}

The VAR model does not consider the possibility of cointegration between spot and futures returns.

3.4.3 Error Correction Model

Engle and Granger (1987) stated that if two series are integrated, then there exists an error correction representation of data as follows:

$$R_{st} = \alpha_s + \sum_{i=1}^{k} \beta_{si} R_{st-i} + \sum_{j=1}^{l} \delta_{Fj} R_{Ft-j} + \lambda_s Z_{t-1} + \mu_{St} \quad (3.8)$$

$$R_{Ft} = \alpha_F + \sum_{i=1}^{k} \beta_{Fi} R_{Ft-i} + \sum_{j=1}^{l} \delta_{Sj} R_{St-j} + \lambda_f Z_{t-1} + \mu_{Ft} \quad (3.9)$$

where,

R_{st} = Return on spot prices at time‘t’

R_{ft} = Return on futures prices at time‘t’

α_s = Intercept term of model (3.8)

α_f = Intercept term of model (3.9)

β_{st} = Coefficients lagged return on spot prices in model (3.8)

δ_{ft} = Coefficients lagged return on futures prices in model (3.8)

β_{ft} = Coefficients lagged return on futures prices in model (3.9)

δ_{st} = Coefficients lagged return on spot prices in model (3.9)

μ_{ts} = Error term in model (3.8)

μ_{ft} = Error term in model (3.9)

and Z_{t-1} is the error correction term and λ_s and λ_f are adjustment parameters. Minimum variance hedge ratio is estimated as the ratio of covariance of residual of spot and futures return and variance of futures obtained from the error correction model.

3.5 Empirical Results

To assess the hedging effectiveness of futures contracts which are traded on NSE, we collected data on three index futures contracts, namely, S&P CNX Nifty Futures, Bank Nifty Futures and CNXIT Futures contracts. While the data for S&P CNX Nifty is collected for the period 12 June 2000 to 26 March 2009, data for Bank Nifty and CNXIT are collected from 2nd January 2007 to 26 March, 2009. Besides this, we also assess the hedging effectiveness of 10 stock futures contracts. We collected data on 10 single stock futures from November, 2001 to 31 March, 2009 which are listed below:

1. Bharat Heavy Electricals Ltd
2. Bharti Airtel
3. ICICI Bank
4. Indian Trading Corporation (ITC)
5. Infosys Technology
6. Oil and Natural Gas Corporation (ONGC)
7. Reliance
8. State Bank of India (SBI)
9. Steel Authority of India Ltd (SAIL)
10. Wipro

At the outset, we plotted the Nifty and Nifty futures daily series for identifying the broad pattern in these two series over the sample period 12 June 2000 and 26 March 2009.

Fig. 3.1: Trend of Nifty & Nifty Futures

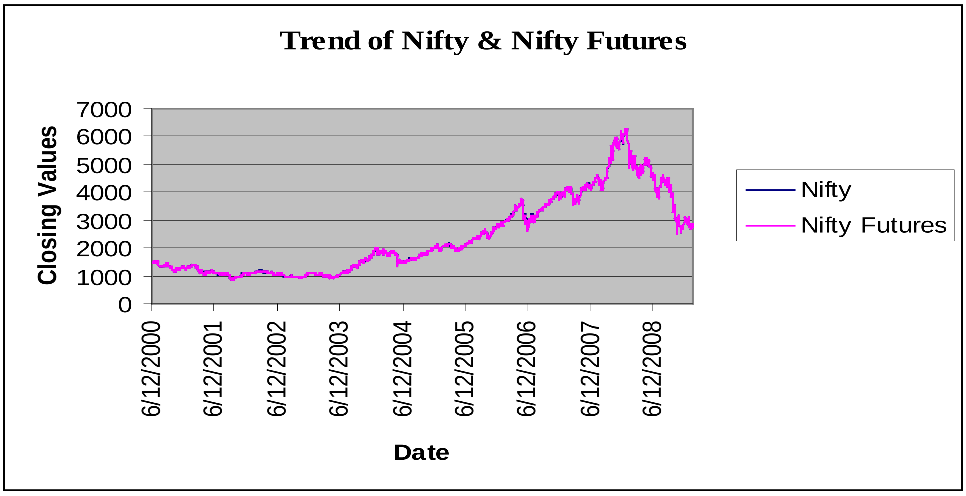
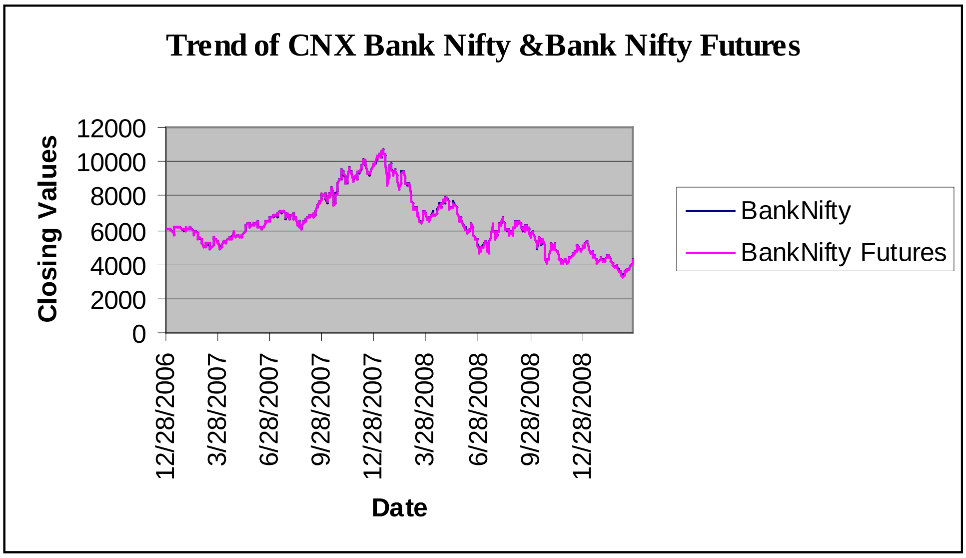


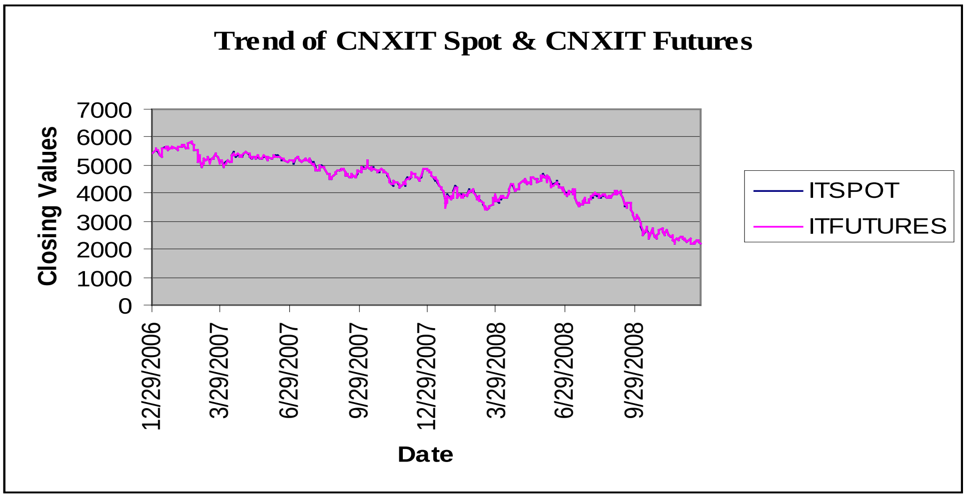
Figure 3.1 shows the trend of Nifty and Nifty Futures over this period showing a rising trend up to August-September 2008.

Fig.3.2: Trend of Bank Nifty and Bank Nifty Futures



With the onset of economic slowdown round the world, the Indian stock market also went into bearish mode and that is quite visible from the time series plot. Both Nifty and Nifty futures shows a declining trend since then. We also plotted the bank nifty and bank nifty futures which shown below in Figure 3.2. This shows the trend of bank nifty and bank nifty futures over the sample period 28 December 2006 and 26 March 2009. Two broad trends can be identified from Figure 3.2. After crossing 10000 mark somewhere in December 2007 and January 2008, both Bank Nifty and bank nifty futures shows declining trend. Now they are trading somewhere in between 4000 and 6000 points. The impact of mortgage crisis arising out of US is clearly visible on this sectoral index and its futures contract in the latter part of the sample.

Fig 3.3: Trend of CNXIT and CNXIT Futures



Another sectoral index and futures contract considered is IT sector. CNXIT spot and CNXIT futures series are plotted in Figure 3. 3 which shows the opposite kind of trend vis-à-vis the main market index S&P CNX Nifty. The whole IT sector was moving just opposite to the main index in the last few years. The reason might be strengthening of the rupee against dollar which impacted the IT and IT enabled services sector to a larger extent. Due to appreciating rupee, the export revenue of these companies declined substantially in recent time. The rupee-dollar exchange rate, however, started depreciating in most part of 2008-09. Nonetheless, this positive sign was coupled with economic slowdown triggered by mortgage crisis in the US. The rupee-dollar exchange rate condrum is clearly visible in the declining trend of CNXIT and CNXIT futures markets in this period.

Next, we computed the descriptive statistics of returns of daily Nifty, Nifty Futures, Bank Nifty, Bank Nifty Futures, CNXIT, and CNXIT Futures. The results are reported in Table 3.1.

Table 3.1: Descriptive Statistics (in %)

Indices/Summary Statistics	Nifty	Nifty Futures	Bank Spot	Bank Futures	CNXIT	IT Futures
Mean	0.0454	0.0467	0.0008	0.0012	-0.1554	-0.1522
Median	0.1363	0.0933	-0.0375	-0.0458	-0.2456	-0.1557
Maximum	8.2952	10.0684	11.31	11.82	7.84	8.75
Minimum	-12.23	-15.0052	-12.61	-12.91	-7.23	-7.67
Std. Dev	1.6836	1.7808	2.88	2.96	2.407	2.509
Skewness	-0.5718	-0.6506	0.0699	0.0476	0.1951	0.1416
Kurtosis	7.92	9.27	4,25	4.33	3.87	4.24
Jarque-Bera	2299.77	3704.17	32.64	36.91	18.90	33.23
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

The mean returns over the sample period 12 June 2000 to 26 March 2009 of Nifty and Nifty Futures are 0.0454% and 0.0467% respectively. As evident from the coefficient of skewness and kurtosis that the Nifty and Nifty Futures return are not normally distributed, therefore we reported median return of Nifty and Nifty futures which are 0.13% and 0.09% respectively over the sample period. The standard deviation of returns of Nifty and Nifty Futures over the sample period is 1.68 and 1.78 respectively which indicates that volatility of the futures market is comparatively higher than its underlying cash market. The value of skewness for Nifty and Nifty futures are -0.5718 and -0.6506 respectively which is different from zero indicating that the distribution is not symmetric. Besides this, kurtosis of Nifty and Nifty Futures are 7.92 and 9.72 respectively which are relatively large values compared to value of 3. This shows that returns is leptokurtic or heavily tailed and sharply peaked around the mean. Thus, the daily returns are not normal but leptokurtic and skewed. Jarque-Bera (1980) test indicate that the null of no normality of returns cannot be rejected at 1 percent level.

Similarly, we computed the descriptive statistics for the returns of Bank Nifty spot and Bank Nifty futures. The mean returns of bank nifty and bank Nifty futures are 0.0008% and 0.0012% over the sample period 28 December 2006 and 26 March 2009. While the mean return for bank nifty and bank nifty futures are almost 0, the median return for bank nifty and bank nifty futures are negative viz. -0.0375% and -0.0458% respectively over this sample period. The volatility of returns as indicated by standard deviation are 2.88 and 2.96 for the bank nifty and bank nifty futures respectively. One important point is that the volatility of futures market is higher than the volatility of the underlying spot market as evident from the standard deviation. Returns of bank nifty and bank nifty futures are not symmetric and normally distributed as indicated by the values of skewness and kurtosis.

Likewise, the mean returns over the sample period 28 December 2006 to 26 March 2009 of CNXIT spot and CNXIT Futures are negative viz. -0.1554% and -0.1522% respectively. As evident from the coefficient of skewness and kurtosis that the CNXIT spot and CNXIT Futures return are not normally distributed, therefore we reported median return of CNXIT spot and CNXIT futures which are -0.2456% and -0.1557% respectively over the sample period. The standard deviation of returns of CNXIT spot and CNXIT Futures over the sample period is 2.407 and 2.509 respectively which indicates that volatility of the futures market is comparatively higher than its underlying cash market. The value of skewness for CNXIT spot and CNXIT futures are 0.1951 and 0.1416 respectively which is different from zero indicating that the distribution is not symmetric. Besides this, kurtosis of CNXIT spot and CNXIT Futures are 3.87 and 4.24 respectively which are relatively large values compared to value of 3. This shows that returns is leptokurtic or heavily tailed and sharply peaked around the mean. Thus, the daily returns are not normal but leptokurtic and skewed. Jarque-Bera (1980) test indicate that the null of no normality of returns cannot be rejected at 1 percent level.

Table 3.2: AR(1) Model for Testing Stationarity

1. Nifty = 2.55 +0.99 Nifty (t-1) 2. Nifty Futures = 2.78 + 0.99 Nifty Futures (t-1)
3. Bank Nifty = 40.42 + 0.9936 Bank Nifty(t-1) 4. Bank Nifty Futures = 42.41 + 0.99 Bank Nifty Futures (t-1)
5. CNXIT = -2.78 + 0.99CNXIT (t-1) 6. CNXIT Futures = -0.42 + 0.99CNXIT Futures (t-1)

We proceeded further by testing stationarity of the series under question. The results of the OLS will be spurious if the variables in the regression model are not stationary. To determine the stationarity of Nifty, Nifty Futures, Bank Nifty, Bank Nifty futures, CNXIT and CNXIT Futures, we take the help of one informal technique, that is, AR(1) model. We also conducted a formal test for stationarity by Augmented Dickey Fuller test. The results of AR (1) model with drift term is reported in Table 3.2. The value of slope coefficient in each case is found to be 0.99. When the value of slope coefficient in AR(1) model is close to 1, we have unit root problem. The existence of unit problem implies that the series is not stationary. We also conducted a formal test of stationarity using Augmented Dickey –Fuller test.

The results of ADF test is provided in Table 3.3. The results show that the Nifty, Nifty Futures, Bank Nifty, Bank Nifty Futures, CNXIT and CNXIT Futures are not stationary in log level. However, the log return series of Nifty, Nifty Futures, Bank Nifty, Bank Nifty Futures, CNXIT and CNXIT Futures are stationary. Since all the series are becoming stationary after first differencing, they are integrated of order one.

Table 3.3: Unit Root test in level and return series

Level Series	ADF Test
Nifty Spot	-1.047
Nifty Futures	1.034
Bank Nifty	-1.4140
Bank Nifty Futures	-1.4160
CNXIT	-0.1843
CNXIT Futures	-0.2869
Return Series	ADF Test
Nifty	-43.1366
Nifty Futures	-45.4777
Bank Nifty	-18.88
Bank Nifty Futures	-19.20
CNXIT	-22.1525
CNXIT Futures	-23.0782

After checking the stationarity of all the series, we computed the optimal hedge ratio from above three models and compared the hedging effectiveness of each model. The results from conventional regression model are reported in Table 3.4.

Table 3.4: Optimal Hedge Ratio by OLS Method

ΔNifty = 0.0531 + 0.9253 Δ Nifty Futures (0.026) (304. 0008) R square = 0.97 df = 2160 F Statistic = 92416 (0.00)
Δ Bank Nifty = 0.0183 + 0.9637 Δ Bank Nifty Futures (0.0180) (183.01) R square = 0.98 df = 491 F Statistic = 33496.15 (0.00)
Δ CNXIT = -0.3529 + 0.9469 Δ CNXIT Futures (-0.4782) (124.81) R square = 0.96 df = 490 F Statistic = 15579.57 (0.00)

The results show that the optimal hedge ratio for Nifty futures is 0.9253. In OLS regression model the hedging effectiveness of futures contract is ascertained by the R^2

value. The results show the hedging effectiveness of Nifty futures contract is 97 percent. In other words, 97 percent of the variation in spot Nifty is explained by the Nifty futures contract. Similarly, the optimal hedge ratio for Bank Nifty futures and CNXIT futures are 0.9637 and 0.9469. The hedging effectiveness of Bank Nifty futures and CNXIT Futures are indicated by R square which are 0.98 and 0.96 respectively. In other words, 98 percent variation in Bank Nifty is explained by bank nifty futures. Likewise, 96 percent variation in CNXIT index is explained by CNX IT futures.

Next, we estimated bi-variate vector autoregressive model (VAR) and vector error correction model (VECM) with five lags for Nifty and Nifty futures, Bank Nifty and Bank Nifty Futures and CNXIT and CNXIT Futures. The estimates of bi-variate VAR and VECM Model are reported in Appendix Table III.3 through Table III.9 at the end of the chapter III. To calculate optimal hedge ratio, we obtained residuals from estimated VAR and VECM model. Using equation (6), we computed the optimal hedge ratio. The optimal hedge ratio from VAR and VECM model are reported in Table 3.5. While the optimal hedge ratio from VAR model is 0.9282, the hedge ratio from VECM model is 0.9284 for Nifty Futures contract. From the results, it is clear that the hedge ratio from OLS, VAR and VECM models are almost same. The hedging effectiveness of the VAR and VECM models are 0.96 and 0.97 percent respectively.

Table 3.5: Estimates from VAR Model for Nifty Futures

	VAR	VECM
Covariance (μ_s, μ_f)	0.0002971	0.000296
Variance (μ_f)	0.00032	0.000318
Hedge Ratio	0.92	0.93
Var (U)	0.000286	0.000284
Var(H)	0.00001	0.000008
Hedging Effectiveness	0.96	0.97

We also estimated VAR and VECM model for Bank Nifty and Bank Nifty Futures and then obtain the residuals from the VAR and VECM models for Bank Nifty futures contract. Again using equation (6), we estimated optimal hedge ratio. The hedge ratio and hedging effectiveness for Bank Nifty futures contract is reported in Table 3.6.

Table 3.6: Optimal hedge ratio and Hedging Effectiveness for Bank Nifty Futures

	VAR	VECM
Covariance (μ_s, μ_f)	0.000839	0.000835
Variance (μ_f)	0.00087	0.000866
Hedge Ratio	0.9643	0.964
Var(U)	0.000819	0.000815
Var(H)	0.000009	0.00001
Hedging Effectiveness	0.98	0.98

Hedge ratio for Bank Nifty futures are 0.9643 and 0.964 respectively from the VAR and VECM models. The hedging effectiveness of Bank Nifty futures contract from VAR and VECM models are 0.98. Thus, the 98 percent of variation in spot prices are explained by futures prices. This indicates that for hedging one has to take nearly equal and opposite position in the futures market.

Table 3.7: Optimal hedge ratio and Hedging Effectiveness for CNXIT Futures

	VAR	VECM
Covariance (μ_s, μ_f)	0.0005726	0.000568
Variance (μ_f)	0.000601	0.000596
Hedge Ratio	0.9527	0.953
Var(U)	0.000559	0.000555
Var(H)	0.0000134	0.000014
Hedging Effectiveness	0.974	0.978

Next, we computed hedge ratio and its effectiveness for another sectoral index, that is, CNX IT futures contract. We estimated VAR and VECM models for CNXIT and CNXIT Futures and obtained the residual from both the models and estimated hedge ratio. The hedge ratio from both the VAR and VECM models are given in Table 3.7 which shows that the hedge ratio for CNX IT futures contract from VAR and VECM are 0.9527 and 0.953 respectively. The hedge ratio for CNXIT futures contract from OLS, VAR and VECM model are 0.94, 0.9527 and 0.953 which are essentially equal in their magnitude. The hedging effectiveness of CNXIT futures contract by OLS, vector autoregression (VAR) and vector error correction model (VECM) are 0.96, 0.9744 and

0.978 respectively. The VAR and VECM models outperform OLS model in their hedging effectiveness. Moreover, the hedging effectiveness of 10 single stock futures are also estimated. By and large, all the stock futures provide effective hedge to market players. The hedging effectiveness of all single stock futures contracts are well above 0.95 except for BHEL and SAIL (See Appendix Table III.I through Table III.3).

3.6 Conclusion

One of the important functions of the futures market is providing effective hedge besides price discovery at distant future date. We estimated optimal hedge ratio and hedging effectiveness for three futures contract viz. S&P CNX Nifty futures, Bank Nifty Futures and CNXIT Futures from three alternative models, an OLS based model, vector autoregression model (VAR) and vector error correction model (VECM). We compare the hedging effectiveness of the contacts using these models, *ex post* (in-sample) and *ex ante* (out-of-sample). The study shows that cash prices and futures prices are co-integrated and there exist a long run equilibrium relationship between cash and futures prices. In case of all contracts, VECM performs better than OLS and VAR models. The study found that Nifty futures, Bank nifty futures and CNXIT futures contracts traded on NSE provide effective hedging facility to the market players. Stock futures contracts also provide effective hedge for risk management.

Appendix Tables

Table III. 1: Hedge Ratio by OLS Method

Stock Futures	Hedge Ratio	Hedging Effectiveness
Bharti Airtel	0.96	0.97
BHEL	0.06	0.04
ICICI Bank	0.99	0.98
Infosys	1.009	0.97
ITC	0.96	0.94
ONGC	0.93	0.94
Reliance	0.98	0.98
SAIL	0.15	0.16
SBI	0.95	0.98
Wipro	0.93	0.94

Table III.2: VAR Model for Stock Futures

Stock Futures	Covariance (μ_s, μ_f)	Variance (μ_f)	Hedge Ratio	Var(U)	Var(H)	HE
Bharti Airtel	0.000819	0.000848	0.9663	0.000809	0.000023	0.97
BHEL	0.001441	0.0222	0.0649	0.001838	0.00174	0.05
ICICI Bank	0.001565	0.001588	0.98	0.001566	0.000023	0.98
Infosys	0.0006141	0.000606	1.01	0.000636	0.000014	0.97
ITC	0.00052	0.000544	0.9558	0.000522	0.000024	0.95
ONGC	0.008008	0.000851	0.94	0.000791	0.000037	0.95
Reliance	0.000957	0.00097	0.98	0.000957	0.000012	0.98
SAIL	0.001762	0.01009	0.17	0.00163	0.001323	0.18
SBI	0.001004	0.001059	0.948	0.000971	0.000018	0.98
Wipro	0.00051	0.000541	0.9528	0.00052	0.000026	0.95

Table III.3: VECM Model for Stock Futures

Stock Futures	Covariance (μ_s, μ_f)	Variance (μ_f)	Hedge Ratio	Var(U)	Var(H)	HE
Bharti Airtel	0.000825	0.000854	0.966	0.000815	0.000018	0.97
BHEL	0.001447	0.0222	0.0651	0.001852	0.001758	0.05
ICICI Bank	0.001565	0.001586	0.9867	0.001566	0.00003	0.98
Infosys	0.000616	0.000608	1.01	0.000639	0.000015	0.97
ITC	0.000523	0.000547	0.9561	0.000525	0.000025	0.95
ONGC	0.0007972	0.000846	0.942	0.000789	0.000038	0.95
Reliance	0.000962	0.000974	0.9876	0.000962	0.000012	0.98
SAIL	0.001771	0.010094	0.1754	0.001637	0.001326	0.18
SBI	0.000997	0.001052	0.947	0.000964	0.000019	0.98
Wipro	0.000512	0.000544	0.9512	0.000528	0.000022	0.95

Table III.4: VAR Model for Nifty and Nifty Futures

Parameters	Estimated Coefficient	Parameters	Coefficients
α_s	0.0271 (0.45)	α_f	0.0270 (0.40)
B_{s1}	0.2097 (0.07)	B_{f1}	-0.4707 (0.00)
B_{s2}	0.0660 (0.59)	B_{f2}	-0.3501 (0.00)
B_{s3}	-0.0014 (0.99)	B_{f3}	-0.1438 (0.00)
B_{s4}	0.2107 (0.08)	B_{f4}	-0.3076 (0.25)
B_{s5}	0.1700 (0.13)	B_{f5}	-0.2748 (0.01)
δ_{f1}	-0.1148 (0.30)	δ_{s1}	0.5361 (0.01)
δ_{f2}	-0.1281 (0.27)	δ_{s2}	0.3044 (0.00)
δ_{f3}	0.0094 (0.93)	δ_{s3}	0.1581 (0.23)
δ_{f4}	-0.1885 (0.11)	δ_{s4}	0.3299 (0.01)
δ_{f5}	-0.1685 (0.12)	δ_{s5}	0.2781 (0.02)
R^2	0.013	R^2	0.014

Table III.5: VECM Model for Nifty and Nifty Futures

Parameters	Estimated Coefficient	Parameters	Coefficients
λ	0.1850* [2.18613]	λ	0.3365* [3.75703]
B_{s1}	0.054336 [0.40691]	B_{f1}	-0.205538*** [-1.52424]
B_{s2}	-0.059509 [-0.44544]	B_{f2}	-0.133208 [-0.98137]
B_{s3}	-0.088471 [-0.67176]	B_{f3}	0.017285 [0.12941]
B_{s4}	0.120599 [0.94263]	B_{f4}	-0.161613 [-1.24815]
B_{s5}	0.127556 [1.09795]	B_{f5}	-0.1872*** [-1.59187]
δ_{f1}	0.038484 [0.30199]	δ_{s1}	0.269015** [1.90392]
δ_{f2}	-0.000727 [-0.00567]	δ_{s2}	0.087716 [0.62050]
δ_{f3}	0.100387 [0.79527]	δ_{s3}	-0.000336 [-0.00241]
δ_{f4}	-0.102526 [-0.83785]	δ_{s4}	0.1794*** [1.32547]
δ_{f5}	-0.1231 [-1.10752]	δ_{s5}	0.1939*** [1.57752]
α_s	0.000307 [0.85028]	α_f	0.000309 [0.80823]
R^2	0.01	R^2	0.01

Table III.6: VAR Model for Bank Nifty and Bank Nifty Futures

Parameters	Estimated Coefficient	Parameters	Coefficients
α_s	-0.04 (-0.33)	α_f	-0.04 (-0.3357)
B_{s1}	-0.03 (-0.06)	B_{f1}	-0.3597 (-0.77)
B_{s2}	0.2063 (0.40)	B_{f2}	-0.56 (-1.12)
B_{s3}	0.57 (1.12)	B_{f3}	-0.85 (-1.67)
B_{s4}	0.7708 (1.53)	B_{f4}	-1.14 (-2.26)
B_{s5}	0.2060 (0.44)	B_{f5}	-0.4616 (-1.001)
δ_{f1}	0.14 (0.32)	δ_{s1}	0.47 (0.99)
δ_{f2}	-0.2068 (-0.41)	δ_{s2}	0.57 (1.10)
δ_{f3}	-0.5503 (-1.1)	δ_{s3}	0.88 (1.69)
δ_{f4}	-0.84 (-1.71)	δ_{s4}	1.08 (2.09)
δ_{f5}	-0.2986 (-0.66)	δ_{s5}	0.36 (0.78)
R^2	0.04	R^2	0.04

Table III.7: VECM Model for Bank Nifty and Bank Nifty Futures

Parameters	Estimated Coefficient	Parameters	Coefficients
λ	-0.373563 [-0.77782]	λ	-0.118819 [-0.24002]
B_{s1}	0.217490 [0.38260]	B_{f1}	-0.416401 [-0.72226]
B_{s2}	0.286617 [0.51408]	B_{f2}	-0.464757 [-0.82259]
B_{s3}	0.572999 [1.06732]	B_{f3}	-0.698515 [-1.28502]
B_{s4}	0.8191*** [1.6183]	B_{f4}	-1.099311** [-2.14685]
B_{s5}	0.214037 [0.48469]	B_{f5}	-0.396228 [-0.88617]
δ_{f1}	-0.110726 [-0.19796]	δ_{s1}	0.521403 [0.88986]
δ_{f2}	-0.269724 [-0.49208]	δ_{s2}	0.488030 [0.84921]
δ_{f3}	-0.538096 [-1.02036]	δ_{s3}	0.738167 [1.33394]
δ_{f4}	-0.908163*** [-1.82811]	δ_{s4}	1.0163 ** [1.9479]
δ_{f5}	-0.293783 [-0.67726]	δ_{s5}	0.318862 [0.70052]
α_s	-0.000744 [-0.60159]	α_f	-0.000738 [-0.57868]
R^2	0.036	R^2	0.031

Table III.8: VAR Model from CNXIT and CNXIT Futures

Parameters	Estimated Coefficient	Parameters	Coefficients
α_s	-0.2125 (-1.92)	α_f	-0.2112 (-1.845)
B_{s1}	0.5652 (1.83)	B_{f1}	-1.01 (-3.30)
B_{s2}	0.2344 (0.707)	B_{f2}	-0.61 (-1.82)
B_{s3}	0.071 (0.21)	B_{f3}	-0.31 (-0.93)
B_{s4}	-0.24 (-0.75)	B_{f4}	-0.05 (-0.15)
B_{s5}	0.2729 (0.90)	B_{f5}	-0.35 (-1.85)
δ_{f1}	-0.5333 (-1.80)	δ_{s1}	1.029 (3.22)
δ_{f2}	-0.3330 (-1.02)	δ_{s2}	0.526 (1.52)
δ_{f3}	-0.12 (-0.36)	δ_{s3}	0.2693 (0.77)
δ_{f4}	0.117 (0.3632)	δ_{s4}	-0.06 (-0.19)
δ_{f5}	-0.1845 (-0.634)	δ_{s5}	0.44 (1.43)
R^2	0.0424	R^2	0.0505

Table III.9: VECM Model for CNXIT and CNXIT Futures

Parameters	Estimated Coefficient	Parameters	Coefficients
λ	0.179058 [0.60921]	λ	0.420391*** [1.38064]
B_{s1}	0.372915 [1.02157]	B_{f1}	-0.641897** [-1.73573]
B_{s2}	0.019077 [0.05242]	B_{f2}	-0.251840 [-0.68073]
B_{s3}	0.033509 [0.09482]	B_{f3}	-0.159119 [-0.44378]
B_{s4}	-0.396656 [-1.17343]	B_{f4}	0.184770 [0.53982]
B_{s5}	0.158952 [0.53516]	B_{f5}	-0.179111 [-0.59934]
δ_{f1}	-0.349713 [-0.97966]	δ_{s1}	0.650736** [1.72075]
δ_{f2}	-0.114462 [-0.32053]	δ_{s2}	0.166603 [0.44187]
δ_{f3}	-0.065251 [-0.18853]	δ_{s3}	0.127382 [0.34794]
δ_{f4}	0.246756 [0.74684]	δ_{s4}	-0.327475 [-0.93513]
δ_{f5}	-0.071625 [-0.24829]	δ_{s5}	0.270595 [0.87940]
α_s	-0.001762*** [-1.70256]	α_f	-0.001761*** [-1.64303]
R^2	0.042360	R^2	0.05

Chapter-IV

Price Discovery in Cash and Futures Market

4.1 Introduction

There is perhaps no question more central to economics than how prices are discovered by the market. In this chapter, we will try to find whether or not futures market performs its basic function of price discovery. Price discovery refers to the process through which markets attempt to reach equilibrium prices. In a static sense, price discovery implies the existence of equilibrium prices and in the dynamic sense, the price discovery process describes how information is produced and transmitted across the markets.

The ability of futures markets to provide information about prices is a central theme for the existence of these markets. In order to obtain an optimum allocation of resources in an economy, prices must accurately reflect relative production costs and relative consumption utilities. Futures markets, by providing a mechanism through which information about current and future spot prices can be assimilated and disseminated to all participants in the economy, help to achieve this goal.

All these prices are the result of open and competitive trading and reflect the underlying supply and demand for a financial asset or a good, both in the present and at various times in the futures. More specifically, in the case of future delivery, future prices reflect current expectations about what the supply and demand for a commodity or a financial asset are likely to be at different times in future. Futures prices mainly changes because of the buyers and sellers expectation about uncertain future. In other words, expectation about what the price of a particular good will be at some point of time in future. As expectation changes with arrival of more information in the market, the demand and supply condition accordingly changed and the price of futures contract may be bid upward or downward. As such futures prices discover ‘expected’ spot prices that are expected to prevail at various times in the future.

The relationship between the futures market and its underlying market has been a major issue of research due to considerable volume of trading in these contracts and their role in discovering future prices. Price discovery in the context of futures trading refers to the use of futures price for predicting future spot price. The significance of this important function of the futures market lies in the fact whether new information is reflected first in the futures market or in the underlying cash market. The amount of price discovery originating in the futures market has important implication for hedgers and arbitragers who use these markets.

In a perfectly frictionless world, futures price and spot price would be contemporaneously perfectly correlated. In other words, if the futures and cash markets are perfectly efficient, informed traders are indifferent between trading in either markets and the new information will come to both markets simultaneously. However, as futures market provides leverage in trading and the transaction cost is also lower in this market than the cash market, it is expected that the new information will first reflect in the futures market and then flow to the cash market. Thus, futures market is, in general, expected to lead the cash market. This lead-lag or price discovery relationship is a subject of great concern to academics, practitioners and regulators because the price discovery function of the futures markets is closely associated with market efficiency and arbitrage. There are many theoretical as well as empirical works, which investigates information exchange and price discovery roles of the futures markets. and the regulatory bodies, academicians and practitioners unanimously have agreed upon the common notion that organized futures markets contain significant information for the prospective cash market price changes in short-run, irrespective of the fact that in the long-run, both markets observe strong and stable co-movement. However, Wahab and Lashgari (1993), Chan and Lien (2001), Chen et al., (2002), Lin et al., (2002), Lien et al., (2003), Lin et al., (2003), Mukherjee and Mishra (2006) and Thomas (2006) have found contrary evidence suggesting that cash market serves as dominant market and futures market behaves like satellite market.

The relationship between spot and related futures markets has been the focus of much literature for some time. There is a wide body of research, which clearly indicates futures markets lead spot markets and suggest this provides evidence of futures markets acting as a vehicle for price discovery within the corresponding stock markets. Reasons for why futures prices seem to lead spot prices are numerous. They include the fact that futures markets tend to have less trading constraints than the cash markets, leading to futures markets being more informationally efficient as the marginal costs from trading will be less than in the cash markets. This is further compounded by the fact that futures markets tend to have lower transaction costs and higher liquidity.

The earliest attempt to study the lead-lag relationship between stock index and stock index futures was carried out by Kawaller, Koch, and Koch (1987) using minute by minute S&P 500 futures and S&P500 spot price for six days during 1984 and 1985 concluded that the futures contract leads the cash index for as long as 20 to 45 minutes employing three stage least square. Laatsch and Schwarz (1988) studied Major Market Index ((MMI) and documented simultaneous pricing for minute by minute data. However, Finnerty and Park (1987) for the period August 1984 to August 1986 found a significant lead-lag relationship exists for minute by minute MMI data.

Herbst, McCormack, and West (1987) studied S&P 500 and Value Line futures contacts and its relationship with underlying counterparts by using spectral analysis cross correlations to determine lead-lag relationship. They reported that futures lead the cash index with the lead varying from 0 to 16 minutes. Stoll and Whaley (1990) computed correlation coefficients for various multiples of minute interval data for the S&P 500 and MMI contracts. The findings of their study were that on average futures lead cash with a lead time of 5 minutes. Nonetheless, the futures and cash prices are often contemporaneous. They attributed the lag effect to infrequent trading for the cash stocks. Stoll and Whaley (1990) considered that higher liquidity and lower transaction cost play a vital role in explaining why futures markets tend to exhibit price leadership effects over stock markets. They examined intra-day price changes from S&P 500 and MMI stock index and futures contracts for serial correlation via an ARMA(p,q) process. They found strong evidence of futures markets leading stock indices. One other explanation for why futures lead stock markets relates to Chan's (1992) evidence on the impact of market-wide and firm-specific news events upon a spot / futures relationship. Chan hypothesized that market-wide information, being systematic in nature, would feed through the futures markets before entering the spot market as traders find it more convenient to trade index futures than portfolios which attempt to track an index.

Abhyanker (1995) using hourly retruns in the FTSE 100 stock index futures and spot index analyzed the lead –lag mechanism for the period 1986 to 1990 taking into account differential transaction costs, spot volumes and volatility and impact of good and bad news. This study documented that futures lead of the spot reduced when transaction costs for the underlying asset fell. The findings suggest that futures markets can provide investors with important information, especially during periods of high volatility. Turkington and Walse (1999) studied Shares Price Index (SPI) futures and the All-Ordinary Index (AOI) in Australia employing cost-of carry model, ARMA (p,q), Bivariate VEC, VAR models. They concluded that SPI futures and AOI index are cointegrated and there exist a strong bi-directional causality between the two markets. Jong and Donders (1998) found that Amsterdam Exchange (AEX) lead European Option Exchange (EOE) by approximately 10 minutes.

In India, Thenmozi (2002) and Raju and Karnade (2003) made earliest studies on the lead-lag and price discovery of equity futures market in India. Raju and karnade (2003) studied Nifty index futures and Nifty index using data for a period two and half years. They found partial support for price discovery. Thomas and Karnade (2002) and Sahadevan (2002) price discovery in commodity futures in India. While Mukherjee and Mishra (2006), Sah and Kumar (2006) and Bhatia (2007) found strong evidence of lead-lag relationship between futures and spot prices.

4.2 Theoretical Background

There are two views in futures literature regarding formation of price in futures market. In the first the inter-temporal relationship between cash and futures prices of futures is explained by the cost-of-carry model (Kaldor, 1939; Working 1948; Telser, 1958).

The theory of inter-temporal relationship between cash and futures prices can be explained with the cost-of-carry model. This is given as:

$$F_t. = S_t e^{rT} \tag{4.1}$$

where,

F_t = Futures price at time'‘t’

S_t = Spot price at time‘t’

r = holding costs

T = time till expiration

If $F>Se^{rT}$ or $F<Se^{rT}$ then futures price is away from its 'fair value’ and arbitrage opportunities exist there. The relationship between the cash market and futures market are thought of as being maintained by professional arbitragers who employ computerized trading systems to capitalize on deviations of stock index futures prices from ‘perceived’ fair values or whenever parity represented by equation (4.1) is violated. If actual futures price exceeds their perceived fundamental value, the futures contract is overvalued (Wahab and Lashgari, 1993). In this situation, arbitragers simultaneously take positions in the underlying market and futures market, and hence lock in a secure payoff. When the futures contract is overvalued, arbitragers sell futures contract and buy stocks in the underlying market while on the other hand, an undervalued futures contract triggers a short arbitrage position where arbitragers buy futures and sell stocks simultaneously in both the markets.

The second view splits the futures price into an expected risk premium and a forecast of a future spot price (Cootner, 1960; Dusak, 1973; Breeden, 1980; Hazuka, 1984). Supporters of the second view on the price formation process for futures prices argue that the basis can be expressed as a sum of an expected premium and an expected change in the spot price

$$F_t^T .- S_t^T .. = E_t\left[P(t,T) + E_t\left(S_T - S_t\right)\right] \qquad (4.2)$$

where,

$F_t^T - S_t^T$ = Basis[3]

$E_t = [P(t,T)]$ = Expected premium

$E(S_T - S_t)$ = Expected future spot price

[3] Basis is the difference between futures and spot price at a specified time period.

Here the expected premium is defined as the bias of the future price as a forecast of the future spot price as follows:

$$E_t\left[P(t,T)\right] = F_t^T - E_t\left[S_T\right] \qquad (4.3)$$

$E_t = [P(t,T)]$ = Expected premium

F_t^T = Futures price at the time of expiry

$E_t(S_T)$ = Expected spot price at the time of expiry

Fama and French (1988) argue that the theory of holding costs, equation (4.1) and equation (4.2) are alternative but not competitive views of the basis, and that variation in expected change in the spot price in (4.2) translates into variation in the interest rate and the marginal holding cost in (4.1). Both theories imply that there should be a long run stable relationship between spot and futures prices. In addition, for the future price to be an unbiased predictor of eventual spot price premium must be zero, the future price should lead the spot price (Garbade and Silber, 1983). Hasbrouck (1995) argue that the relationship enshrined in cost-of-carry model implies that the price movements in cash and futures markets will be the same since they are subject to common information set(s), and any deviation between two price series must be subject to transaction cost (Protopapadakis and Stoll (1983) and Goodwin (1992). . However, it has been observed that though stable long-run relationship persists between two markets, but short-run deviations cannot be ruled out, which offer exploitable arbitrage opportunities (Cox et al., (1981) and Stoll and Whaley (1990)).

The implication of the cost-of-carry model is that in perfectly efficient and continuous spot and futures markets, price adjustments are instantaneous. The observed relation between price changes in the two markets will be noisy due to market imperfections and because price observations from the two markets are not simultaneous. Therefore, the normal relationship between stock index and stock index futures would be bounded by a lower and upper bound of no-arbitrage trading band. This no-arbitrage trading band is determined by market imperfections. Besides this, a lead-lag relation between price changes in the two markets is very likely, if there are economic incentives for traders to use one market over the other. There are studies which have documented presence of market frictions, which leads to deviations between futures and the spot prices (Stoll and Whaley (1990)) because market frictions disturb market equilibrium and the asset market with less transaction costs starts leading the other market. This suggests that trading rules may be formulated to exploit the discrepancies (Brannen and Ulveling (1984), Lai and Lai (1991), Jong and Donders (1998), Min and Najand (1999) and Chan et al., (2004)).

4.3 Research Design

This study investigates price discovery functions of futures markets at two levels viz. market level and firm level. To represent market, we have chosen S&P CNX Nifty on which Nifty futures is based. Besides this, we also considered two sectoral index namely Bank Nifty and CNX IT index. Data on S&P CNX Nifty and Nifty Futures, Bank Nifty and Bank Nifty Futures and CNXIT and CNXIT Futures are collected. For Nifty and Nifty futures daily data is collected for the period June 12, 2000 to 31 March, 2009. For bank Nifty and Bank Nifty Futures and CNXIT and CNXIT Futures, data are collected for the period 1st January 2007 to 26 March 2009. We also collected data on 10 individual stocks on which futures contract are available for trading. Since futures trading on individual securities started on 9 November, 2001, we collected data from November 9, 2001 to 31 March, 2009 for underlying as well as near month futures contract.

1. Bharat Heavy Electricals Limited (BHEL)
2. Bharti Airtel
3. ICICI Bank
4. Infosys Technology Ltd
5. ITC Ltd
6. ONGC
7. Reliance
8. State Bank of India (SBI)
9. Steel Authority of India Limited (SAIL)
10. Wipro

The criterion used for selection of companies in the sample is the market capitalization of the company. Moreover, these companies are most liquid stocks available for trading on exchange. Besides this, we considered only near month contract as the trading volume for middle month and far month contracts are very low.

4.4 Hypotheses

Price discovery may occur in both the cash and futures markets and by incorporating information from each market one can predict future spot prices. This has led to the formulation of the following hypothesis:

H_0: The futures and spot prices are predictable from each other

H_1: The futures and spot prices are not predictable from each other

According to Black (1976a) the most important benefit of opening a futures market is it increases the forecast information and increases the quantity of information available to the public. Futures markets are expected to increase the information content of market prices. There are three reasons for this. First, transaction costs are generally lower in futures market than the cash market. Second futures market attracts speculators or informed traders and is expected to improve the amount of information in price formation. Third, in processing the information, speculators take into account the responses of all market participants to the prices implied by any single piece of information, thus improving the rationality of market prices. However, there are economists who question the informational role of futures prices. This discussion led to the development of the following hypotheses:

H_0: Futures lead the spot price

H_1: Futures do not lead the spot price

H_0: Spot leads the futures price

H_1: Spot does not lead the futures price

4.5. Methodology

In this study, a co-integration approach and an error correction model (ECM) using the Engle-Granger methodology is applied to capture both the long run and the short run dynamics of spot and futures prices. In addition to this, we also make use of Johnston system approach for studying lead-lag relation between cash and futures markets. Before doing co-integration analysis, it is necessary to test statistical properties of time series data because presence of unit root problem may lead to spurious results. In order to test for the existence of unit roots and to determine the order of differencing necessary to make non stationery series into stationary series, Dickey-Fuller and Augmented Dicky-fuller (ADF) tests have been applied.

4. 5.1 Testing Stationarity

Let us consider an AR(1) model

$$y_t = \rho_1 y_{t-1} + e_t \qquad (4.4)$$

where,

$y_t =$ y at time 't'

$y_{t-1} =$ one lagged value of y

$\rho_1 =$coefficient of y_{t-1}

The simple AR(1) model represented in equation (4.4) is called a random walk model. A random walk is a special case of what is known as a unit root process. The names comes from the fact that $\rho = 1$ in the AR(1) model. To take care of trend , a random walk with drift is more appropriate:

$$y_t = \alpha_0 + \rho_1 y_{t-1} + e_t, t = 1,2,... \qquad (4.5)$$

where,

$y_t =$ y at time 't'

$y_{t-1} =$ one lagged value of y

ρ_1=coefficient of y_{t-1}

α_0 = drift term

A random with drift is also a unit root process because it is the special case $\rho_1 = 1$ in an AR(1) model with an intercept when $\rho_1 = 1$. There are informal tests that provide guidance about whether a time series is a unit root process or not. A very simple tool is AR(1) model and if $|\rho_1| < 1$, then the process is I(0), but it is I(1) if $\rho_1 = 1$. Most economists think that differencing is warranted if estimated $\rho > 0.9$; some would difference when estimated $\rho > 0.8$.

4.5.2 Dickey-Fuller Test

One formal method of testing stationarity of a series is Dickey-Fuller test, which involves estimating regression equation and carrying out the hypothesis test. The simplest approach to testing for a unit root is with an AR(1) model:. Let us consider an AR(1) process:

$$y_t = c + \rho y_{t-1} + \varepsilon_t \tag{4.6}$$

where c and ρ are parameters and ε_t is assumed to be white noise. If -1<ρ<1, then y is a stationary series while if ρ=1, y is a non-stationary series. If the absolute value of ρ is greater than one, the series is explosive. Therefore, the hypothesis of a stationary series is involves whether the absolute value of ρ is strictly less than one. The test is carried out by estimating an equation with y_{t-1} subtracted from both sides of the equation:

$$\Delta y_t = c + \gamma y_{t-1} + \varepsilon_t \tag{4.7}$$

where γ =ρ-1 , and the null and alternative hypotheses are

$$H_0 : \gamma = 0$$
$$H_1 : \gamma \prec 0$$

The usual t-statistic under the null hypothesis of a unit root does not have the conventional t-distribution. Dickey and Fuller (1979) showed that the distribution under the null hypothesis is nonstandard, and simulated the critical values for selected sample sizes. More recently, MacKinnon (1991) has implemented a much larger set of simulations than those tabulated by Dickey and Fuller.

More generally, we can add p lags of Δy_t to the equation to account for the dynamics in the process. This extended version of the Dickey-Fuller is called the augmented Dickey-Fuller test because the regression has been augmented with the lagged changes. The inclusion of lagged changes is intended to clean up any serial correlation in Δy_t. The more lags we include the more initial observations we lose. If we include too many lags, the small sample power of the test generally suffers. But if we include too few lags, the size of the test will be incorrect, even asymptotically, because the validity of the critical values relies on the dynamics being completely modeled. Often the lag length is dictated by the frequency of the data. For annual data, one or two lags usually suffice. For monthly data, we might include twelve lags. But there is no hard and fast rule.

4.5.3 Augmented Dickey-Fuller Test

The simple unit root test is valid only if the series is an AR(1) process. If the series is correlated at higher order lags, the assumption of white noise disturbances is violated. The ADF controls for higher-order correlation by adding lagged difference terms of the dependent variable to the right-hand side of the regression:

$$\Delta y_t = c + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + \delta_2 \Delta y_{t-2} + ... + \delta_p \Delta y_{t-p} + \varepsilon_t \qquad (4.8)$$

This augmented specification is then tested for

$$H_0 : \gamma = 0$$
$$H_1 : \gamma \prec 0$$

in this regression.

4. 5.4 Co-Integration and Error Correction Model

Engle and Granger (1987) introduced the concept of co-integration when he wrote that two variables may move together though individually they are non-stationary. Co-integration is based on the long run relationship between variables. The idea arises from considering equilibrium relationships, where equilibrium is a stationary point characterized by forces that tend to push the variables back toward equilibrium.

In general, if y_t and x_t are both integrated of order I(d) then any linear combination of the two series will also be I(d); that is, the residuals obtained on regressing y_t on x_t are I(d). If, however, there exists a vector b, such that the disturbance term from the regression ($e_t = y_t - x_t$) is of a lower order of integration I(d-b), where b>0, then Engle and Granger (1987) define y_t and x_t as cointegrated of order (d,b).

If two or more series are cointegrated then even though the series themselves may be non-stationary, they will move closely together over time and their difference will be stationary. Their long run relationship is the equilibrium to which the system converges overtime, and the disturbance term e_t can be construed as the disequilibrium error or the distance that the system is away from equilibrium.

Engle-Granger advocated two-step method for testing cointegration between two variables. Following procedure:

Step 1: Test order of integration in variables:

The first step is to find out whether Y and X are I(1). This is same as to determining whether or not these variables contain unit roots. Thus, the first step is to find order of integration in each variable. The Dickey- Fuller (DF) and Augmented Dickey-Fuller (ADF) can be used to find the number of unit roots in each of the variables. While determining order of integration three cases can arise which tell us either go to next step or stop. When both the variables are integrated of order zero i.e. I(0), there is no need to proceed further as we apply classical regression analysis to stationary series. If two variables are integrated of different order, it is certain that these variables are not cointegrated. When two variables are integrated of the same order then go to second step of Engle and Granger methodology.

Step II: Test for cointegration

If in step I it is established that both the series are integrated of the same order, then go to next step and estimate the parameters of cointegrating regression equation as given below:

$$Y_t = \alpha + \beta X_t + \mu_t \qquad (4.9)$$

If X_t and Y_t are cointegrated, then ordinary least squares regression gives 'super-consistent' estimates for parameters α and β. In order to find if X_t and Y_t are actually cointegrated, obtain the OLS residual $\hat{\mu}_t$ and test whether or not residual is stationary. If residual is stationary then Y and X are cointegrated that means they move very closely over time.

Historically, the accepted practice for overcoming the possible spurious relationship between two time series has been to first difference each series and then run regression. The problem with this practice was that it led to loss of valuable long-run information. The question was how to capture both short run and long run effects between two variables. Cointegration formed the basis through which this can be done. Engle and Granger (1987) have shown that if Y and X are both I(1) variables, an error correction model exists. Engle and Granger method for testing existence of cointegration is as follows:

$$\Delta Y_t = \theta_1 + \sum_{i=1}^{m} \alpha_{1i} \Delta Y_{t-i} + \sum_{i=1}^{m} \beta_{1i} \Delta X_{t-i} + \psi_1 \mu_{t-1} + \varepsilon_{1t}$$
$$\Delta X_t = \theta_2 + \sum_{i=1}^{m} \alpha_{2i} \Delta Y_{t-i} + \sum_{i=1}^{m} \beta_{2i} \Delta X_{t-i} + \psi_2 \mu_{t-1} + \varepsilon_{2t} \quad (4.10)$$

with

$$|\psi_1| + |\psi_2| \neq 0$$

where μ_{t-1} is the error lagged one period derived from the co-integrating regression. In the above error correction model, the coefficient of one period lagged error term indicates the long run disequilibrium deviations from the equilibrium point. Ψ being the adjustment factor which takes values between 0 and 1.

4.5.5 Johansen System Approach

In addition, the long run relationship between two series has been examined by applying Johansen and Juselius (1990) cointegration procedure. Johansen's Maximum Likelihood Procedure provides a unified framework of estimating and testing the cointegration relationships in a VAR error correction mechanism, which incorporate different 'short-run' and 'long-run' dynamic relationships in a variable system. Let us suppose that a set of g variables ($g \geq 2$) that are I(1). A VAR with k lags containing these variables:

$$Y_t = \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + ... + \beta_k Y_{t-k} + \mu_t \qquad (4.11)$$

To implement Johansen test, the VAR needs to be turned into a vector error correction model of the form:

$$\Delta Y_t = \prod Y_{t-1} + \Gamma_1 \Delta Y_{t-1} + \Gamma_2 \Delta Y_{t-2} + ... + \Gamma_k \Delta Y_{k-1} \Delta Y_{t-(k-1)} + \mu_t \qquad (4.12)$$

where $\Pi = \left(\sum_{j=1}^{k} \beta_i \right) - I_g$ and $\Gamma_i = \left(\sum_{j=1}^{i} \beta_j \right) - I_g$

This VAR contains g variables in first differenced form on the left hand side and k-1 lags of the differenced dependent variables on the right hand side each with a Γ coefficient matrix attached to it.

The Johansen cointegration test revolves around an examination of the Π matrix. Π can be viewed as long-run coefficient matrix because in equilibrium, all theΔY_{t-i} will be zero and expected value of error terms, μ_t, $\Pi\Delta Y_{t-k}$=0. The test for cointegration between the Y_s is determined by looking at the rank of the Π matrix via its eigenvalues. The rank of the matrix is equal to the number of its characteristic roots. Under the Johnsen's approach, there are two test statistics for cointegration

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{p} In(1 - \hat{\lambda}_i)$$

and

$$\lambda_{\max}(r, r+1) = -T \ In(1 - \hat{\lambda}_{r+1})$$

where, P is the number of separate series to be examined. T is the number of usable observations; and $\hat{\lambda}_i$ are estimated eigenvalues obtained from the (i+1) x (i+1) cointegrating matrix.

Trace test λ_{trace} is a joint test which tests whether the number of distinct cointegrating vectors is less or equal to r. This test involves a null hypothesis of no cointegrating vectors. If the null is not rejected, it would be implied that there are no cointegrating vectors. However, if null hypothesis of no cointegrating vectors is rejected, the null of that there is one more cointegrating vector would be tested and so on. Therefore, the value of r is continually increased until the null is no longer rejected. The second test statistic λ_{max} test conducts separate tests on each eigenvalue and has the null hypothesis in this test is that number of cointegrating vectors is 'r' against 'r+1' alternative.

'r' is the rank of Π. Πmatrix can not be full rank since this would correspond to the original Y_t being stationary. If Π has zero rank, then it implies that ΔY_t depends only on ΔY_{t-j} and not on Y_{t-1} indicating no long run relationship between the elements of Y_{t-1}. Hence, no cointegration. For 1<Π<g, there are 'r' cointegrating vectors. Π is then defined as the product of two matrices, α and β' of dimension (g x r) and (r x g) respectively.

$$\Pi = \alpha\beta' \tag{4.13}$$

The matrix β' gives the cointegrating vectors and matrix α gives the amount of each cointegrating vector entering each equation of the VECM, also known as the adjustment parameters.

The VECM, F-test and t-tests may be inferred as within-sample causality tests. They can only signify the only Granger-exogenity or endogenity of the dependent variable within the sample period. They do not give indication of the dynamic properties of the system, nor do they permit to gauge the relative strength of the Granger-causal chain or degree of exogenity amongst the variables beyond the sample period. VDCs, which may be termed as out-of-sample causality tests, by partitioning the variance of the forecast error of a certain variable, say the cash price into amount attributable to innovations (or shocks) in each variable in the system including its own, can provide an indication of these relativities.

Alternatively, VDCs provide a literal breakdown of the change in the value variable in a given period arising from changes in the same variable in addition to the changes in other variables in previous periods. A variable that is optimally forecast from its own lagged values will have all its forecast error variance accounted for by its own disturbances. The information contained in the VDCs may also be equivalently represented by impulse response functions (IFRs) as both are obtained from the moving average representation of the original VAR model. IFRs basically map out the dynamic response path of a variable say, the cash price due to a one-period standard deviation shock to another variable say, futures trading volume.

4.6 Empirical Results

At the outset, we looked at the trend of S&P Nifty and S&P Nifty futures in Figure 4.1 and Figure 4.2 over the sample period from 12 June 2000 to 26 March 2006. Both the figures show that there was a rising trend in Nifty and Nifty futures from 12 June 2000 till 2008. With onset of economic slowdown, the stock markets round the world have declined. There is a close resemblance in the movements of Nifty and Nifty Futures.

Figure 4.1: Trend of S&P CNX Nifty

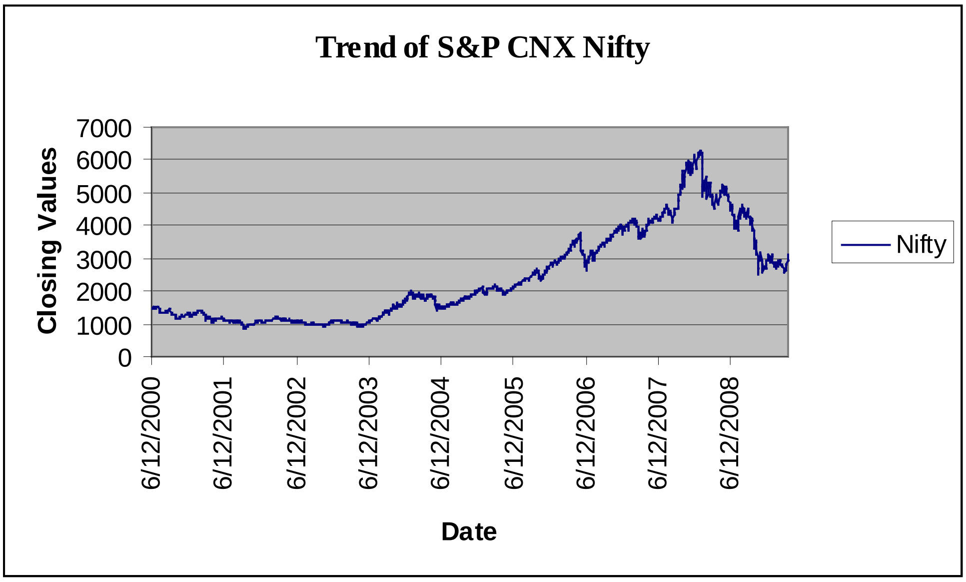
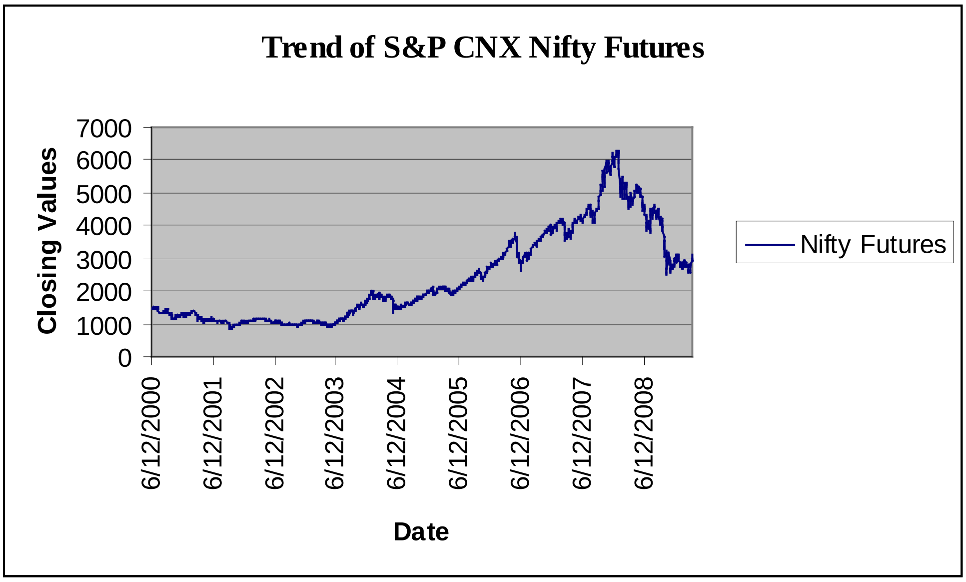


Figure 4.2: Trend of S&P CNX Nifty Futures



We started our empirical analysis first looking at the correlation between Nifty and Nifty futures, Bank Nifty and Bank Nifty futures and CNXIT and CNXIT futures. In this study, we have taken close-to-close prices to examine the price discovery function of the futures market on the presumption that closing prices contain all the information of the whole trading session.

Table 4.1: Coefficient of Correlation and its Significance

Indices	**Coefficient of Correlation**	**Two-tailed significance Test (t-statistic)**	**Probability Value**
Nifty and Nifty futures	0.9804	233.30	0.00
Bank Nifty and Bank Nifty Futures	0.9938	276.32	0.00
CNXIT and CNXIT Futures	0.9998	276.58	0.00

Table 4.1 shows the degree of relationship measured by the coefficient of correlation between S&P Nifty and S&P Nifty futures, Bank Nifty and Bank Nifty futures and CNXIT and CNXIT futures. There exists a positive correlation of 0.99 between in

case all the three indices indicating both the markets are having high degree of correlation. The coefficient of correlation of 0.99 can be interpreted as when futures prices increase 99 percent of the time spot prices will also increases. The observed correlation between Nifty and S&P Nifty futures, Bank Nifty and Bank Nifty futures and CNXIT and CNXIT futures are due to chance or are there really exist a strong relationship? To know the strength of this relationship, significance test is done by *t-statistic*. This test is given by the following formula:

$$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}} \qquad (4.14)$$

Table 4.1 reports the significance test of coefficient of correlation which shows that correlation between Nifty and S&P Nifty futures, Bank Nifty and Bank Nifty futures and CNXIT and CNXIT futures are not due to chance. It is significant at 1% level, which is statistically highly significant. Thus, high degree of correlation established that the information on one variable can be used to predict the movement of another variable. However, coefficient of correlation is symmetric in nature; relation between Y and X is same as relation between X and Y. This technique will not help to explain one variable in terms of another variable; if we want to explain movement of Nifty in terms of Nifty futures then regression analysis is the appropriate technique.

4.6.1 Unit Root Tests

In times series analysis, the usual OLS inferences are not valid if the assumptions of classical linear regression model are violated. One of the problems of time series econometrics is unit root problem. Now, it is customary to test for unit root process to know whether data are I(0) or I(1) process. We conducted unit root test for spot Nifty and Nifty futures first in levels and then on natural log return. We started with simplest approach of AR (1) model. Since, it is clear from the Figure 1 that both S&P Nifty and Nifty futures are trending over time. We specified a random walk model with a drift as follows:

$$Nifty_t = \alpha + \rho_1 Nifty_{t-1} + e_t$$

Similarly, for Nifty futures the model is specified as follows:

$$Niftyfutures_t = \alpha + \rho_1 Niftyfutures_{t-1} + e_t$$

If the estimated $|\rho_1| \prec 1$, then the process is I(0). However, it is I(1) if $\rho_1 = 1$. Most of the researchers think data contain unit root and call for differencing if estimated $\rho_1 \succ 0.9$. Others would difference when estimated $\rho \succ 0.8$. The results of unit root test from AR (1) model is reported in Table 4.2.

Table: 4.2: Estimated AR (1) Model

Nifty = 2.62 +0.99 Nifty (t-1)
Nifty futures = 2.85 + 0.99 Niftyfutures (t-1)
Bank Nifty = 24.84 +0.99 Bank Nifty (t-1)
Bank Nifty futures = 26.71 + 0.99 Bank Nifty futures (t-1)
CNXIT = 4.28 +0.99 CNXIT (t-1)
CNXIT futures = 5.35 + 0.99 CNXIT futures (t-1)

The results of Table 4.2 show that the estimated $\hat{\rho}_1 = 0.99$ for both Nifty and Nifty futures, Bank Nifty and Bank Nifty futures and CNXIT and CNXIT futures, which are very close to one. This indicates that all the series contain unit root and are not stationary. To perform unit root test in a formal manner, we conducted Dickey- Fuller test on Nifty and Nifty Futures, Bank Nifty and Bank Nifty futures and CNXIT and CNXIT futures. To this end, we estimated equation (4.7). The results of Dickey-Fuller are presented in Table 4.3

Table 4.3: Unit Root Test by DF Test

ΔNifty	= 2.62 - 0.0007 Nifty (t-1) (1.16) (-0.9603)
ΔNifty futures	= 2.85 -0.0008 Niftyfutures (t-1) (1.18) (-1.01)
ΔBank Nifty	= 24.84 -0.0047 Bank Nifty (t-1) (0.78) (-0.92)
ΔBank Nifty futures	= 26.71 – 0.0046 Bank Nifty futures (t-1) (0.82) (-0.96)
ΔCNXIT	= 4.28 -0.0023 CNXIT (t-1) (0.28) (-0.67)

ΔCNXIT futures	= 5.35 -0.0026CNXIT futures (t-1) (0.34) (-0.72)
Figures in () parenthesis are t-statistic. MacKinnon critical values for rejection of hypothesis of a unit root are -3.43, -2.86, -2.57 are at 1%, 5% and 10% respectively.	

From Table 4.3, it is clear the value of estimated ρ = 1- (-0.0007) which is almost one. The t-statistic on $Nifty_{t-1}$ is -0.9603. Because the 5% critical value is –2.86, we cannot reject the null of unit root hypothesis at the 5% level. A similar result was found in case of Nifty futures and the null of unit root was not rejected implying Nifty and Nifty futures series are not stationary in their log level. Likewise, in case of Bank Nifty, Bank Nifty futures, CNXIT and CNXIT futures, the null of unit root cannot be rejected.

The simple unit root test is valid only if the series is an AR(1) process. If the series is correlated at higher order lags, the assumption of white noise disturbances is violated. Thus, we also need to test for unit roots in models with more complicated dynamics. If a series follows a random walk with drift with $\rho = 1$, then it is serially uncorrelated. We can allow the series to follow an AR model by augmenting equation (4.7) with additional lags. We included two lags on the assumption that financial markets are informally efficient and two days time is enough to incorporate all information. To this end, we estimated equation (4.8). The results of ADF test are given in Table 4.4

Table 4.4: Unit Root Test by ADF Test

Level Series	**ADF Test**
Nifty Spot	-1.02
Nifty Futures	-1.01
Bank Nifty	-1.4140
Bank Nifty Futures	-1.4160
CNXIT	-0.1843
CNXIT Futures	-0.2869
Return Series	**ADF Test**
Nifty	-43.48
Nifty Futures	-45.83
Bank Nifty	-18.88

Bank Nifty Futures	-19.20
CNXIT	-22.1525
CNXIT Futures	-23.0782

The actual procedure to conduct Augmented Dickey-Fuller test is to estimate equation (4.8) by OLS; divide the estimated coefficient of $Nifty_{t-1}$ by its standard error to compute the (τ) statistic and compare it with MacKinnon critical tau values. If the computed absolute value of the tau exceeds the MacKinnon critical tau values, we reject the null hypothesis.

From the table 4.4, it is clear that for Nifty and Nifty futures the estimated tau value are -0.25 and -0.28 respectively, which in absolute value is below even the 10% critical value of -2.5842. Since, the former is smaller than the latter, our conclusion is that spot and futures prices are not stationary. ADF test also confirm the presence of unit root in spot and futures prices of Nifty as we are unable to reject null hypothesis when absolute value of tau statistic compared with MacKinnon critical values. Likewise, ADF test confirm that Bank Nifty, Bank Nifty futures, CNXIT and CNXIT futures are not stationary in their log level. However, log return series are stationary.

4.6.2 Cointegration Analysis

Since the two series are I(1), both the Engle-Granger and the Johansen mutivariate procedure tests for cointegration can be used. The first step in the Engle-Granger cointegration test is to see whether the variables are cointegrated or not. If Y_t and X_t are cointegrated the error term 'e_t' will be stationary. This is accomplished by testing the residuals of cointegrating regression for stationarity by performing ADF unit root test. We estimated the cointegrating equation by ordinary least square method (OLS). Then ADF test is conducted on residual obtained from cointegrating equation. The results of ADF test is reported in Table 4.5

Table 4.5: Engle-Granger Cointegration test

Cointegrating Equation	Dickey-Fuller Test on Residual
Nifty = 2.3069 +1.00 Nifty Futures (4.55) (5450.04) R^2 =0.99 df = 2199	$U_t = 0.0056 + 0.7098U_{t-1}$ (0.03) (47.26)
Bank Nifty = 41.22 + 0.99 Bank Nifty Futures (9.79) (1576.77) R^2 = 0.99 df = 551	$U_t = 0.04 + 0.58U_{t-1}$ (0.049) (16.72)
CNXIT = -0.36 + 1.00 CNXIT Futures (-0.11) (1367.42) R^2 = 0.99 df = 551	$U_t = 0.0322 + 0.62U_{t-1}$ (0.051) (18.54)

Unit root test for stationarity of residual from the cointegrating equation shows that the null hypothesis of unit root are rejected at 1 percent level of significance in case Nifty spot and Nifty futures, Bank Nifty and Bank Nifty futures, CNXIT and CNXIT futures implying prices are cointegrated. This indicates that there exists a long-run equilibrium relationship between spot and futures prices.

In this chapter, in order to consider the two series jointly and cross check the existence of cointegration between them, cointegration is also estimated by Johansen multivariate system approach. Table 4.6 reports the results of Johansen cointegration test based on Maximal eigenvalue and Trace test for the number of cointegrating vectors. The test statistics for the alternate hypothesis $r \leq 1$ are greater than the critical values at the 5% and 1% level. These results indicate that the null of zero cointegrating vectors is rejected at both 5% and 1% level. However, the null of one or more cointegrating vector cannot be rejected. Thus, spot price and Futures price are I(1) in their levels with linear combination being I(0) implying that the two prices are integrated of order one i.e. CI (1,1).

Table 4.6: Johansen Cointegration Test

Trace Test				
Variables	Number of CEs Equation under the Null	Trace Statistic	5% critical Value	1% critical Value
Nifty & Nifty Futures	$r=0$ $r \leq 1$	83.89 0.82	15.41 3.76	20.04 6.65
Bank Nifty & Bank Nifty Futures	$r=0$ $r \leq 1$	31.76 0.24	15.41 3.76	20.04 6.65
CNXIT and CNXIT Futures	$r=0$ $r \leq 1$	47.46 0.07	15.41 3.76	20.04 6.65
Maximal-Eigenvalue Test				
Variables	Number of CEs Equation under the Null	Max-Eigen statistic	5% critical Value	1% critical Value
Nifty & Nifty Futures	$r=0$ $r \leq 1$	83.07 0.44	14.07 3.76	18.63 6.65
Bank Nifty & Bank Nifty Futures	$r=0$ $r \leq 1$	31.46 0.25	14.07 3.76	18.63 6.65
CNXIT and CNXIT Futures	$r=0$ $r \leq 1$	47.44 0.07	14.07 3.76	18.63 6.65

4.6.3 VECM Analysis

Since both spot and futures in case of three indices are integrated of order one, an error correction model with lag length of five on ΔS_t and ΔF_t is estimated using OLS regression:

$$\Delta S_t = a_1 + a_s Z_{t-1} + \sum_{i=1}^{5} a_{s,i} \Delta S_{t-i} + \sum_{i=1}^{5} b_{s,i} \Delta F_{t-i} + \varepsilon_{s,t} \quad (4.15)$$

$$\Delta F_t = a_1 + a_f Z_{t-1} + \sum_{i=1}^{5} a_{f,i} \Delta S_{t-i} + \sum_{i=1}^{5} b_{f,i} \Delta F_{t-i} + \varepsilon_{f,t} \quad (4.16)$$

where $a_{s,t}$, $b_{s,t}$ $a_{f,t}$ $b_{f,t}$ are the short-run coefficients, $Z_{t-1} = \beta X_{t-1}$ is the error correction term. It is also important to note that if Nifty and Nifty futures are cointegrated then causality must exist at least in one direction (Granger, 1988). The results of Johansen multivariate VECM are reported in Table 4.7.

Table 4.7: Estimates of VECM for Nifty and Nifty Futures

Variables	ΔS_t	ΔF_t
Z_{t-1}	0.1850* [2.18613]	0.3365* [3.75703]
ΔS_{t-1}	0.054336 [0.40691]	0.269015** [1.90392]
ΔS_{t-2}	-0.059509 [-0.44544]	0.087716 [0.62050]
ΔS_{t-3}	-0.088471 [-0.67176]	-0.000336 [-0.00241]
ΔS_{t-4}	0.120599 [0.94263]	0.1794*** [1.32547]
ΔS_{t-5}	0.127556 [1.09795]	0.1939*** [1.57752]
ΔF_{t-1}	0.038484 [0.30199]	-0.205538*** [-1.52424]
ΔF_{t-2}	-0.000727 [-0.00567]	-0.133208 [-0.98137]
ΔF_{t-3}	0.100387 [0.79527]	0.017285 [0.12941]
ΔF_{t-4}	-0.102526 [-0.83785]	-0.161613 [-1.24815]
ΔF_{t-5}	-0.1231 [-1.10752]	-0.1872*** [-1.59187]
Constant	0.000307 [0.85028]	0.000309 [0.80823]
R^2	0.015182	0.019236

Unidirectional causality from Nifty futures to Nifty requires that some of the $b_{s,t}$ coefficients are non-zero and/or a_s the error correction in equation (1), is significant at conventional levels. Similarly, unidirectional causality from spot to futures requires some of the $a_{f,s}$ coefficients are non-zero and or a_f is significant at conventional levels. If both variables cause each other, then it is said that there is a two-way feedback relationship between spot and futures. The interaction between futures and spot prices work through the long run equilibrium price channel is supported by the above results. The reactions of the spot index and futures prices to the disequilibrium errors captured by the speed of adjustment which show that in next period 18% of the adjustment is achieved in the spot market while 33% of the disequilibrium error is corrected in the futures market. The results show that the futures market responds faster to the previous period's deviation from the long run equilibrium. This reflects the fact that compared with the spot market, the futures market incorporates new information more quickly than the spot market.

We also conducted similar test on Bank Nifty and Bank Nifty futures, CNXIT and CNXIT futures and 10 single stock futures. In case of Bank Nifty and Bank Nifty futures, the error correction terms are insignificant at conventional levels indicating no lead-lag relationship. In case of CNXIT and CNXIT futures, spot leads the futures market. By and large, in case of stock futures, there exists bi-directional relationship between spot and futures prices. The results are provided at the end of this chapter in the appendix Table IV.4 through appendix Table IV.6.

Table4.8: Restriction on speed of adjustment coefficients

Null Hypothesis (H_0)	Chi-square	P-value
$a_s = 0$	2.69	0.10
$a_f = 0$	7.8	0.005

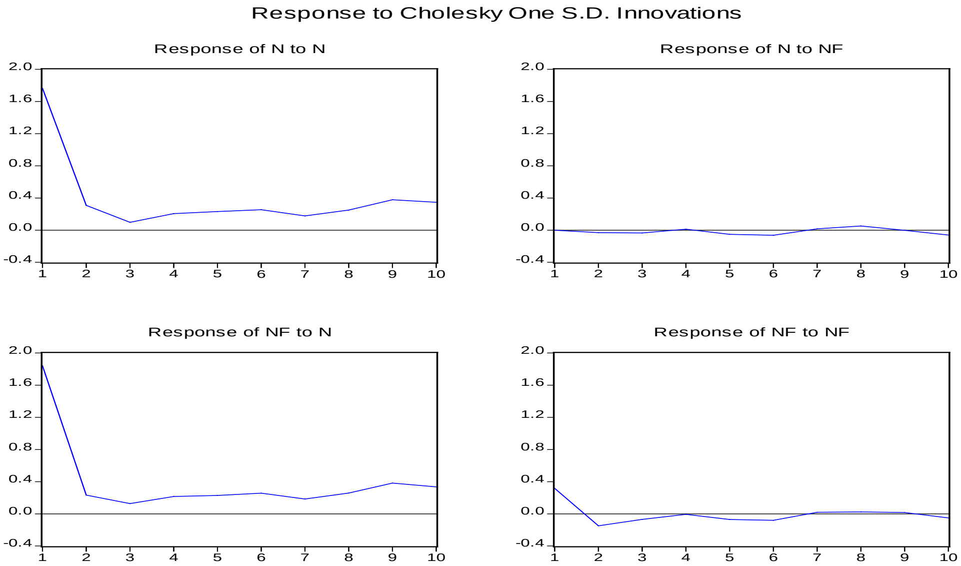
The results of the restriction imposed on the speed of adjustments coefficients are reported in Table 4.8, which indicates that the spot and futures market behave differently. The lack of significance of a_s means the spot market does not respond to the previous period's deviation from equilibrium. The significance of a_f means the current period futures innovation responds to the previous period's deviation from equilibrium. The finding that one of the speeds of adjustment coefficients is non-zero confirms that the model is an error correction model. The significant speed of adjustment of a_f does not imply that the spot market leads or causes the futures market and the insignificant speed of adjustment of a_s does not mean that the futures market is not leading the spot market. The coefficient on $a_{s,1}$ and $a_{f,1}$ are statistically highly significant that indicates the existence of a bi-directional causality or a feedback relationship between the two markets, since the last period's price changes in spot (futures) 'short run' affect the current period's price changes in futures (spot).

Our first hypothesis is whether prices are predictable from each other. Our test shows that prices are predictable from each other. Second hypothesis was whether futures market leads the spot market. Our tests established that there exists bi-directional causality between the two markets; price discovery takes place in both the markets.

4.6.4 Impulse Response

A more insight on the causal relationship between nifty and nifty futures prices is obtained by analyzing the impulse response function of the VECM. This measures the reaction of nifty to Nifty futures in response to one standard error shocks in the equations of the VECM. Impulse response is calculated by 'orthogonalising' the underlying shocks to the model using a Cholesky decomposition of the covariance matrix VECM equation. The Impulse response function helps to understand how the system behaves when a shock is given to the system. Initially, it is assumed that the system is at a steady state, and then perturbing it using a shock or innovation into the error term. The shock filters back through the lag structure of both equations simultaneously, and the value of the dependent variable at each time period that follows the impulse can be calculated from the estimated equations and then graphed. The time profiles of the responses to Cholesky one standard deviation to innovation are presented in Figure 4.3

Figure 4.3; Response to Cholesky one S.D innovation



The impulse response functions are the time path of the impact of innovations on the model's endogenous variables. Impulse response functions tell us how over the next 10 days nifty futures and nifty behaves when shock is given to the system. The first plot of second row shows the response of Nifty futures to Nifty. The estimate suggests futures contract does not adjust within 10 periods due to shock in Nifty. However, response of Nifty to Nifty futures in second plot of first row suggests that Nifty does not respond to futures market.

4.6.4 Variance Decomposition

The forecast error variance decomposition provides the proportion of the movements in a sequence due to its own shocks and shocks due to other variables. It may not be possible to find unique values for the information share due to existence of contemporaneous correlation between innovations. However, we can still determine upper and lower bounds by making use of variance decomposition in combination with a Cholesky ordering. In the above Table 4.9, an attempt is made to find the information share of each market. The higher the information share, the more the market contributes in the price discovery process.

Table 4.9: Variance Decomposition

Cholesky Ordering	Information share of Nifty		Information share of Nifty Futures	
	Nifty	Nifty Futures	Nifty	Nifty Futures
Nifty, Nifty Futures	98.1	1.69	98.42	1.58
Nifty Futures, Nifty	9.96	90.04	9.53	90.47

In the price discovery process of Nifty spot, we found that the cross contributions of both the markets to each other's price discovery is about same. Nifty contributes information in the range of 1.58 to 9.53 percent to the futures process. The futures market on the other hand contributes in the range of 1.69 to 9.96 percent to the spot price movement process for the Nifty index. Thus while the information shares do not establish the dominance of any market in the price discovery, it is clear that both markets incorporate information from each other's prices.

4.7 Conclusion

The conclusion is that there exists a long-run relationship between Nifty spot and Nifty futures, Bank Nifty and Bank Nifty futures, and CNXIT and CNXIT futures prices. Our second finding is that one can combine information of spot and futures prices to predict the future Nifty price. Thirdly, the error correction model leads to the conclusion that there exists a feed back between Nifty spot and Nifty futures, Bank Nifty and Bank Nifty futures, and CNXIT and CNXIT futures. This is also true in case of stock futures. The results also established that price discovery takes place in both the markets. This has an important implication for the market participants in the Indian capital market, indicating that there are opportunities for significant arbitrage profits and hedging strategies.

Appendix Tables

Table IV.1: Unit Root Test

Unit Root Test (ADF)				
Series	Levels		Difference	
	Intercept	Intercept & Trend	Intercept	Intercept & Trend
BHEL	-0.05	-2.48	-12.97	-13.04
BHEL Futures	-0.11	-2.54	-12.81	-12.88
Bharti Airtel	-0.96	-1.83	-12.32	-12.31
Bharti Airtel Futures	-0.97	-1.85	-11.86	-11.86
ICICI Bank	-0.31	-2.13	-13.83	-13.82
ICICI Bank Futures	-0.31	-2.12	-13.80	-13.80
ITC	-1.22	-2.15	-12.74	-12.75
ITC Futures	-1.23	-2.16	-12.71	-12.72
Infosys	-0.29	-1.92	-11.90	-11.90
Infosys Futures	-0.28	-1.95	-12.00	-12.00
ONGC	-0.14	-2.02	-13.39	-13.45
ONGC Futures	-0.21	-2.07	-13.52	-13.57
Reliance	-2.86	-2.60	-11.97	-12.04
Reliance Futures	-2.92	-2.69	-12.42	-12.48
SBI	-0.47	-1.39	-12.58	-12.58
SBI Futures	-0.47	-1.46	-12.50	-12.49
SAIL	-1.17	-2.30	-13.96	-13.98
SAIL Futures	-1.16	-2.30	-13.80	-13.82
Wipro	-0.92	-2.14	-12.91	-12.90
Wipro Futures	-0.92	-2.18	-12.94	-12.94

Table IV.2: Pairwise Granger Causality

Null Hypothesis	F-Statistic	Probability
Nifty Futures does not Granger Cause Nifty	1.0303	0.3979
Nifty does not Granger Cause Nifty Futures	4.7045	0.0002
Bank Nifty futures does not Granger Cause Bank Nifty	0.68172	0.63746
Bank Nifty R does not Granger Cause Bank Nifty Futures	0.90665	0.47630
CNXIT Futures does not Granger Cause CNXIT	0.86934	0.50140
CNXIT does not Granger Cause CNXIT Futures	2.67010	0.02137
SBI Futures does not Granger Cause SBI	1.31530	0.25592
SBI does not Granger Cause SBI futures	1.77576	0.11602
SAIL Futures does not Granger Cause SAIL	0.21210	0.95737
SAIL does not Granger Cause SAIL Futures	0.57822	0.71673
BHEL futures does not Granger Cause BHEL	0.15886	0.97729
BHEL does not Granger Cause BHEL futures	0.24950	0.94004
ICICI Bank futures does not Granger Cause ICICI Bank	0.30333	0.91089
ICICI Bank does not Granger Cause ICICI Bank Futures	0.86285	0.50584
Reliance Futures does not Granger Cause Reliance	1.14057	0.33772
Reliance does not Granger Cause Reliance Futures	1.06391	0.37945
ONGC futures does not Granger Cause ONGC	0.30083	0.91235
ONGC does not Granger Cause ONGC futures	1.03479	0.39626
Bharti Airtel Futures does not Granger Cause Bharti Airtel	1.60330	0.15738
Bharti does not Granger Cause Bharti Airtel Futures	0.95478	0.44510
ITC futures does not Granger Cause ITC	1.46467	0.19968
ITC does not Granger Cause ITC futures	0.51619	0.76410
INFOSYS futures does not Granger Cause INFOSYS	0.54278	0.74388
INFOSYS does not Granger Cause INFOSYS futures	1.37980	0.23018
Wiprof does not Granger Cause Wipro	1.4768	0.19968
Wipro does not Granger Cause Wipro Futures	0.49619	0.77410

Table IV.3: Johansen Cointegration Test

Variables	Number of CEs Equation under the Null	Trace Statistic	Max-Eigen statistic
BHEL and BHEL Futures	$r = 0$ $r \leq 1$	79.08 8.19	79.89 8.19
Bharti Airtel and Bharti Airtel Futures	$r = 0$ $r \leq 1$	53.38 0.94	52.44 0.94
ICICI Bank and ICICI Bank Futures	$r = 0$ $r \leq 1$	86.64 0.09	86.55 0.09
ITC and ITC Futures	$r = 0$ $r \leq 1$	80.31 1.73	78.54 1.73
Infosys and Infosys Futures	$r = 0$ $r \leq 1$	47.50 0.07	47.43 0.07
ONGC and ONGC Futures	$r = 0$ $r \leq 1$	55.64 0.02	55.61 0.02
Reliance and Reliance Futures	$r = 0$ $r \leq 1$	63.25 0.002	63.24 0.002
SBI and SBI Futures	$r = 0$ $r \leq 1$	29.75 0.25	29.50 0.25
SAIL and SAIL Futures	$r = 0$ $r \leq 1$	69.94 1.36	68.57 1.36
Wipro and Wipro Futures	$r = 0$ $r \leq 1$	67.48 0.86	66.61 0.86

Note:

For null $r = 0$ critical value for trace test at 5% and 1% level 15.41 and 20.04

For null $r \leq 1$ critical value for trace test at 5% and 1% level are 3.76 and 6.65

For null $r = 0$ critical value for Max-Eigen test at 5% and 1% level 14.07 and 18.63

For null $r \leq 1$ critical value for Max-Eigen Test at 5% and 1% level are 3.76 and 6.65. Both Trace test and Max-eigen value indicates 1 cointegrating equation(s) at both 5% and 1% levels except in case of Bharat Heavy Electricals Ltd (BHEL)

Table IV.4: VECM Model for Bank Nifty and Bank Nifty Futures

Variables	D(LBANK)	D(LBANKS)
Z_{t-1}	-0.373563 [-0.77782]	-0.118819 [-0.24002]
ΔS_{t-1}	0.217490 [0.38260]	0.521403 [0.88986]
ΔS_{t-2}	0.286617 [0.51408]	0.488030 [0.84921]
ΔS_{t-3}	0.572999 [1.06732]	0.738167 [1.33394]
ΔS_{t-4}	0.8191*** [1.6183]	1.0163 ** [1.9479]
ΔS_{t-5}	0.214037 [0.48469]	0.318862 [0.70052]
ΔF_{t-1}	-0.110726 [-0.19796]	-0.416401 [-0.72226]
ΔF_{t-2}	-0.269724 [-0.49208]	-0.464757 [-0.82259]
ΔF_{t-3}	-0.538096 [-1.02036]	-0.698515 [-1.28502]
ΔF_{t-4}	-0.908163*** [-1.82811]	-1.099311** [-2.14685]
ΔF_{t-5}	-0.293783 [-0.67726]	-0.396228 [-0.88617]
Constant	-0.000744 [-0.60159]	-0.000738 [-0.57868]
R^2	0.038383	0.035689

Note: Figures in [ ] are t-statistics

*, ** and *** Indicate significance at 1%, 5% and 10% level respectively

Table IV.5: VECM Model for CNXIT and CNXIT Futures

Variables	D(LCNXIT	D(LCNXIT Futures)
Z_{t-1}	0.179058 [0.60921]	0.420391*** [1.38064]
ΔS_{t-1}	0.372915 [1.02157]	0.650736** [1.72075]
ΔS_{t-2}	0.019077 [0.05242]	0.166603 [0.44187]
ΔS_{t-3}	0.033509 [0.09482]	0.127382 [0.34794]
ΔS_{t-4}	-0.396656 [-1.17343]	-0.327475 [-0.93513]
ΔS_{t-5}	0.158952 [0.53516]	0.270595 [0.87940]
ΔF_{t-1}	-0.349713 [-0.97966]	-0.641897** [-1.73573]
ΔF_{t-2}	-0.114462 [-0.32053]	-0.251840 [-0.68073]
ΔF_{t-3}	-0.065251 [-0.18853]	-0.159119 [-0.44378]
ΔF_{t-4}	0.246756 [0.74684]	0.184770 [0.53982]
ΔF_{t-5}	-0.071625 [-0.24829]	-0.179111 [-0.59934]
Constant	-0.001762*** [-1.70256]	-0.001761*** [-1.64303]
R^2	0.042360	0.053210

Note: Figures in [ ] are t-statistics

*, ** and *** Indicate significance at 1%, 5% and 10% level respectively

Table IV.6: VECM Model for Stock Futures on Individual Stocks

Variables	D(LSBI)	D(LSBIF)	D(LSAIL)	D(LSAILF)	D(LRS)	D(LRF)
Z_{t-1}	-0.419 [-1.42]	-0.227 [-0.73]	-0.005 [-0.84]	0.056542* [3.49535]	0.8297*** [1.59324]	1.1051** [2.10844]
ΔS_{t-1}	0.258 [0.645]	0.546 [1.308]	0.093395 [1.95141]	0.107008 [0.90041]	-0.827713 [-1.35640]	-0.485627 [-0.79076]
ΔS_{t-2}	0.451 [1.131]	0.568 [1.364]	-0.019 [-0.403]	-0.041505 [-0.34923]	0.058758 [0.09674]	0.191254 [0.31288]
ΔS_{t-3}	-0.124 [-0.31]	-0.071 [-0.175]	-0.0085 [-0.177]	-0.028542 [-0.23981]	0.443965 [0.75959]	0.535673 [0.91068]
ΔS_{t-4}	0.557 [1.476]	0.714 [1.81]	-0.110 [-2.30]	-0.1342 [-1.125]	-0.339 [-0.615]	-0.253 [-0.455]
ΔS_{t-5}	-0.16 [-0.47]	-0.17 [-0.48]	-0.018 [-0.38]	-0.097038 [-0.81154]	-0.287791 [-0.61186]	-0.233075 [-0.49238]
ΔF_{t-1}	-0.182 [-0.46]	-0.477 [-1.17]	-0.019 [-1.00]	-0.000912 [-0.01898]	0.923925 [1.52875]	0.569426 [0.93621]
ΔF_{t-2}	-0.475 [-1.22]	-0.593 [-1.46]	-0.002 [-0.124]	0.027586 [0.57364]	-0.098594 [-0.16321]	-0.226296 [-0.37223]
ΔF_{t-3}	0.1157 [0.304]	0.062 [0.158]	0.001511 [0.07802]	0.042502 [0.88368]	-0.528892 [-0.91082]	-0.618010 [-1.05754]
ΔF_{t-4}	-0.578 [-1.57]	-0.722 [-1.88]	0.005369 [0.27713]	0.038027 [0.79051]	0.243852 [0.44404]	0.161510 [0.29223]
ΔF_{t-5}	0.057 [0.176]	0.060 [0.177]	0.002249 [0.11615]	0.054298 [1.12915]	0.272318 [0.58117]	0.219629 [0.46575]
C	-0.0001 [-0.13]	-0.0001 [-0.137]	0.000211 [0.12064]	0.000200 [0.04605]	0.000389 [0.28945]	0.000369 [0.27284]
R-squared	0.03045	0.0283	0.020597	0.028128	0.042980	0.042218

Note: Figures in [ ] are t-statistics
*, ** and *** Indicate significance at 1%, 5% and 10% level respectively

Table IV. 5 Continued

Variables	D(ONGC)	D(ONGCF)	D(INFO)	D(INFOF)	D(ICICI)	D(ICICIF)
Z_{t-1}	0.182649 [1.10630]	0.413862* [2.42062]	0.525200** [1.73605]	0.704886** [2.38954]	-0.239530 [-0.51661]	0.011068 [0.02372]
ΔS_{t-1}	-0.210054 [-0.90276]	0.014789 [0.06137]	-0.285699 [-0.72530]	0.057884 [0.15071]	0.209124 [0.37552]	0.493077 [0.87986]
ΔS_{t-2}	-0.105772 [-0.45055]	-0.071039 [-0.29221]	-0.031112 [-0.07890]	0.184118 [0.47889]	-0.197890 [-0.35960]	-0.121799 [-0.21994]
ΔS_{t-3}	-0.075797 [-0.32596]	-0.137862 [-0.57248]	-0.197982 [-0.51260]	-0.068687 [-0.18238]	0.364419 [0.69753]	0.499356 [0.94983]
ΔS_{t-4}	-0.126622 [-0.55918]	-0.198654 [-0.84714]	-0.221829 [-0.60837]	-0.127304 [-0.35806]	-0.093887 [-0.18561]	-0.003349 [-0.00658]
ΔS_{t-5}	-0.302837 [-1.48729]	-0.4444** [-2.10756]	0.256874 [0.79635]	0.323112 [1.02730]	0.097888 [0.22022]	0.181217 [0.40513]
ΔF_{t-1}	0.268840 [1.19501]	0.021843 [0.09376]	0.255483 [0.64466]	-0.095875 [-0.24811]	-0.100390 [-0.18080]	-0.395282 [-0.70745]
ΔF_{t-2}	0.132376 [0.57960]	0.098881 [0.41807]	-0.092831 [-0.23311]	-0.302795 [-0.77977]	0.171091 [0.31113]	0.102145 [0.18459]
ΔF_{t-3}	0.017357 [0.07675]	0.080529 [0.34384]	0.166166 [0.42585]	0.033735 [0.08866]	-0.323014 [-0.61943]	-0.459990 [-0.87659]
ΔF_{t-4}	0.111517 [0.50636]	0.174093 [0.76333]	0.124050 [0.33641]	0.042781 [0.11898]	0.009763 [0.01932]	-0.080604 [-0.15853]
ΔF_{t-5}	0.211120 [1.06618]	0.350214*** [1.70784]	-0.255975 [-0.78516]	-0.323165 [-1.01658]	-0.141914 [-0.31948]	-0.224355 [-0.50191]
C	-0.000355 [-0.29216]	-0.000357 [-0.28370]	-0.001134 [-1.03112]	-0.001144 [-1.06700]	-0.001661 [-0.96560]	-0.001638 [-0.94666]
R-squared	0.021464	0.030286	0.028528	0.037051	0.025001	0.024233

Note: Figures in [ ] are t-statistics
*, ** and *** Indicate significance at 1%, 5% and 10% level respectively

Table IV. 5 Continued

Variables	D(BATL)	D(BATLF)	BHEL	BHELF	ITC	ITCF	WIPRO	WIPROF
Z_{t-1}	0.378717 [1.27245]	0.603662** [1.98133]	0.001821 [0.32921]	0.0786* [4.101]	-0.251826 [-1.45190]	-0.081068 [-0.45775]	0.056* [3.49]	0.829*** [1.59]
ΔS_{t-1}	-0.896* [-2.30739]	-0.601500 [-1.51217]	0.049369 [1.10621]	-0.095645 [-0.61809]	-0.349672 [-1.43671]	0.000322 [0.00130]	0.107 [0.90]	-0.827 [-1.35]
ΔS_{t-2}	-0.279844 [-0.72045]	-0.077557 [-0.19505]	-0.031166 [-0.69722]	-0.128457 [-0.82881]	-0.162259 [-0.65487]	-0.005391 [-0.02131]	-0.041 [-0.349]	0.058 [0.096]
ΔS_{t-3}	-0.549031 [-1.43096]	-0.488823 [-1.24457]	-0.000390 [-0.00872]	-0.006811 [-0.04390]	-0.283126 [-1.16121]	-0.187654 [-0.75375]	-0.028 [-0.23]	0.443 [0.75]
ΔS_{t-4}	0.027993 [0.07762]	0.131288 [0.35560]	-0.005891 [-0.13179]	0.081186 [0.52378]	-0.159255 [-0.67734]	-0.061203 [-0.25493]	-0.1342 [-1.125]	-0.339 [-0.615]
ΔS_{t-5}	0.139469 [0.43766]	0.154066 [0.47228]	-0.061804 [-1.38332]	-0.057344 [-0.37017]	-0.266146 [-1.27288]	-0.257349 [-1.20540]	-0.097 [-0.81]	-0.287 [-0.611]
ΔF_{t-1}	0.9006* [2.36373]	0.5978*** [1.53286]	0.001338 [0.10442]	0.037115 [0.83556]	0.303388 [1.25687]	-0.043801 [-0.17771]	-0.0009 [-0.018]	0.923*** [1.528]
ΔF_{t-2}	0.194140 [0.50837]	0.000494 [0.00126]	0.008514 [0.66545]	0.032802 [0.73940]	0.172748 [0.70371]	0.021003 [0.08379]	0.027 [0.57]	-0.098 [-0.16]
ΔF_{t-3}	0.483021 [1.28055]	0.432360 [1.11973]	-0.006759 [-0.52844]	0.018594 [0.41923]	0.200565 [0.83012]	0.108080 [0.43809]	0.042 [0.88]	-0.528 [-0.91]
ΔF_{t-4}	-0.052598 [-0.14864]	-0.153314 [-0.42324]	0.003540 [0.27675]	0.024313 [0.54821]	0.118325 [0.50785]	0.013665 [0.05744]	0.038 [0.79]	0.243 [0.44]
ΔF_{t-5}	-0.168791 [-0.53777]	-0.175321 [-0.54565]	0.002221 [0.17367]	0.037700 [0.85002]	0.197506 [0.94978]	0.193065 [0.90925]	0.054 [1.129]	0.272 [0.58]
C	-6.00E-05 [-0.04855]	-3.46E-05 [-0.02738]	-0.000707 [-0.37943]	-0.000704 [-0.10892]	0.000255 [0.25697]	0.000234 [0.23108]	0.0002 [0.04]	0.00038 [0.289]
R^2	0.029789	0.026379	0.008116	0.033042	0.031599	0.017084	0.028128	0.042980

Note: Figures in [ ] are t-statistics
*, ** and *** Indicate significance at 1%, 5% and 10% level respectively

Chapter-V
Volatility of the Underlying Market

5.1 Introduction

Volatility in simple words is the variation in the price of financial assets during a period of time. It is the amount by which the price of a financial asset such as share of a company has fluctuated or is expected to fluctuate during a period. Thus, it is clear that volatility measures variability or dispersion. In other words, it measures the deviation from its average past price. Greater the deviation, the greater is the volatility. The more volatile a stock is, the harder it is to locate its value on a future date with any certainty. Volatility of the financial markets remains a concern for investors, policy markers and regulators. The concern about volatility stems from the fact that price of an asset under volatile conditions no longer plays its role as a 'signal' about the true value of a firm, a concept that is core paradigm of the informational efficiency of markets. Volatility is closely associated with the notion of risk. In fact, volatility and risks are synonyms in the market place. Thus, the more volatile the stock is, the riskier it becomes. In general, investors are risk averse and do not like much risks.

One of the important reasons for introducing derivatives trading in India was high volatility of the Indian stock markets. The Indian stock market is one of the most volatile markets in the world. With the introduction of derivatives instruments such index futures, index option, futures on individual securities and option on individual securities in the Indian markets the issue of volatility and risk have come to the center stage. The important question is whether the Indian stock market has become more volatile due to the introduction of new products. This chapter delves into the issue of derivatives trading and volatility of the underlying market. The objectives of this chapter are:

1. To examine whether the Indian stock markets show some significant change in the volatility after the introduction of derivatives trading.
2. To study whether flow of information has increased after futures trading between cash and futures market.

3. To examine whether decline or rise in volatility can be attributed to introduction of derivatives alone or due to some other reasons.

5.2 Computation of Volatility

The computation of volatility of a financial asset such as stock prices is based on a mathematical model.

5.2.1 Discrete Method

In this method, the return is calculated over discrete time periods. The equation for the return value is

$$R_t = \frac{P_t - P_{t-1}}{P_{t-1}} \tag{5.1}$$

where,

$R_t =$ Return at time't'

$P_t =$ Price at time 't'

$P_{t-1} =$ Price at time 't-1'

Let $\overline{m} = \frac{1}{n}\sum_{i=1}^{n} R_i$ represent the mean return and the variance estimate yields a formula for the volatility

$$\sigma^2 = \frac{1}{n-1}\sum_{i=1}^{n}(R_i - \overline{m})^2 \tag{5.2}$$

Thus, the volatility of a share price is the standard deviation of the return on the share over a specified period of time. Standard deviation is the square root of variance.

5.2.2 Continuous Method

In this method, rate of return is compounded continuously. In case of continuous compounding, the rate of return is computed as

$$R_t = In\left(\frac{P_t}{P_{t-1}}\right) \tag{5.3}$$

where,

$R_t =$ Return at time't'

$P_t =$ Price at time 't'

$P_{t-1} =$ Price at time 't-1'

Ln = Natural logarithm

Let $\overline{m} = \frac{1}{n}\sum_{i=1}^{n} R_i \overline{m}$ mean return. The standard deviation, which is the measure of volatility, can be given by:

$$\sigma = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(R_i - \overline{m}\right)^2} \tag{5.4}$$

Thus, the volatility is the standard deviation of the continuously compounded rates of return on the asset over a specified period of time.

5.3 Types of Volatility

There are mainly four types of volatility. They are:

5.3.1 Historical Volatility

Historical volatility is a measure of variation in the price over time. It uses historical (daily, weekly, monthly, quarterly, and yearly) price data to measure the volatility of a market or instrument in the past. Historical volatility is calculated as the standard deviation of the return. The formula for historical volatility is:

$$\sigma = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(R_i - \overline{m}\right)^2} \qquad (5.5)$$

where,

σ = standard deviation or historical volatility

n = number of observations

$\overline{m}$ = Mean return

R_t =Return

Historical volatility is used in applications such as value-at-risk. They might be also used by financial engineers for who implied volatilities are not available or to supplement implied volatility.

5.3.2 Exponentially Weighted Moving Average:

In this approach, volatility is an example of exponential smoothing. Exponential smoothing techniques use one or more exponential smoothing parameters to give more weight to recent observations and less weight to older observations.

Historical volatility according to exponentially weighted moving average is given by the following formula:

$$\sigma_t^2 = \lambda(\sigma_{t-1}^2) + (1-\lambda)r_t^2 \qquad (5.6)$$

where λ is a parameter which determines how rapidly volatility estimates change.

5.3.3 GARCH Volatility

In the computation of volatility, it is assumed that volatility is constant over time. Historical volatility represents the unconditional standard deviation of the time t log return. When it represents the standard deviation of the time t log returns conditional on information available at time t-1, it becomes conditional volatility. In other words, return volatility is time dependent which result in pronounced temporal volatility clustering. This can be parameterized using GARCH model. A GARCH (1, 1) is specified as:

$$\sigma^2{}_t = \omega + \alpha_1\varepsilon_{t-1}^2 + \beta_1\sigma^2{}_{t-1} \qquad (5.7)$$

The conditional volatility as defined in the above equation is determined by three effects namely, the constant given by w, yesterday's news about volatility represented by the ARCH term expressed by $\alpha_1 \varepsilon_{t-1}^2$ and the forecasted volatility from the previous period called GARCH component expressed by $\beta_1 \sigma_{t-1}^2$. It has been found that GARCH models provide better volatility forecasts.

5.3.4 Implied Volatility

Implied volatility is defined as the theoretical value for volatility embedded in the market price of an exchange traded option. It is a representation of the market's opinion of future volatility. The volatility is calculated from a theoretical option-pricing model. The most commonly used option-pricing model is Black-Scholes formula for European put and call options. The Black-Scholes formula for a European call is:

$$c = S_0 * e^{-qT} * N(d_1) - K * e^{-rT} * N(d_2)$$

where

$$d_1 = \frac{In\left(\frac{S_0}{K}\right) + \left(r - q + \sigma^2 / 2\right) * T}{\sigma * \sqrt{T}} \qquad (5.8)$$

$$d_2 = d_1 - \sigma * \sqrt{T}$$

σ =Volatility

r = risk free interest rate

T = time to expiration

S_0 = Initial stock price

K =Strike /Exercise price

q =dividend yield.

Implied volatility is calculated by using the current option price and solving for the volatility input. In this study, we have made use of GARCH volatility and return of S&P CNX Nifty is defined by continuous method.

5.4 Information and Volatility

Stock index futures were first introduced by Kansas City Board of Trade (KCBT) in 1982. It was introduced to manage stock price risk. However, the index futures market is also believed to perform an informational role. Black (1976a) was of the view that the most important benefit of opening a futures market is that it increases the flow of information. The introduction of futures market provides market participants quotes on futures as well as spot prices conveying information on future demand and supply in the stock market. Besides this, futures market also attracts informed traders to make profits with their superior information, where the transaction costs of trading on such information is lower. Thus, opening of the futures market increases the quantity of information available to the public. If index futures trading increase the information available, then its introduction could be accompanied by an increase in volatility of the underlying stock price (Ross, 1989).

Index futures trading can cause market volatility basically in two ways. There are two main practices in stock futures trading that have been alleged to cause stock market volatility. These are index arbitrage also called program trading[4] and portfolio insurance[5]. Both the activities contribute to volatility because they quickly dump large orders on the market at critical times. These large orders can reinforce existing trends in prices, thereby contributing to stock market volatility.

5.5 Review of Literature

Both theoretical and empirical studies have been carried out to assess the impact of listing of futures and options on the cash market. There are two hypotheses concerning the impact of derivatives trading on the spot market in the literature. Proponents of

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[4] In index arbitrage, sophisticated traders look for discrepancies between the stock price and futures prices. When the actual futures price does not conform to the theoretical price of the cost-of-carry model, arbitrage opportunities arises. When the futures price exceeds its true price or theoretical price, traders will buy the index and sell the index futures by borrowing money in the market. This is called *cash-and carry strategy*. On the other hand, when the futures price is significantly lower than from its fair value, arbitragers will engage in *reverse cash-and-carry strategy* in which he will buy the futures and sell the index.

[5] Portfolio insurance refers to managing the risk of an underlying portfolio with help of various techniques. The goal of portfolio insurance is to manage the risk of a portfolio to ensure that the value of the portfolio does not decline below a specified level, while at the same time allowing for the portfolio's value to increase. Portfolio insurance strategies are put into action using options and futures. When portfolio insurance strategies are implemented with the help of stock index futures, it is called dynamic hedging. Portfolio insurance can also lead to order imbalance that might influence stock price. A decrease in stock price call for portfolio insurer to sell additional stock index futures while a rise in stock price force the insurer to buy stock index futures. A potential problem for market volatility arises because portfolio insurance generates trading in the same directions that the market happens to be moving. Thus, portfolio insurance can contribute to the existing momentum of the market.

‘destabilizing forces’ hypothesis argue that derivatives trading increases stock market volatility because of high degree of leverage, likely presence of uninformed traders due to low transactions cost involved to take position in the futures market. The lower level information of derivatives traders with respect to cash market traders is likely to increase the asset volatility. Stein (1987) in his pioneering theoretical model concluded that opening a futures market improves risk sharing and therefore reduces price volatility and if the speculators observe a noisy but informative signal, the hedgers react to the noise in the speculative trades producing an increase in volatility. These uninformed traders could destabilize the cash market. Cox (1976), Figlewski (1981) and Chatrath et al (1995) found results supporting this hypothesis. However, the speculators perform the important role in providing liquidity to the market and rapid processing of information. Derivatives trading can enhance the availability of information flow due to low transaction costs than those in the cash market thereby transmitting new information more quickly to the futures market. Thus, derivatives market provides an additional channel by which information can be transmitted to the cash markets. Frequent arrival and rapid processing of information might lead to increased volatility in the underlying spot market. Antoniou and Holmes (1995) however did not find a link between information and volatility.

However, proponents of ‘market completion’ hypothesis argue that derivatives trading helps in price discovery, improve the overall market depth, enhance market efficiency, augment market liquidity, reduce asymmetric information and thereby reduce volatility of the cash market (Schwarz and Laatsch, 1991; Kumar et al, 1995; Antoniou et al, 1998). Powers (1970) argued that futures markets enhance the overall market depth and make it informationally efficient. Stroll and Whaley (1988) documented that futures market improve quality of market in terms of efficiency. Dentine (1978) in his theoretical model argued that the futures market improves market depth and reduce volatility. Bray (1981) and Kyle (1985) in their model also asserts that futures trading reduce the volatility of the underlying market. Besides this, speculative activity may be transferred from the cash market to a more regulated futures market, dampening spot market volatility by reducing amount of noise trading. This also suggests that with the introduction of derivatives trading would be accompanied by a decline in trading volume of the underlying market.

The effect of futures trading on stock market volatility is an important issue and has received considerable attention particularly following the stock market crash of 1987 and the mini crash of 1989 (Kawaller et al, 1990). There is no consensus among the researchers as to the precise effects futures trading may have on the underlying spot markets. Many researchers documented results that support the hypothesis that introduction of futures trading has increased the volatility of the underlying market perhaps through encouraging excessive largely irrational speculative activities (Harris, 1989; Brorsen, 1991; Antoniou and Holmes, 1995). Gulen and Mayhem (2000) found that futures trading is associated with increased volatility in the United States and in Japan and in many others.

However, there are studies which categorically deny any increase in spot market volatility after the introduction of index futures trading. In fact, these studies try to point out that futures trading attract more informed traders to the cash market, making it more liquid and less volatile. There are several studies, which report the volatility of the underlying market has either declined or remained unchanged after the introduction of the futures trading (Edwrad, 1988a, 1988b; Darrat and Rahman, 1995; Pilar and Rafael, 2002). Recently, Faff and McKenzie (2002) investigated the impact of the introduction of stock index futures trading on the daily returns of the underlying index for seven countries Australia, Germany, Japan, Spain, Switzerland, the United States and the United Kingdom using GARCH framework. The reported that introduction of futures trading is associated with reduced seasonality of mean returns. Besides, assessing the impact of futures trading at the aggregate level, there are some studies which make an attempt to study the impact of futures trading at the individual asset level. These studies do not find support for the alleged impact of futures on volatility of the underlying asset (Bortz, 1984; Nath, 2003).

Various studies have been conducted to assess the impact of derivatives trading on the underlying market mostly related to US and other developed countries markets. Very few studies attempted to know the impact of introduction of derivatives trading in emerging market economies like India. In the 1990s, many emerging market economies have introduced trading of futures and options contracts. The very few studies conducted to assess the impact of the derivatives trading found decline in the volatility of the underlying market (Bolonga and Cavallo, 2002).

In the Indian context, early study by Thenmozhi (2002) reported decline in volatility due to increased flow of information while Shebagaraman (2003) did not find significant impact on market volatility in India. Raju and Karanade (2003) also studied the behaviour of volatility of the S&P CNX Nifty index after the introduction of derivatives trading. All the above studies relating to S&P Nifty reported a decline in the volatility. Bandivadekar and Ghosh (2003) studied volatility behaviour of both NSE Nifty and BSE Sensex after the introduction of futures trading and documented 'futures effects' in the volatility behavior of NSE Nifty.

5.6 Methodology

The impact of the introduction of derivatives on the underlying market is tested by using ARCH and GARCH class of model. Autoregressive conditional heteroskadastic (ARCH) model was first introduced by Engle (1982), which does not assume variance of error to be constant. In ARCH\GARCH models, the conditional mean equation is specified, in the baseline scenario, by an AR(p) process i.e. is regressed on its own past values. Let the conditional mean under the ARCH model may be represented as:

$$y_t = \alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + ... + \beta_n x_n + \mu_t \text{ and } \mu_t \sim (N, 0, \sigma_t^2) \qquad (5.9)$$

In equation (5.9), the dependent variable y_t varies over time. Similarly, conditional variance of μ_t may be denoted as σ_t^2, which can be represented as:

$$\sigma_t^2 = \text{var}(u_t \mid u_{t-1}, u_{t-2} .....) = E[(u_t - E(u_t)^2 \mid u_{t-1}, u_{t-2} ....)] \qquad (5.10)$$

It is usually assumed that $E(\mu_t) = 0$, so:

$$\sigma_t^2 = \text{var}(u_t \mid u_{t-1}, u_{t-2} ....) = E(u_t^2 \mid u_{t-1}, u_{t-2}, ...) \qquad (5.11)$$

Equation (5.11) states that the conditional variance of a zero mean is normally distributed random variable u_t is equal to the conditional expected value of the square of

u_t. In ARCH model, 'autocorrelation in volatility' is modeled by allowing the conditional variance of the error term, σ_t^2, to depend immediately previous value of the squared error. This may be represented as:

$$\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 \quad (5.12)$$

The above model is ARCH (1) where, the conditional variance is regressed on constant and lagged values of the squared error term obtained from the mean equation. In equation (5.12), conditional variance must be strictly positive. To ensure that these always result in positive conditional variance, all coefficients in the conditional variance are usually required to be non-negative. In other words, this model make sense if $\alpha_0 > 0$ and $\alpha_1 \geq 0$. However, if $\alpha_1 = 0$, there are no dynamics in the variance equation.

An ARCH (p) can be specified as:

$$h_t = \omega + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 \varepsilon_{t-2}^2 + ... + \alpha_p \varepsilon_{t-p}^2 \quad (5.13)$$

5.6.1 Generalized ARCH (GARCH) Model

This ARCH model might call for a long-lag structure to model the underlying volatility. A more parsimonious model was developed by Bollerslev (1986) leading to generalized ARCH class of models called GARCH in which, the conditional variance depends not only on the squared residuals of the mean equation but also on its own past values. The simplest GARCH (1, 1) is:

$$\sigma^2{}_t = \omega + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \sigma^2{}_{t-1} \quad (5.14)$$

The conditional volatility as defined in the above equation is determined by three effects namely, the intercept term given by w, the ARCH term expressed by $\alpha_1 \varepsilon_{t-1}^2$ and the forecasted volatility from the previous period called GARCH component expressed by $\beta_1 \sigma_{t-1}^2$. Parameters w and α should be higher than 0 and β should be positive in order to ensure conditional variance σ_t^2 to be nonnegative. Besides this, it is necessary that $\alpha_1 + \beta_1 \prec 1$. This condition secures covariance stationarity of the conditional variance. A straightforward interpretation of the estimated coefficients in (5.14) is that the constant term ω is the long-term average volatility, i.e. conditional variance, whereas α and β represent how volatility is affected by current and past information, respectively.

A general GARCH model is given by the following equation:

$$\sigma_t^2 = \omega_t + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^2 + v_t \tag{5.15}$$

where p is the degree of ARCH; q is the degree of GARCH process; and v_t is error term with white noise properties. The identification of GARCH is based on the same principles of ARMA method and degree of p, q are identified by the help of autocorrelation function and partial autocorrelation function of the squares of residual. The size of the parameters α_1 and β_1 determine the short run dynamics of the resulting volatility time series. Large GARCH coefficient β_1 shows that shocks to conditional variance take a long time to die out, so volatility is persistent. Large GARCH error coefficients indicate that volatility reacts quite intensely to market movements.

5.6.2 Asymmetric GARCH Model

The GARCH model has few limitations. First, restrictions on parameters are imposed to keep the conditional volatility positive, which is often questioned. Second, GARCH model in its crude form fails to address the asymmetric response of volatility as the conditional variance is modeled as the function of only magnitude and not the sign of the stock returns innovations. Third, a shock in a period, regardless of its sign goes to increase the conditional variance for next periods, and thus, fails to take into account the cyclical and non-cyclical behaviour on the part of volatility. These limitations of the basic GARCH model led to the development of asymmetric GARCH model. Further, Nelson (1991), taking into account asymmetric relationship between conditional volatility and conditional mean proposed an exponential GARCH (EGARCH) based on a logarithmic expression of the conditional volatility in the variable.

The simplest asymmetric GARCH model first proposed by Glosten, Jagannathan and Runkle (1993). In GJR model, not only the size but also the sign of the residual obtained from the mean equation, determine the conditional variance, which captures asymmetry. Zakoïan (1994), in a similar attempt, introduced Threshold GARCH

(TGARCH) model where conditional standard deviation was used instead of conditional variance. TGARCH is specified as:

$$\sigma_t^2 = w + \alpha\varepsilon_{t-1}^2 + \lambda\varepsilon_{t-1}^2 d_{t-1} + \beta\sigma_{t-1}^2 \qquad (5.16)$$

where $d_{t-1} = 1$ takes the value of 1 if $\varepsilon_t \succ 0$ and 0 if $\varepsilon_t \prec 0$. In TARCH good news ($\varepsilon_t \succ 0$) , and bad news($\varepsilon_t \prec 0$) , have different impacts on the conditional variance. The good news has an impact of (α) and bad news has an impact of (α+λ). If $\lambda \succ 0$, then there exists leverage effect while if $\lambda \neq 0$, then the news has asymmetric impact. We are not going to use TARCH model in this study.

Another, popular asymmetric GARCH model is the exponential GARCH (EGARCH) model proposed by Nelson (1991) based on log-transformed conditional variance. Since conditional variance is log-transformed, asymmetric impact is exponential instead of quadratic as in the GJR.

This model under the assumption of normally distributed errors is specified as follows:

$$\log(\sigma_t^2) = \omega + \alpha\frac{\varepsilon_{t-1}}{\sigma_{t-1}} + \lambda\left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}} - \sqrt{\frac{2}{\pi}}\right| + \beta\log(\sigma_{t-1}^2) \qquad (5.17)$$

The leverage effects can known from testing the hypothesis that $\lambda \succ 0$. The impact is asymmetric if $\lambda \neq 0$.

5.7 Empirical Results

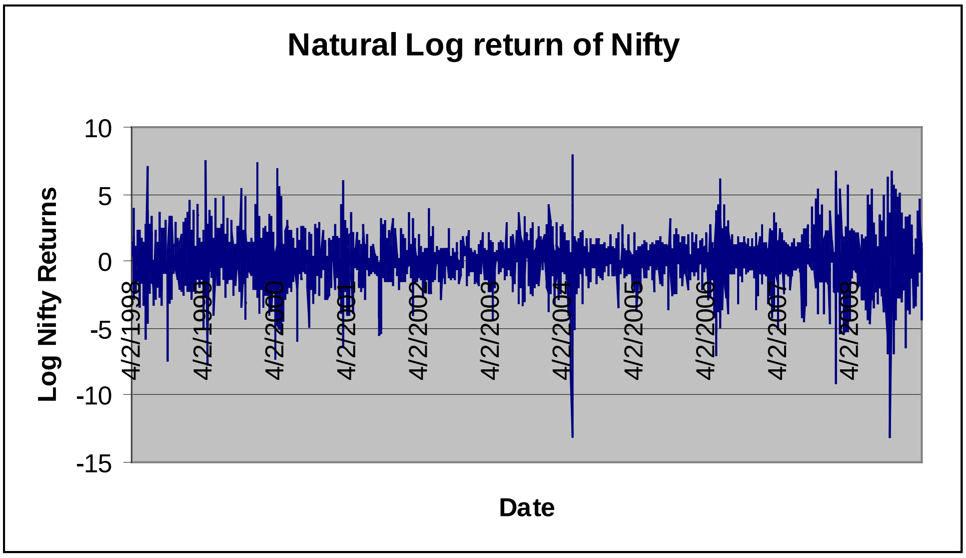
At the outset, we computed descriptive statistics of logarithmic first-differences of daily Nifty and Junior Nifty closing prices. The results are reported in Table 5.1. The mean returns over the sample period 1st April, 1998 to 31st March, 2009 of Nifty and Junior Nifty are 0.0350%, 0.041% respectively.

Table 5.1: Descriptive Statistics

Summary Statistics	Nifty	Nifty Junior
Mean	0.0350	0.041
Std. Dev.	1.761	2.0864
Skewness	-0.5207	-0.6826
Kurtosis	7.3442	6.6516
Jarque-Bera	2290.14 (0.00)	1744.08 (0.00)

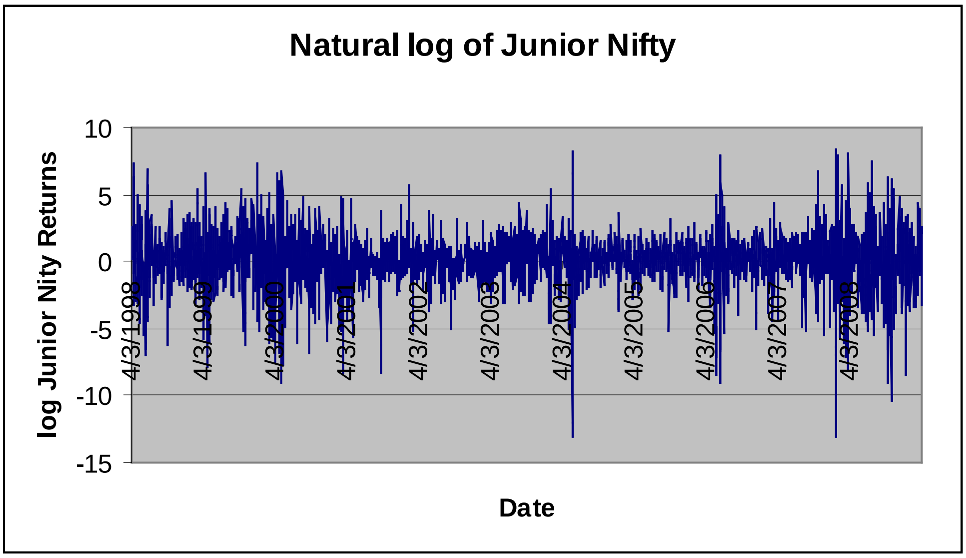
The volatility of returns of Nifty and Junior Nifty as indicated by standard deviation are 1.76 and 2.08 respectively over the sample period. The value of skewness is –0.52 and -0.68 for Nifty and Junior Nifty respectively which is different from zero indicating that the distribution is not symmetric. Besides this, the relatively large value of the Kurtosis for Nifty and Junior Nifty are 7.34 and 6.65 respectively suggests that data is leptokurtic or heavily tailed and sharply peaked around the mean. Thus, daily log returns of Nifty returns are not normal but leptokurtic and skewed. Jarque-Bera (1980) test also indicates departures from normality for both the indices. Thus, in first impression, it appears that returns contain ARCH effects. It also clears from the Figure 5.1:

Figure 5.1: Log Nifty Returns



In the above Figure 5.1 and 5.2 and which shows the log returns of Nifty and Junior Nifty there are clear regions where the volatility is relatively high and regions where the volatility is relatively low i.e. volatility tend to cluster together in time popularly called 'volatility clustering' in literature. In other words, high volatility is followed by higher volatility and low volatility is followed by lower volatility over time. Thus, volatility is time dependent or volatility is not constant over time. The above figure clearly depicts the ARCH effect contained in Nifty and Junior Nifty.

Figure 5.2: Log Junior Nifty Returns



Besides this, there is a formal way of testing ARCH effect in data. It has been customary to check for possible presence of ARCH effects in data before estimating ARCH class of models. Since ARCH effects signifies the temporal dependence in second moment, the approach is to check for the dependence in the squared innovations or residuals from a model. ARCH effect in data can be checked by Lagrange Multiplier (LM) test.

This test has been proposed by Engle (1982). LM test is done by computing TR^2 statistic, where R^2 is the coefficient of determination estimated from the regression of ε_t^2 on $\varepsilon_{t-1}^2 \ldots \varepsilon_{t-q}^2$ and T is the number of observations. The test statistic test for the null hypothesis of 'no q-th order ARCH effect' in the squared residuals is asymptotically chi-squared distributed with q-degrees of freedom. The logic behind test is quite simple: If squared innovations at time 't' is predicted by its past values, then the presence of ARCH effect is confirmed. Accordingly, we tested for presence of ARCH effect in S&P Nifty and Junior Nifty. ARCH effect in financial time series can be computed by first fitting an OLS regression equation as specified below:

$$return_t = \alpha_0 + \beta return_{t-1} + u_t \tag{5.18}$$

If we compute OLS residual from equation (5.18) and square them, and regress them on the lagged squared residuals:

$$\mu_t^2 = \alpha_0 + \beta\mu_{t-1}^2 + u_t \tag{5.19}$$

The significance of coefficient of μ_{t-1}^2 indicates the presence of ARCH effect. The presence of ARCH effect in Nifty, Junior Nifty returns are tested using the above procedure and the results is reported in Table 5.2:

Table 5.2: ARCH LM test

Coefficients	Nifty	Junior Nifty
α	2.15 (14.26)	2.70 (14.08)
β	0.30 (16.6)	0.36 (20.51)

The t-stat on coefficient of μ_{t-1}^2 in Nifty, Junior Nifty returns is statistically highly significant indicating strong ARCH effect in returns of all indices.

It is confirmed from preliminary analysis that Nifty and Junior Nifty returns data contains ARCH effects indicating volatility is time varying. ARCH class of models can better characterize this kind of heteroskedasticity. The GARCH (1, 1) is used as a benchmark model-to-model stock return volatility. In this paper, we specified mean equation as follows:

$$R_t = c_t + \beta_1 R_{t-1} + \beta_2 R_{t-2} + \beta_3 R_{t-3} + \varepsilon_t$$

$$\varepsilon_t \setminus \varepsilon_{t-1} \sim N(0, h_t)$$

$$\sigma_t^2 = \omega + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2 + \delta D_{futures} + \psi D_{option} + v_t \tag{5.20}$$

where R_t is the daily return on the S&P Nifty and R_{t-i} is the lagged three days return. The conditional variance equation is augmented with dummy variable, D_f , dummy for introduction of futures and D_0, dummy for introduction of option, which assumes value zero and one for the pre and post derivatives trading period respectively. The sign and magnitude of dummy variable indicates change in volatility of the spot market. For instance, δ and ψ are statistically significant, this implies that the introduction of futures and option trading had significant effect on spot market volatility. In addition, a positive sign on δ and ψ implies that volatility is increased, while a negative sign implies that volatility is decreased following the introduction of futures and option trading.

In this chapter, the objective is to assess the impact of introduction of derivatives mainly index futures and index options on the underlying market. To test this empirically, we estimated equation (5.20) and the result is reported in Table 5.3 for S&P Nifty Index. The index futures and options were introduced on S&P Nifty not on indices like S&P CNX 100. Besides this, futures and option trading was introduced in most of the scripts included in the S&P Nifty. Therefore, if futures and options trading were the only factors involved in reducing the underlying volatility then the reduction in volatility is expected to be more in the context of Nifty in comparison to other indices available in NSE.

Table 5.3: Volatility of Nifty after Introduction of Futures & Options

Mean Equation			
Variables	Coefficients	t-statistic	Prob
C	0.117226	4.683543	0.0000
$Nifty_{t-1}$	0.091781	4.221053	0.0000
$Nifty_{t-2}$	-0.037187	-1.878930	0.0603
$Nifty_{t-3}$	0.037099	1.968588	0.0490
Variance Equation			
C	0.274798	6.681232	0.0000
ARCH(1)	0.157064	12.91630	0.0000
GARCH(1)	0.797477	55.22198	0.0000
Futures Dummy	-0.115821	-2.499699	0.0124
Option Dummy	-0.047715	-1.354524	0.1756

Table 5.3 presents the results of change in volatility of Nifty after the introduction of Nifty futures, Nifty option stock futures trading simultaneously. The coefficients of futures and options dummy are –0.1158 and –0.04771 respectively in case of S&P Nifty. The sign of the both coefficients of index futures and option indicates that volatility of S&P Nifty has declined after the introduction of futures and option contracts. The results support the hypothesis that introduction of futures and option have reduced the volatility of Nifty significantly. However, the result for Junior Nifty and CNX100 are quite different on which futures and options introduced later on in 1st June, 2007. The results of Junior Nifty and CNX 100 indices show that volatility of the underlying markets have increased after the introduction of futures trading (See Appendix Tables V.1).

In this chapter, the issue of whether introduction of derivatives (Futures and Options) has been the only factor responsible for the change in volatility is also addressed. Following Bolonga and Cavallo (2002), returns from a surrogate index such as Nifty Junior into mean equation of the GARCH (1, 1) is included to account for the additional factors affecting the volatility of the market. The new sets of equations are as follows:

$$R_t = c_t + \beta_i R_{t-i} + \delta JuniorNifty + \varepsilon_t \qquad (5.21)$$

$$i = 1, 2, 3$$

$$\varepsilon_t \setminus \varepsilon_{t-1} \sim N(0, h_t)$$

$$\sigma_t^2 = \omega + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2 + \delta D_{futures} + \psi D_{option} + v_t$$

To address the issue of whether introduction of derivatives has been alone responsible in reducing volatility, we incorporated the returns from surrogate index, Junior Nifty for Nifty into mean equation to control the additional factors influencing the market volatility following Bologna and Cavallo (2002). We estimated equation (5.21) and the results are reported in Table 5.4.

Table 5.4: Volatility of Nifty When Market Wide Volatility Controlled

Mean Equation			
Variables	Coefficients	t-statistic	Prob
C	0.008891	0.563588	0.5730
$Nifty_{t-1}$	-0.037836	-4.038557	0.0001
$Nifty_{t-2}$	-0.019094	-2.155783	0.0311
$Nifty_{t-3}$	-0.012372	-1.313241	0.1891
Junior Nifty	0.730781	121.9727	0.0000
Variance Equation			
C	0.034150	4.958955	0.0000
ARCH(1)	0.069646	8.120198	0.0000
GARCH(1)	0.900196	75.42391	0.0000
Futures Dummy	-0.004800	-0.595806	0.5513
Option Dummy	-0.007790	-1.041515	0.2976

Table 5.4 presents the result of behaviour of volatility of Nifty after the introduction of both Nifty futures, options and stock futures simultaneously after controlling for movements in Junior Nifty. The coefficients of both futures and option dummies are extremely low in their magnitude. The sign of the coefficients are indicative of the fall in volatility of Nifty. However, the coefficients of futures and options dummies are statistically highly insignificant. Thus, futures and option effect on the volatility of the underlying index S&P CNX Nifty vanishes when movements in Junior Nifty is taken into account.

Further, in this chapter, we also fitted one popular asymmetric GARCH model called Exponential GARCH (EGARCH) to examine the behaviour of volatility before and after introduction of derivatives trading. The simple GARCH models, though, proved successfully account for features of return series such as volatility clustering and the leptokurtosis in the empirical distribution but these models do not take into account for asymmetry and non-linearity in the conditional variance. This particular problem also called leverage effect provided further impetus in the development of GARCH class of models and have given rise to an array of asymmetric models.

EGARCH model is considered superior to other GARCH as it captures time-variation of volatility, volatility clustering and asymmetric relationship between news and volatility in better way than other GARCH model. Kim and Kon (1994) based on statistical comparisons showed that EGARCH is the most appropriate model for stock indices. Further, Engle and Ng (1993) compared the performance of different GARCH models and found EGARCH provide better volatility forecast. The EGARCH model to see the impact of futures and option trading on the underlying market is specified as:

$$R_t = c_t + \beta_1 R_{t-1} + \beta_2 R_{t-2} + \beta_3 R_{t-3} + \varepsilon_t$$

$$\log \sigma_t^2 = \omega + \alpha \left| \frac{\varepsilon_{t-1}^2}{\sigma_{t-1}^2} - \sqrt{\frac{2}{\pi}} \right| + \gamma \frac{\varepsilon_{t-1}}{\sigma_{t-1}} + \beta \log \sigma_{t-1}^2 + \delta D_{futures} + \psi D_{option} + v_t$$

σ_t^2 is the conditional volatility, ω is the long term volatility, through this $\frac{\varepsilon_{t-1}}{\sigma_{t-1}}$ term the EGARCH (1,1) allows negative and positive shocks to have different impacts on conditional volatility and the coefficient, γ, measures the asymmetric relationship between news and volatility. If γ is negative then negative news increases volatility more than positive news. δ and ψ are the dummies for futures and option respectively.

Table 5.5: EGARCH (1,1) Model of Volatility

Mean Equation			
Variables	Coefficients	t-statistic	Prob
C	0.055515	2.216867	0.0266
$Nifty_{t-1}$	0.107065	5.192778	0.0000
$Nifty_{t-2}$	-0.027272	-1.453109	0.1462
$Nifty_{t-3}$	0.066568	3.655376	0.0003
Variance Equation			
w	-0.107292	-6.576982	0.0000
α	0.269095	13.12516	0.0000
γ	-0.138614	-10.96472	0.0000
β	0.926072	130.5193	0.0000
δ	-0.052249	-2.953376	0.0031
ψ	0.000784	0.049219	0.9607

Table 5.5 reports the results of AR(3)-EGARCH(1,1) model. the result shows the behaviour of volatility of Nifty after the introduction of F&O. The sign of the futures and option dummy variables are –0.0522 and 0.000784 with a t-statistic of –2.95 and 0.04 respectively, which indicate that volatility has dampened after the introduction of index futures while volatility has increased after options trading.

The estimated volatility persistence coefficient is 0.92 with a robust t-statistic of 130.51. Alternatively, the estimated persistence coefficient indicates that the response function of volatility to shocks decay at a slower rate. The asymmetry coefficient for Nifty is –0.1386 with a significant t-statistic of –10.96 indicating the volatility increases when stock price decreases. Thus, the 'leverage effect' presence is there in data. Table 5.6 reports the results of AR(3)-EGARCH(1,1) model when controlled for market wide volatility. The result shows the behaviour of volatility of Nifty after the introduction of F&O.

The sign of the futures and options dummy variables are –0.0089, and -0.0088 with a t-statistic of –1.01, and -1.06 respectively, which indicate that volatility has dampened after the introduction of index futures and options. The estimated volatility persistence coefficient 0.96 with a robust t-statistic of 177.04. Alternatively, the estimated persistence coefficient indicates that the response function of volatility to shocks decay at a slower rate.

The asymmetry coefficient for Nifty is –0.0079 with a insignificant t-statistic of –1.07 indicating the volatility increases when stock price decreases. Thus, the 'leverage effect' presence is there in data but it is not significant. We also estimated EGARCH(1,1) model for Bank Nifty, CNXIT and 14 individual stocks. The results show that volatility of Bank Nifty and CNXIT indices have increased after the introduction of futures trading. However, the results of 14 stocks show that volatility of the underlying stocks have declined after the futures trading in general (See Appendix Tables V.2).

Table 5.6: EGARCH (1, 1) Model of Volatility When Market wide Volatility Controlled.

Mean Equation			
Variables	Coefficients	t-statistic	Prob
C	0.011304	0.717575	0.4730
$Nifty_{t-1}$	-0.037431	-4.025098	0.0001
$Nifty_{t-2}$	-0.020012	-2.280154	0.0226
$Nifty_{t-3}$	-0.014902	-1.603617	0.1088
Junior Nifty	0.728587	120.4962	0.0000

Variance Equation			
w	-0.115217	-8.900165	0.0000
α	0.154237	9.405813	0.0000
γ	-0.007981	-1.072569	0.2835
β	0.969841	177.0452	0.0000
δ	-0.008969	-1.011158	0.3119
ψ	-0.008876	-1.064269	0.2872

To study whether or not the flow of information has increased after futures trading, we estimated GARCH (1, 1) model for pre and post futures trading. The results are reported in Table 5.7a and 5.7b.

Table 5.7a: GARCH (1, 1) Model before Futures Trading

Mean Equation				
	Coefficient	Std. Error	z-Statistic	Prob.
C	0.093465	0.083910	1.113871	0.2653
NR(-1)	0.039740	0.051412	0.772979	0.4395
NR(-2)	-0.029135	0.047142	-0.618015	0.5366
NR(-3)	0.006108	0.046358	0.131764	0.8952
NR(-4)	-0.019312	0.048065	-0.401785	0.6878
NR(-5)	-0.036977	0.042519	-0.869658	0.3845
Variance Equation				

C	0.455215	0.205713	2.212868	0.0269
ARCH	0.090288	0.027703	3.259177	0.0011
GARCH	0.794021	0.070905	11.19831	0.0000

The mean equation of Table 5.9a shows that the lagged values of Nifty are statistically insignificant, which implies that market was efficient in its weak form. However, the coefficients of ARCH and GARCH term are 0.09 and 0.79 respectively in the period before futures trading. This implies returns volatility was more determined by old news and less by recent news.

Table 5.7b: GARCH (1, 1) Model after Futures Trading

Mean Equation				
	Coefficient	Std. Error	z-Statistic	Prob.
C	0.116499	0.026708	4.361908	0.0000
NR(-1)	0.104312	0.024759	4.213072	0.0000
NR(-2)	-0.050116	0.022111	-2.266562	0.0234
NR(-3)	0.042682	0.022070	1.933941	0.0531
NR(-4)	0.025342	0.022656	1.118551	0.2633
NR(-5)	-0.017000	0.021952	-0.774440	0.4387
Variance Equation				
C	0.108106	0.014700	7.354249	0.0000
ARCH	0.175107	0.014655	11.94853	0.0000
GARCH	0.790370	0.015831	49.92592	0.0000

However, the mean equation of Table 5.7b shows that the first three lags of Nifty are statistically highly significant, which implies that market has become inefficient in the period after futures trading. Nonetheless, the coefficients of ARCH and GARCH terms are 0.17 and 0.79 respectively in the period after futures trading. The impact of recent news have increased while the volatility in returns arising from the effect of old news has remained the same implying that the quality of information flowing have improved to the cash market in post derivatives period.

5.8 Conclusion

In this chapter, we tried to assess the impact of futures and option trading on the underlying market S&P CNX Nifty, Bank Nifty and CNXIT. The study concludes that the volatility of the underlying markets Nifty declined after the introduction of futures and option trading. However, volatility of bank nifty and CNXIT indices have increased. Our second finding is that when surrogate index – Junior Nifty – is used to account for market wide volatility then the effect of futures and option on the volatility of the underlying market vanishes. In other words, futures and option have not destabilized the underlying market. Broadly, it can be said that volatility of the market has dampened but the contribution of futures and option trading is negligible. The asymmetric EGARCH model also shows that the volatility has declined after the introduction of futures and option contracts. The estimated volatility persistence coefficients of Nifty, bank Nifty and CNXIT are high indicating that the response function of volatility to shocks decay at a very slow rate. The asymmetric EGARCH model also showed that it exhibits leverage effect, which implies volatility increases when the stock price decreases. The results of EGARCH model for individual stocks on which futures trading are permitted showed significant decline in the volatility of the underlying stock after the introduction of futures trading.

Appendix Tables

Table V.1: Behaviour of Volatility of Selected Companies

$$R_t = c + \beta_1 R_{t-1} + \beta_2 R_{t-2} + \beta_3 R_{t-3} + \beta_4 Nifty + \varepsilon_t$$

$$\varepsilon_t \mid \psi_{t-1} \sim N(0, \sigma^2)$$

$$\sigma_t^2 = \omega + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2 + \delta D_{futures} + v_t$$

Mean equation					
$R_t = c + \beta_1 R_{t-1} + \beta_2 R_{t-2} + \beta_3 R_{t-3} + \beta_4 Nifty + \varepsilon_t$					
Coefficients / Companies	c	β_1	β_2	β_3	β_4
Junior Nifty	0.1391 (0.84)	0.0939* (10.24)	-0.001 (-0.11)	0.0208** (2.28)	0.9612* (101.82)
CNX 100	0.0338 (1.42)	-0.0697* (5.66)	-0.0236* (-2.11)	-0.0378* (-3.27)	0.8199* (71.58)
ACC	0.0191 (0.49)	0.009 (0.46)	0.007 (0.42)	0.004 (0.21)	0.8517* (41.04)
BHEL	0.127* (3.35)	0.1451* (8.98)	-0.0307** (-1.8)	-0.0217 (-1.52)	0.9369* (43.09)
BPCL	-0.02078 (-0.48)	0.029427 (1.51)	0.035405** (2.18)	0.025*** (1.79)	0.7601* (33.82)
CIPLA	-0.40897* (-11.00)	0.238759* (12.01)	0.420748* (21.7)	-0.11034* (-7.21)	1.3038* (67.9)
DRREDDY	-0.0721 (-0.39)	0.007142 (0.18)	-0.03543 (-0.77)	-0.0079 (-0.14)	0.6332 (7.74)
GRASIM	0.042448 (1.14)	0.034445** (2.21)	-0.01198 (-0.72)	0.034534** (2.03)	0.821478* (40.57)
HDFC	-0.15415 (-0.42)	0.000723 (0.011)	-0.0114 (-0.28)	-0.01907 (-0.27)	0.766464* (5.17)
INFOSYS	-0.1468 (-0.43)	-0.00502 (-0.11)	-0.00305 (-0.05)	-0.06559** (-1.94)	0.924317* (7.58)
ITC	-0.85394 (-0.11)	0.005764* (3.23)	-0.02387* (-7.21)	0.022128** (2.03)	0.617824* (45.12)
M&M	0.016718	0.0538*	0.040358**	0.100413*	0.981586*

	(0.26)	(2.41)	(1.93)	(4.84)	(31.54)
MTNL	-0.10509** (-2.44)	0.058946* (3.49)	-0.04713* (-2.83)	-0.01097 (-0.65)	0.922722* (40.83)
SBI	0.020202 (0.61)	0.010848 (0.83)	-0.00318 (-0.23)	0.015349 (1.06)	1.052055* (62.37)
TATAPOWER	0.02488 (0.68)	0.057776* (3.86)	-0.02576 (-1.56)	-0.0049 (-0.29)	0.953218* (44.92)
TATATEA	-0.00038 (-0.01)	0.089618* (5.56)	-0.04846* (-2.91)	-0.00472 (-0.26)	0.75455* (38.97)

Variance Equation				
Coefficients / Companies	w	α_1	β_1	δ
Junior Nifty	0.0268* (4.98)	0.0872* (8.66)	0.8884* (71.07)	0.0056 (0.71)
CNX 100	0.0201* (2.8)	0.1155* (5.75)	0.844* (33.14)	0.0103 (1.3)
ACC	19.26* (13.71)	0.1896* (10.98)	0.7161* (35.56)	-18.85* (-13.84)
BHEL	4.17* (9.89)	0.68* (18.57)	0.2943* (8.24)	-2.81* (-8.19)
BPCL	7.7835* (13.00)	0.504446* (27.76)	0.144608* (4.17)	-4.5555* (-9.6)
CIPLA	2.103579 (7.97)	0.315741* (21.57)	0.327885* (24.25)	-0.96533* (-3.86)
DRREDDY	9.326393 (1.58)	-0.00437* (-3.47)	0.589535** (2.27)	-0.40126 (-1.43)
HDFC	26.66345 (0.73)	-0.00131* (-69.25)	0.597078 (1.08)	-12.3755 (-0.73)
INFOSYS	18.26315 (0.73)	-0.00218* (-5.42)	0.575761 (0.99)	-0.53282 (-0.76)
ITC	2.103579*	0.365741*	0.347885*	-0.96533*

	(7.96)	(18.14	(20.15)	(-2.16)
M&M	1.593795* (5.68)	0.200707* (6.34)	0.656259* (14.45)	-0.00453 (-0.042)
MTNL	1.003736* (-5.66)	0.111934* (7.97)	0.771485* (26.61)	-0.419* (-4.24)
SBI	0.328758* (5.48)	0.096922* (8.05)	0.833534* (42.86)	-0.12454* (-3.19)
TATAPOWER	0.697904* (6.63)	0.128562* (10.36)	0.807962* (44.86)	-0.44814* (-5.8)
TATATEA	0.479898* (6.36)	0.099826* (10.33)	0.850428* (62.3)	-0.29855* (-5.28)
GRASIM	0.209332 (3.74)	0.049516 (8.27)	0.929989 (106.47)	-0.14484 (-3.22)

Table V.2: EGARCH (1, 1) Model

$$R_t = \alpha + \beta_1 R_{t-1} + \beta_2 R_{t-2} + \beta_3 R_{t-3} + \beta_4 Nifty_t + \varepsilon_t$$

$$\varepsilon_t \mid \psi_{t-1} \sim N(0, \sigma^2)$$

$$\log \sigma_t^2 = \omega + \alpha \left| \frac{\varepsilon_{t-1}^2}{\sigma_{t-1}^2} - \sqrt{\frac{2}{\pi}} \right| + \gamma \frac{\varepsilon_{t-1}}{\sigma_{t-1}} + \beta \log \sigma_{t-1}^2 + \delta D_{futures} + v_t$$

Mean Equation					
Coefficients / Companies	c	β_1	β_2	β_3	β_4
Junior Nifty	0.004408 (0.25)	0.0927* (10.43)	-0.00039 (-.0.04)	0.020616** (2.25)	0.95574* (100.84)
CNX 100	0.0346 (1.44)	-0.064* (-5.19)	-0.026* (-2.24)	-0.039* (-3.2)	0.8138* (71.22)
ACC	0.090 (2.49)	-0.0555* (-2.98)	-0.034** (-2.07)	-0.050* (-2.7)	0.8506* (52.3)
BHEL	0.079*** (1.91)	0.0922* (5.2)	-0.025 (-1.39)	-0.006 (-0.44)	0.970* (42.87)
BPCL	0.0756 (1.6)	0.0521* (2.72)	0.0511* (3.19)	0.0145 (0.95)	0.7743* (35.05)
CIPLA	0.2111* (2.49)	0.1154* (5.91)	0.1382* (5.72)	0.0341 (1.51)	1.1803* (56.39)
DRREDDY	0.0416 (1.26)	-0.015 (-0.88)	0.1514* (11.59)	-0.080* (-9.7)	0.6382* (50.49)
HDFC	-0.3024* (-4.8)	-0.051* (-3.04)	-0.026* (-2.67)	-0.032** (-2.06)	0.8468* (30.97)
INFOSYS	-0.305* (-3.58)	0.0385* (4.98)	-0.162* (-9.93)	-0.033* (-3.71)	1.1654* (35.4)
ITC	-0.853* (-15.35)	0.0057* (2.61)	-0.023** (-2.42)	0.0221* (2.84)	0.6178* (25.6)
M&M	-0.026 (-0.45)	0.0497* (4.35)	0.0063 (0.39)	0.0023 (0.13)	1.0119* (36.94)
MTNL	-0.092 (-2.19)	0.0651 (4.1)	-0.045 (-2.77)	-0.009 (-0.61)	0.9293 (40.69)

SBI	0.024 (0.76)	0.0184 (1.46)	-0.005 (-0.43)	0.0183 (1.36)	1.0497* (62.97)
TATAPOWER	0.0141 (0.38)	0.055* (3.78)	-0.025** (-1.61)	-0.019 (-1.16)	0.9548* (46.36)
TATATEA	-0.043 (-1.17)	0.0857 (5.28)	-0.038 (-2.84)	-0.004 (-0.25)	0.751 (39.89)
GRASIM	0.0599 (1.73)	0.026 (1.71)	-0.015 (-0.96)	0.03*** (1.83)	0.822* (40.67)

Note: Figures in () are t-statistics

* indicates significant at 1% level.
****** indicates significant at 5% level.
*** indicates significance at 10% level.

Variance Equation					
Coefficients / Companies	ϖ	α	γ	β	δ
Junior Nifty	-0.141* (-11.16)	0.1814* (11.11)	-0.022* (-2.93)	0.976** (2.06.78)	0.0001 (0.027)
CNX 100	-0.234 (-6.12)	0.238 (6.48)	-0.002 (-0.1)	0.945 (56.44)	0.0286 (1.53)
ACC	-0.024 (-1.29)	0.306* (19.95)	0.1463* (12.68)	0.9687* (197.61)	-0.149* (-10.62)
BHEL	0.081 (1.59)	0.683 (24.43)	0.0967 (3.62)	0.773 (32.69)	-0.187 (-6.19)
BPCL	0.618* (7.09)	0.653* (32.77)	0.1819* (11.86)	0.576* (16.83)	-0.3086* (-8.03)
CIPLA	1.456* (11.74)	0.716* (24.38)	0.6457* (28.71)	0.221* (4.97)	0.489* (11.93)
DRREDDY	2.132* (41.07)	1.111* (38.73)	-0.521* (-16.52)	0.068* (4.80)	-1.231* (-29.14)
HDFC	5.343* (27.99)	0.300* (8.12)	0.2728* (8.5)	0.597* (11.35)	-2.434* (-34.23)
INFOSYS	3.0364*	0.4803*	0.4688*	.0.3129*	0.349*

	(33.47)	(29.33)	(34.23)	(13.08)	(5.93)
ITC	6.2106* ((-144.91)	-0.473* (-50.12)	-0.4188* (-45.25)	0.776* (133.26)	-1.466* (-3.74)
M&M	-0.017** (-2.12)	0.0729* (9.07)	0.1044* (12.89)	0.9866* (342.44)	-0.0053** (-2.05)
MTNL	0.059 (1.78)	0.2258* (9.68)	0.0122 (0.98)	0.889* (45.18)	-0.057* (-4.09)
SBI	-0.050* (-4.04)	0.169* (8.78)	0.0207** (1.96)	0.9475* (107.27)	-0.024* (-3.23)
TATAPOWER	-0.057* (-4.17)	0.2383* (13.58)	0.0163 (1.46)	0.9441* (124.59)	-0.053* (-5.51)
TATATEA	-0.045* (-2.73)	0.2265* (12.84)	-0.034* (-2.95)	0.9395* (109.12)	-0.051* (-5.06)
GRASIM	-0.0453* (-5.63)	0.0966* (9.11)	-0.0122** (-1.86)	0.9867* (288.84)	-0.0137* (-2.65)

Note: Figures in () are t-statistics

Figures in parentheses are t-statistics.
* indicates significant at 1% level.
****** indicates significant at 5% level.
*** indicates significance at 10% level.

Table V.3: Behaviour of Volatility before and after futures trading

ACC				
Pre Futures				
C	1.409291	0.644485	2.186694	0.0288
ARCH	0.166055	0.175123	10.08465	0.0000
GARCH	0.625429	0.042810	7.601695	0.0000
Post Futures				
C	0.198980	0.037475	5.309733	0.0000
ARCH	0.327897	0.011596	11.02908	0.0000
GARCH	0.544778	0.014363	58.81769	0.0000
BHEL				
Pre Futures				
C	4.396518	2.104848	2.088758	0.0367
ARCH	0.105624	0.046105	2.290936	0.0220
GARCH	0.573949	0.181673	3.159249	0.0016
Post Futures				
C	1.244517	0.126671	9.824776	0.00
ARCH	0.641949	0.034261	18.73714	0.00
GARCH	0.417967	0.026715	15.64564	0.00

Table V.3 Continued

BPCL				
Pre Futures				
C	9.946048	1.064529	9.343148	0.0000
ARCH	0.804153	0.056948	14.12095	0.0000
GARCH	-0.002193	0.042598	-0.051486	0.9589
Post Futures				
C	0.179348	0.037797	4.745074	0.0000
ARCH	0.053542	0.005431	9.857713	0.0000
GARCH	0.924697	0.008373	110.4364	0.0000
M&M				
Pre Futures				
C	2.321284	0.598539	3.878248	0.0001
ARCH	0.200198	0.051314	3.901426	0.0001
GARCH	0.638197	0.077140	8.273222	0.0000
Post Futures				
C	1.600977	0.343576	4.659752	0.0000
ARCH	0.098544	0.020688	4.763360	0.0000
GARCH	0.756813	0.047708	15.86344	0.0000

Table V.3 Continued

CIPLA				
Pre Futures				
C	6.315919	0.550652	11.46989	0.0000
ARCH	1.405246	0.086859	16.17851	0.0000
GARCH	0.008040	0.025173	0.319372	0.7494
Post Futures				
C	2.653394	0.107535	24.67459	0.0000
ARCH	2.849384	0.094777	30.06423	0.0000
GARCH	-0.000976	0.001206	-0.809178	0.4184
DR REDDY				
Pre Futures				
C	11.92008	17.53186	0.679910	0.4966
ARCH	-0.006001	5.00E-05	-120.0217	0.0000
GARCH	0.585577	0.610075	0.959844	0.3371
Post Futures				
C	4.878397	3.535452	1.379851	0.1676
ARCH	-0.002437	9.67E-05	-25.20041	0.0000
GARCH	0.594197	0.294361	2.018598	0.0435

Table V.3 Continued

HDFC				
Pre Futures				
C	50.49426	89.66648	0.563134	0.5733
ARCH	-0.002459	9.57E-05	-25.69898	0.0000
GARCH	0.593804	0.721387	0.823142	0.4104
Post Futures				
C	0.063903	0.003028	21.10502	0.0000
ARCH	-0.001943	6.36E-05	-30.55799	0.0000
GARCH	0.995526	0.000404	2465.534	0.0000
INFOSYS				
Pre Futures				
C	0.465880	0.148438	3.138550	0.0017
ARCH	0.294374	0.023028	12.78314	0.0000
GARCH	0.793284	0.009183	86.38786	0.0000
Post Futures				
C	14.68714	14.68542	1.000117	0.3173
ARCH	-0.001564	0.002056	-0.760820	0.4468
GARCH	0.496032	0.503878	0.984427	0.3249

Table V.3 Continued

MTNL				
Pre Futures				
C	0.254883	0.120606	2.113352	0.0346
ARCH	0.062871	0.015360	4.093037	0.0000
GARCH	0.917495	0.020458	44.84871	0.0000
Post Futures				
C	0.845275	0.124711	6.777878	0.0000
ARCH	0.159485	0.015767	10.11482	0.0000
GARCH	0.727514	0.027340	26.61008	0.0000
SBI				
Pre Futures				
C	0.494312	0.135648	3.644075	0.0003
ARCH	0.126188	0.029663	4.254030	0.0000
GARCH	0.818930	0.032520	25.18267	0.0000
Post Futures				
C	0.096497	0.022148	4.356944	0.00
ARCH	0.083430	0.009179	9.089321	0.00
GARCH	0.903995	0.010570	85.52636	0.00

Table V.3 Continued

TATA POWER				
Pre Futures				
C	2.391123	0.733106	3.261635	0.0011
ARCH	0.152594	0.040229	3.793101	0.0001
GARCH	0.632970	0.096543	6.556377	0.0000
Post Futures				
C	0.209821	0.037347	5.618094	0.0000
ARCH	0.147537	0.012642	11.67018	0.0000
GARCH	0.829003	0.013768	60.21095	0.0000
TATA TEA				
Pre Futures				
C	1.448840	0.486665	2.977080	0.0029
ARCH	0.120737	0.033062	3.651894	0.0003
GARCH	0.740513	0.071855	10.30564	0.0000
Post Futures				
C	0.344867	0.061444	5.612745	0.0000
ARCH	0.139861	0.016580	8.435561	0.0000
GARCH	0.794594	0.023492	33.82379	0.0000

Table V.3 Continued

GRASIM				
Pre Futures				
C	0.284521	0.171405	1.659935	0.0969
ARCH	0.064918	0.018080	3.590556	0.0003
GARCH	0.913992	0.022757	40.16249	0.0000
Post Futures				
C	0.284521	0.061444	5.612745	0.0000
ARCH	0.074918	0.016580	8.435561	0.0000
GARCH	0.883992	0.023492	33.82379	0.0000
ITC				
Pre Futures				
C	0.315030	0.098858	3.186674	0.0014
ARCH	0.079369	0.018199	4.361203	0.0000
GARCH	0.885731	0.026742	33.12129	0.0000
Post Futures				
C	26.71720	30.91916	0.864099	0.3875
ARCH	-0.000969	0.001194	-0.811524	0.4171
GARCH	0.598234	0.464764	1.287179	0.1980

Chapter – VI
Hedging and Speculation in the F&O Segment

6.1 Introduction

One of the basic objectives of introducing derivatives trading in India was to provide hedging facilities to the market participants like large financial institutions, banks and asset mangers to manage risk properly in the backdrop of globalized scenario. It was also thought that the cash market which was suffering from high degree of speculation, with the introduction of derivatives trading, speculation will shift to the Futures and Options segment. Speculation as such is not bad as it provides liquidity to the market. Nevertheless high speculation is always undesirable.

Indian stock market is considered as one of the most speculative markets in the world as pointed out in one of the important studies (Singh, 2001). According to reports Indian financial markets were second only to NASDAQ in speculation surpassing New York Stock Exchange (NYSE), London Stock Exchange (LSE) and markets in Germany, France, Hong Kong, Singapore and Japan. The volume of speculative trading in Indian financial markets is extremely high. As rightly pointed out by Gupta (1992), "the high volume of speculative trading has not helped even an iota towards strengthening the market's capital raising function; rather it had the opposite effect. Speculative trading in the financial markets diverts large amounts of financial resources away from productive purposes and consequently fewer are left for funding long term economic development programs". In addition, it results in irrational price behavior and higher volatility in the market (Singh, 2001).

The speculative nature of the Indian stock markets is also reflected in the settlement statistics on two premier stock exchanges in India viz. NSE and BSE. In 1999-2000, only 19.87% securities accounting for 10.07% turnover settled by delivery on NSE. During 2003-04, 24.47% securities accounting for 20.04% turnover settled by delivery and the balance (80%) were squared up on the National Stock Exchange (ISMR, 2000 and 2004). In BSE, in 1999-2000, only 24.03% securities accounting for 16.06% turnover were settled by delivery. However, during 2003-04, 37.18 % securities accounting for 25.73% turnover settled by delivery and the rest were squared up. The settlement statistics is showing some improvement in recent years nonetheless this indicates preference for non-delivery based trades, which is basically speculative in nature.

One of the reasons for banning *Badla* trading system by the Securities and Exchange Board of India (SEBI) was excessive speculation supported by this system. The SEBI also held this system responsible for payments crises on several occasions because this allowed scope for market manipulation by sophisticated traders. *Badla system* was a facility for borrowing funds or shares, using which speculators obtain leveraged positions on the market. *Badla* facilitated deferment of settlement obligations into the next settlement period. Basically, *Badla* was like a futures market without a stated expiration date. Since settlement could be deferred for an indefinite period of time, the default risk was extremely large in *Badla* system. The essential problem of the *Badla* system was non-transparent dangerous leverage. It is the leverage embedded in *Badla* that led to the Securities scam of 1992 and frequent payments crises in the Indian stock market in the past.

The Securities Exchange Board of India (SEBI) banned the Badla system in March 1994. The reasons were B*adla* system facilitated 'excessive speculation' and responsible for destabilizing the market. However, due to excessive pressure from brokers and stock exchange officials, *Badla* system was reintroduced in 1996 on Bombay Stock Exchange (BSE). Nonetheless, Badla was again banned in July 2001. There is a general perception that futures market/derivative market is essentially a speculative market and futures trading rest primarily on an urge for speculation. Hedging is rarely mentioned except in arguments justifying the continuation of futures trading (Working, 1952).

With the introduction of index futures in the Indian markets in June 2000 and particularly with the introduction of single stock futures excessive speculation argument has taken centrestage. It is believed that speculators have migrated from the cash market to the futures market as it provides low transaction costs and high leverage.

Single stock futures is not very popular globally. It was one of the reasons that the L.C. Gupta Committee on derivatives, appointed by the Securities and Exchange Board of India (SEBI), was not much in favour of introducing single stock futures in India. However, towards the end of 2000, the United States passed the commodities futures modernization act that demarcated the jurisdiction of the Commodity Futures Trading Commission (CFTC) and the Securities and Exchange Commission (SEC), USA, thereby removing the regulatory obstacle to single stock futures in that country. Single stock futures started trading in the US market almost two years ago. Now, single stock futures have expanded substantially from 2001 onwards in U.K, Greece, Mexico, Canada, Singapore, Hong Kong, Netherlands, Spain, Australia, Sweden, Finland, Denmark, Portugal, Hungary and South Africa. London International Financial Futures and Option Exchange (LIFFE), trades Single stock futures on a range of stocks from around the world including the USA. Nonetheless, except for the Indian and Spanish markets, single stock futures have not been very successful. A reason for this may be the higher risk profile of stock futures. The introduction of stock index futures has consistently been surrounded with controversy. However, the traditional favourable view, towards the economic benefits of speculation activity has not always been acceptable to regulators. Against this background, this chapter tests whether futures market trading is going for hedging or speculation. We test whether trading is oriented towards hedging price risk or to fulfill speculative desires of the sophisticated trader. This hypothesis will be tested using index futures and selected stock futures.

6.2. The Concept of Hedging

"Futures trading (in commodities) may be defined as trading conducted under special regulations and conventions, more restrictive than those applied to any other class of commodity transactions, which serve primarily to facilitate hedging and speculation by promoting exceptional convenience and economy of the transactions" (Working, 1952).

One of the important functions of the futures market is to provide hedging facilities to the market participant. The dictionary meaning of 'hedge' is

- a means of protection or defense
- to protect oneself from losing or failing by a counter balancing action
- to protect against risks from price fluctuations
- to protect oneself financially as by buying or selling commodity futures as a protection against loss due to price fluctuation

Futures markets provide hedging facilities to the economic agents either to reduce or eliminate risk that cannot be insured or diversified away. And, here, lies the rationale behind futures trading everywhere in the world. Hedging is obtained by taking opposite position in the futures market. The significance of hedging in a volatile price environment is not difficult to imagine. To see the demise of an otherwise efficient firm or farmer as a consequence of adverse price fluctuations over which it had no control is really pitiable. This high degree of volatility in prices is seen often in the case of agricultural commodities when a good crop causes harvest prices to fall below a farmer's cost of production. In fact, it was this very situation that led to establishment of Chicago Board of Trade and the introduction of commodity futures in 1860's. Similar volatility in prices of financial assets were also observed after the breakdown of Bretton Wood system in early 1970's that led to numerous financial innovations like financial futures.

6.3 Multipurpose Concept of Hedging

Hedging in its traditional sense refers to taking opposite position in the futures market i.e. matching one risk with an opposing risk, and hedging is effective because changes in spot prices of a commodity tend to accompanied by similar changes in the futures price. However, the concept of hedging involves more than risk-avoidance. There are several categories of hedging and is done for variety of reasons which differ according to circumstances.

6.3.1 Carrying –Charge Hedging

In carrying charge hedging a hedger holds stock of commodity for direct profit from storage. The traditional concept of hedging refers to taking opposite position in the futures market that would influence the stockholding only through making it less risky business. In carrying charge hedging, the hedger transforms the operation from one that seeks profit by anticipating changes in price level to one that seeks profit from anticipating changes in price relations.

Whereas the traditional hedging concept represents the hedger as thinking in terms of possible loss from his stockholding being offset by gain on the futures contracts held as hedge, the carrying-charge hedger thinks rather in terms of change in ‘basis’ – that is, change in the spot-future price relation. And, the decision that he makes is not primarily whether to hedge or not, whether to store or not.

6.3.2 Operational Hedging

Operational hedging is done chiefly to facilitate operations involved in a merchandising or processing business. It normally entails the placing and 'lifting' of hedges in such quick succession that expected changes in the spot-future price relation over the interval can be largely ignored; and it is this fact which chiefly distinguishes operational hedging from carrying –charge hedging. Because the intervals over which individual operational hedges are carried tend to be short, the amount of risk reduction accomplished tends to be small – quite insufficient to explain the observed prevalence of operational hedging. Besides reducing risk, to an extent that the hedger may or may not consider significantly advantageous, it leads to economies through simplifying business decisions and allowing operations to proceed more steadily than otherwise.

These business advantages of operational hedging depend on the existence of high correlation between changes in spot prices and changes in futures prices over short intervals – day to day or within the day. Such correlation of short –interval price changes is not always present, and in its absence there tends to be little operational hedging even though the broader correspondence between changes in spot and futures prices be close enough to permit effective risk reduction through hedging.

6.3.3 Selective Hedging

Selective hedging is the hedging of commodity stocks under a practice of hedging or not hedging according to price expectations. Because the stocks are hedged when a price decline is expected, the purpose of the hedging is not risk avoidance, in the strict sense, but avoidance of loss. When hedging is done selectively, the advantage of the hedging to the individual firm may often be measured approximately by the amount of loss avoided directly by the hedging. Though curtailment of the amount of unsold stocks is an alternative means of restricting loss at a time of expected price decline, it is a means that few firms are able to use freely, owing to operating needs for carrying stocks. Selective hedging almost inevitably yields large advantages to any merchandising or processing firm that is able to anticipate price changes reasonably well. From an economic standpoint selective hedging deserves appraisal as simply one aspect of the use of futures markets as a means by which handlers of a commodity increase the efficiency of their participation in the price-forming process, instead of largely withdrawing from such participation, as they do when they practice routine carrying charge or operational hedging. Futures markets that receive a large amount of selective hedging tend also to have a considerable amount of 'speculation' by handlers of commodity. Inasmuch as selective hedging must come chiefly from those handlers of the commodity who commonly hold substantial stocks, and who therefore take a long position by merely refraining from hedging, it is to be presume that the 'speculative' use of futures by handlers of the commodity comes mainly from dealers whose business requires relatively holding of physical stocks.

6.3.4 Anticipatory Hedging

Anticipatory hedging, which also is ordinarily guided by price expectations, differ from selective hedging in that the hedging contract is not matched by either an equivalent stocks of goods or a formal merchandising commitment that it may said to offset. It takes either of two principal forms:

- purchase contracts in futures acquired by processors to cover raw 'requirements' or
- sales contracts in futures by producers, made in advance of the completion of production.

In either of these forms the anticipatory hedge serves as a temporary substitute for a merchandising contract that will be made later. In the one case it serves as a substitute for immediate purchase of the raw material on a merchandising contract; in the other case it serves as a substitute for a forward sale of the specific goods that are in course of production. The purpose of the hedge may be said to be to take advantage in convenience or economy through the choice made between alternatives.

6.3.5 Risk-avoidance hedging

Pure risk-avoidance hedging, though unimportant or virtually nonexistent in modern business practice, may have played a significant part in the early history of futures markets. In the absence of records concerning the uniformity of hedging by firms using the early futures markets, however, it is impossible to know to what extent early hedging described as done to ‘reduce risks’, actually had that purpose in strict sense or was selective hedging, done to avoid incurring loss from an expected price decline.

6.4. Theories of Hedging and Speculation

Speculation is ordinarily understood to mean the purchase of a good for later resale than for use, or the temporary sale of a good with intention of later re-purchase in the hope of profiting from an intervening price change.

6.4.1 Keynes-Hicks Risk-Transfer Hypothesis

The best-known theory of speculation related with the names of J.M. Keynes and J.R.Hicks and it is called *risk-transfer hypothesis*. According to this hypothesis, speculators are relatively risk-tolerant individuals who are rewarded for accepting price risks from more risk-averse hedgers. Hedgers who anticipate being long position on the commodity for instance, a farmer with a crop of rice approaching harvest, may hedge by selling now in a forward or futures market, for future delivery at a currently determined price. An individual who is or anticipates being short the commodity for example, a miller of wheat, may hedge by buying now for future delivery at current price for future delivery. Speculators in the forward or futures market may be on the long or short side of any single such transactions, but in aggregate their commitments must offset any imbalance of the long and short hedgers’s positions.

In the Keynes-Hicks view the hedgers are divesting themselves of price risks. It is these price risks that are correspondingly being accepted by the speculator. This gave rise to Keynes celebrated theory of *normal backwardation.* The normal backwardation hypothesis postulates that futures prices tend to rise over the life of a futures contract because hedgers tend to be short in futures market. The logic behind this notion is that the hedgers hold short positions as insurance against their cash position and must pay speculators a return to hold long positions in order to offset their risk. Markets are therefore considered to be in normal backwardation when the futures price is less than the expected future spot price.

Keynes's theory explains the prevalence of insurance premium handlers of commodity pay to speculators to protect themselves from the risk of the fluctuating value of their inventories. The normal backwardation hypothesis says that at any time, the futures price must be a downward biased estimate of the future spot price i.e. the futures price must rise as the contract nears maturity as shown below:

$$FU(t) < E[S(t)] \quad (6.1)$$

where FU(t) refers to futures price at time't', E stand for expectation and S(t) is spot price at time 't'. The argument behind the normal backwardation is that in the futures market there are basically two types of players – hedgers and speculators. Hedgers use futures to reduce or eliminate price risk and there are speculators who are looking for profit from price movements and are willing to accept some risk. The crucial prediction of the theory of normal backwardation is that futures prices are biased. Keynes (1930) therefore suggested that, " The quoted forward price though above the present spot price, must fall below the anticipated future spot price by at least the amount of the normal backwardation.

6.4.2 Working's Knowledgeable Forecasting Hypothesis

Holbrook Working did not make any such fundamental distinction between motivations of speculators and hedgers. According to his knowledgeable forecasting hypothesis what look like risk-transfer behaviour is only the interactions of traders with more and less optimistic beliefs about developments that will offset prices. An individual who expects prices to rise will make speculative purchases; one who expect them to fall will sell. Thus, Working's hypothesis is against the well-accepted view of hedgers as pure risk minimisers and emphasized expected profit maximization. In his view hedgers functioned much like speculators, but since they held positions in the cash market as well, they were concerned with relative not absolute price changes. Instead of expecting cash and futures price to move together, he argued, "most hedging is done in expectation of a change in spot-futures price relations." Holders of a long position in the cash market would, according to Working, hedge if the basis was expected to fall and would not hedge if the basis was expected to rise.

6.4.3 The Portfolio Theory of Hedging

The portfolio theory of hedging presumes a role for risk-aversion. The major postulate of portfolio analysis is that among assets with the same average return, people prefer those whose returns are least risky in commodities. Johnson (1960) and Stein (1961) contended that firms in the commodity business consider a blend of two assets, hedged inventory, which earns a low but relatively steady rate of return and unhedged inventory, which has a higher but riskier return. In its simplest form, the portfolio theory of hedging begins with the assumption that hedged and unhedged inventory are two separate assets that a dealer in commodities could combine into a portfolio based on the riskiness of their returns. Unhedged inventory is simply a commodity in store while hedged inventory is actually a package of two assets, a commodity in store and a short position in a futures market. Since the asset-hedged inventory embodies the sale of a futures contract, the number of futures. The fundamental conclusion of the portfolio theory of hedging is that a greater degree of risk aversion induces a dealer to use futures market more.

Futures market/derivatives market is essentially thought of as a speculative market and hedging is rarely mentioned except in arguments justifying the continuation of futures trading. However, it is difficult to determine the comparative roles of speculation and hedging in sustaining futures trading. According to Working, hedging is like the driver, and speculation in futures like a companion going where hedging gives it opportunity to go. Thus, the amount of speculation depends on the amount of hedging. It is also true that hedgers prefer to use the exchange, which has the largest volume of speculative trading.

6.5 Data and Variables

To examine whether trading in F&O segment is for hedging purpose or to fulfill speculative desires of sophisticated traders, we collected data on S&P Nifty index futures from 12 June, 2000 to 31 March, 2009. We divided the whole sample into three sub-samples to see emerging trend in the futures market as markets matures. We also collected data on 10 single stock futures from November, 2001 to 31 March, 2009 which is listed below:

1. Bharat Heavy Electricals Ltd
2. Bharti Airtel
3. ICICI Bank
4. Indian Trading Corporation (ITC)
5. Infosys Technology
6. Oil and Natural Gas Corporation (ONGC)
7. Reliance
8. State Bank of India (SBI)
9. Steel Authority of India Ltd (SAIL)
10. Wipro

In this chapter, three variables are used to assess whether trading is basically for hedging or for speculation in the futures market. One of the important variables used for testing this objective is futures return. It is computed as:

$$FR_t = In\left(\frac{F_t}{F_{t-1}}\right) \qquad (6.2)$$

We used two concept of volume in this chapter. One is the turnover or volume. It refers to the number of purchases/sales in the various contracts listed on an exchange during a given period of time. Since the exchange automatically matches a purchase with a corresponding sale, turnover gives an account of the total number of purchases or sales in the specified period. The basic unit of time on exchanges is the trading day, with the information on activity usually being reported in number of contracts traded. Turnover is a flow concept, which is generally used by market participants as an indicator of liquidity in a particular contract or as a measure of an exchanges success in attracting trading business.

Another proxy for volume of the futures market or futures market activity *is open interest*. It refers to the total number of contracts that have not yet been offset by an opposite transaction or fulfilled by delivery of the asset underlying a contract. Although each transaction has both a buyer and a seller, only one side of the transaction is included in open interest statistics. Open interest is a stock concept reflecting the net outcome of transactions on a given date. It is often interpreted as an indicator of the hedging or long-term commitment of traders to a particular contract. Open interest is generally smaller than turnover because a large number of contracts that are bought or sold during the course of the day are reversed before the end of the trading session.

6.6 Methodology

There are basically two reasons for trading by investors either for rebalancing their portfolios for risk sharing or to speculate on their private information. These two types of traders are called hedger and speculator respectively and result into different return dynamics. When a subset of market participants sells a stock for rebalancing their portfolio, the price of stock must decrease to attract other investors to buy. Since the future expectation of the stock payoff remains the same, the decrease in the price causes a low return in the current period and a high return for the next period. However, when a group of investors sells a stock for speculative reasons, its price decreases, reflecting the negative private information about its future payoff. Since this private information is partially impounded into the price, the low return in the current period will be followed by a low return in the next period, when the negative private information further reflected in the price. And accordingly hedging trades generate negatively autocorrelated returns and speculative trades generate positively autocorrelated returns.

Volume of futures trading can help to identify the periods in which either allocational or informational shocks occur, and thus can provide valuable information to market. In periods of high volume, stocks with a high degree of speculative trading tend to exhibit positive return autocorrelation and stocks with a low degree of speculative trading tend to exhibit negative return autocorrelation. The actual dynamics of returns depend on the relative importance of the return generating mechanisms. In this study, an attempt is made to examine returns generated by trading with special attention to the relative amount of hedging trade versus speculative trade and their relative impact on stock prices. When all trades are hedging trades, current returns together with high volume predict strong reversals in futures returns. When speculative trades are more important, current returns together with high volume predict weaker reversals in future return (Wang, 1994).

To examine whether Futures and Option (F&O) segment of the National Stock Exchange (NSE) is dominated by speculative trades or hedging trades, this study uses Llorente, Michaely, Saar and Wang (2002), methodology. The return volume dynamics of stocks is based upon three sources. First, new information on future payoffs comes into the market, and changes investors' expectations on future payoffs. Information, by definition is random and independent, and the model assumes that market participants receive the information simultaneously and the stock prices change to incorporate this new information completely. This price change does not motivate any trading activity, as all participants agree on the future payoffs. Importantly, returns in the two periods are uncorrelated.

Trades generated due to speculative positions and portfolio rebalancing leads to serially correlated returns, and are the other two sources of the return volume dynamics. Speculative trades are based upon investors' private information held today, and are designed to provide investors with higher returns in the next period when that private information is fully revealed to the market. This implies a positive correlation in returns as market incorporate the information into prices. Trades due to portfolio rebalancing, or hedging, is not information based, and occurs when a trader may increase (or decrease) his stock holding by buying (or selling) a portion of his stock holding. This will be accomplished by increasing (or decreasing) the stock price to induce the opposite side of the trade. Price changes without information are not in equilibrium, and must reverse in the next period, resulting in a negative correlation of returns.

To analyze this particular objective the following regression is used for Nifty index futures and ten single stock futures:

$$FR_{i\,t+1} = \alpha + \beta_1 r_{it} + \beta_2 r_{it} * v_{it} + \varepsilon_{i\,t+1} \tag{6.3}$$

where,

$r_{i,t}$ is the return for the i[th] stock futures at time t.

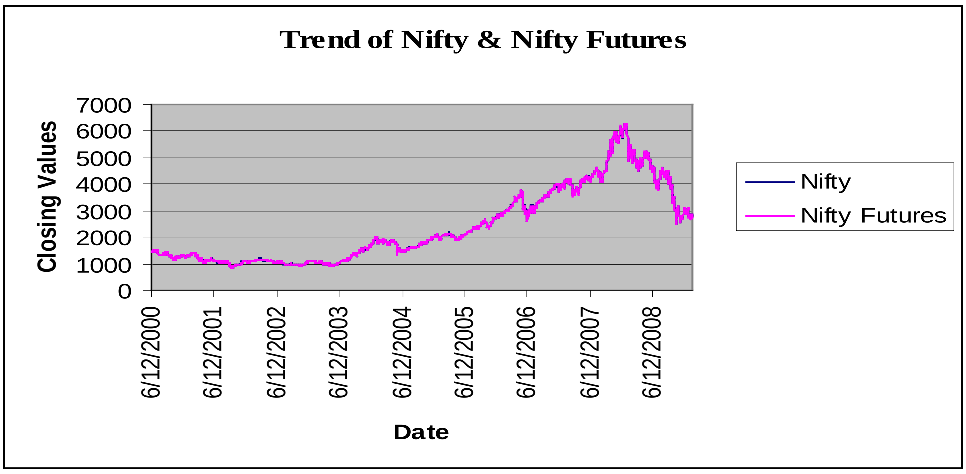
$v_{i,t}$ is the turnover for the i[th] stock futures at time t.

This return volume dynamics can be observed from the coefficient of β_2. If the trades are only speculative in nature β_2 should be positive, since returns are positively correlated. The level of speculation will be measured by the scaling factor $v_{i,t}$. However, if the trades are primarily to rebalance portfolio (hedging), β_2 will be negative, and the scaled by $v_{i,t}$. Thus the level of private information will be directly related to the value of β_2.

6.7 Empirical Results

We proceed with our empirical analysis first keeping in mind Keynes-Hicks risk-transfer hypothesis that makes a distinction between the market participants as speculators and hedgers. According to this hypothesis, hedgers divest their price risks by taking short positions while speculators are risk-tolerant individual who bear price risk and therefore futures price must be less than expected future spot price to compensate speculators with a positive risk premium i.e. future spot price is biased downward.

Figure 6.1: Spot Nifty Vs Nifty Futures



We matched the last traded Nifty futures price and closing price of spot Nifty on the expiration date of the futures contract. We selected last traded price because the closing futures price is an average of last half an hour price, which do not reflect true closing price. Figure 6.1 shows the Nifty spot and futures on expiration date from 29 June, 2000 to 26 March, 2009. It is clear from the Figure 6.1 that Nifty futures is less than Nifty spot on most of the occasion. In the first impression, it appears that Keynes-Hicks normal backwardation hypothesis holds in India.

Further, we calculated the total number of expiration date and percentage of time when expected future spot price was less than futures price. We have total number of 702 expiration date. On 56 occasions futures price was less than expected future spot price i.e. 54% of the time market was in normal backwardation while 35% of the time market was in contago. And on 10 occasions futures price was equal to expected future spot price implying no rewards to speculators for bearing price risks.

Table 6.1: Futures and Expected Spot on Expiration

Futures < Spot	56	54.91%
Futures > Spot	36	35.29%
Futures = Spot	10	9.8%

Our results show that Keynes-Hicks normal backwardation holds partially in the Indian case. Further, using Llorente, Michaely, Saar and Wang (2002) methodology in this chapter, we test whether trading in Futures and Options segment of NSE is oriented towards hedging or speculation. Towards this end, we conducted test at index level and firm level. We used two proxy for futures market activity viz. turnover and open interest. To see hedging and speculative transactions at index level, we divided the whole period into three sub-samples. The results are reported in Table 6.2 when turnover is used as a proxy for volume.

Table 6.2: Return Volume Dynamics of Nifty Futures (Turnover)

Coefficients/ Variables	**Full Sample (June 2000 to March 2009)**	**S 1**	**S 2**	**S 3**
α	0.048 (1.26)	-0.050 (-1.02)	0.1497* (2.71)	0.0325 (0.38)
β_1	-0.0038* (-3.89)	0.039 (1.08)	0.0129 (0.35)	-0.011* (-4.33)
β_2	0.0020* (4.38)	0.0051* (8.57)	-0.0023* (-3.39)	0.0036* (3.40)
		F Stat = 39.05 (0.00)	F Stat = 6.30 (0.001)	F Stat =1 6.29 (0.00)

Note:

Figures in parentheses are t-statistics.

* indicates significance at 1% level.

** indicates significance at 5% level.

*** indicates significance at 10% level

S1 – (June 2000 to March 2003)
S2 – (April 2003 to March 2006)
S3 – (April 2006 to March 2009)

The return volume dynamics can be observed from β_2. If the trades are only speculative in nature β_2 should be positive, since returns are positively correlated. The results show that in case of full sample that consist data from 12 June 2000 to 26 March 2009, the sign of the coefficient β_2 is positive, which indicates speculative transactions. Sub-sample 1 cover period from 1st April 2000 to 31 March, 2003 and sub-sample 2 cover period from 1st April, 2003 to 31st March, 2006. Sub-sample 3 cover period from 1st April 2006 to 31st March, 2009. While coefficient of β_2 in sub-sample 1 and sub-sample 3 are positive implying speculative trading. However, in sub-sample 2, β_2 is negative which indicates portfolio rebalancing or hedging.

Table 6.3: Return Volume Dynamics of Nifty Futures (Open Interest)

Coefficients/ Variables	**Full Sample**	**Sample1**	**Sample 2**	**Sample 3**
α	0.037 (0.97)	-0.051 (-0.99)	0.1709* (3.08)	-0.012 (-0.14)
β_1	0.026 (1.22)	0.071** (1.89)	0.0296 (0.81)	0.0046 (0.12)
β_2	0.0026* (3.15)	0.0022*** (1.58)	0.0033* (2.81)	0.0023 (1.40)
	F stat = 5.83 (0.00)	F Stat= 3.29 (0.00)	F Stat = 4.46 (0.00)	F stat = 0.99 (0.36)
Note: Figures in parentheses are t-statistics. * indicates significant at 1% level. ****** indicates significant at 5% level. *** indicates significance at 10% level.			S1 – **(June 2000 to March 2003)** **S2 – (April 2003 to March 2006)** **S3 – (April 2006 to March 2009**	

When open interest is used as proxy for futures market activity, we found that the sign of β_2 is positive in case of full sample, which indicates speculative nature of trading in the F&O segment. All sub-samples have positive β_2 implying presence of substantial speculation present in futures trading.

We also studied the return volume dynamics at firm levels on which single stock futures were introduced. We took ten companies namely, BHEL, BHARTI AIRTEL, ICICI BANK, ITC, INFOSYS, ONGC, RELIANCE, SBI, SAIL and WIPRO as these companies are highly liquid with high turnover.

Table 6.4: Return Volume Dynamics of Companies (Turnover)

Companies \ Coefficients	α	β_1	β_2
BHEL	1.06* (31.3)	-0.06*** (-1.88)	2.67E-05 (0.04)
Bharti Airtel	0.001** (2.03)	-0.11 (-0.66)	0.009 (0.36)
ICICI Bank	0.001** (2.06)	0.38 (1.59)	-0.04 (-1.53)
ITC	0.001 (-0.85)	-0.13 (-0.33)	0.02 (0.38)
Infosys Technology	0.001 (2.21)	0.04 (0.24)	-0.0009 (-0.04)
ONGC	0.001 (1.46)	-0.07 (-0.67)	0.009 (0.68)
Reliance	0.008 (0.83)	0.15 (0.90)	-0.009 (-0.48)
SBI	0.001** (2.15)	0.03 (0.20)	0.0007 (0.03)
SAIL	1.02* (29.83)	-0.001 (-0.03)	-0.002** (-2.04)
Wipro	0.001*** (1.76)	-0.15 (-0.88)	0.01 (0.82)

Figures in parentheses are t-statistics.
* indicates significant at 1% level.
****** indicates significant at 5% level., *** indicates significance at 10% level

We want to see hedging and speculation is company specific or irrespective of company speculation is done. The results are reported in Table 6.4. When turnover was used as a proxy for futures market volume, it is evident from Table 6.4 that at firm level speculation is prompt. We found positive β_2 in case of ICICI Bank, INFOSYS, RELIANCE and SBI. However, BHEL, BHARTI AIRTEL, ONGC, SAIL have negative β_2 implying trading is basically for rebalancing portfolio.

Table 6.5: Return Volume Dynamics of Companies (Open Interest)

Companies \ Coefficients	α	β_1	β_2
BHEL	1.06* (31.13)	-0.04 (-1.20)	-0.001*** (-1.75)
Bharti Airtel	0.001 (2.09)**	-0.39 (-0.85)	0.02 (0.74)
ICICI Bank	0.001** (2.02)	1.13 (1.2)	-0.08 (-1.18)
ITC	-0.001 (-0.84)	-0.29 (-0.43)	0.02 (0.46)
Infosys Technology	0.001** (2.18)	0.37 (0.58)	-0.02 (-0.53)
ONGC	0.001 (1.45)	-0.02 (-0.07)	0.001 (0.07)
Reliance	0.0008 (0.80)	0.35 (0.91)	-0.01 (-0.72)
SBI	0.001** (2.15)	-0.07 (-0.10)	0.008 (0.15)
SAIL	1.02* (29.93)	0.02 (0.67)	-0.003* (-2.66)
Wipro	0.001 (1.73)	0.30 (0.71)	-0.02 (-0.74)
Note: Figures in parentheses are t-statistics. * indicates significant at 1% level. ****** indicates significant at 5% level. *** indicates significance at 10% level.			

When open interest is used as a proxy for futures market volume, we found positive β_2 in case of ICICI Bank, INFOSYS, RELIANCE, SAIL and WIPRO. Table 6.5 show that BHEL, BHARTI AIRTEL, ITC, ONGC and SBI have negative β_2 implying trading is basically for rebalancing portfolio. One more thing is clear from Table 6.5 that in those companies where futures volume is moderate speculation is concentrated. However, in case of those companies in which volume is relatively high exhibits portfolio rebalancing i.e. hedging.

6.8 Conclusion

Three important conclusions emerge from this chapter. First, the normal backwardation theory of Keynes-Hicks holds partially in the Indian case. Second, the analysis of returns and volume dynamics of Nifty and ten stock futures show that speculation is widespread in Nifty futures trading. Firm level studies shows mixed results. While speculation is rampant in some companies, trading is also done for hedging purpose in select stocks. Thus, it implies that index futures and stock futures trading are basically meant for speculation.

Chapter-VII

Market Quality

7.1. Introduction

This chapter deals with the efficiency and liquidity of the underlying market before and after the introduction of futures and options (F&O) in India. It is presumed that derivatives market enhances the liquidity and efficiency of the underlying market. In this chapter we tested whether the efficiency and liquidity of the market have improved in post derivatives phase.

The concept of efficiency is central to financial markets viz. money markets, capital markets, derivatives markets and foreign exchange market. Market efficiency is essentially a relationship between stock prices and information. A market is considered to be efficient if security prices 'fully reflect' the information available (Fama, 1970). If the markets are efficient neither chartist nor fundamentalists find 'bargains' in the stock market. Their recommendation to buy or sell has no economic value since in an efficient market the current share price is the best estimate of its true economic value.

In efficient market security prices fully reflect all information. If markets are efficient then new information is reflected quickly into market prices. In other words, price movements do not follow any pattern or trend meaning past price movements cannot be used to predict future price movements. It is a situation where the market price of securities is an unbiased estimate of the fundamental value or true value of the investment or prices follow what is known as a 'random walk', an intrinsically random unpredictable pattern. In simple words, market efficiency does not call for that market price of securities be equal to fundamental value or true value at every point in time. It only calls for that errors in the market price of financial assets be unbiased. Prices can be greater than or less than fundamental value or true value but as long as these deviations are random, markets are efficient. The fact that deviations of market price of financial assets from its fundamental value are random implies that at any point in time there is an equal chance that stocks are undervalued or overvalued and that these deviations are uncorrelated with any observable variable. The foremost implication of this efficient market hypothesis (EMH) is that if the market prices of financial assets are unbiased or random then no group of investors would be able to consistently find undervalued or overvalued stocks using any particular investment strategy.

Market efficiency is attained by the competitive activities of security analysts and the number of analysts in the market. The larger the number, the lower the correlation between the mistakes of judgment, the more efficient will be the market. But the point is what are the incentives of those analysts to continue security analysis if markets are efficient because their analysis.

Efficient market hypothesis (EMH) states that market price reflects all information. However, depending upon the amount and type of information impounded into the price of assets, efficiency of the markets are classified into:

Under weak form efficiency, the current market price reflects all the past information relating to stock prices, volume, odd lot transactions, price changes, etc. There is no information in past stock prices suggesting that charts and technical analyzes that uses past prices alone would not be useful in finding undervalued stocks. So that no investor can earns abnormal returns based on that information and following any particular trading strategy. Tests of the weak-form hypothesis try to answer basically two questions:

- Do market prices of securities over time have sufficient correlation to allow investors to forecast future price movements by studying trends?
- Can investment strategies based on price movements offer opportunities for abnormal profits?

Under semi-strong form of market efficiency, the current price reflects the information contained not only in past prices but also all public information which includes all stock market information plus all publicly available financial, economic, or other type of information on the specific company, the national economy, the world and so on. Security prices react immediately to all new information. Thus, no amount of public information can help investor to earn abnormal returns based on that information and following some trading strategy.

Under strong form of market efficiency, the current market price reflects all public as well private information. And no investor can earn abnormal returns based on public and private information. It is assumed in a perfect market situation *all* information is available to everyone at the same time cost-free. Market anomalies such as the weekend effect, January effect and firm size effects are basically irregularities or inconsistencies that conflict with the notion of efficient capital market. These irregularities or inconsistencies suggest that security prices are non-random and follow some pattern. Market anomalies have attracted considerable attention because it challenges one of the central results of finance theory – Efficient Market Hypothesis (EMH).

Capital markets offer a forum to business community: what projects are likely to succeed; what technologies are likely to flourish; and what products consumers are likely to purchase. If security prices reflect these views accurately provided the markets are efficient then they give useful signals to corporate managers and business entities that are trying to maximize value of their firms. On the contrary, if prices really contain large systematic errors, managers of business firms who use these price signals to make decisions are merely responding to noise. The extent to which stock markets are efficient remains an important question that has very high significance for allocational functions of the securities markets. The informational efficiency of capital markets is closely associated with allocational efficiency of markets and hence the efficiency of the markets is crucial.

7.2 Review of Literature

The concept of market efficiency had been anticipated by Bachelier (1900) at the beginning of the century in his PhD dissertation in mathematics. Bachelier in opening paragraph of his dissertation remarks, "*past, present and even discounted future events are reflected in market price, but often show no apparent relation to price changes*". Bachelier had concluded that commodity prices fluctuates randomly and further work by Cowles and Jones (1937) showed that US stock prices and other economic series also share these properties.

Cowles (1933) appraised the investment strategy of William Peter Hamilton during the period 1904-1929. He found that the market returns were far higher than his returns. He examined the portfolio of 20 fire insurance companies and 16 financial services that were trend chasers and concluded that patterns are missing. Hence, technical analysis is of no use. In subsequent work, Cowles (1944) provided corroborative results for a large number of forecasts over a much longer sample period. Until 1950s, these studies however remained largely overlooked by researchers. Thus, by 1940s, there was scattered evidence in favour of the weak-form market efficiency and strong-form efficiency.

Karl Pearson (1905) discussed the problem of the optimal search for finding a drunk left in a middle of a field. The drunk is likely to end up closer to where he had been left than to any other point under the assumption that the drunk stagger in a totally unpredictable and random fashion. In finance, this analogy has been applied to series whose successive returns are serially independent. In the early 1950s, researchers like Kendall (1953), examined 22 UK stock and commodity prices and surprised to find that, "*in series of prices which are observed at fairly close intervals the random changes from one term to the next are so large as to swamp any systematic effect which may be present. The data behave almost like wandering series.*" The near-zero serial correlation of price changes came to be known as the 'random walk model' or 'random walk theory'. Roberts (1959) demonstrated that a time series generated from a sequence of random numbers was indistinguishable from a record of US stock prices. Similarly, Osborne (1959) showed that common stock prices have properties analogous to the movement of molecules.

Fama's (1965) observed strong evidence in favour of random walk hypothesis. He stated that the movements in price of stocks are independent and returns of the stock prices confirms to the leptokurtic distribution. However, Fama (1966) in his discussion paper stated that since the returns are more skewed and the kurtosis is relatively higher in speculative markets, the returns do not confirm to normal distribution. Fama's (1970) paper presented a comprehensive literature review on efficient market hypothesis. He classified the informational efficiency in three categories i.e. weak form efficiency, semi-strong form and strong form efficiency depending upon the level of information impounded in the current market price. If the current stock price is independent of its all past prices then the market is efficient in its weak form. If the stock prices are insensitive to public announcements, market will be efficient in semi-strong form. However, if the directors of the companies have any information which is not disclosed may affect the future price movements; market insensitive to such information will be efficient in strong form.

Most of the studies in the seventies concentrated on predicting prices from past prices. While studies in the 1980's looked at the possibility of forecasting returns based on variables such as dividend yield (e.g. Fama & French, 1988), and P/E ratios (e.g. Campbell and Shiller, 1988) studies in the nineties looked at inadequacies of current asset pricing models.

In recent years, the accumulating evidence against EMH in the form of stock market anomalies such 'January Effect', 'Weekend Effect', 'small firm effect', P/E ratio effect suggests that stock prices can be predicted with a fair degree of reliability. Two competing explanations have been put forward for predictability of stock prices. According to the proponents of EMH (Fama and French, 1995) predictability of stock prices results from time-varying equilibrium expected returns generated by rational pricing in an efficient market that compensates for the level of risk as predicted by capital asset pricing model (CAPM). Critics of EMH, however, maintains that the predictability of stock returns can be explained in terms of psychological factors, social factors, noise trading, and fashions or "fads" of irrational investors. The question about whether predictability of returns represents rational variations in expected returns or arises due to irrational speculative deviations from theoretical values has provided the impetus for further inquiries about the validity of EMH.

Most of the studies conducted in the developed markets confirm to the weak form of efficiency while the same is not true with developing and less developed markets. In India, all three forms of market efficient hypothesis tests were conducted on Indian stock markets. Barua (1981, 1987); Ramchandran (1985); Sharma and Kennedy (1977); Gupta (1989) found evidence of weak form efficiency. However, Kulkarni (1978) and Chaudhary (1991) studies did not support weak form efficiency of Indian Stock markets. Semi strong form of efficiency was supported by Ramchandran (1985). Madhusudanan(1998), however, tested the behaviour of stock prices in India by applying variance ratio test to the weekly data on BSE Sensex, BSE National Index and also to the data on 120 individual stock prices traded on BSE for the period January 1987 to December 1995 the results indicated that RWH could not be accepted in the Indian market.

The non-linear dependence in the Indian stock market has been examined by Poshakwale (2002) which found evidence of non-linear dependence in the index as well as some individual stocks. Dhankar and Chakraborty (2007) studied markets of the South Asia - India, Sri Lanka and Pakistan using daily data. They employed variance ratio test and BDS test to examine the efficiency of these South Asian markets. Their results of variance ratio test established that daily indices of all the three countries have shown that these markets do not follow random walk. They also documented the rejection of IID by the BDS tests implying non-linear dependence in the return series of the stock markets of South Asia.

7.3 Methodology

Testing market efficiency in its *weak form* involves testing of two separate hypotheses – successive stock prices are independent and the price changes are identically distributed random variable. In this study, we concentrate on testing both the hypotheses. To establish the statistical independence of stock price, three main tests that are widely used are random walk, the Sample Autocorrelation Function (SACF) and Q-statistic. However, if stock prices are non-linear, standard tests of efficiency like autocorrelation and random walk which are incapable of capturing non-linearity may lead to inappropriate inferences. To capture the non-linear aspect and whether the price changes are identically distributed random variable, this study proposed to use BDS test. The data on NSE Nifty and ten individual stocks are collected on which futures and option are available for trading in the Indian market.

7.3.1 Random Walk

Random walk process also known as 'Brownian motion' was introduced by Louis Bachelier in 1900 (Bachelier, 1900) for security and commodity markets. The random walk, in its simplest form represented as:

$$P_t = P_{t-1} + \varepsilon_t \tag{7.1}$$

where P_t is the price at time't' and ε_t is the error term which has zero mean and whose values are independent of each other. The price changes, $\Delta P_t = P_t - P_{t-1}$ is thus simply ε_t

and is hence independent of past price changes and current price is the summation of all past errors:

$$P_t = \sum_{i=1}^{t} \varepsilon_t \qquad (7.2)$$

Thus, the random walk model implies that prices are generated by purely random changes. To test random walk hypothesis one of the most direct way for an individual time series is to check for autocorrelation.

7.3.2 Serial Correlation Analysis

The independence of the stock price changes is also determined by the Sample Autocorrelation Function (SACF), which measures the amount of linear dependence between observations in a time series that are separated by lag k. The SACF is defined as:

$$\rho_k = \frac{\sum_{t=1}^{n-k} (x_t - \overline{x})(x_{t+k} - \overline{x})}{\sum_{t=1}^{n-k} (x_t - \overline{x})^2} \qquad (7.3)$$

If the price changes of the stocks are independently distributed, the ρ_k will be zero for all time lags.

7.3.3 The Q-Statistic

Developed by Box and Pierce (1978), this test is defined as:

$$Q = n\sum_{k=1}^{m} \hat{\rho}_k^2 \qquad (7.4)$$

where n= sample size and m= lag length. The Q statistics is use to test the joint hypothesis that all the serial correlation for lags 1 through m are simultaneously zero against the alternative hypothesis that at least some of them are not equal to zero. This Q statistics in large sample is approximately distributed as the Chi-square distribution with ‘m’ degree of freedom. If the calculated Q is greater than the critical Q value at the chosen level of significance from the chi-square distribution, one can reject the null hypothesis in favour of alternate hypothesis. The rejection of null hypothesis implies dependency of the series, which violates the random walk process.

A variant of the Q statistics is the Ljung-Box (LB) statistics defined as:

$$LB = n(n+2)\sum_{k=1}^{m}\left(\frac{\hat{\rho}_k^2}{n-k}\right) \qquad (7.5)$$

which has better small sample properties than the Q statistics. However, in large sample both follow the chi-square distribution with m degree of freedom.

7.4 Empirical Analysis of Efficiency

Empirical analysis is done for various samples and sub-samples. We have taken separate samples for before and after introduction of futures and options. We divided the whole data set into three sub-samples : sample one pertains to period before futures trading i.e. from 1 April 1998 to 9 June, 2000; sample two covers a period from 12 June 2000 to 26 March 2009. The data is divided into sub-samples to see whether there are tendency towards market efficiency.

7.4.1 Random Walk Analysis

To test random walk hypothesis, we looked at association between price changes on consecutive days. We specified this as:

$$\Delta P_t = \alpha + \beta \Delta P_{t-1} + \varepsilon_t \qquad (7.6)$$

If Nifty is efficient in its weak form, then $\beta = 0$ or close to zero. Table 7.1 reports the results of Random walk tests after and before futures and option trading in India.

Table 7.1: Random Walk Model for Nifty: $\Delta P_t = \alpha + \beta \Delta P_{t-1} + \varepsilon_t$

Variables	Before Futures Trading	After Futures Trading	Full-Sample
α	0.0380	0.031	0.0.325
	(0.44)	(0.85)	(0.97)
β	0.0160	0.0825	0.065
	(0.37)	(3.88)	(3.44)
Wald test:	F= 0.14 (0.70)	F= 15.08 (0.0001)	F = 11.89 (0.0006)
$H_0 : \beta = 0$	χ^2 =0.14 (0.70)	χ^2 =15.08 (0.001)	χ^2 =11.89(0.0006)

The results for random walk model with drift for sub-samples and full –sample are reported in Table 7.1. The results show that Nifty follows random walk before the commencement of the futures trading i.e. market as represented by Nifty was efficient in its weak form. The null of $\beta = 0$ for this sub-sample covering period 1 April, 1998 to 9 June, 2000 cannot be rejected. However, in other sub-samples period covering after the commencement of futures trading Nifty does not follow random walk The null of $\beta = 0$ can be rejected not only in case of full sample covering period from 1 April, 1998 to 31 March, 2009 but also in sub-samples which covers period after futures trading. This implies that market was efficient before futures trading in its weak form. However, after the commencement of futures trading market has become inefficient.

7.4.2 Serial Correlation or Autocorrelation Analysis:

In this chapter, we also conducted autocorrelation analysis. The weak form of market efficiency can be carried out by testing whether successive S&P Nifty log price changes are independent. The sample autocorrelation functions (SACFs) and partial autocorrelation (PACFs) were estimated up to lags 25 and reported in table. If significant correlation is found in successive stock price changes, the series is considered as predictable and hence the stock market is inefficient. It should be remembered that the coefficient of the first lag in the SACFs represent the coefficient of the random walk model.

In case of sample 1, the sample autocorrelation function (SACFs) between successive nifty returns is very close to zero indicating nifty returns are independently distributed. Besides this, nifty returns have no autocorrelations with almost every coefficient of the returns series being within the asymptotic bounds for sub-sample relating to Nifty returns before futures trading as evident from SACF from Table 7.2. The bound is calculated as $\frac{2}{\sqrt{T}}$ which yields to ± 0.08. However, in case of sub-sample relating to return relating after futures trading, the coefficient of sample autocorrelation functions (SACFs) is not zero between the successive nifty returns indicating stock returns is not independently distributed. The asymptotic bound for sample 2 is calculated as $\frac{2}{\sqrt{T}}$ is equal to ± 0.12.

Table 7.2: SACFs and PACFs for the Nifty Returns

Samples	**Before F&O**		**After F&O**		**Full sample**	
Lags	***ACFs***	***PACFs***	***ACFs***	***PACFs***	***ACFs***	***PACFs***
1	0.016	0.016	0.084	0.084	0.066	0.066
2	-0.046	-0.046	-0.05	-0.058	-0.05	-0.054
3	-0.002	0.00	0.008	0.017	0.005	0.012
4	-0.023	-0.025	0.013	0.008	0.004	0.000
5	-0.028	-0.027	0.006	0.006	-0.003	-0.003
6	-0.025	-0.027	-0.048	-0.048	-0.041	-0.04
7	0.001	-0.001	-0.009	0.000	-0.004	0.001
8	0.025	0.022	0.048	0.044	0.043	0.039
9	0.044	0.042	0.009	0.002	0.018	0.013
10	0.092	0.092	0.017	0.022	0.036	0.039
11	-0.022	-0.022	-0.016	-0.02	-0.019	-0.024
12	-0.009	0.001	-0.007	-0.005	-0.011	-0.006
13	-0.006	-0.005	0.037	0.035	0.023	0.021
14	-0.028	-0.021	0.073	0.072	0.049	0.049
15	0.007	0.014	-0.004	-0.012	-0.001	-0.004
16	-0.007	-0.007	-0.004	0.004	-0.005	0.001
17	0.047	0.046	0.028	0.023	0.031	0.028
18	-0.1	-0.112	-0.009	-0.018	-0.031	-0.04
19	-0.031	-0.032	-0.004	0.005	-0.015	-0.004
20	0.017	0.00	-0.057	-0.053	-0.045	-0.044

The coefficient of SACFs at lag 1, 5 and 7 are not zero and are outside the bound indicating presence of autocorrelation in returns. The bound for sample after F&O is estimated to be ± 0.04. The coefficients of SACFs in sample after F&O trading are outside the bound indicating autocorrelations in returns.

7.4.3 Q-Statistics Analysis

The Ljung Box statistics Q (k) up to 25 is calculated and reported in Table 7.3. The insignificant value of the Q statistic at lags 1, 5, 10, 15 and 25 in case of sample 1 covering a period from 1 April, 1998 to 9 June 2000 indicates that there is no evidence of autocorrelation in the Nifty returns series implying prevalence of market efficiency in its weak form before the introduction of futures trading. The Nifty returns follow random walk. However, Ljung Box statistic for sample 2, sample 3 and full sample shows significant value of Q-statistics at lag 1, 5, 10, 15 and 25 showing evidence of strong autocorrelation at each selected lag length. The Q-analysis also suggests that before futures trading market was efficient in its weak form however, after that market has become in efficient.

Table 7.3: Results of Ljung Box statistics

	Before F&O		**After F&O**		**Full Sample**	
Lags	***Q-Stat***	***P-value***	***Q-Stat***	***P-value***	***Q-Stat***	***P-value***
Q(1)	0.1348	0.71	15.36	0.00	12.21	0.00
Q(5)	2.03	0.84	21.48	0.001	19.05	0.001
Q(10)	8.65	0.56	32.54	0.000	33.28	0.00
Q(15)	9.45	0.85	48.23	0.000	42.57	0.00
Q(25)	18.56	0.81	60.85	0.00	58.12	0.00

The Ljung-Box statistic shows that the null hypothesis of no autocorrelation can be rejected at lags 1, 5, 10, 15 and 25 at 1 percent implying inefficiency of the S&P Nifty return series after futures trading.

7.4.4 GARCH-M Model

This study also employs GARCH-M model to test market efficiency. When the market risk premium is too high, the volatility will also follow leading to a false rejection of inefficiency. To test this, GARCH-M model is estimated which incorporate time-varying risk premium. The results are reported in Table 7.4. The coefficients of lag returns α_1, α_2 and α_3 are insignificant with t-statistics of 0.73, -0.63 and 0.19 respectively for the period 1 April, 1998 to 9 June, 2000. This indicates that before the introduction of futures trading the Indian stock market was unpredictable and hence efficient. The GARCH-M coefficient shows insignificant positive relationship between stock returns and equity premium implying the unpredictability of the Indian stock market before the introduction of futures trading. However, Nifty returns are outside risk-return relationship. However, for the sample period after the introduction of futures trading the GARCH-M model shows that market is not efficient in its weak form as evident from the significant coefficients of lag returns α_1, α_2 and α_3 with t-statistics of 4.18, -2.34 and 2.10 respectively for the period 12 June, 2000 to 31 March, 2009.

Table 7.4: GARCH-M Model

Coefficients	Before F&O	After F&O	Full Sample
α_0	0.0316	0.1247	0.11*
	(0.05)	(1.4)	(2.80)
α_1	0.0372	0.1051*	0.09*
	(0.73)	(4.18)	(4.16)
α_2	-0.029	-0.052**	-0.038
	(-0.63)	(-2.34)	(-1.98)**
α_3	0.009	0.046**	0.039**
	(0.19)	(2.1)	(2.06)
λ	0.0312	-0.005	0.002
	(0.09)	(-0.07)	(0.13)
ARCH (1)	0.0863*	0.1750*	0.1556*
	(3.21)	(11.97)	(13.64)
GARCH (1)	0.8016*	0.78*	0.81*
	(11.57)	(49.76)	(69.21)

Figures in parenthesis are t-statistic

The GARCH-M coefficient shows insignificant negative relationship between stock returns and equity premium implying the predictability of the Indian stock market over the sample period however, is outside risk-return relationship. The CAPM does hold in the Indian context over this sample period.

For the period 1 April 1998 July to 31 March, 2009, the GARCH-M model shows the market is not efficient in its weak form as evident from the significant coefficients of lag returns. The relationship between stock returns and risk premium is positive but insignificant implying that the market is outside the risk-return purview of relationship.

One important thing to note here is that flow of information has increased after the commencement of futures and option trading. The variance equation in the GARCH model has two components. The ARCH component is the coefficient of square of the error term and the GARCH component represents the coefficient of lagged variance term. ARCH component captures the effect of 'recent news' and the GARCH component capture the effect of 'old news'.

Table 7.4 shows the GARCH-M (1, 1) for various sub-samples. For sample 1 the results the coefficients of ARCH and GARCH components are 0.08 and 0.80 respectively before the introduction of Nifty futures while in the post-introduction phase the ARCH component has gone and is 0.58 and the GARCH component has declined and is 0.18. Similarly, for sample 3, the ARCH and GARCH coefficients are 0.21 and 0.56 respectively. The results shows that the impact of recent news have increased in the post-introduction phase of Nifty futures while the volatility in returns arising form the effect of old news has declined. Hence after the introduction of futures the quality of information flowing has improved to the cash market. This results is consistent with the results of Antoniou and Holmes (1995) and Bolonga and Cavallo (2002) for U.K and Italy respectively.

Both autocorrelation analysis and GARCH-M (1, 1) model shows that period before the introduction of the futures and options trading were characterized by weak form efficiency. However, period immediately after the introduction of futures is not efficient in its weak form. The causes of observed inefficiency of the market during the period after the introduction of futures and option trading may be the result of dynamics of higher order moments. To examine this, we conducted BDS test to detect non-linear dependences in the data.

7.4.5 BDS Test

It is a known fact that financial data often possess time varying volatilities characterized by GARCH and its variants. BDS would be an appropriate test for testing the null of no autocorrelation in returns of higher order. Under BDS test, in principle no distributional assumptions are made about the data under the null hypothesis other than that it is independent identically distributed (i.i.d) and can be interpreted as a test for nonlinearity.

In the first step, the ARCH (1) is fitted to the data, thus eliminating non-linearity of order two from the data. In the second step, BDS test is applied by running it on the residuals of that ARCH (1) model so that any dependence found in the residuals must be non-linear in nature of higher order.

This test for independence based on estimation of correlation integrals at various dimensions. BDS statistic estimation is non-parametric, which asymptotically follows a normal distribution. BDS test statistics is given by Brock *et. al*. (1996):

$$BDS = \sqrt{n-m+1}\frac{T_m(\xi)}{V_m(\xi)} \qquad (7.7)$$

where n is the total number of observations, $T_m(\xi) = C_m(\xi) - C_1(\xi)$, $C_m(\xi)$ and $C_1(\xi)$ are the correlation integrals, $V_m(\xi)$ is the standard error of $T_m(\xi)$ and ξ and m are the distance and dimension respectively whose values are chosen by the investigator. In most of the cases the values of ξ used are 0.5 and the value of m is fixed in line with the number of observations for example using only $5 \leq m$ if $500 \leq n$.

S&P Nifty returns are filtered for linear dependence using ARCH (1). To study whether the higher order dependence structure can be sufficiently accounted by ARCH (1), ARCH (1) standardized residuals are then tested for independently identically distributed (i.i.d) using BDS test. If the null hypothesis of i.i.d. is rejected by the BDS test, we then suspect that observed inefficiency in returns may be due to some dynamics in higher order (greater than second) moments of the residuals. The results of BDS test is reported in Table 7.5.

Table 7.5: BDS Test

Samples	D=2	D=3	D=4
Before F&O	0.006 (0.03)	0.0136 (0.008)	0.0242 (0.00)
After F&O	0.0276 (0.00)	0.0522 (0.00)	0.0674 (0.00)
Full Sample	0.0157 (0.00)	0.0343 (0.00)	0.0524 (0.00)

Note:

BDS test statistics tests for the null of i.i.d for sub-samples innovations.

'D' refers to embedding dimension.

Figures in the parentheses refer to bootstrap probability values.

The BDS test results shows that for ξ = s.d of linear filtered data with m = 3, 4 and 5 the null of i.i.d was rejected for all the samples indicating inefficiency observed in returns may be due to some dynamics in higher order moments of the residuals.

Table7.6: Ljung-Box statistic for ARCH residuals

Lags / ***Samples***	Q (1)	Q (5)	Q (10)	Q (15)	Q (25)
Before F&O	0.05 (0.81)	0.77 (0.97)	7.21 (0.70)	8.49 (0.90)	16.04 (0.90)
After F&O	6.93 (0.008)	13.85 (0.01)	20.89 (0.02)	25.74 (0.04)	42.82 (0.01)
Full Sample	0.54 (0.45	7.01 (0.21)	22.26 (0.01)	25.06 (0.04)	35.11 (0.08)

Autocorrelation analysis of the residual of ARCH (1) is done by the help of the Ljung-Box statistic is reported in Table 7.6. The results shows that the null hypothesis of no autocorrelation can be rejected at lags 1, 5, 10, 15 and 25 for sample 1 indicating that returns are independent. However, in case of sample2, sample 3 and sample 4, the null of no autocorrelation at lags 5, 10, 15, and 25 cannot be rejected even at 1 percent level indicating after the introduction of futures and option trading observed inefficiency can be explained by some dynamics in higher order moments of the residuals.

7.5 Liquidity

Liquidity means the ease with which a physical asset can be turned into cash. In this sense, money is the most liquid asset. In the context of financial market, liquidity means the ease at which shares and bond can bought and sold. The liquidity of the market is important for market players to buy and sale assets and it enhances the credibility of the financial market. Liquidity of the market provides accurate price signals to investors and corporations, which are crucial for efficient risk sharing and accurate investment decisions. In fact, financial markets cease to exist in the absence of counteroffers and are replaced by individualized bilateral contracts. Therefore some liquidity is essential for the very existence of a market. The high levels of liquidity in a financial market expand the set of potential counteroffers and enhance the probability of a favourable match. Therefore, increase in liquidity increases the expected level of satisfaction (utility) of the market players. Further, growing empirical literature shows a positive relationship between asset returns and liquidity of the market. This established the fact that liquidity directly affects a firm's cost of capital and hence its willingness to undertake real investment. Moreover, liquidity has significance for the investors for developing trading strategies. Not only this, the regulator and the exchange officials can also identify conditions likely to disturb trading activity.

There is no universally accepted definition of market liquidity reason being the multifaceted dimensions of it that are intertwined more or less firmly. Black (1971) defined liquid market is that market in which a bid-ask price is always quoted, its spread is small enough and small trades can be immediately executed with minimal effect on price. In other words, a liquid market is a market where a large volume of trades can be immediately executed with minimum effect on prices.

Liquidity defined as the ability of individuals to trade quickly at prices that are reasonable in light of underlying demand or supply conditions. According to Darst (1975) the liquidity or marketability of a security is consist of two aspects – the volume of securities which can be bought or sold at one time without significantly affecting its price and the amount of time needed to complete a desired transaction. The above definitions of liquidity reflect two dimensions. One is the speed at which transaction is made i.e. transaction time and the other is price at which transaction is completed i.e. transaction cost. Cost of illiquidity arises on the account of paying a price concession to execute orders quickly on the part of buyers and sellers. Illiquidity occurs in a non-frictionless market related to trading cost. Trading costs includes direct transaction cost, bid-ask spread, market impact cost, delay and search cost arise due to illiquidity (Amihud and Mendelson, 1991). In broad sense, liquidity refers to the ability of the financial market to provide immediate execution a market order often called immediacy and the ability of the market to execute small orders without large changes in the market price often called market depth or resiliency.

Thus, there are three dimensions to market liquidity, namely, tightness and depth. While tightness measures the ability of the market to match supply and demand at a low cost, depth refers to the volume of trades possible without any noticeable impact on prices. Other measures of liquidity are price volatility, the volume of trades, and frequency of trade and turnover ratio. Among these, price volatility, which is sometimes treated as one of the depth indicators is a widely used measure of liquidity. However, these three attributes can lead to conflicting assessments of market liquidity. For instance, a market may be deep but lack breadth. Thus, there is no single, unambiguous, theoretically correct measure of liquidity (Dubofsky and Groth, 1984), and Bernstein (1987). In the absence of precise definition of market liquidity researchers use certain proxies for liquidity. Common liquidity proxies include bid-ask spreads, trading volume, and trading turnover.

Liquidity of the stock market measures the degree of easiness with which stocks can be traded. The significance of stock market liquidity lies in the fact that many investments involved long gestation-period but investors might not want to tie up their savings for a long time period. In such a situation, a liquid market facilitates investors to dispose off equity easily if they desire thereby making equity relatively more desirable investment. The long term investment by the investors in equities i.e. changes in the portfolio of the investors in favour equity lowers the cost of shifting to more profitable long-term projects for firms. This in turn increases the productivity of the capital that boosts economic growth. Further, it also increases returns on investments in equity that may induce individuals to save and invest more in physical capital which in turn enhances economic growth.

It is argued that liquidity and efficiency of the market greatly improves with the introduction of derivatives. Since futures and option provides a mechanism to hedge price risk to the market participants those traders who were earlier did not trade in the absence of these instruments will participates and enhance the liquidity of the cash market. Nonetheless, introduction of futures and option can also decrease the liquidity of the cash market as the speculators who were earlier trading in the cash market will shift to the futures and option exchange due to less transactions cost. This might lead to decline in the liquidity of the underlying spot market. Against this background this study tries to look into how the liquidity of the Indian stock market has evolved since the introduction of futures and option trading in India.

7.5.1 Measures of Market Liquidity

Since it is difficult to define liquidity in precise terms, various proxies are used for liquidity in empirical works. One common measure of liquidity is the *bid-ask spread.* It is the price that market makers impose for liquidity services. A high bid-ask price indicates a relatively illiquid stock. However, the bid-ask spread is more directly a measure of transactions cost than liquidity and suffers from several shortcomings as a liquidity measure.

Another broad measure of liquidity is trading volume i.e. number of shares traded where higher trading volume represents higher liquidity. Gupta (1992) has used trading volume as a measure of liquidity to detect "excessive" or speculative trading. However, one limitation of this measure is that it would be difficult to assess liquidity only with reference to absolute volume of shares traded.

In some of the recent studies, researchers have used stock-trading turnover as a proxy for liquidity (Kamara, 1994). In fact, liquidity has often been analysed in terms of turnover data. Higher turnover means higher liquidity. At the aggregate level, trends in turnover i.e. number of shares traded multiplied by price becomes a measure of market liquidity. At times, total turnover in relation to market capitalisation is considered as a relative measure which can be used for comparison across different markets or over time. Turnover as a proxy for liquidity show a similar pattern to volume. Figure 7.2 shows the trend in turnover of the cash market before and after the introduction of futures and option trading.

7.5.2 Testing Liquidity

In this study, we will try to examine the impact of futures and option trading on the liquidity of underlying stocks also by taking a sample of ten companies on which futures and option are available. We aim to study liquidity by employing two commonly used proxies for liquidity viz. volume of trading and turnover. This study employs a sample of fourteen stocks on which stock futures and options were traded apart from Nifty index to examine the impact of the introduction of futures trading on the liquidity of the underlying stock. These stocks are:

1. ACC
2. BHEL
3. BPCL
4. CIPLA
5. DR REDDY
6. GRASIM
7. HDFC
8. INFOSYS
9. ITC
10. M&M
11. MTNL
12. SBI
13. TATA POWER
14. TATA TEA

To study the impact of introduction of futures on the liquidity of underlying index and stocks as well, we employ classic event-study methodology. We compare the average trading volume and turnover before and after the introduction of futures and option. Let V_{pre} denotes pre-futures mean trading volume and V_{post} denotes post-futures mean trading volume. The change in mean trading volume following the introduction of futures trading is referred to as mean difference ($V_{post} - V_{pre}$). The hypothesis of our interest is whether the change in the average trading volume is equal to zero:

$$H_0 : V_{post} - V_{pre} = 0 \tag{7.8}$$

The initial task of conducting an event study is to define the event of interest, the length of estimation window and the interval of the data. The date, on which futures introduced is considered as event i.e.12 June, 2000 event date in our study. The length of the estimation window is 200 days – 100 days before the event date and 100 days after the event date. So this study employs 200 trading days for each company in the sample around the time of event. In case of individual stocks the event date is 9 November, 2001. The length of the estimation window is 200 days – 100 days before the event date and 100 days after the event date in case all fourteen individual stocks.

7.6 Empirical Results on Liquidity

To study the impact of introduction of futures and option trading on the liquidity, empirical tests are conducted to study the behaviour of volume and turnover. Table 1 provides the results of the paired t-tests of changes in trading turnover and volume for each firm in our sample. The difference in the volume and turnover across the two periods is reported with the computed significance level of the test against null hypothesis of a zero difference in the volume and turnover trading.

Table 7.7 shows the results of paired t-tests of changes in volume for fourteen companies before and after the introduction of futures trading. The null hypothesis of change in the average trading volume is equal to zero is rejected for ACC, BHEL, BPCL, DR REDDY, GRASIM, INFOSYS, ITC, M&M, MTNL, SBI, TATA POWER and TATA TEA except HDFC at 1% level of significance implying that the volume of these stock on which stock futures were introduced have changed after the introduction of futures trading. It is important to note that the turnover of companies such as ACC, BHEL, BPCL, GRASIM, INFOSYS, M&M, MTNL, SBI, TATA POWER and TATA TEA have significantly increased after the introduction of futures trading. However, the turnover of few companies such as CIPLA, ITC, DR REDDY and HDFC have declined after the introduction of futures trading. Thus, it is established that the liquidity of the underlying stocks have increased after the introduction of futures trading. In case of CIPLA, ITC, DR REDDY and HDFC, the turnover declined after commencement of futures trading. This might be shifting of trading from cash market to futures segment of these stocks.

Table 7.7: Results of Paired t-test

Companies	**t-statistic**
ACC	-3.21 (0.001)
BHEL	-6.62 (0.00)
BPCL	-8.44 (0.00)
CIPLA	5.06 (0.00)
DR REDDY	2.35 (0.02)
GRASIM	-4.69 (0.00)
HDFC	2.36 (0.53)
INFOSYS	-4.36 (0.00)
ITC	3.51 (0.00)
M&M	-5.19 (0.00)
MTNL	-5. 29 (0.00)
SBI	-4.21 (0.00)
TATA POWER	-2.73 (0.007)
TATA TEA	-2.65 (0.009)

Note: Figures in ( ) are probability values

7.7 Conclusion

In this chapter, we have tried to examine the efficiency of the market before and after the introduction of futures and option trading. Serial correlation analysis and GARCH-M model establish that market was efficient in its weak form before the introduction of futures and option trading may be due to institutional reform and other reforms to improve the functioning of the cash market. Secondly, after the introduction of futures and option the market became inefficient might be because of faster flow of information from futures to cash market that may have led to trading by informed and less informed traders. Thirdly, inefficiency of the market after the introduction of futures and option is due to non-linearity in returns, which may be the result of psychological factors, noise trading or irrational behaviour of the investors. The positive relationship between stock returns and risk premium as predicted by capital asset pricing model (CAPM) does not hold in India.

We also tried to find the enhancement of market quality of the underlying market in terms of liquidity. We used turnover to assess liquidity before and after the introduction of the futures trading. We employed a classic event- study methodology to examine the change in average turnover before and after futures trading. Our results established that average turnover of the underlying stocks have changed significantly after the introduction of futures trading.

Chapter –VIII

Summary and Conclusion

Derivatives are financial instruments that derive value from their underlying assets such as an index or a commodity. Derivatives includes futures, forwards, options and swaps, and these can be combined with each other or traditional securities and loans to create hybrid instruments. These instruments are used for risk management and hedging by taking opposite position in the futures market. Equity derivatives in India was started as a part of capital market reforms to hedge price risk resulted from greater financial integration between nations in the 90's. These reforms were an integral part of financial sector reforms recommended by the *Narasimham Committee Report on Financial System*, in September 1992. These reforms were aimed at enhancing competition, transparency, and efficiency in the Indian financial market. More than one decade of reforms have brought a major transformation and structural change during this period such as shift to electronic trading from floor-based trading, abolition of 'Badla' transaction and introduction of 'rolling' settlement gradually to 'T+2' to improve cash market operation in India. Further, not only new financial products like derivatives, exchange-traded funds and hedge funds but also entry to foreign players like foreign institutional investors (FIIs) were allowed to invest in India. Introduction of derivatives in India was recommended by the L.C. Gupta Committee Report on Derivatives in 1997 in a phased manner. Accordingly, stock index futures were introduced first. BSE was the first stock exchange in the country to start trading in index futures based on BSE Sensex on June 9, 2000. NSE also commenced its trading on 12 June, 2000 based on S&P Nifty. Subsequently, other products like stock futures on individual securities were introduced in November 2001. This was followed by approval of trading in index options based on these two indices and options on individual securities. The volumes in derivatives markets especially on the Futures and Options segment of the NSE witnessed a tremendous growth and now the turnover is much higher than the turnover in the cash markets. Till today, there are only four derivatives instruments available in the Indian markets, namely, index futures, index options, stock futures and stock options.

The introduction of derivatives instruments in the Indian market has been debated among policy makers, regulators and market participants. One view was that the Indian market is not ripe for highly leveraged products like derivatives, the introduction of which might heighten volatility in the underlying spot market. The other and opposite view is that closer economic integration of the different countries of the world and progressive deregulation of financial sector, together with large fluctuations in real sectors of Indian economy in recent years, have exposed market players to different risks. India would be, according to this view, at a disadvantage unless financial derivatives as risk management tools are introduced. In India, four derivatives instruments viz. index futures, index option, stock futures and stock option are traded on the Indian stock exchanges.

The moot question is whether the introduction of these leveraged products in the Indian market has helped their basic economic function of price discovery. Besides this, another important issue relating to the introduction of derivatives market is whether it has destabilized the underlying cash market. In other words, whether derivatives are playing their part as risk management tools and how it is benefiting the underlying market in terms of pricing efficiency, liquidity and stability through the supposed informational role of derivatives trading.

We tested the following objectives in this study:

1. To determine the hedging effectiveness of index futures and stock futures.
2. To study whether futures market are performing their price discovery function.
3. To study whether introduction of futures and options have destabilized the underlying market.
4. To examine whether trading in futures market is done for hedging or speculation.
5. To examine whether market quality in terms of efficiency and liquidity have enhanced after the introduction of derivatives products.

We employed various econometric techniques. To assess the hedging effectiveness of index futures viz. S&P Nifty futures contract, Bank Nifty futures and CNXIT futures. Data for Nifty and Nifty futures were collected from 12 June 2000 to 26 March 2009 and for Bank Nifty and Bank Nifty futures, and CNXIT and CNXIT futures, data were collected for the period 2 January 2007 and 26 March 2009. We used three alternative models viz. OLS, VAR and VECM for finding hedge ratio and hedging effectiveness of index futures and stock futures on individual stocks.

To study the price discovery function of the futures market, we employed Engle – Granger method of conitegration and vector error correction model proposed by Johnston multivariate system approach for index futures and stock futures on individual stock. Data on S&P Nifty and Nifty futures were collected for the period 12 June 2000 and 26 March 2009. Data for Bank Nifty and Bank Nifty futures, CNXIT and CNXIT futures and stock futures were collected from 2nd January to 26 March 2009. To examine the impact of introduction of futures and options trading on the volatility of the underlying market, we used ARCH/GARCH techniques. To meet this objective, we collected data on S&P Nifty and Junior Nifty from 1st January 1998 to 31 March, 2009. While data on CNX 100 index was from 2nd January 2006 to 31 March, 2009. Moreover, data on 14 individual stocks were also collected from 1st Janury 1999 to 31st March, 2009 to find the behaviour of volatility of individual stocks before and after futures trading. To examine whether trading in futures market is done for hedging or for speculation, we used LMSW method proposed by Llorente, Michaely, Saar and Wang (2002). The same set of data were used for this objective also. To examine market quality in terms of efficiency and liquidity, we applied various tests of efficiency on S&P Nifty before and after the introduction of F&O. We also used an event technique to assess the impact of F&O trading on the liquidity of underlying index and stock.

In the third chapter, we studied the hedging effectiveness of index and stock futures. The study showed that cash prices and futures prices are co-integrated and there exist a long run equilibrium relationship between cash and futures prices. In case of all contracts, VECM performs better than OLS and VAR models. The study found that Nifty futures, Bank nifty futures, CNXIT futures and stock futures contracts traded on NSE provides effective hedging facility to the market players for risk management.

In fourth chapter, we examined the price discovery function of the futures market. The findings are: There exists a long-run relationship between at market level as well as firm level between cash and futures prices. One can combine information of spot and futures prices to predict the future spot price. Thirdly, the error correction model leads to the conclusion that there exists a feed back between spot and futures. The results also established that spot market leads the futures market and price discovery takes place in both the markets. This has an important implication for the market participants in the

Indian capital market, indicating that there are opportunities for significant arbitrage profits and hedging strategies.

In the fifth chapter, we studied the impact of futures and option on the underlying market. The findings are: after the introduction of the futures and options the volatility of the underlying markets has declined in case of Nifty but the volatility of Junior Nifty and CNX 100 index has increased after the introduction of futures trading. The results showed that volatility of individual stocks have declined after the futures trading. When surrogate index – *Junior Nifty* – was used to account for market wide volatility, the effect of futures and option on the volatility of the underlying market vanishes. Broadly, it can be said that volatility of the market has dampened but the contribution of futures and option trading is negligible. The impact of recent news have increased while the volatility in returns arising from the effect of old news has declined implying that the quality of information flowing have improved to the cash market.

In chapter sixth, we tried to find whether trading volume in futures segment is generated by hedging or speculation. The findings are: at market level, results establish that trading is basically for rebalancing portfolio. At firm level, in those companies where futures volume is moderate speculation is rampant. However, in case of those companies in which volume is relatively high, trading is done basically for portfolio rebalancing i.e. hedging.

Finally in seventh chapter, we examined the enhancement in market efficiency and liquidity before and after the introduction of derivatives instruments in the Indian market. The findings are: efficiency tests establish that market was efficient in its weak form before the introduction of F&O may be due to institutional reform and other reforms which were carried out to improve the functioning of the cash market before the introduction of futures. Secondly, after the introduction of F&O the market became inefficient. It might be because of faster flow of information from futures to cash market that may have led to trading by informed and less informed traders. Thirdly, inefficiency of the market after the introduction of futures and option is due to non-linearity in returns, which may be the result of psychological factors, noise trading or irrational behaviour of the investors. The positive relationship between stock returns and risk premium as predicted by capital asset pricing model (CAPM) does not hold in India. Results established that average volume and turnover of the underlying stocks have changed significantly after the introduction of futures and option trading.

The following conclusions emerge from this study. Index futures contracts S&P Nifty futures, Bank Nifty Futures, CNXIT futures and stock futures on individual scripts provide effective hedging facility to the market participants. 'Market completion' hypothesis which argue that derivatives trading helps in price discovery, improves the overall market depth, enhance market efficiency, augment market liquidity, reduce asymmetric information and thereby reduce volatility of the cash market. This hypothesis seems to hold in case of India because flow of information has increased after the introduction of this market. This is established by this study. Price discovery takes place in both the markets. No dominance of any market is established in this study. There exists feedback relationship in cash and futures market. Prices are predictable from each other and one can incorporate information from each market to predict the future prices. The introduction of derivative instruments like index futures and index options have not destabilized the underlying market S&P CNX Nifty. Thus, the hypothesis of 'destabilizing forces' does not hold in case India. Trading in the F&O segment of NSE is done for portfolio rebalancing. This is established at market level. At firm level, trading in some stocks is done for fulfilling speculative desires. The underlying market over the sample period was efficient before the introduction of derivatives trading. Market has become inefficient in post derivatives period. This might be because of faster flow of information from futures to cash market that may have led to trading by informed and less informed traders. In addition, inefficiency of the market after the introduction of futures and option is due to non-linearity in returns, which may be the result of psychological factors, noise trading or irrational behaviour of the investors. The liquidity of underlying market has significantly increased after the introduction of derivative trading. This is true at market as well as at firm level.

The analysis and above mentioned results have in our judgement, important implications for policy and regulation**.** In NSE, trading in derivatives instruments takes place on a segment called F&O segment. This study found that there is no clear cut dominance of futures market over spot market in price discovery process. This might be result of conducting both types of trading in the same exchange. It is also important to note that the trading rules and entry requirements for futures trading is different from those for cash trading. This study found that market has become inefficient in its weak form after the introduction of futures and option trading. Since both cash and futures trading is taking place in the same exchange, the possibility of collusion among traders seems to be greater that might have result into irrational trading and ‘noise’. It is established in this study that Nifty returns have non-linear characteristics. The L.C. Gupta Committee was also in favour of separate exchange from regulatory point of view. “From the purely regulatory angle, a separate exchange for futures trading seems to be a neater arrangement….” (Paragraph 3.8).

The L.C. Gupta Committee report on derivatives was not in favour of introducing single stock futures in India. “The fourth type, viz. individual stock futures, was favoured much less. It is pertinent to note that the U.S.A. does not permit individual stock futures. Only one or two countries in the world are known to have futures on individual stocks.” (Paragraph 2.3). However, trading in single stock futures in the US, started in early 2003 with physical settlement system.

However, in India, single stock futures and options contracts are cash-settled. When introducing stock futures and option it was promised by the Indian authorities that within six months the physical settlement would be in place. Physical settlement was not introduced at the time of introduction due to lack of infrastructural facilities. However, even after five years physical settlement has not introduced in case of single stock futures and stock options contracts. The problem with cash settlement is that it deters the link between the market and the real economy. If the market participants know that they would never be required to deliver the asset underlying the futures contract sold by them, many of them are tempted to indulge in excessive speculation or to create artificial prices unrelated to the real economic factors. Because, it is easy to arrange cash than securities for settlement of trade. The principle of physical settlement in the case of deliverable type of asset underlying the futures is used by all well-functioning futures exchanges. The only exception is broad-based index futures where the regulatory authorities are convinced that prices of such products cannot be easily manipulated and their supply cannot be cornered. This study also found that speculation is rampant in case of stock futures trading. In fact, stock futures trading are most successful in India than anywhere in the world because they are simply a substitute for badla. To curb speculation physical delivery is very important. In all developed market, derivative trades are delivery settled.

Futures market without delivery is more of a speculative avenue than fulfilling the need of hedging.

Appendix A

A Short Account of Commodity Futures in India

Commodity derivatives trading are not new in India. With the beginning of forward trading in Cotton in 1875, the commodity derivatives trading began in India. In 1900, trading in oilseeds started at Bombay and in 1912 forward trading in raw jute and jute goods started at Calcutta. Since 1913 forward market in wheat at Hapur had been functioning and Bullion at Bombay since 1920. The Government of Bombay passed Control Contract (War Provision) Act and also established Cotton Contract Board in 1919. In 1939, the Government of Bombay issued an Ordinance to prohibit option with a view to restrict speculative activity in cotton market. Later, this Ordinance was replaced by Bombay Options in Cotton Prohibition Act, 1939. In 1943, the Defence of India Act was used to prohibit and regulate forward trading all over India and ban imposed on forward trading of oilseeds, spices, vegetables oils, sugar and cloth. These ban retained with necessary modifications in the Essential Supplies Temporary Powers Act, 1946 and in 1947, with a view to evolve a unified systems of Bombay, Bombay Forward Contract Control Act 1947 was enacted.

After Independence, ‘Stock Exchanges and Futures Market’ was placed under the Union list. The Parliament passed Forward Contracts (Regulation) Act, 1952 which regulate forward contracts in commodities all over India define commodity as goods which are any movable property other than security, currency, actionable claims.

Forward trading in commodities was banned except for Pepper, Turmeric, Castorseed and Linseed in 1960s on account of shortage in most of the essential commodities due to certain political and economic factors. But futures trading in Castorseed and Linseed was suspended in1977.

However, forward trading in Potato and Gur were allowed in early 1980s on the recommendations of Khusro Committee and in 1985 trading was allowed in Castorseed.

The liberalization of the Indian economy started in 1990 in the wake of balance of payment crisis. India adopted Structural Adjustment Programme (SAP) advocated by the International Monetary Fund (IMF) and started reforming the economy. In this connection, the Government of India set up a Committee in 1993 under the Chairmanship of Prof. K. N. Kabra to examine the role of futures trading in the age liberalization and globalization. The Kabra Committee made following recommendations:

- Allowing futures trading in 17 commodity groups.
- Strengthening Forward Markets Commission
- Amendments to Forward Contracts (Regulation) Act, 1952.
- Allowing options in goods,
- Increasing outer limit for delivery and payment from 11 days to 30 days for the contract to remain ready delivery contract
- Registration of brokers with Forward Markets Commission.

In response to these recommendations, the Government of India permitted the futures trading in all the commodities that the commission recommended except bullion and basmati rice. In 1998, forward trading in cotton and jute goods were permitted. The year 1999 saw the revival of the derivatives trades in some oilseeds. The National Agriculture Policy in July 2000 announced that the Government would like to encourage futures trading in a large number of commodities to minimize the wide fluctuations in commodity prices and also allow the hedging. The Finance Minister in his budget speech on February 28, 2002 indicated that the futures and forward trading would be expanded to include all agricultural commodities. The real respite for the derivatives markets in commodities came on April 1, 2003 the Government of India issued a notification rescinding all previous notifications which prohibited futures trading in a large number of commodities in the country. This was followed by another notification in May 2003 revoking the prohibition on non-transferable specific delivery forward contract.

There are currently 25 exchanges on which commodity futures are traded. The following three are national level multi commodity exchanges

- National Multi Commodity Exchange (NMCE)
- Multi Commodity Exchange (MCX)
- National Commodities and Derivatives Exchange (NCDEX)

The national level multi commodity exchanges have set up many terminals all over the country. NCDEX has set up 505 terminals in 138 centers. MCX and NMCE have set up 763 and 346 terminals in 132 and 90 centers respectively (Economic Survey 2003-04). The rest of the exchanges are, however, single commodity platforms. A large number of commodities have access to futures trading. There is a tremendous increase over time in the number of commodities traded on these commodity exchanges, from just 8 in 2000 to 80 in 2004.

Table 1: Turnover of Commodity Futures Markets

(Rs. Crores)

Exchange	2001-02	2002-03	2003-04	2004-05 First half
NCDEX	0	0	1490	54011
NBOT	14278	34376	53014	51038
MCX	0	0	2456	30695
NMCE	0	4572	23842	7943
All Exchanges	4495	66530	129364	170720

Source: Economic Survey 2004-05

In the year 2000-01 the value of trading in all the commodity exchanges recorded a sum of Rs.4495 crores. It maintained a rising trend and registered Rs.129364 crores in 2003-04. This figure for the first half of the year 2004-05 is Rs.170720 crores as shown in the table below. An annual trading value of over Rs. 1000 crores have been contributed by about 12 exchanges. The number of contracts in each of the commodities has also disclosed an impressive growth over time. While 19 localized exchanges were offering generally one contract each per commodity traded in 2000, with the emergence of the national level multi commodity exchanges, the scenario has changed drastically with most of the commodities having about 100 contracts each (Nair 2004).

Appendix B

Main Recommendations of L.C. Gupta Committee Report on Derivatives

1. **L C Gupta Committee**
    - Appointed on 18th November 1996
    - To develop appropriate regulatory framework for derivatives trading
    - Focus on financial derivatives and in particular, equity derivatives
    - Submitted its report in March 1998
    - Approved by SEBI in May and circulated in June 1998
2. **Executive Summary**
    - Both Hedgers and speculators required for efficient markets
    - Equity derivatives could begin with index futures
    - Development in phased manner
    - Index Options and Options on Shares to follow
    - Main emphasis on exchange-level regulation
    - Stricter governance by SEBI compared to Cash segment
    - Stringent entry requirements
    - Mutual funds should be allowed to hedge
    - Derivatives Cell, Advisory Committee and Economic Research Wing to be set up within SEBI
3. **Report Summary**
    - Substantive report
    - Suggestive bye-laws for regulation and control of trading and settlement of derivative contracts
4. **Legal Amendments**
    - Securities Contract Regulation Act
    - Derivatives contract declared as a ‘security’ in Dec 1999
    - Notification in June 1969 under section 16 of SCRA banning forward trading revoked in March 2000

5. Survey Results

Committee conducted a survey amongst:

Brokers	67
Mutual funds	10
Banks/FIs	14
FIIs	12
Merchant banks	9
Total	112

- Wide recognition of need for derivatives
- Equity, Interest Rate and Currency derivative products
- Stock Index Futures most preferred
- Stock Index Options second preference
- Options on individual stocks third preference
- 70% respondents indicated hedging as their activity
- 39% speculation/dealing
- 64% broking
- 36% option writing
- Multiple responses were permitted in the questionnaire
- 3 month Futures were most preferred
- American Options were preferred over European Options
- 33% expected fast growth in derivatives segment
- 41% expected moderate growth
- 16% expected slow growth

6. Cash Market Suggestions

Committee has suggested the following improvements:

- Uniform settlement cycle among all exchanges
- Move towards rolling settlement cycles
- Tighter supervision
- Speeding up demat
- Increase delivery transactions

7. **Derivatives Exchanges**

- Existing exchanges may start Derivative segments or separate exchanges may be set up
- On-line screen trading with disaster recovery site
- Per half hour capacity should be 4-5 times the anticipated peak load
- Independent clearing Corporation/House
- Online surveillance capability
- Real-time information dissemination over at least 2 networks
- Minimum 50 members
- Separate membership for derivative segment - no automatic membership
- Separate governing council for derivatives segment
- Common Governing Council and Governing Board members not allowed
- Percentage of broker-members in the council to be prescribed by SEBI
- Chairman cannot carry on broking/dealing business during his term
- Arbitration and investor grievances cells in 4 regions
- Adequate inspection capability

8. **Regulatory Recommendations**

- Emphasis on exchange-level regulation
- SEBI to act as regulator of last resort
- Modern systems for fool-proof and fail-proof regulation
- All members to be inspected
- SEBI will approve rules, bye-laws and regulations
- New derivative contracts to be approved by SEBI
- Exchange to provide full details of proposed contract
- Economic purposes of the contract
- Likely contribution to the market's development
- Safeguards incorporated for investor protection and fair trading

9. **Trading Stipulations**

- Trading days and hours to be stipulated in advance
- Pre-determined expiration date and time for each contract
- Last trading day to be stipulated in advance
- Contract expiration period may not exceed 12 months

10. Entry Rules

- No automatic entry
- Capital adequacy - higher than cash market
- Clearing and non-clearing members
- Minimum net worth Rs 300 lakhs
- Minimum deposit Rs 50 lakhs
- Option writers - higher deposits
- Broker members, sales persons and dealers to pass a certification program
- Registration with SEBI in addition to registration with exchange

11. Clearing Corporation

- Full novation
- Upfront and mark-to-market margins
- Power to disable member from trading
- Margins to factor in volatility
- Margins based on value at risk - 99% confidence
- No trading interests on board
- National level clearing corp in future
- Maximum deposit based exposure limit
- EFT for margin payments
- Cross-margining not advisable
- Margin collection from clients
- Exposure limits on gross basis
- Trading to be clearly indicated as own/clients and opening/closing out
- Segregation of own/clients margin
- No set off permitted
- In case of default, only own margin can be set off against members' dues
- Prompt transfer of clients in case of default by brokers
- Close out all open positions by CC at its option
- Special margins on members permitted
- Margins can be withheld - additional margins can be further demanded
- CC may prescribed maximum long/short positions by members
- Exposure limit in quantity / value / % of base capital
- Ask members to close out excess positions

- CC may close out such positions

12. Mark to Market and Settlement

- Daily settlement of futures contracts
- Daily settlement price - closing price of futures
- Final settlement price - closing price of underlying security

13. Categories of Members

- TM Clearing Member (own, clients, TMs, their clients)
- Trading Member (own, clients)
- Professional (Custodian) Clearing Member (TMs, their clients)

14. Sales Practices

- Risk disclosure document with each client mandatory
- Sales personnel to pass certification exam
- Specific authorisation from client's board of directors/trustees

15. Trading Parameters

- Each order - buy/sell and open/close
- Unique order identification number
- Regular market lot size, tick size
- Gross exposure limits to be specified
- Price bands for each derivative contract
- Maximum permissible open position
- Off line order entry permitted

16. Brokerage

- Prices on the system shall be exclusive of brokerage
- Maximum brokerage rates shall be prescribed by the exchange
- Brokerage to be separately indicated in the contract note

17. Margins From Clients

- Margins to be collected from all clients/trading members
- Daily margins to be further collected

- Right of clearing member to close out positions of clients/TMs not paying daily margins
- Losses if any to be charged to clients/TMs and adjusted against margins

18. Cash V/s Futures Market

- CC - full novation i.e. Counterparty to each trade
- Value at risk - 99% confidence
- Daily settlement through EFT
- Trading and Clearing members
- Certification requirement
- Higher capital adequacy and deposit
- Compulsory collection of margins from clients
- Segregation of clients funds
- Shifting of positions to other members
- Client registration, risk disclosure document and ethical sales practices
- Inspection of all members
- SEBI approval for new contracts

19. J R Varma Committee Report

- Constituted in June 1998
- Submitted its report in Nov 1998
- Objectives - recommend measures for risk containment in the Indian derivative market
- Opertionalise the recommendations of the L C Gupta Committee

20. Background scenario

- Volatility in India is high compared to developed markets
- Cross margining not permitted
- Initial margin to be based on 99% Value at Risk (VAR)
- Collection of margins before trading hours next day from all clients

21. Statistics

- Mean I.e. arithmetic average
- Standard Deviation - a measure of dispersion
- Variance = square of Standard Deviation

- Normal Distribution - a probability distribution that can be adequately described/predicted based on the Mean and Standard Deviation

22. Margining System

- Exponential weighted moving average method for estimating daily volatility
- Variance at end of day t = (0.94 x variance at end of day (t-1)) + (0.06 x square of return of day t)
- Logarithmic Returns
- 0.94 is recommended by Prof J R Varma
- Model based on J P Morgan RiskMetrics
- Margins for 99% VAR based on 3 sigma limits - theoretically the maximum amount a portfolio can lose (typically in a day)
- During first 6 months, parallel estimation of cash and futures market
- Margins to be higher of the two
- Initial margins to be at least 5%
- Initial calculations based on last 1 year of cash market
- Futures volatility expected to be higher
- The method attaches higher weights to more recent volatility
- Trading software would provide volatility information on real-time basis
- Volatility of day t will be used for margin calculations on day t evening

23. Margining for Calendar Spreads

- Basis risk and no market risk
- 0.5% per month of spread (on far month contract)
- Minimum 1% and maximum 3% margin
- On expiry of near month contract, the far month would become an open position
- Position to be treated as open over the last 4 days gradually
- 100% open on day of expiry, 80% open 1 day before, 60% open 2 days before, 40% open 3 days before and 20% open 4 days before expiry
- Calendar spread open position = 1/3 of mark to market value of the far month contract

24. Periodic Reporting

- Exchange to report to SEBI highlighting specific instances where price moves are beyond 99% VAR limits
- Incidences of failure in collection of margin or settlement dues on quarterly basis
- Failure defined as shortfall for 3 consecutive trading days of 50% or more of liquid net worth

25. Liquid Net Worth

- Total liquid assets deposited with the exchange/cc less
- Initial margin applicable to total gross open position
- Liquid net worth shall be at least Rs 50 lakhs
- Gross open positions shall not exceed 33.33 times liquid net worth
- Back-testing over 8 years reveals that this level has been insufficient only twice on Nifty and never on Sensex
- LNW includes cash, fixed deposits, bank guarantees, treasury bills, Govt securities, dematerialised securities
- Securities to be marked to market at least on weekly basis
- Only investment grade debt securities accepted - haircut 10%
- Equity in demat form - 15% haircut
- Acceptable equities - top 100 by market cap out of top 200 by market cap and trading value
- All securities to pledged in favour of CC
- At least 50% shall be cash, bank guarantees, FDs, T-bills and Govt sec

26. Position Limits

- Customer level limits impractical
- Persons acting in concert owning 15% or more of open interest to report this fact to the exchange
- Trading member limit - 15% of open interest of Rs 100 crores whichever is higher
- Clearing member should ensure that his own position and his TMs are within above limits

27. Back-testing Results

- 8 year period 1990-98
- 1,750 trading days
- At 99% confidence - breach should have occurred 18 times
- Actual breach 22 times in Nifty and 23 times in the Sensex
- Within ’green zone’ as defined by BIS

Appendix C
SEBI's Varma Committee Report
Risk Containment in the Derivatives Market

SEBI has appointed a committee under the chairmanship of Dr. L. C. Gupta in November 1996 to "develop an appropriate regulatory framework for derivatives trading in India". In March 1998, the L. C. Gupta Committee (LCGC) submitted its report recommending introduction of derivatives markets in a phased manner beginning with the introduction of index futures. The SEBI Board while approving the introduction of index futures trading put up the setting up of a group to recommend measures for risk containment in the derivative market in India. Accordingly, SEBI constituted a group in June, 1998: with Prof. J.R. Varma, as Chairman.

The group submitted its report in 1998. The group began by enumerating the risk containment issues that assumed importance in the Indian context while setting up an index futures market. The recommendations of the Group as covered by its report are as under:

Estimation of Volatility (Clause 2.1)

Several issues arise in the estimation of volatility:

- The Volatility in the Indian market is quite high compared to developed markets.
- The volatility in the Indian market is not constant and is varying over time.
- The statistics on the volatility of the index futures markets does not exists and therefore, in the initial period, reliance has to be made on the volatility in the underlying securities market. The LC Gupta Committee (LCGC) has prescribed that no cross margining would be permitted and separate margins would be charged on the position in the futures and the underlying securities market. In the absence of cross margining, index arbitrage would be costly and therefore possibly will not be efficient.

Calendar Spreads (Clause 2.2)

In developed markets, calendar spreads are essentially a play on interest rates with negligible stock market exposure. As such margins for calendar spreads are very low. In India, the calendar basis risk could be high due to the absence of efficient index arbitrage and the lack of channels for the flow of funds from the organised money market to the index future market.

Trader Net Worth (Clause 2.3)

Even an accurate 99% "value at risk" model would give rise to end of day mark to market losses exceeding the margin of approximately once every 6 months. Trader networth provides an additional level of safety to markets and works as a deterrent to the incidence of defaults. A member with a high networth would try harder to avoid defaults as his own networth would be at stake.

Margin Collection and Enforcement (Clause 2.4)

Apart from the right calculation of margin, the actual collection of margin is also of equal importance. Since initial margins can be deposited in the form of bank guarantee and securities, the risk containment issues in regard to these need has to be tackled.

Clearing Corporation (Clause 2.5)

The clearing corporation provides novation and becomes the counter party for every trade. In this circumstances, the credibility of the clearing corporation assumes the importance and issues of governance and transparency need to be addressed.

Position Limit (Clause 2.6)

It can be necessary to prescribe position limits for the market considering whole and for the individual clearing member / trading member / client.

Margining System (Clause 3) - Mandating a Margin Methodology not Specific Margins (Clause 3.1.1)

The LCGC recommended that margins in the derivatives markets would be based on a 99% (VAR) approach. The group discussed ways of operationalizing this recommendation keeping in mind the issues relating to estimation of volatility discussed.

It is decided that SEBI should authorise the use of a particular VAR estimation methodology but should not make compulsory a specific minimum margin level.

Initial Methodology (Clause 3.1.2)

he group has evaluated and approved a particular risk estimation methodology that is described in 3.2 below. The derivatives exchange and clearing corporation should be authorised to start index futures trading using this methodology for fixing margins.

Continuous Refining (Clause 3.1.3)

he derivatives exchange and clearing corporation should be encouraged to refine this methodology continuously on the basis of further experience. Any proposal for changes in the methodology should be filed with SEBI and released to the public for comments along with detailed comparative backtesting results of the proposed methodology and the current methodology. The proposal shall specify the date from which the new methodology will become effective and this effective date shall not be less than three months after the date of filing with SEBI. At any time up to two weeks before the effective date, SEBI may instruct the derivatives exchange and clearing corporation not to implement the change, or the derivatives exchange and clearing corporation may on its own decide not to implement the change.

Initial Margin Fixation Methodology (Clause 3.2)

he group took on record the estimation and backtesting results provided by Prof. Varma from his ongoing research work on value at risk calculations in Indian financial markets. The group, being satisfied with these backtesting results, recommends the following margin fixation methodology as the initial methodology for the purposes of 3.1.1 above. The exponential moving average method would be used to obtain the volatility estimate every day.

Daily Changes in Margins (Clause 3.3)

The group recommends that the volatility estimated at the end of the day's trading would be used in calculating margin calls at the end of the same day. This implies that during the course of trading, market participants would not know the exact margin that would apply to their position. It was agreed therefore that the volatility estimation and margin fixation methodology would be clearly made known to all market participants so that they can compute what the margin would be for any given closing level of the index. It was also agreed that the trading software would itself provide this information on a real time basis on the trading workstation screen.

Margining for Calendar Spreads (Clause 3.4)

The group took note of the international practice of levying very low margins on calendar spreads. A calendar spread is a position at one maturity which is hedged by an offsetting position at a different maturity: for example, a short position in the six month contract coupled with a long position in the nine month contract. The justification for low margins is that a calendar spread is not exposed to the market risk in the underlying at all. If the underlying rises, one leg of the spread loses money while the other gains money resulting in a hedged position. Standard futures pricing models state that the futures price is equal to the cash price plus a net cost of carry (interest cost reduced by dividend yield on the underlying). This means that the only risk in a calendar spread is the risk that the cost of carry might change; this is essentially an interest rate risk in a money market position. In fact, a calendar spread can be viewed as a synthetic money market position. The above example of a short position in the six month contract matched by a long position in the nine month contract can be regarded as a six month future on a three month T-bill. In developed financial markets, the cost of carry is driven by a money market interest rate and the risk in calendar spreads is very low.

In India, however, unless banks and institutions enter the calendar spread in a big way, it is possible that the cost of carry would be driven by an unorganised money market rate as in the case of the badla market. These interest rates could be highly volatile.

Given the evidence that the cost of carry is not an efficient money market rate, prudence demands that the margin on calendar spreads be far higher than international practice. Moreover, the margin system should operate smoothly when a calendar spread is turned into a naked short or long position on the index either by the expiry of one of the legs or by the closing out of the position in one of the legs. The group therefore recommends that:

- The margin on calendar spreads be levied at a flat rate of 0.5% per month of spread on the far month contract of the spread subject to a minimum margin of 1%

and a maximum margin of 3% on the far side of the spread for spreads with legs upto 1 year apart. A spread with the two legs three months apart would thus attract a margin of 1.5% on the far month contract.

- The margining of calendar spreads be reviewed at the end of six months of index futures trading.
- A calendar spread should be treated as a naked position in the far month contract as the near month contract approaches expiry. This change should be affected in gradual steps over the last few days of trading of the near month contract. Specifically, during the last five days of trading of the near month contract, the following percentages of a calendar spread shall be treated as a naked position in the far month contract: 100% on day of expiry, 80% one day before expiry, 60% two days before expiry, 40% three days before expiry, 20% four days before expiry. The balance of the spread shall continue to be treated as a spread. This phasing in will apply both to margining and to the computation of exposure limits.
- If the closing out of one leg of a calendar spread causes the members' liquid net worth to fall below the minimum levels specified in 4.2 below, his terminal shall be disabled and the clearing corporation shall take steps to liquidate sufficient positions to restore the members' liquid net worth to the levels mandated in 4.2.
- The derivatives exchange should explore the possibility that the trading system could incorporate the ability to place a single order to buy or sell spreads without placing two separate orders for the two legs.
- For the purposes of the exposure limit in 4.2 (b), a calendar spread shall be regarded as an open position of one third of the mark to market value of the far month contract. As the near month contract approaches expiry, the spread shall be treated as a naked position in the far month contract in the same manner as in 3.4 (c).

Margin Collection and Enforcement (Clause 3.5)

Apart from the correct calculation of margin, the actual collection of margin is also of equal importance. The group recommends that the clearing corporation should lay down operational guidelines on collection of margin and standard guidelines for back office accounting at the clearing member and trading member level to facilitate the detection of non-compliance at each level.

Transparency and Disclosure (Clause 3.6)

The group recommends that the clearing corporation / clearing house shall be required to disclose the details of incidences of failures in collection of margin and / or the settlement dues at least on a quarterly basis. Failure for this purpose means a shortfall for three consecutive trading days of 50% or more of the liquid net worth of the member.

Appendix D

A note to dataset : Due to paucity of space, we are unable to append the complete data sets used in estimation in chapters III, through (VII). In fact a number of observation nos. from 553 to 2500. We therefore give the format of the data sets which provide a sample of data in a matrix form. However, the complete data set is available in electronic form in the CD enclosed to the thesis (see CD Box inside of the last cover page)

Data Set 1 (used in Chapter-III)

Date	LN	LNF	Date	LBN	LBNF	LIT	LITF
12-Jun-00	7.2726761	7.281214	28-Dec-06	8.7041	8.709259	8.6001087	8.60179166
13-Jun-00	7.2674556	7.27153	29-Dec-06	8.701	8.70582	8.616115	8.6197227
14-Jun-00	7.2692685	7.278974	2-Jan-07	8.7061	8.710001	8.6322525	8.63314344
15-Jun-00	7.2760376	7.278422	3-Jan-07	8.7112	8.713188	8.6175633	8.62225566
16-Jun-00	7.2979714	7.297294	4-Jan-07	8.7009	8.705704	8.6128488	8.61627806
19-Jun-00	7.3123867	7.311652	5-Jan-07	8.7076	8.706697	8.5886391	8.58975568
20-Jun-00	7.3179426	7.322477	8-Jan-07	8.6942	8.694385	8.5860007	8.5847023
21-Jun-00	7.296515	7.303944	9-Jan-07	8.6785	8.678129	8.5796514	8.57918159
22-Jun-00	7.3053562	7.308777	10-Jan-07	8.6523	8.653802	8.6075	8.60912494
23-Jun-00	7.2945132	7.298242	11-Jan-07	8.6567	8.664699	8.6301736	8.63076292
26-Jun-00	7.2804561	7.287561	12-Jan-07	8.7255	8.726546	8.6363175	8.63214556
27-Jun-00	7.28228	7.28338	15-Jan-07	8.7266	8.7276	8.6382597	8.63613112
28-Jun-00	7.2930177	7.292848	16-Jan-07	8.7254	8.726668	8.6350473	8.63325029
29-Jun-00	7.3081073	7.306766	17-Jan-07	8.7348	8.734407	8.6421857	8.64098481
30-Jun-00	7.2940036	7.302867	18-Jan-07	8.7306	8.733296	7.612238	7.60976309
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12-Mar-09	7.8699558	7.863536	12-Mar-09	8.144	8.13963	7.6345306	7.63590757
13-Mar-09	7.9081114	7.906989	13-Mar-09	8.1977	8.198653	7.6890736	7.69026316
16-Mar-09	7.9292165	7.928118	16-Mar-09	8.2259	8.22644	7.7014489	7.70411317
17-Mar-09	7.9220616	7.919992	17-Mar-09	8.201	8.199766	7.6841861	7.68533552
18-Mar-09	7.93548	7.930152	18-Mar-09	8.2235	8.221869	7.6958944	7.69621264
19-Mar-09	7.939925	7.937643	19-Mar-09	8.2331	8.231815	7.7138739	7.71574785
20-Mar-09	7.9398894	7.937964	20-Mar-09	8.2138	8.212948	7.7094653	7.71096689
23-Mar-09	7.9861308	7.985603	23-Mar-09	8.2801	8.278949	7.7346026	7.73938097
24-Mar-09	7.9857226	7.985365	24-Mar-09	8.2961	8.294699	7.733377	7.73874953
25-Mar-09	8.0011372	8.000718	25-Mar-09	8.3252	8.324482	7.7408166	7.74172905
26-Mar-09	8.0334151	8.033561	26-Mar-09	8.3629	8.362899	7.7779811	7.77306846
LN=log Nifty		LBN =log Bank Nifty			LIT=log CNXIT		
LNF=log Nifty futures		LBNF= log Bank Nifty futures			LITF=log CNXIT Futures		

Data Set 2 (Used in Chapter IV)

Date	LBS	LBF	Lbhel	Lbhelf	.	.	LSBI	LSBIF
2-Jan-07	6.4526	6.452	1.8645	1.86439			7.13373	7.13891
3-Jan-07	6.4623	6.4557	1.866	1.86497			7.14271	7.14606
4-Jan-07	6.4579	6.4457	1.8653	1.86342			7.12528	7.13262
5-Jan-07	6.4557	6.4421	1.865	1.86285			7.12617	7.12621
8-Jan-07	6.4331	6.4268	1.8615	1.86048			7.10143	7.10538
9-Jan-07	6.4349	6.4284	1.8617	1.86073			7.06894	7.07517
10-Jan-07	6.4194	6.4068	1.8593	1.85736			7.03562	7.04176
11-Jan-07	6.4558	6.4493	1.865	1.86397			7.0453	7.05574
12-Jan-07	6.498	6.499	1.8715	1.87164			7.11106	7.11387
15-Jan-07	6.4944	6.4934	1.8709	1.87078			7.10845	7.11229
16-Jan-07	6.5071	6.4996	1.8729	1.87173			7.09821	7.10406
17-Jan-07	6.5044	6.496	1.8725	1.87119			7.10869	7.11102
18-Jan-07	6.5121	6.5035	1.8737	1.87235			7.11396	7.11794
19-Jan-07	6.5295	6.5208	1.8763	1.875			7.10685	7.10935
22-Jan-07	6.5168	6.5172	1.8744	1.87444			7.11033	7.11428
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4-Mar-09	6.398	6.3972	1.856	1.85586			6.86375	6.84891
5-Mar-09	6.3797	6.3726	1.8531	1.852			6.83985	6.82067
6-Mar-09	6.4007	6.3994	1.8564	1.85621			6.84705	6.84407
9-Mar-09	6.3763	6.3712	1.8526	1.85179			6.79716	6.79021
12-Mar-09	6.3071	6.3074	1.8417	1.84172			6.81482	6.81168
13-Mar-09	6.3237	6.3281	1.8443	1.845			6.85967	6.85862
16-Mar-09	6.3479	6.3511	1.8481	1.84862			6.89472	6.89472
17-Mar-09	6.3484	6.3486	1.8482	1.84824			6.85651	6.85588
18-Mar-09	6.3452	6.3442	1.8477	1.84755			6.86725	6.86756
19-Mar-09	6.3469	6.3491	1.848	1.84831			6.87595	6.87528
20-Mar-09	6.3446	6.3443	1.8476	1.84756			6.8614	6.86077
23-Mar-09	6.3855	6.3859	1.854	1.85409			6.93103	6.92966
24-Mar-09	6.4031	6.3997	1.8568	1.85625			6.9395	6.9409
25-Mar-09	6.3818	6.3847	1.8535	1.8539			6.9565	6.95802
26-Mar-09	6.4327	6.4321	1.8614	1.86131			6.99897	6.99897
LBS=log Bharti Airtel Spot			Lbhel =log Bhel			LSBI=logSBI		
LBF=log Bharti Airtel futures			Lbhelf= log Bhel futures			LSBIF=log SBI futures		
Note: Data for 10 compnaies namely Bharti airtel, Bhel, ICICI Bank, Infosys							ITC, ONGC	
Reliance,	SAIL, SBI and Wipro are compiled in the above format.							

Data Set 3 (Used in Chapter V)

Date	BHEL	CIPLA	BPCL	.	TATATEA	FD	
4-Jan-99	-0.5288	2.2416	0		0.02817	0	
5-Jan-99	-1.73818	4.85785	-3.6242		1.37046	0	
6-Jan-99	7.71038	1.85608	2.7731		2.87494	0	
7-Jan-99	7.70469	0.87924	2.9476		-0.2703	0	
8-Jan-99	1.23104	1.93785	3.6264		5.37396	0	
11-Jan-99	-7.27286	-3.0772	0.6382		1.29955	0	
12-Jan-99	-0.91647	-3.6059	0.3968		2.52482	0	
13-Jan-99	-2.65534	3.08371	-1.5968		-2.4615	0	
14-Jan-99	-2.80254	-2.6581	-3.5429		-4.4624	0	
15-Jan-99	-0.52494	0.86191	-3.3276		-1.8692	0	
18-Jan-99	1.12151	2.72895	-2.5097		2.26525	0	
9-Mar-09	-0.7733	-0.6651	-6.8889		-0.9905	1	
12-Mar-09	3.10267	0.7142	0.2539		-0.1199	1	
13-Mar-09	2.15974	-0.3934	-2.8288		0.81791	1	
16-Mar-09	2.41349	-0.6178	4.2137		-3.2369	1	
17-Mar-09	-0.22804	-0.5469	-1.4836		-0.3219	1	
18-Mar-09	4.02725	-0.4497	-3.9841		-1.2694	1	
19-Mar-09	-3.31634	-1.3613	-0.4854		-0.0673	1	
20-Mar-09	-2.40898	0.32941	-1.8303		2.90809	1	
23-Mar-09	2.3133	2.02837	2.11		2.61694	1	
24-Mar-09	2.34068	0.79013	2.8698		-2.963	1	
25-Mar-09	2.6217	0.1229	0.2141		2.04931	1	
26-Mar-09	5.50345	2.40274	2.4227		2.77884	1	
27-Mar-09	-1.03348	5.09575	1.3408		0.98602	1	
30-Mar-09	-5.11643	-0.9158	1.3773		2.46215	1	
31-Mar-09	2.55122	1.21158	1.8384		0.82453	1	
Note: Data of log return for 14 companies namely are compiled in the above format.							
The names of campanies are:							
Bhel	Cipla	BPCL	Reddy	mahindra	ITC	SBI	
Tatatea	Tatapower	Grasim	MTNL	HDFC			

Data Set 4 (Used in Chapter VI)

Date	NFR	Turnover	Open Int	Date	BFR	Turnover	Open Int
13-Jun-00	-0.9684	181.2	4000	2-Jan-07	0.3779	19548.3	8213000
14-Jun-00	0.7444	94.79	5000	3-Jan-07	-1.003	25716	8669000
15-Jun-00	-0.0552	96.16	6800	4-Jan-07	-0.366	30117.4	8675000
16-Jun-00	1.8872	205.43	8200	5-Jan-07	-1.525	20383.8	9095000
19-Jun-00	1.4358	296.87	10600	8-Jan-07	0.1616	17967.7	9328000
20-Jun-00	1.0825	320.06	16400	9-Jan-07	-2.163	25378.5	9297000
21-Jun-00	-1.8533	187.32	17000	10-Jan-07	4.2487	19302.8	9852000
22-Jun-00	0.4833	159.47	17200	11-Jan-07	4.9675	26235.9	9200000
23-Jun-00	-1.0535	118.61	16200	12-Jan-07	-0.558	64151.3	8851000
26-Jun-00	-1.0681	184.3	16800	15-Jan-07	0.6186	31661.4	8966000
27-Jun-00	-0.4181	242.08	10000	16-Jan-07	-0.354	39375.6	9112000
28-Jun-00	0.9468	61.34	8600	17-Jan-07	0.7519	19245.1	9160000
29-Jun-00	1.3919	105.67	8200	18-Jan-07	1.7303	47148.5	8170000
30-Jun-00	-0.3899	188.21	7200	19-Jan-07	-0.369	41831.2	6973000
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3-Mar-09	-1.8566	831092	3.1E+07	3-Mar-09	-2.547	16158.1	8002500
4-Mar-09	1.5017	1051197	3.3E+07	4-Mar-09	0.5179	31102	8187500
5-Mar-09	-2.8246	1006955	3.1E+07	5-Mar-09	-2.463	28600.3	7808500
6-Mar-09	2.0076	1086216	3.2E+07	6-Mar-09	2.6875	28691.1	8051500
9-Mar-09	-2.3367	1104477	3.1E+07	9-Mar-09	-2.824	29991.5	7698000
12-Mar-09	2.0315	814607	3.1E+07	12-Mar-09	-6.381	16904.4	7890000
13-Mar-09	4.3453	1104156	3E+07	13-Mar-09	2.0746	94469.3	8817500
16-Mar-09	2.1129	975269	2.9E+07	16-Mar-09	2.2945	71513.3	8891500
17-Mar-09	-0.8125	949807	3E+07	17-Mar-09	-0.245	35545.3	9008000
18-Mar-09	1.016	1112602	2.9E+07	18-Mar-09	-0.438	29240.9	8454500
19-Mar-09	0.749	1077089	2.8E+07	19-Mar-09	0.482	48794	7287500
20-Mar-09	0.0321	973720	2.6E+07	20-Mar-09	-0.473	24353.5	6652000
23-Mar-09	4.764	787089	2.4E+07	23-Mar-09	4.1549	27984.1	5672000
24-Mar-09	-0.0238	1021733	2.2E+07	24-Mar-09	1.3807	32990.9	5089000
25-Mar-09	1.5353	1379818	1.8E+07	25-Mar-09	-1.499	36810.6	3682000
26-Mar-09	3.2843	1340857	1.7E+07	26-Mar-09	4.7448	29426.2	2940500
Note: Data of futures return, turnover and open interest							
This analysis in Ch 6 is done for Nifty and 10 individual companies.							
NFR=Nifty Futures Return							
BFR= Bharti Airtel futures Return							

Data Set 5 (Used in Chapter VII)

Date	Tbhel	TCIPLA	TBPCL	.	.	TTATA	
1-Jan-99	322.5419	25.3867	31.771			8381.272	
4-Jan-99	744.3184	87.5259	40.049			4851.202	
5-Jan-99	633.5204	300.849	138.28			4396.069	
6-Jan-99	1444.283	179.253	95.127			6163.136	
7-Jan-99	2466.981	239.491	335.98			5247.762	
8-Jan-99	1820.504	323.29	227.13			7518.378	
11-Jan-99	1856.327	217.429	247.64			7582.751	
12-Jan-99	2091.249	136.103	292.31			6815.251	
13-Jan-99	1039.665	74.2864	212.64			12772.63	
14-Jan-99	1070.351	108.373	142.73			11433.67	
15-Jan-99	782.4232	38.4261	81.047			12597.66	
18-Jan-99	767.1951	183.69	154.75			4930.829	
13-Mar-09	11856.27	4641.2	1701.1			176.6126	
16-Mar-09	13753.03	1698.48	2734			479.581	
17-Mar-09	13541.07	1524.37	3156.9			196.6649	
18-Mar-09	28676.21	1058.73	2998.7			452.1748	
19-Mar-09	21808.2	1430.01	1638.9			438.4968	
20-Mar-09	36850.85	1940.69	1769.8			426.7131	
23-Mar-09	27075.38	2249.19	1749.6			353.1964	
24-Mar-09	29799.16	2203.69	4133.8			306.6056	
25-Mar-09	22583.56	2544.56	1889.8			255.7327	
26-Mar-09	60958.04	3544.72	3189.7			628.0512	
27-Mar-09	26375.49	4799.9	2206			310.2266	
30-Mar-09	21864.05	2787.56	2221.9			953.3469	
31-Mar-09	22240.89	3170.2	5349.5			1289.799	
Note: Data for 14 individual companies are compiled in the above format							
Bhel	Cipla	BPCL	Reddy	mahindra	ACC	ITC	SBI
Tatatea	Tatapower	Grasim	MTNL	HDFC	Infosys		
Tbhel = Turnover of Bhel in lakhs			TBPCL=Turnover of BPCL				
TCIPLA= Turnover of Cipla			TTATA= Turnover of Tata Tea				

Glossary

ADR	A certificate of ownership issued by a US bank as a convenience to investors in lieu of the underlying foreign corporate shares it holds in custody.
American Options	It is a option which is exercisable anytime on or before a specified date.
Anticipatory Hedge	A trader expects to make a spot transaction at a future date and opens a futures position now to protect against a change in the spot price.
Arbitrage	The simultaneous buy or sale of a contract in different markets in order to profit from discrepancies in prices between those markets.
Ask Price	The price at which the market maker is willing to sell. Also called the offer price
Backwardation	When price of the current futures contracts is trading higher than the deferred contracts.
Basis Risk	The possibility that the value of the basis will change over time.
Basis	The difference between the spot price and price of futures.
Beta	A measure of volatility or the relative systematic risk faced by an asset or portfolio. It is found by regressing stock on a proxy for market returns.
Call Option	The right to buy a security or commodity at a pre-agreed price at a specified date in futures without obligation to do so.
Carrying Charges	The cost of storing a physical commodity over a period of time; insurance and interest lost on the invested fund.
Cash Market	Market for immediate delivery.

Cash Settlement	Transactions that are settled in cash, as opposed to actual delivery of security or commodity
Clearing Member	A member of the clearinghouse or association. All trades of a non-clearing member settled through a clearing member.
Clearinghouse	An adjunct to a stock exchange through which transactions executed on the floor of the exchange are settled. The clearinghouse is also charged with assuring the proper conduct of delivery procedures and adequate financing of trade.
Contract Month	The month in which futures contracts might be satisfied by making or accepting a delivery.
Contract Multiplier	The monetary value that is multiplied by the index value to determine the market value of the futures contract.
Contract Specification	The standard terms of the futures contract to be traded e.g. size of the contract, tick size, settlement and margining methodology, trading times, delivery procedures.
Contracts	A term of reference for a unit of trading.
Convergence	The movement to equality of the spot and futures prices as the delivery date approaches.
Cost of carry	The cost of holding a stock of the underlying e g the costs of storing, insuring and financing the asset
Counterparty	The other party (buyer or seller) to a transaction
Counterparty Risk	The risk the counterparty will not fulfill the terms of the contract. Also called default risk.
Delivery	The transfer of ownership of an actual financial instrument, or final cash payment in lieu thereof, in settlement of a futures contract under the specific terms and procedures established by the exchange

Delivery Month	The calendar month on which the futures contract matures, resulting in delivery or cash settlement of the specified financial instrument. Also known as expiration month.
Derivative	A financial instrument designed to replicate an underlying security for the purpose of transferring risk.
EMH	The idea that the prices of securities reflect their economic or intrinsic value.
Ex Ante	Before the fact; what is expected to occur; what is anticipated.
Ex Post	After the fact; what has actually occurred.
Exotic Derivatives	The derivatives which have many non-standardized features, which might appeal to special class of investors.
Expiration	The date that any futures contract (or option) ceases to exist.
Fair value	The no-arbitrage price of a futures contract. Also known as theoretical value.
Far Contract	The future that is furthest from its delivery month i. e. has the longest maturity.
Far Month	Refers to 3-month contract
Forward Contract	An agreement between two parties to trade an asset at a specified future date and price. This is an OTC product.
Futures Contract	A legal, transferable standardised contract that represents an agreement to buy or sell a quantity of a standardised asset at a predetermined delivery date. This is an exchange traded product.
Hedge	A spread between a spot asset and a futures position that reduces risk.

Hedging	The purchase or sale of futures contracts to offset possible changes in the value of assets or cost of liabilities currently held, or expected to be held at some future date.
Index Derivatives	It is a derivative whose underlying is some index number of prices of financial instruments at a given market.
Initial Margin	The amount that must be placed on deposit in order to initiate a futures position.
Leverage Effect	When the price of a share rises and the value of the firm's outstanding debt is fixed, the ratio of debt to equity falls, i.e. its leverage (or gearing) falls. This makes return on the share less risky. A reverse argument applies for price falls
Liquidity	When a market has a high level of trading activity, it is said to be liquid.
Long	A market position established by buying one or more futures contracts not yet close out through an offsetting sale; the opposite of short
Maintenance Margin	The minimum amount which a person is required to keep in their margin account
Margin	A deposit of funds to provide collateral for an investment position.
Margin Call	A request for the payment of additional funds into a person's margin account.
Market Lot	It is a fixed minimum number in which or in multiples of which shares or securities are bought or sold.
Marking to Market	The daily revaluation of open positions to reflect profits and losses based on closing market prices at the end of the trading day.
Maturity	The length of time before delivery.

Middle Month	Refers to 2-month contract
Near Contract	The future that is nearest to its delivery month i.e. has the shortest maturity.
Net Position	The difference between the long and short open positions in any one future held by an individual or group.
Novation	The legal word for the conversion of a futures contract between a buyer and seller into two separate contracts, each with the clearing house as counterparty.
Open Interest	The cumulative number of either long or short contracts which have been initiated on an exchange, and have not been offset.
Open Positions	Contracts which have been initiated and are not yet offset by a subsequent sale of purchase, or by making or taking delivery.
Over-the-counter	It is a market which is not an organized exchange; it comprises a network of securities dealers who trade in financial assets; though not organized, it is officially recognized.
Physical Delivery	Settlement of a futures contract by the supply or receipt of the asset underlying the contract.
Portfolio Insurance	An investment strategy employing various combinations of shares, options, futures and debt that is designed to provide a minimum or floor value to the portfolio.
Positions Limit	The maximum number of contracts, net long or net short, that one person or firm can hold.
Premium	The amount for which an option trades. This term also refers to the amount that a product is trading over the cash or over fair value.

Price Limit	The maximum and minimum prices, as specified by the exchange, between which transactions may take place during a single trading session.
Put	The right to sell a commodity or security at a pre-agreed price on a specified date in future without obligation to do so.
Random Walk	The theory that changes in the variable are at random; that is, they are independently and identically distributed over time.
Settlement Price	The price which the clearing house uses to determine the daily variation margin payments. It may differ from the price of the last transaction
Settlement	The process by which clearing members close positions
Short	A market position established by selling one or more futures contracts not yet closed out through an offsetting purchase in anticipation of falling prices; the opposite of long.
Speculation	Trading on anticipated price changes, where the trader does not hold another position which will offset any such price movements.
Spot	Market for immediate delivery.
Spread	Difference between the price of far month and near month contracts.
Tick size	Minimum permitted movement in the quotation. Measured in index points.
Trading Limit	The maximum number of contracts that a person can trade in a single day.
Triple Witching Hour	That time every 3 months when four different contracts reach maturity – stock index futures contracts, stock index options

	on index futures and some options on index futures and some options on individual stocks.
Vanilla Derivatives	They are those derivatives which are standardized as specified by exchanges and have simple standard features.
Variation Margin	The gain or losses on open contracts, which are calculated by reference to the settlement price at the end of each trading day and are credited or debited by the clearing house to the clearing member’s margin accounts and by those members to or from the appropriate customer’s margin accounts.
Volatility	A market is volatile when it is prices fluctuate a lot. Academics often choose to measure the volatility of a variable by its variance.
Volume	The number of buy or sale of a futures contract made during a specified time.

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