CHAPTER - II

REVIEW OF LITERATURE

Out of many liberalization policies and structural changes implemented by the government of India one of the most noteworthy was introduction of derivatives in Indian securities markets. Derivatives are believed to be very important to the stock market as well as for the economy of a country in terms of its risk management capability. The arrival of this new financial product in the securities markets has treated renewed interest in the academicians, researchers and practitioners to learn more about derivatives and derivatives markets, its operations and implications. Thus the empirical works on derivatives market has grown manifold in recent years at national and international level.

This empirical research work adds to the growing literature on existing research by examining the relationship between price volatility, trading volume and market depth for futures markets, and forecasting the symmetric and asymmetric behaviour of futures market. As a prelude the literatures that considered the characteristics of return and volume relationship without specific reference to the open interest as proxy variables for calculating market depth are reviewed. While the reference of open interest is often mentioned briefly in most futures textbooks, relatively little research has considered this specific relationship between price volatility, trading volume and market depth for futures
markets. The present research focused on relationship and modeling volatility is expected to be helpful to test the market efficiency, market setting, anomalies in investor behavior and its applicability for the futures markets. An exhaustive literature review has been carried to identify the gap. For the sake of clarity and simplicity all the studies reviewed have been categorized the relationship studies and forecasting and modeling studies.

1. **Relationship between Futures Returns, Trading Volume and Market Depth Variables:**

**Thomas Epps and Mary Lee Epps (1976)**\(^1\) have investigated the financial markets based upon two-parameter portfolio model to identify the stochastic dependence between transaction volume and changes in security price from one transaction to next. The change price can be viewed as mixture of distributions with transaction volume as the mixing variable. In common stocks, these distributions appear to be pronounced in the excess of frequency near the mean and a deficiency in outliers, relative to the normal. Finally, the findings are consistent with the hypothesis that stock price changes over fixed intervals of time follow mixtures of finite variance distributions.

**Richard Rogalski (1978)**\(^2\) examined whether security prices and volume are causally related. The existing models that attempt to analyze the interdependence of price and volume in speculative markets are dependent. Significant cross correlations were observed at zero lag using a 5% significance level. The results
suggest that the knowledge of behavior of volume may marginally improve conditional price forecasts over price forecasts based on past prices alone. A shortcoming of the methodology is that one cannot distinguish between contemporaneous feedback and unidirectional causality for which there is no lag effect. In other words, sample cross correlations that are non-zero primarily at lag zero are consistent with three types of causality: volume causes price change, price change causes volume, and feedback between price change and volume. All three cases are indicative of dependence as revealed by this study. Finally, the results of this study have not established that speculative markets are operating inefficiently. This would require correlation between current price change and lagged volume. No such dependence has been found in this study. Thus, even if volume series could be predicted from past volume values by an appropriate ARMA model, such predictions would contain no information relevant to the expected value of price change. Such predictions would be useful, however, in forecasting the variance of price change.

Figlewski (1981) has analyzed the impact of futures trading in Government National Mortgage Association (GNMA) on price volatility in the cash market. The objective of this study was to examine price volatility, the standard deviation of day to day price changes. The empirical evidence showed that price volatility in the GNMA cash market was related to several factors like increased volatility, measured by GNMA’s outstanding and proxies for the volume of cash market
activity, and lower average prices tended to stabilize the market, while futures market activity increased the volatility of prices. Several possible reasons for this result were discussed; however there were no evidence of insufficient speculative activity in futures relating to hedging, and price manipulation because of the extensive safeguards against it. The futures prices are believed to be determined largely by the actions of inexperienced new class of traders who were likely to have less information than the GNMA securities and set prices in the cash market. When the additional “noise” in futures prices is transmitted to the cash market, price volatility increases. Finally, the effect is expected to diminish as they become more seasoned and broaden the population of GNMA.

Tauchen George and Pitts Mark (1983) studied the relationship between the variability of daily price change and the daily volume of trading on speculative markets for the period from 6th January to 30th June 1979. The work extends the theory of speculative markets in two ways. First, the joint probability distribution of the price change was derived along with trading volume over any interval of time within the trading day. And secondly, the paper tried to determine how joint distribution changes as more traders enter (or exit from) the market. The results of the estimation found reconciling the conflict between the price variability-volume relationship for the market and the relationship obtained by previous investigators for other speculative markets.
Grammatikos and Saunders (1986) examined the contemporaneous and sequential relation between price variability and trading volume in futures markets using disaggregated data and improved measures of price variability. The sample consisted of daily observations for five different foreign currency futures traded on the International Monetary Market (IMM): the German mark, the Swiss franc, the British pound, the Canadian dollar, and the Japanese yen over the period March 1978-March 1983. They employed both classical and Garman-Klass estimators of price volatility, to test whether there exist positive contemporaneous correlations between trading volume and price volatility. The results appeared to be consistent with the MDH and inferences were drawn as maturity is not a suitable surrogate for the common directing variable. Specifically, while maturity has a strong effect on volume, no such relation is found for price variability. Finally, consistent with previous work with stock market data it was found that, in majority of the cases price variability and trading volume were contemporaneously correlated, there were a significant number of cases in which a sequential relation between price variability and volume appeared to be present.

Karpoff Jonathan (1987) attempted an empirical and theoretical research into the price-volume relation for 18 financial markets including equities, futures, currencies and Treasury Bills. The theoretical justifications for studying price volume relationship, that were put forth are, the returns or trading volume
relation provides insight into the structure of financial markets. Second, the return or trading volume relation is important for event studies that use a combination of stock returns and trading volume data to draw inferences. Third, the returns or trading volume relation is critical to the debate over the empirical distribution of speculative prices. The main conclusion has been the positive correlation between price and volumes exists and is mainly conspicuous with larger volumes.

Bessembinder & Seguin (1992) have examined whether greater futures trading activity is associated with greater equity market volatility for S&P 500 index from January 1978 to September 1989. He evaluated with the help of Pearson Correlation Coefficients, Regression of S&P 500 return standard deviation for spot and future trading using dummy variables. Their findings were consistent with the theories predicting that active futures markets enhance the liquidity and depth of equity markets. They provide additional evidence suggesting that active futures markets are associated with decreased rather than increased volatility. However, the evidence reported here, that equity volatility declines with predictable futures-trading activity, is consistent with the reasoning that the low cost of futures trading attracts additional informed traders, and the equity volatility is reduced in future market.
Douglas Foster and Viswanathan (1993)\(^8\) examined the empirical behavior of stock market trading volume, trading costs, and price change for New York Stock Exchange data from 1988, with the help of Ordinary Least Square Method. The Intraday test results indicate that, for actively traded firms trading volume, adverse selection costs, and return volatility are higher in the first half-hour of the day. This evidence is inconsistent with the Admati and Pfleiderer (1988) model which predicts that trading costs are low when volume and return volatility are high. Intraday test results showed that, for actively traded firms, trading volume is low and adverse selection costs are high on Monday, which is consistent with the predictions of the Foster and Viswanathan (1990) model. The result indicates that existing theoretical models based on the adverse selection faced by the market maker are broadly consistent with observed patterns in the volume-volatility relation. That is, intraday trading volume is high when returns are most volatile.

Bessembinder & Seguin (1993)\(^9\) has examined the relations between volume, volatility, and market depth in eight physical and financial futures markets, employing econometric methods that accommodate volatility persistence, asymmetries in the volume-volatility relation and interactions of conditional return means and conditional return volatilities over the period from May 1982 to March 1990. The evidences suggest that linking volatility to total volume does not extract all information. When volume is partitioned into expected and
unexpected components, the paper finds that unexpected volume shocks have a larger effect on volatility. Further, the relation is asymmetric; the impact of positive unexpected volume shocks on volatility is larger than the impact of negative shocks.

**Hiemstra and Jones (1994)** examined the dynamic relation between daily Dow Jones stock returns, percentage changes in New York Stock Exchange (NYSE) and trading volume by using both linear and nonlinear Granger causality tests. By applying the tests to check daily Dow Jones stock returns and percentage changes in NYSE trading volume over the period from 1915 to 1946 and 1947 to 1990. The modified Baek and Brock test provides evidence of significant bidirectional nonlinear causality between stock returns and trading volume in both sample periods. It also examined whether the nonlinear causality from volume to stock returns detected by the modified Baek and Brock test could be due to volume serving as a proxy for daily information flow in the stochastic process generating stock return variance. After controlling for simple volatility effects, the modified Baek and Brock test continued to provide evidence of significant nonlinear Granger causality from trading volume to stock returns. However, nonlinear theoretical mechanisms and empirical regularities could have been considered when devising and evaluating models for the joint dynamics of stock prices and trading volume.
Brailsford Timothy (1994)\textsuperscript{11} has empirically analyzed the relationship between trading volume and stock return volatility in the Australian market with the period from 24\textsuperscript{th} April 1989 to 31\textsuperscript{st} December 1993. Trading volume was then examined in the context of conditional volatility using a GARCH framework. He tested both the asymmetric model and the mixture of distributions hypothesis in relation to the Australian market. The results indicate strong support for the asymmetric model. Furthermore, the results were also found consistent with Lamoureux and Lastrapes [1990] and showed that ARCH effects are diminished and persistence in variance is reduced when trading volume is incorporated as an explanatory variable in the general ARCH model. These results have implications for inferring return behaviour from trading volume data. Hence, there is evidence that if trading volume proxies for the rate of information arrival, then ARCH effects and much of the persistence in variance can be explained.

Andersen (1996)\textsuperscript{12} demonstrated the return volatility-trading volume relationship by integrating the market microstructure framework in which informational asymmetries and liquidity needs motivate trade in response to information arrivals. A continuously compounded daily return series, corrected for dividends and stock splits, is constructed from closing prices on IBM common stock over January 1, 1973 to December 31, 1991 with a sample of 4693 observations. The resulting system modified the so-called "Mixture of Distribution Hypothesis" (MDH). The dynamic features were governed by the information flow, modeled
as a stochastic volatility process, and generalize standard ARCH specifications. Specification tests support the modified MDH representation and show that it vastly outperforms the standard MDH. Finally, our findings suggest model may be useful for analysis of the economic factors behind the observed volatility clustering in returns.

Ragunathan & Peker (1997) investigated the nature of the relationship between volume, price variability and market depth for four futures contracts traded on the Sydney Futures Exchange and is based on the methodology developed by Bessembinder and Seguin (1992, 1993) between January 1992 to December 1994. He tested the asymmetries in volume and open interest shocks by separating volume and open interest into expected and unexpected variables, this study envisaged the asymmetric relationship between volume, open interest and volatility, and tried to investigate whether unexpected volume and open interest had a positive or negative shock. The results lead to the conclusion that positive volume shocks have a greater impact on volatility than negative shocks. The same conclusion is arrived at when open interest shocks are analyzed, that is, a positive open interest shock is more likely to have an impact on volatility than a negative shock. Therefore, it can be concluded that market depth does have an effect on volatility.
Galloway and Miller (1997) explored the relation between index futures trading and volatility in equity market using the S&P MidCap 400 stock index and MidCap 400 index futures. Daily return and trading volume data were obtained for 398 stocks from the CRSP database for three separate periods. The first i.e. pre-index period includes 250 trading days before June 5, 1991. This period precedes both the existence of MidCap index and the trading of MidCap futures. The second, or interim, period includes 175 trading days after June 5, 1991 till February 13, 1992. The study documents a significant decrease in return volatility and systematic risk, and a significant increase in trading volume for the MidCap 400 stocks after the introduction of MidCap index. A control sample of medium-capitalization stocks, however, exhibits similar contemporaneous changes in these measures. The MidCap stocks and control stocks also experienced a significant decrease in volatility and an increase in volume after the introduction of MidCap 400 index futures. Consequently, the study confirms that there is no significant relationship between futures trading and volatility in the stock market. Finally, a new puzzle emerged concerning why there are market-wide changes in risk and liquidity. Prior studies document that aggregate stock market volatility varies over time and the variation is related to a variety of economic variables.

Jacobs and Onochie (1998) revealed that there is a positive relationship between trading volume and price volatility, by measuring the price changes in
conditional heteroskedasticity in international financial futures markets by applying bivariate GARCH(1,1). The underlying products are interest rate assets representing investments in various international money and bond markets of Sterling, Eurodollar, U.S. Treasury bond, German Government bond (Bund), 3-month European Currency Unit (ECU), and the Euromark. The result suggest that there is a strong evidence of second-order dependence in the joint return and trading volume process for various international financial futures markets and the level of trading volume positively influences the conditional variance of futures price change. It also inferred that the issue of time varying volatility is of importance to option pricing. The implication of these findings that futures price changes and volume are not only jointly distributed, but also influences price volatility, can guide theorists and practitioners alike in rethinking the pricing relationships for financial futures.

Gong-meng Chen, Michael Firth and Oliver Rui (2001) examined the dynamic relationship between returns, volume, and volatility for major nine national stock indexes for the period from 1973 to 2000. They evaluated with the help of quadratic time trend method, Augmented Dickey Fuller test, Regression the daily trading volume on stock returns and absolute returns, Vector Auto regression (VAR) and EGARCH techniques were used to examine the returns, trading volume, conditional volatility relation. The results show a positive correlation between trading volume and absolute value of stock price
change. Granger Causality tests demonstrated that for some countries, returns cause volume and volume causes returns. The findings indicate that trading volume contributes some information to the returns process and more can be learned about the stock market through studying the joint dynamics of stock prices and trading volume than by focusing only on the univariate dynamics of stock prices. The results of the study were found robust across all nine major stock markets, implying that there are similar returns, trading volume, and volatility patterns across all markets under study.

Toshiaki Watanabe (2001)\textsuperscript{18} examined the relation between price volatility, trading volume and open interest for Nikkei 225 stock index futures traded on the Osaka Securities Exchange (OSE) by employing the method developed by Bessembinder and Seguin (1993) for the sample period extended from 24\textsuperscript{th} August 1990 to 30\textsuperscript{th} December 1997. The reason for investigating the Nikkei 225 futures traded on the OSE was that the OSE changed regulation such as margin requirements, price range and time interval in updating quotation several times. The authors felt interesting to examine whether changes in regulation may influence the effects of volume on volatility. Therefore, the samples prior to and beginning 14 February 1994 were analyzed separately. However, no relation between price volatility, volume and open interest was found for the period prior to 14 February 1994, when the regulation increased gradually. This result
provides evidence that the relation between price volatility, volume and open interest may vary with the regulation.

**Bhanupant (2001)**\(^{19}\) investigated the dynamic relationship between stock index returns and trading volume using the Augmented Dickey-Fuller (ADF), Linear and Non-Linear Granger Causality hypothesis test on the National Stock Exchange (NSE) data 1 January 1996 to 6 August 2002 with a total of 1649 data points. Linear Granger Causality test was used to investigate the linear relationship while the Non-Linear Granger causality was investigated using modified Baek and Brock test proposed by Hiemstra and Jones (1994) for the daily returns on S&P CNX Nifty and the total trading volume at NSE. Bidirectional linear Granger causality between index returns and volume change was observed for the period when rolling settlement was either not introduced or partially introduced. The period, when rolling settlement was introduced, there found no evidence of linear causality in either direction. The shift in linear causal relationship indicates that efficiency at NSE has improved with introduction of rolling settlement mechanism. Nonlinear Granger causality between the returns and volume change was not evident in either direction.

**Otavio Medeiros & Bernardus Van Doornik (2006)**\(^{20}\) investigated the empirical relationship between stock returns, return volatility and trading volume for Brazilian stock market covering a period 1\(^{st}\) March 2000 to 29\(^{th}\) December
2005. The empirical methods used include cross-correlation analysis, unit-root tests, bivariate simultaneous equations regression analysis, GARCH modeling, VAR modeling, and Granger causality tests. Their evidence suggests that there was a significant relationship between stock returns and trading volume, which is detected in the cross-correlation analysis. Additionally, by applying Granger causality, the results showed no signs of causality between trading volume and stock returns. However, a simultaneous equation analysis showed that stock returns depend on trading volume, but it does not apply the other way. This result contributes to the understanding of the microstructure of emerging stock markets.

Pati & Kumar (2006)\textsuperscript{21} attempted to examine the maturity and volume effects on the volatility dynamics for futures price in Indian Futures Market for the period from January 1, 2002 to December 29, 2005 for near month contract with 1009 sample data points. For empirical analysis they used ARMA-GARCH, ARMA-EGARCH models. The empirical evidence suggests that there is time-varying volatility, volatility clustering and leverage effect in Indian futures market. With respect to volume-volatility relationship, the results suppressed the Mixtures of Distribution Hypothesis. This study concluded that time-to-maturity is not a strong determinant of futures price volatility, but rate of information arrival proxied by volume and open interest are the important sources of volatility. This relationship has important implications for the new futures contracts. This study does not provide support for the Samuelson Hypothesis in
Indian futures market, which is found to be informational efficient. The finding of this study had a message for investors, market regulator-market surveillance that risk management practices should be further strengthened to take care of greater market volatility associated with an increased volume of trading. Finally, the result suggests maturity effect does not hold in Indian futures markets, the investors should not base their investment decision on time-to-maturity.

Mahmood & Salleh (2006) examined the relationship between return, trading volume and market depth for two futures contracts, namely Stock Index Futures and Crude Oil Futures traded at the Kaula Lumpur Option and Financial Futures and Commodity and Monetary Exchange for the period from 15th December 1995 to 19th January 2001. They tested with the two famous hypothesis one, whether the sequential arrival of new information to the market move both the trading volume as well as price. The second one is about the mixture of distribution hypothesis where information may be considered as mixing variable. They used the diagnostic tests like Unit root Test, Ljung-Box Test and ARIMA (10,1 ,0) and evaluated with the help of GARCH (1,1). The effects of volume as well as open interest, proxy of market depth, on volatility and vice versa were also studied. Since both volume and open interest were found highly serially correlated, these variables were divided into expected and unexpected components. Finally, the results showed a positive expected and unexpected volume and market depth effect on volatility.
Eric Girard & Rita Biswas (2007) surveyed the relationship between volatility and volume in 22 developed markets by using 27 emerging markets for the period from January 1985 to June 2005. In this study the empirical analysis were carried out by applying TGARCH model specification for explaining the daily time dependence with the rate of information arrival to the market for all stocks traded in frontier market exchange. Thus, using volume as a proxy for the flow of information, TARCH was found to be an appropriate model to mimic the conditionality of second moments. Compared to developed markets, emerging markets showed a greater response to large information shocks and exhibited greater sensitivity to unexpected volume. Both of these findings evidenced the presence of noise trading and speculative bubbles in emerging markets. Their results suggest that negative relation was found between expected volume and volatility in several emerging markets, which can be attributed to the speculative trading activity which drives bid-ask spreads higher, and diminishes the relative inefficiency in those markets. The findings showed that official price reporting mechanisms and insider trading laws are also relatively weaker in these countries; a change in local policies to design better systems is warranted if foreign investors are to be attracted to these markets.

Christos Floros & Dimitrios Vougas (2007) examined the contemporaneous relationship between trading volumes and returns in Greek stock index futures
contracts in the Athens Derivatives Exchange (ADEX) for the period September 1999 to August 2001. They utilized the tools like Generalized Method Moments (GMM), Unit root test and GARCH effect. The study suggested that GARCH effects were explained by trading volume under both GARCH and GMM. For FTSE/ASE-20, trading volume contributes significantly in explaining GARCH effects. However, the estimated results of GMM suggested that there is a significant relationship between lagged volume and absolute returns, while a positive contemporaneous relationship does not hold good. Their findings indicate that market participants use volume as indicators of prices, but for FTSE/ASE Mid 40, the empirical results give different conclusions. Both GARCH and GMM methods confirm that there is no evidence of positive relationship between trading volume and returns.

Malabika & Srinivasan (2008) analyzed the empirical relationship between stock return, trading volume and volatility for select Asia-Pacific Stock Market by applying preliminary test, Granger Causality test and EGARCH (1,1) model. The data set comprises of seven national stock markets for the period spanning from 1st January 2004 to 31st March 2008. The results evidenced a significant relationship between trading volume and the absolute value of price changes. Granger Causality test was used to explore, whether return causes volume or volume causes return. The results suggested that the returns were influenced by volume and volume also was influenced by returns for most of the markets.
Therefore, trading volume contributes some information to the return and volatility for determining contemporaneous and lagged volume effect after incorporation. The empirical results were found robust across the national markets during the study period.

Mahajan and Singh (2008)\textsuperscript{26} suggested the pattern of information flow between trading volume and return volatility using daily data for Nifty index during the period from July 2001 to March 2006. The methods used included Correlation analysis, Unit root tests, VAR modeling, Granger causality test, GARCH (1,1) and EGARCH model. The study provided evidence of low but significant positive contemporaneous relationship between volume and return volatility that was indicative of both mixture of distribution and sequential arrival hypothesis. The differential cost of taking long and short positions were examined by applying asymmetric EGARCH (1,1) model to check the relationship between the variables. The study further confirmed a weak unidirectional causality from volume to return volatility, which also indicates the mild support for sequential information flow directed from volume to price change. The study contributes to the enhance understanding of researchers, regulators, speculators, and other participants in market on market efficiency and information processing.
2. Modelling and Forecasting Futures Market Volatility:

Franses and Van Dijk (1996)\textsuperscript{27} compared the volatility forecasting performance of GARCH model, Quadratic GARCH model and Threshold GARCH models against Random Walk model using weekly dataset for German, Dutch, Italian, Spanish and Swedish stock index returns over the period from 1986 to 1994. They report that the random walk model performs particularly well when the crash of 1987 was included in the estimated sample, while the QGARCH model can significantly improved the linear GARCH model and found no significant change in forecasting.

McMillan, Speight and Apgwilym (2000)\textsuperscript{28} analyzed and compared the volatility forecasting performance by using GARCH models, asymmetric TGARCH and exponential GARCH models for the Financial Times-Stock Exchange (FTSE 100) index and Financial Times Actuaries All Share index at the London Stock Exchange. The dataset are partitioned into in-sample and out-sample estimation periods from 2 January 1984 to 31 July 1996 for the FTSE100 index and 1 January 1969 to 31 July 1996 for the FTA All Share index data, the out-of-sample forecast periods covering the remaining period from 1995 to 1996 for both data sources. A total of ten volatility forecasting models are considered, including the historical mean, moving average, random walk, exponential smoothing, exponentially weighted moving average, simple regression, GARCH,
TGARCH, EGARCH, and CGARCH models. The forecasting performed for monthly, weekly and daily data frequencies under symmetric and asymmetric loss functions. The results suggest that the random walk model provides superior monthly volatility forecasts, while random walk, moving average, and recursive smoothing models provide moderately superior weekly volatility forecasts, and GARCH, moving average and exponential smoothing models provide marginally superior daily volatility forecasts. If attention is restricted to one forecasting method for all frequencies, the most consistent forecasting performance is provided by moving average and GARCH models. More generally, their results suggested that GARCH class models provide relatively poor volatility forecasts.

Najand Mohammad (2002)\textsuperscript{29} examined the relative ability of various models to forecast daily stock index futures volatility for S&P 500 futures index between January 1983 and December 1996 with a continuous sequence of 3561 observations are gathered over fourteen year period. He estimated the models using 3500 and 3380 observations and saving the last 60 and 180 observations for out-of-sample forecasting comparisons between models. The linear and non-linear models employed for the study are Random Walk, AR model, MA model, Single Exponential Smoothing models, Double (Holt) Exponential Smoothing models, GARCH - M, EGARCH and ESTAR models. Their findings suggest autoregressive (AR) model is a more appropriate model under RMSE and MAPE criteria. In non linear model, GARCH and ESTAR model fitting were more
appropriate than linear models by using RMSE and MAPE error statistics. Finally, EGARCH appeared to be the best model for forecasting stock index futures price volatility.

Yu Jun (2002) explored the volatility forecasting performance for New Zealand Stock Exchange 40 index for the sample period consists of 4741 daily returns over the period from 1 January 1980 to 31 December 1998. The competing modes contain both simple models such as the Random Walk, Historical average, Moving Average, Simple Regression, Exponential smoothing, Exponentially-weighted moving average (EWMA) and complex models such as ARCH, GARCH, SV model. Four different measures were used to evaluate the forecasting accuracy, namely, the root mean square error (RMSE), the mean absolute error (MAE), the Theil-U statistic and the LINEX loss function. The main results are the following: (1) the stochastic volatility model provides the best performance among all the models; (2) ARCH-type models can perform well or badly depending on the dataset chosen for the study. (3) The regression and exponentially weighted moving average models do not perform well according to any assessment measure, in contrast to the results found in various markets. Moreover, all the models examined in this paper belong to the univariate time series family and multivariate models should be kept into consideration to forecast volatility. However, he finds that the added information cannot improve the out-of-sample forecasting performance and there
are some other variables that are useful to forecast volatility, such as inflation rates or numbers of listed companies.

**Pandey Ajay (2002)** reported the empirical performance of various unconditional volatility estimators and conditional volatility models by using S&P CNX Nifty, India. The dataset on S&P CNX Nifty for the period 1\textsuperscript{st} January 1996 to 31\textsuperscript{st} December 2001 were considered by using different class of models. In order to test the ability of models estimated to forecast volatility, he compared the unconditional estimators with the realized volatility measure. For conditional volatility models, the forecasts for the same periods are obtained by estimating models from the time-series prior to the forecast period. The results indicate, that the conditional volatility models provide less biased estimates, extreme-value estimators are more efficient estimators of realized volatility. As far as forecasting ability of models is concerned, conditional volatility models fare extremely poorly in forecasting five-day (weekly) or monthly realized volatility. In contrast, extreme value estimators, other than the Parkinson estimator, perform relatively well in forecasting volatility over these horizons.

**Caiado Jorge (2004)** investigated the volatility forecast for daily and weekly data for Portuguese Stock Index (PSI-20) by using simple GARCH, GARCH-M, Exponential GARCH and Threshold ARCH models from the period January 2, 1995 to November 23, 2001 for a total of 1708 and 359 observations.
respectively. The out-of-sample forecast error statistics Root Mean Square Prediction Error, Mean Absolute Prediction Error and Mean Absolute Percentage Prediction Error for each model obtained by sequences of both 100 one day ahead and 20 one week ahead forecasts for PSI - 20 indexes. The findings suggested that, there are significant asymmetric shocks to volatility in daily stock returns and declined by 24.42 per cent, but the same was not evidenced in the weekly stock returns, indicating that the Portuguese stock market becomes more nervous when negative shocks take place. Finally, the EGARCH models were found to provide better daily forecasts, while the GARCH model with the variance equation provided superior weekly forecasts. Therefore, he concluded that reduction of the sample period for estimation improves the accuracy of predicting future observations of the PSI-20 index and stock returns.

Sarno Lucio and Valente Giorgio (2005)\textsuperscript{33} have investigated the dynamic relationship between spot and futures prices in stock index futures markets using data since 1989 at weekly frequency for three major stock market indices - the S&P 500, the Nikkei 225 and the FTSE 100 indices by using a conventional cost of carry model to show that futures and stock prices must be Cointegrated and, therefore, linked by a VECM that can be used both to explain and forecast stock returns. The data set comprises weekly time series on prices of futures contracts written on the S&P 500, the Nikkei 225 and the FTSE 100 indices. The sample period examined spans from January 1989 to December 2002.
work was carried out during the period January 1989-December 1998, reserving the last four years of data for out-of-sample forecasting tests. The empirical results provided evidence in favor of the existence of international spillovers across these stock markets and a well-defined long-run equilibrium relationship between spot and futures prices which was consistent with mean reversion in the futures basis. Using the estimated models in an out-of-sample forecasting exercise it was found that both nonlinearity and international spillovers are important in forecasting stock returns. Overall, their empirical evidence suggests that the statistical performance of the linear and nonlinear models examined, differs little in terms of conditional mean, regardless of whether allowance is made for international spillovers across the stock indices. In particular, they focused on the information provided by the futures market for forecasting stock returns.

Karmakar (2005) estimated the conditional volatility models in an effort to capture the stock market volatility in India by employing GARCH (1,1) models by suing three sets of data. The first 2 sets comprised of S & P CNX Nifty and BSE Sensex for the period from 2nd January, 1991 to 10th June 2003. The third set comprised of daily closing prices of 50 underlying individual companies from June 1994 to October 2002. To evaluate the models in terms of out-of-sample forecast accuracy by Mean Error, Mean Absolute Error, Mean Absolute Percentage Error and Root Mean Square error are investigated whether there is
any leverage effect in Indian companies. It is observed that the GARCH (1,1) model provides reasonably good forecasts of market volatility. The findings suggest, the movement in stock market return volatility is not explained by the fundamental economic factors, but also the presence of ‘fade’ due to the actions of noise traders in the market might be associated with these immeasurable elements of stock price volatility. However, the initial boost up of share prices and the resultant fluctuation were believed to be due to fundamental economic factors of the period which were supplemented by a number of liberalization policies and procedures of the government. Finally, the real cause of excessive movement was attributed to the irrational behaviour of the market speculators and frenzy investors who drove the price away from fundamental level resulting in fads or bubble as the natural outcome of the price formation process.

Gospodinov, Gavala and Jiang (2006) investigated several parametric and nonparametric volatility measures, such as implied, realized and model-based volatility for S&P 100 index and the forecasting performance of different volatility models were evaluated among ARFIMA models, Near-integrated AR model, EGARCH, FIEGARCH and Stochastic volatility models. The daily dataset were used for the exercise for the S&P 100 index and the implied volatility index VIX for the period June 1, 1988 to May 17, 2002. To obtain measures of realized and historical volatility S&P 100 returns were used as proxies of the latent integrated volatility process. The result suggested that
implied volatility provides valuable information about future movements of volatility and the information content of option prices were considered as more efficient methods for modeling and forecasting the volatility process. Furthermore, their findings suggest that combined information from different volatility models tends to improve the performance of volatility forecasts, especially at long forecasting horizons. Finally, their paper considered only forecasts from univariate models by using simultaneously information from stock returns and option prices by including the implied volatility in a GARCH-type model or adding exogenous variable that contain some incremental information about volatility such as trade volume, that lead to increased forecast accuracy.

Jaesun Noh and Tae-Hwan Kim (2006) analyzed both implied volatility and high frequency historical volatility for different financial time series by using two time series, the S&P 500 and FTSE 100 futures, to measure the predictive power of implied volatility and historical volatility using both daily and high frequency returns over a non-overlapping monthly sample period of January 4, 1994 through June 30, 1999 by using Augmented Dickey-Fuller test, Phillips-Perron (1988) test, Johansen’s co-integration test, Wald test for the coefficient restrictions and GMM estimation. For both futures, was selected the next closest maturity month with 1385 daily observations for S&P 500 futures and for the FTSE 100 futures there are 1386 daily observations. Their findings suggest that implied, realized and historical volatilities are co-integrated over a non-
overlapping monthly sample. The results showed that both implied volatility and historical volatility using high-frequency returns could outperform each other in forecasting future volatility. Implied volatility has more incremental forecasting information than historical volatility for the S&P 500 futures. However, they found that implied volatility outperforms historical volatility in forecasting future volatility for the S&P 500 futures. The results also indicated that historical volatility using high frequency returns could be an unbiased forecast for the FTSE 100 futures.

Sadorsky Perry (2006) used several different univariate and multivariate statistical models to estimate forecasts of daily volatility in petroleum futures price returns. The univariate models used were Random Walk, Historical Mean, Moving Average, Exponentially Smoothing (ES), Linear Regression model (LS), Autoregressive Models (AR), GARCH (1,1), Threshold GARCH, MGARCH and State Space model (SS). Two multivariate models, Vector Autoregression (VAR) and Bivariate GARCH were also used. The data for this study consisted of daily closing observations for futures price returns on crude oil, heating oil 2, unleaded gasoline, and natural gas. The data set for crude oil, heating oil 2 and unleaded gasoline covers the period February 5, 1988 to January 31, 2003 for a total of 3911 observations. The natural gas data set covers the period April 3, 1990 to January 31, 2003 with 3349 observations. The out-of-sample forecast summary statistics included well known measures like mean squared error (MSE), mean
absolute deviation (MAD) and the Theil U statistic. The out-of-sample forecasts were evaluated using forecast accuracy tests and market timing tests. The TGARCH model fits well for heating oil and natural gas volatility and the GARCH model fits well for crude oil and unleaded gasoline volatility. Simple moving average models seem to fit well in some cases provided the correct order is chosen. Despite the increased complexity, models like State Space, Vector Autoregression and Bivariate GARCH did not perform as well as the single equation GARCH model. Most of the models out perform a random walk and there is evidence of market timing.

Magnus and Fosu (2006) have modeled and forecasted volatility of returns on the Ghana Stock Exchange using a linear random walk (RW) model to test the market efficiency, a symmetric GARCH (1,1) models and two asymmetric EGARCH(1,1), and TGARCH(1,1) models to capture the main characteristics of financial time series such as fat-tails, volatility clustering and the leverage effect. The sample of data used in this exercise is the daily closing prices of the Ghana Stock Exchange Databank Stock Index (DSI) over the period extending from 15 June 1994 to 28 April 2004 making total observations of 1508 excluding public holidays. In order to make forecasts, the full sample was divided into two parts comprising 1342 in-sample observations and 166 out of sample observations from 31 March 2003 to 28 April 2004. They found that the DSI exhibited the stylized characteristics such as volatility clustering, leptokurtosis and asymmetry.
effects associated with stock returns on more advanced stock markets. The random walk hypothesis is also rejected for the GSE DSI returns. The parameter estimates of the GARCH models ($\alpha$ and $\beta$) suggest a high degree persistence in the conditional volatility of stock returns on the Ghana Stock Exchange. The evidence of high volatility persistence and long memory in the GARCH models suggests that an integrated GARCH model may be more adequate to describe the DSI series. By and large, the GARCH (1,1) model able to model and forecast the conditional volatility of the DSI better than the other competing models.

Covarrubias. et.al (2006)\textsuperscript{39} empirically modeled the volatility of daily changes in 10-year US Treasury rate by utilizing the iterated cumulative sums of squares (ICSS) algorithm to detect regime shifts in the volatility of the interest rate changes. Daily data from Global Financial covering the period from April 4, 1994 through November 13, 2001 were taken for estimating the two competing GARCH models using 1927 observations and saving the last 60 observations for out-of-sample forecasting comparisons. The analysis utilized, Augmented Dickey-Fuller statistic to test the null hypothesis of the series and GARCH (1,1) framework which has been shown to be a parsimonious representation of conditional variance that adequately fits many economic time series. To assess the forecasting performance of the volatility models, they calculate asymmetric error statistics for the 60 one-step-ahead forecasts by mean mixed error statistics that give different weights to under- and over-predictions of volatility of similar
magnitude. The results indicated that the information about regime shifts was used in conjunction with a GARCH model to determine the effects of shocks on volatility persistence. Consistent with previous research findings, volatility persistence was found significantly reduced by incorporating regime shifts. Moreover, the regimes generally correspond with major economic events and announcements in the direction that one might expect.

Hongyu Pan and Zhichao Zhang (2006) explored a number of linear and GARCH-type models for predicting the daily volatility of Shanghai and Shenzhen equity indices in the Chinese stock market. The initial data set used for estimating both the indices were from 4 January 2000 to 31 December 2004 with 1200 daily observations. Out-of-sample forecasts were constructed for daily data from 5 January 2000 to 15 March 2004 by applying the following methodology: Random walk model, Historical mean model, Moving average model, Exponentially smoothing model, GARCH, GJR-GARCH, EGARCH and APARCH models. The paper consisted of three volatility forecasting techniques, one asymmetric (Standard loss functions) and two values at risk (VAR) criteria i.e. mean absolute error, and mean squared error. The models were estimated under three distributions. First, for the Shenzhen stock market, the traditional method seems superior, and the moving average model was favored for forecasting daily volatility, but for Shanghai index the GARCH, APARCH-N and moving average models was favoured under different criteria. Second, in the
Shenzhen stock market the GJR and EGARCH model performed better than other GARCH-type models and found with no evidence of asymmetric effect. However, they could not find any single model that performs best under all the criteria. But, it appeared that the random walk model was a poor performer, irrespective of both the series on which it was estimated and the loss function used to evaluate the forecast.

Kumar (2006) attempted to examine the efficacy of competing volatility models in forecasting the context of Indian stock and Forex markets. A total of ten different competing models were evaluated on the basis of two categories of evaluation measures like symmetric and asymmetric error statistics. In this study they considered S & P CNX Nifty index and Indian rupee/US dollar exchange rate data were collected from Jun 3 1990 till Dec 31 2005 and Jan 3 1994 till Dec 31 2005 respectively. Out of the total monthly observations 126 for Nifty and 85 Forex market were used for estimating the model parameters and the remaining observations were used for out of sample forecasting. The forecasting performance of each model were estimated using Mean absolute error (MAE), Root Mean Square Error (RMSE), Theil’s U (TU) and Mean Absolute Percentage Error (MAPE). Based on an out of the sample forecasts and a majority of evaluation measures they found that GARCH (4, 1) and EWMA methods lead to better volatility forecasts in the Indian stock market and the GARCH (5, 1) will achieve the same in the Forex market. The same models
performed better on the basis of asymmetric error statistics also. Moreover, the findings are contrary to the findings of Brailsford and Faff (1996) who found no single method as superior.

**Banerjee & Sarkar (2006)**\(^{42}\) attempted to model the daily volatility, using high frequency intraday data, in the stock index return of a very popular stock market in India, using high frequency intra-day data covering a period from June 01, 2000 through December 16, 2003, is used to model volatility using various established volatility models like Random walk, Historical Average, EWMA, GARCH, EGARCH, TGARCH and PGARCH models. The remaining data set, from December 17, 2003 through 30 January, 2004, was used to test the efficacy of various models using RMSE, MAE and Theil-U statistic. Their findings suggest that the Indian stock market experiences with volatility clustering and found GARCH-type models could predict the market volatility better than simple volatility models, like historical average, moving average etc. It was also observed that the asymmetric GARCH models provide better fit than the symmetric GARCH model, confirming the presence of leverage effect. Finally, their results showed that the change in trading volume in the market directly affects the volatility of asset returns and volatility clusters are not very persistent in India, but it is contrary to experienced countries. Further, the presence of FII in the Indian stock market does not appear to increase the overall market volatility. These findings have profound implications for the market regulator.
Hourvouliades (2007) examined the existence and nature of volatility clustering phenomena in the Athens FTSE 20 index futures contract. The purpose of this analysis was to offer an in-depth analysis of volatility clustering, with negative shocks being more persistent than positive ones, in the domestic derivatives market of Greek. They employed the various methodologies like Simple regression, Single exponential smoothing, Holt-Winter’s multiplicative smoothing, GARCH (1,1) and EGARCH (1,1) models in order to compare their forecasting power on volatility for the period from January 2002 to November 2006 with a total sample of 1223 observation. The study used a set of forecasting indicators in order to compare the power of the various forecasting techniques such as MAE, RMSE, MAPE and Theil’s U statistics. The result showed that volatility clustering was found, with returns following a normal distribution and exponential smoothing seemed to offer superior forecast efficiency, despite the more sophisticated GARCH models have similar results, showing the persistence of volatility and that decay its serial correlation slowly. However, the single exponential smoothing method is offering a better explanation than the seasonal HWM method, showing that the market has no seasonal trends and the EGARCH model was not able to show its superiority in forecasting non-symmetric effects. Finally, the explanation of the market’s behaviour it is proved that negative shocks seems in general to be more powerful and persistence.
Zlatko J. Kovacic (2008) estimated the behavior of Macedonian Stock Exchange and focusing on the relationship between returns and conditional volatility. The data used in the paper were the daily closing market index MBI-10 from January 4, 2005 to September 21, 2007, with 632 observations. However, 605 observations were effectively used to calculate returns summary statistics and for estimation. The last 27 observations were left for examination of the out-of-sample forecasting accuracy for conditional mean a GARCH-M model, and for the conditional variance one symmetric (GARCH) and four asymmetric GARCH types of models (EGARCH, GJR, TARCH and PGARCH) were tested. The forecasting performance of each model were evaluated both in-sample and out-of-sample by using three symmetric and two asymmetric measures. Three standard symmetric measures were used to evaluate in-sample and out-of-sample forecasting accuracy they are the root mean square error (RMSE), the mean absolute error (MAE) and the Theil inequality coefficient (TIC). They suggested the innovations in the conditional variance which was highly persistent indicating that large changes in returns tend to be followed by large changes and small changes tend were followed by small changes, which meant that volatility clustering is observed in the Macedonian financial returns series. Moreover, the conditional variance in the mean equation measuring the risk premium effect was statistically significant across all models. However, the sign of the risk premium parameter is negative. The implication is that increase in volatility would decrease returns, which is an unexpected result, but could be theoretically
justified. Finally the two unusual results related to risk premium and leverage effects, i.e. anomalies in stock market behavior could be expected in the early period of emerging stock markets.

Rashid and Ahmad (2008)\textsuperscript{45} evaluated the relative performance of linear versus nonlinear models to forecast stock index volatility by using daily data for the period January 2001 to November 2007 for Karachi Stock Exchange. The purpose of this study was to predict the daily stock price index by employing linear and non linear models like: random walk, autoregressive model, moving average, exponential smoothing, Holt exponential smoothing models, GARCH, EGARCH and PARCHES models, to assess the forecasting performance of the models by considering Root Mean Square Error (RMSE). It was found that, among linear models of stock price index volatility, the exponential smoothing models ranked first using the RMSE criterion. They also found that within the nonlinear models, the GARCH model was superior as compared to the EGARCH and the PGARCH models. Finally, the study concluded based on the RMSE that the nonlinear ARCH-class models clearly dominate the linear models in out-of-sample forecasting exercise for stock price index volatility.

Angelidis and Degiannakis (2008)\textsuperscript{46} argumented in their paper that the intra-day model generates the most accurate forecasts in three European equity markets under the framework of two financial applications, i.e., VaR forecasting and prediction of option prices, plus a volatility forecasting exercise. The intra-day
dataset was obtained from Olsen and associates and comprises three European stock indices: the CAC (from January 3, 1995 to September 8, 2003), the DAX30 (from July 3, 1995 to December 29, 2003) and the FTSE100 (from January 2, 1998 to December 30, 2003) indices by using a simple inter-day model TARCH, a complex inter-day model FIAPARCH and an intra-day model ARFIMAX. To measure the accuracy of the models in forecasting the one-day-ahead conditional variance via three loss functions: (i) the MSE, (ii) the Heteroskedasticity-Adjusted Squared Error (HASE), and (iii) the Logarithmic Error (LE). The results indicated that there was no one unique model for all cases that can be deemed an adequate one, and therefore investors must be extremely careful when they use one model in all cases. Nevertheless, despite this general conclusion, a researcher must use an inter-day model for inter-day based financial applications and intra-day datasets for intra-day volatility forecasting.

McMillan and Garcia (2009)\textsuperscript{47} have examined the forecasting performance of competing models for intra-day volatility in IBEX-35 index futures market during the period from 17 January 2000 up to 31 December 2003, which implies 991 trading days. For this period, they have extracted the data on prices for the IBEX-35 index future and generated a 5-minute returns series. In each and every minute more than one trade can occur, so it is possible that different prices exist for the IBEX-35 index futures at every minute. The dataset was aggregated in two ways. First, to examine the volatility forecasts at different frequencies the 5-
minute returns data were aggregated to 10, 15, 20, 30, 60, 120 and 240 minutes. Second, to construct the realized volatility as an aid to forecast evaluation they aggregated the squared 5-minute returns over the same frequencies. The intra-day volatility for futures market was tested using GARCH, PARCH, CGARCH, IGARCH, FIGARCH, FIEGARCH, HYGARCH models. The results presented here suggest that the HYGARCH and FIEGARCH model provides the best forecast for intra-day volatility and very high-frequency forecasts. Moreover, the IGARCH and FIGARCH models were performed better at frequencies of 1 hour and lower. Finally, the CGARCH model appears to provide consistent performance across all frequencies and the FIEGARCH model performs particularly well when weighting under predictions of volatility higher than over predictions.

**Conclusion**

This chapter has provided as a platform for the empirical work carried out in examining the relationship between price volatility, trading volume and market depth for futures markets, and forecasting the symmetric and asymmetric behaviour of futures market. Numerous studies have attempted at international level for testing the futures market variables, whereas in India studies on futures markets on testing the relationship and modeling volatility behaviour were quite limited. Bhanupant (2001) investigated the dynamic relationship between stock
return and trading volume using linear and non-linear Granger causality and evidenced the relationship have improved after rolling settlement mechanism. Mahajan and Singh (2008) examined the dynamic relationship between trading volume and return for NSE. They found that volatility dynamics was weak and evidenced unidirectional causality running from volume to return and indicated mild support for sequential information hypothesis. Malabika, Srinivasan and Devanadhen (2008) have tested the relationship between return and trading volume series for select Asia-Pacific stock market and envisage bidirectional causality exist between most of the stock exchanges.

Studies relating to modeling and forecasting futures market volatility were examined by Varma (1999) for volatility estimation by using GARCH model and EWMA models in the risk management setting. Pandey (2002) analyzed the extreme value estimators and found the performance with Parkinson estimator for forecasting volatility over these horizons. Karmakar (2005) estimated the movement in stock returns volatility which was found not well explained by the fundamental economic factors, but the presence of ‘fade’ actions taken by the noise traders, liberalizing policies and procedures of the government were found contrary. Kumar (2006) examined the comparative performance of volatility forecasting models in Indian markets and found the results were contrary to Brailsford and Faff (1996). Hence, the current study attempts to shed light on the
relationship and modeling volatility behaviour for selected stock futures market in India, to fill the gap in the existing literature.
References:


