Chapter 7

Summary and Conclusions

The volatility of capital market is the basis for some financial instruments, namely derivatives. Derivatives are those financial instruments whose values are derived from the underlying asset. The first derivatives exchange was founded in Chicago, United States in 1848, namely the Chicago Board of Trade (CBOT) which has been the oldest organized futures market all over the globe. In the post-1970 period, financial derivatives have highlighted to protect risk-averse investors against market fluctuations. Although, derivatives were initially introduced for risk management purposes, they have been criticized for destabilization of the spot market. Therefore, the stabilization and destabilization effects of derivatives trading have been critical issues in the literature over different time and place settings. Figlewski (1981) and Stein (1987) opined that uninformed speculators have been attracted by motivating factors to the futures markets and therefore destabilize spot price movements. On the other hand, some arguments supported the stabilization effects of derivatives trading on underlying spot markets (Turnovsky, 1979; and Bray, 1981). A large number of studies have investigated to find the impact of derivatives trading on spot market volatility in the developed markets. However, a considerable vacuum is found in the literature of emerging economies like India. Investigating this issue in the Indian market has been of interest over the recent decade. Therefore, this study will contribute to fill in the gap of research studies in Indian context. This study analyzed the impact of introduction of futures on underlying spot market, and lead-lag relationship and volatility spillover between spot and futures markets. Chapter 1 presents a brief discussion of the study. The conceptual framework of the study is discussed in Chapter 2: the developments of derivatives products, their economic functions and concepts and derivatives pricing models. Chapter 3 explains the evolution of derivatives market in India, the position of Indian F&O market among the global context, equity derivatives trading mechanism, contract specifications of instruments in F&O market, transaction charges, clearing and settlements, risk management mechanism and types of margins. The regulatory framework of Indian market is also discussed in this chapter. Chapter 4 discusses a survey of literature on the impact of derivatives trading on underlying spot market. This chapter includes two parts. Part A contains the relevant literature on the impact of derivatives trading on the volatility of underlying spot market. The related review of literature on the lead-lag relationship and volatility spillover between derivatives and
corresponding spot market is arranged in Part B. Chapters 5 and 6 focus on the econometric methodologies, results and analysis of the study.

In this study, eight objectives are set out to investigate the impact of futures trading on the underlying spot prices in India market. According to these objectives, seven hypotheses have been formulated and tested. To determine the impact of introduction of futures on underlying spot market volatility, GARCH family models (simple GARCH (1, 1), EGARCH (1, 1) and GJR-GARCH (1, 1)) were applied. The transaction share of NSE F&O segment in Indian market (NSE plus BSE) is above 92 percent on date. The transaction share of the individual stock futures (about 13%) is more than that of individual stock options (6%). Therefore, we used NSE individual stock futures to investigate the impact of derivatives trading on spot market volatility in Indian market. The selection has been taken based on some criteria. Some stocks which have not met the criteria excluded from the sample. The selected stocks are the most representative sample for the analysis of the impact of futures trading on underlying spot market volatility and price discovery process between spot and futures markets. Therefore, the results can be reasonably generalized to Indian market.

7.1 The Results and Analysis

The findings of this study (analyzed in chapters 5 and 6) are summarized and discussed as follows:

7.1.1 The Analysis of Impact of Futures Trading on Underlying Spot Market

As discussed earlier, we analyzed the impact of futures trading on underlying spot market in chapter 5 based on the following objectives. 1) To find whether stock futures trading significantly affects the spot market volatility. 2) To examine whether the volatility of spot is more influenced by old news or recent innovation. 3) To analyze whether spot market volatility behaved differently after the introduction of futures. Based on the certain criteria, 187 stocks were selected from F&O segment of NSE. BSE 200 and S&P 500 indices were selected as market wide and worldwide factors. Daily closing prices of the selected stocks were used to take daily returns using first log difference. Both closing prices and return series were tested for the existence of unit root. The results of unit root test show that closing price series are non-stationary; however, the return series are stationary in all cases. Applying GARCH family models are reasonably justified by non-stationary results of the closing prices. In addition, the
return series were tested for the availability of ARCH effects. To find the precise impact of futures trading on spot market volatility, we removed the effects of market factors from our model. The returns of BSE 200 index and S&P 500 index (-1) were used in conditional mean equation as proxy indices to capture the market wide and worldwide factors, respectively. To examine the impact of introduction of futures trading on the volatility of underlying spot market, we incorporated a dummy variable in conditional variance equation of standard GARCH (1, 1) model. Unconditional volatility was also examined during pre-futures and post-futures sub-periods. To examine the volatility behavior during pre-futures and post-futures sub-periods, we used dates of introduction of futures as a specific cut-off date for each stock and compared the results obtained from GARCH (1, 1) model. Chow test (Chow, 1960) was used to check the stability of coefficients of regressions during pre-futures and post-futures sub-periods. The ARCH and GARCH coefficients are represented as proxies of recent and old news effects, respectively. The existence of leverage effects in the spot market volatility was examined using EGARCH (1, 1) and GJR-GARCH (1, 1) models. To evaluate forecasting ability, the most common measures of forecasting evaluation were used in this study --i.e. Root Mean Squared Error (RMSE), Mean Absolute Error (MAE), Mean Absolute Percentage Error (MAPE) and Theil Inequality Coefficient (TIC). The results of the study are summarized as below:

- Ninety nine companies out of 187 (about 53 percent) indicate positive mean returns over the whole period.
- Seventy six percent of the stocks indicate negative skewness, implying that left tail is longer and most of the distribution is at the right side. This negative skewness reveals frequent small gains and a few extreme losses.
- With respect to the kurtosis values of the stocks, all values appear to be greater than 3 which reflect that the returns have leptokurtic distribution. It means that more values are concentrated around the mean and the returns have thicker tails.
- Seventy four percent of the stock returns have decreased after the introduction of futures trading. In addition, fifty five percent of maximum and minimum range variations of stock return decreased during the post-futures sub-period.
Sixty eight percent of the stocks standard deviations have decreased during the post-futures sub-period. It implies that volatility of the stocks reduced during the post-futures sub-period in majority of the cases.

It can be seen from the results of mean equation of GARCH model that the market wide factor (i.e. BSE 200 index) explained statistically significant all the stocks of our sample. It implies that this index can be a perfect proxy of Indian market to remove the effect of miscellaneous factors from stock return series. On the other hand, the estimates of worldwide factor (i.e. lagged S&P 500 index) are statistically significant in forty five percent (i.e. 84 stocks) of symbols. However, the influence of global factor is more significant compared to the earlier studies due to recent reforms in Indian derivatives market.

The estimated coefficients of futures dummy variables are negative and significant for 110 stocks (59 percent), indicating that the volatility of spot market has reduced after the introduction of futures trading. Those stocks whose volatilities decreased after the futures introduction are mostly from financial service, energy and industrial manufacturing sectors.

On the other hand, 33 stocks (i.e. 18%) indicate positive and significant futures dummy coefficients. It implies that the volatility of spot market has increased following the launch of futures trading.

The coefficients of futures dummy variables for the remaining cases (i.e. 44 stocks) are insignificant.

The overall results show that spot market stabilized after the introduction of futures trading; however, seventy seven cases indicate destabilization and neutral effects.

The estimated coefficients of both GARCH and ARCH are significant for 164 stocks. This indicates the significant impact of news (shocks) on the spot market returns. It also shows the existence of volatility clustering.

In 134 cases (i.e. 72% of securities), GARCH coefficients are higher than ARCH values. This implies that the model responds more to the old information than the recent news.

The values of persistence level are found to be high (close to unity). However, in most cases, persistence values changed significantly after the introduction of futures.
7.1.2 Behavior of the Conditional Volatility

To analyze whether the conditional volatility of each stock behaved differently before and after the introduction of futures, we divide the entire sample into pre-futures and post-futures sub-periods and then apply simple GARCH (1, 1), EGARCH (1, 1) and GJR-GARCH (1, 1) models for each sub-period. The results obtained by these models are summarized as below:

a) The Findings of GARCH (1, 1) Model

- Ninety nine percent (i.e. 186 securities) of estimated coefficients of BSE 200 index are significant during the pre-futures sub-period. However, the sensitivity of stock market returns to domestic market slightly reduced (i.e. 184 securities) after the introduction of futures.
- The estimated coefficients of global market proxy (i.e. lagged S&P 500 index) are significant in nineteen percent of cases (i.e. 36 securities). However, the sensitivity of stock market returns to the global market proxy increased (i.e. 66 stocks) after the commencement of futures trading.
- The estimated coefficients of both ARCH and GARCH are significant at five percent level of significance in 151 securities (81 percent) and 147 securities (79 percent) during pre-futures and post-futures sub-periods, respectively.
- In 140 significant cases (67 percent), GARCH values appear to be greater than ARCH coefficients in the pre-futures sub-period. These findings imply that stocks prices are more sensitive to old news than recent shocks during pre-futures and post-futures sub-periods.
- However, the estimates of thirteen and eighteen securities over pre-futures and post-futures sub-periods, respectively, indicate that stocks prices responds more significantly to recent news (ARCH values). This implies that stock prices are higher efficient during post-futures than pre-futures sub-period.
- The estimates of GARCH (1, 1) constant term show that out of 134 significant constant terms during pre-futures and post-futures sub-periods, 74 cases indicate that constant has decreased after the introduction of futures; however, 55 securities report that constant has increased after the futures listing date.
The values of volatility persistence in 97 securities (52 percent) decreased after the introduction of futures trading. On the other hand, persistence levels of 90 securities (48 percent) are higher during post-futures sub-period than pre-futures sub-period.

The estimates of unconditional volatility indicate that unconditional volatility in 136 securities (73 percent) has reduced after the introduction of futures. However, the estimates of unconditional volatility for 51 securities (27 percent) are larger over pre-futures sub-period than post-futures.

The rates of unconditional volatility reduction range from 0.09 percent (HINDALCO INDUSTRIES) to 99.15 percent (TV18 INDIA).

Based on the results of Chow breakpoint test, there is a structural change in the volatility of Indian stock market after the introduction of futures.

b) The Results of EGARCH (1, 1) Model

The estimates of BSE 200 index in all cases (i.e. 187 securities) are statistically significant during pre-futures and post-futures sub-periods. It shows that BSE 200 index have significant forecasting power about the returns of stocks during both sub-periods.

The estimated coefficients of global market index in 57 (30 percent) and 86 securities (45 percent) are significant during pre-futures and post-futures sub-periods, respectively. Therefore, the sensitivity of stock market prices to global market has relatively increased during post-futures sub-period.

The estimated coefficients GARCH are significant at five percent level of significance in 183 securities (98 percent) and 182 (97 percent) during pre-futures and post-futures sub-periods, respectively.

The persistence levels of most of the cases (130 securities) are close to unity (say more than 0.85).

The estimated coefficients of recent time volatility spillover during post-futures sub-period are significant in 178 cases (95 percent).

The results indicate that there are significant decrease (in 99 securities) and increase (in 88 securities) in ARCH effects after the introduction of futures.

The unconditional volatility (long term volatility), measured by EGARCH constant coefficient, decreased in 86 securities (46 percent) and increased in 101 securities (54 percent) during post-futures sub-period.
The estimated leverage effect coefficients of 107 securities (57 percent) are significant during pre-futures sub-period. Out of these significant estimates, 17 stocks are negative and 90 stocks are positive. Negative and significant coefficients indicate that the volatilities of the stock prices are more sensitive to bad shocks than good ones.

The leverage effects (represented by negative significant estimates) significantly increased from 17 to 47 securities during post-futures sub-period. On the other hand, positive asymmetric coefficients ($\delta > 0$) decreased from 90 to 61 stocks after the introduction of futures.

c) The Results of GJR-GARCH (1, 1) Model

- The estimated coefficients of BSE 200 index returns show statistically significant in all securities except GVK POW & INFRA and HDFC --i.e.185 stocks (99 percent) -- during pre-futures sub-period. The sensitivity of Indian stock returns to domestic market factor remains the same after introduction of futures (184 significant cases). This implies that BSE 200 index has significant predictive ability in estimating Indian stock returns during both pre-futures and post-futures sub-periods.

- The global market returns, represented by lagged S&P 500 index, indicate significant estimates in 43 cases (22 percent) and 74 cases (40 percent) over pre-futures and post-futures sub-periods, respectively.

- The estimated coefficients of ARCH and GARCH are statistically significant at five percent level of significance in 162 stocks (87 percent) and 164 stocks (88 percent), respectively, during pre-futures sub-period.

- The levels of persistence in pre-futures sub-period are very high (more than 0.85) in majority of the cases (132 securities). This implies that the effect of previous time information is persistent over the time, meaning that today’s market has been influenced by yesterday’s news and this, in turn, will affect the returns of future periods subsequently.

- Over the pre-futures sub-period, the values of GARCH coefficients are higher than those of ARCH coefficients in most of the significant cases (139 securities). This indicates that Indian stocks’ prices are more sensitive to old information than the recent news during pre-futures sub-period.
During post-futures sub-period, ARCH and GARCH estimated coefficients are statistically significant at five percent level of significance in 150 stocks (80 percent) and 148 stocks (79 percent), respectively.

In 131 stocks of these significant estimates, GARCH values are more than ARCH values. This implies that the volatility of Indian stock market responds more effectively to old shocks than the recent information during post-futures sub-period.

The significant ARCH and GARCH coefficients decreased from 154 (pre-futures) to 137 stocks (post-futures) and the persistence levels of 117 securities (63 percent) reduced from pre-futures to post-futures sub-period.

According to GJR-GARCH (1, 1) results, it can be found that both conditional and unconditional volatility of Indian stock market have reduced after the introduction of futures.

The estimated leverage effect parameters (obtained by $\lambda$ coefficient in GJR-GARCH (1, 1) model) are significant in 102 securities (55 percent) over the pre-futures sub-period. Out of these significant cases, 41 securities (22 percent) are positive, implying that volatility of these stocks is influenced more by negative shocks than positive news.

The estimated leverage effects coefficients of 70 stocks (37 percent) are positive and significant over the post-futures sub-period. Similar to the results obtained by EGARCH (1, 1), this shows that sensitivity of the stocks prices to the negative shocks has increased after the introduction of futures trading.

### 7.1.3 Analysis of Forecasting Performance of Alternative GARCH Models

- The estimated measures of RMSE indicate that in majority of the cases (76 securities) EGARCH (1, 1) model outperforms the other two alternatives. The GARCH (1, 1) model contains the highest measures of RMSE in 59 securities (31 percent) and GJR-GARCH (1, 1) provides the poorest forecast based on this measure.
- The results of MAE measure support the use of GARCH (1, 1) model, since there are 86 cases (46 percent) with the largest MAE values in the case of this model. The EGARCH (1, 1) model provides less satisfactory forecasting performance based on MAE values. According to this measure GJR-GARCH (1, 1) provides the poorest results.
• Based on the results of MAPE measure, EGARCH (1, 1) model is the most powerful forecasting model among the other alternatives and GJR-GARCH (1, 1) model is found as the most inferior model.

• In the case of TIC measure, the lowest values are provided by EGARCH (1, 1) model (in 80 securities). It implies that EGARCH (1, 1) model provides the best forecasting performance among the others.

The stabilization results are consistent with the findings of Bandivadekar and Ghosh (2003), Srinivasan and Bhat (2008), Debasish (2009), Gupta and Singh (2009), Srinivasan et al. (2009), Singh and Kansal (2010), Gahlot et al. (2010) and Saravanan et al. (2011). On the other hand, those destabilization and neutral effect findings support the results reported by Debasish and Das (2008), Sakthivel and Kamaiah (2009) and Sehgal et al. (2012). As majority of the cases (i.e. 59% of the securities) in this study are negative and significant, it can be concluded that the Indian spot market stabilized following the introduction of futures trading. This stabilization effect may be due to the recent decade reforms and developments in Indian derivatives market. The results of unconditional volatility are consistent with the findings of investigation done by Singla (2012) in Indian NSE market. The results of structural break are similar to those obtained by Ray and Panda (2011). Overall, the findings show that stocks prices are more sensitive to old news than recent shocks during pre-futures and post-futures sub-periods. We find that the volatility of the spot is more influenced by negative news (obtained by GJR-GARCH) and positive news (obtained by EGARCH). In the end, the results of forecasting performance suggest that EGARCH model is the most powerful model in forecasting Indian stock market volatility.

7.2 Lead-lag Relationship and Volatility Spillover

We analyzed two main objectives in this section: 1) To determine the price discovery leadership role between the futures and spot prices of underlying individual stocks. 2) To measure the direction of volatility spillover between the spot and futures markets. The data used in this study consist of one minute transaction prices for 42 most liquid constituents of CNX Nifty for the period from January 01, 2013 to June 31, 2013. These stocks have been selected based on the certain criteria. To investigate the lead-lag relationship and volatility spillover between spot and futures markets, we applied VECM and bi-variate-BEKK-GARCH model, respectively. Before applying VECM model, the series have been tested whether they are
individually \( I (1) \). The long-run cointegrations between spot and futures have also been tested. To test the availability of unit root in the series, we applied Augmented Dickey Fuller test. To test cointegration relationships, we used Johansen cointegration test which includes two statistics, namely maximum eigenvalue statistic \( (\lambda_{\text{max}(r)}) \) and trace statistic \( (\lambda_{\text{trace}(r)}) \). The optimal lag selection of VECM model has been suggested by Akaike information criterion and Schwartz information criterion. Granger causality test has also been used to find the lead-lag relationship between spot and futures market. The findings and conclusions of this study are summarized as follows:

- The spot mean returns of 13 out of 42 stocks (31 percent) are positive. The stocks with the highest spot mean returns are from pharmaceuticals, IT and energy sectors.
- The results show that 55 percent of the stocks are positively skewed. It implies that right tail is longer and most of the distribution is at the left side. On the other hand, 19 spot returns (45 percent) are negatively skewed. It implies that left tail is longer and most of the distribution is at the right side.
- The kurtosis values of all the spot returns are more than 3, implying that all spot returns have leptokurtic distribution.
- 13 stocks (31 percent) show positive futures mean returns and rest cases (29 stocks) indicate negative mean returns.
- Out of 42 stock futures, 22 cases (52 percent) show positive skewness, implying that positive tail is longer and most of the distributions are at the left tail.
- All stock futures returns show the evidence of fat tails as kurtosis values are greater than 3. They are called a leptokurtic distribution as they have a more acute peak around the mean and fatter tails.
- The spot and futures price series of all symbols are found nonstationary. On the other hand, the return series show stationary for all symbols.
- Overall, the results of both trace and maximum eigenvalue statistics support the hypothesis that there is at most one cointegrating relation between spot and futures price series.
- It is evidenced that in case of 21 individual stocks, spot market depends on the lagged values of futures up to eight lags. 20 stocks show serial dependence of futures market up to eight lags. Futures returns depend on spot returns up to eight lags in 19 stocks. The
estimates of ECT for spot market are found more significantly zero than those of futures market, therefore, one can conclude that spot market is more efficient in this particular group of stocks.

- The estimates of other seven stocks, namely CIPLA, ICICIBANK, ITC, KOTAKBANK, PNB, TATAMOTORS and TATASTEEL indicate that spot prices lag futures prices up to seven minutes and futures values lag spot market up to eight minutes for all stocks of this group. The analysis of ECT estimates of these seven stocks support relative higher efficiency of spot compared to futures market.

- The estimated coefficients of seven individual stocks, namely BHARTIARTL, HDFCBANK, HINDUNILVR, IDFC, NTPC, SUNPHARMA and TATAPOWERS show that spot values lag futures values up to six minutes. The coefficient of ECT is shown positive and significant for spot market in HDFCBANK, NTPC and TATAPOWERS. However, the coefficient of ECT is reported insignificant for the remaining four spot symbols. On the other hand, the ECT estimates are negative and significant for futures market in all symbols except HINDUNILVR whose ECT coefficient is not statistically different from zero.

- The estimated coefficients of three stocks, namely DLF, GAIL and RELIANCE indicate that spot values lag futures values up to five minutes and futures values depend on the lagged spot values up to eight minutes. The serial dependence of spot is found significant up to six lags and the serial dependence of futures is significant up to eight lags. The estimated coefficients of ECT for futures indicate that futures prices are out of equilibrium and they will fall next period to adjust long-run relationship with spot prices.

- The estimates of two other stocks, AXISBANK and HCLTECH indicate that spot values lag futures values up to four minutes. On the other hand, futures values lag spot values up to eight minutes. The significant serial dependence is also found for spot and futures markets up to four and eight lags, respectively. The coefficients of ECT are insignificant for spot market, while they are negative and significant for futures market.

- The estimated coefficients of INFY indicate that spot values lag futures up to three minutes and futures values lag spot values up to eight minutes. In case of RANBAXY, spot values depend on lagged futures up to two minutes and futures values lag spot up to three minutes. The spot serial correlation is weak in both INFY and RANBAXY as
indicated by significant lagged spot up to three minutes and one minute, respectively. On the other hand, the serial dependence of futures is significant up to eight lags and three lags for INFY and RANBAXY, respectively.

- The results of Granger causality test support the bidirectional price discovery leadership role between spot and futures markets which evidenced by VECM model estimates.
- Overall results evidenced that there is a bi-directional lead-lag relationship between two markets.
- The coefficients of $\alpha_{ss}$ are statistically significant in all 21 individual indicating that past news (shocks) of spot returns statistically affects the volatility of spot returns at time $t$. There is a bi-directional shock transmission between spot and futures markets in majority of cases (19 stocks) as the pair of off-diagonal coefficients $\alpha_{sf}$ and $\alpha_{fs}$ are statistically significant. There is a bi-directional volatility linkage between spot and futures in all cases except BHEL which indicates that the volatility spillovers only from futures to spot market. However, the degree of volatility spillover from spot market to futures market is more significant than the reverse direction in most of the symbols. By comparing the estimated $b_{ss}$ and $\alpha_{ss}$, one can conclude that spot market volatility depends more on the old news (GARCH effect) than the recent news (ARCH effect). Similar analysis can be repeated for futures market of this group of stocks.

- The significant estimates of $\alpha_{ss}$ and $\alpha_{ff}$ in seven stocks, namely CIPLA, ICICIBANK, ITC, KOTAKBANK, PNB, TATAMOTORS and TATASTEEL indicate that the volatility of spot and futures markets at time $t$ are significantly influenced by past shocks of spot and futures returns, respectively. All stocks except CIPLA evidence that there is a bi-directional shock transmissions between spot and futures markets. However, the degree of shock transmission from spot to futures market is more significantly than the reverse direction. The volatility persistence estimates ($b_{sf}$ and $b_{fs}$) indicates that the volatility significantly spillovers from spot to futures or from futures to spot in all symbols. However, the degree of volatility spillover is higher from spot to futures than the reverse direction.

- The significant estimated coefficients of past shocks ($\alpha_{ss}$ and $\alpha_{ff}$) of seven individual stocks, namely BHARTIARTL, HDFCBANK, HINDUNILVR, IDFC, NTPC, SUNPHARMA and TATAPowers show that the volatility of both spot and futures
returns at time $t$ are affected by their own lagged shocks. The estimates of five out of seven stocks demonstrate that the effects of own lagged shocks are higher for spot market than futures market. The statistically significant coefficients of $\alpha_{sf}$ and $\alpha_{fs}$ suggest that past innovations in spot market have the significant effect on the volatility of futures market at time $t$ and past shocks in futures market affect the volatility of spot market at time $t$. There is a bi-directional volatility spillover between spot and futures markets. In case of the stocks like HINDUNILVR, IDFC, NTPC and TATAPOWERS, it is demonstrated that the volatility spillovers from spot to futures are stronger than the reverse.

- The results of seven stocks, namely DLF, GAIL, RELIANCE, AXISBANK, HCLTECH, INFY and RANBAXY show that ARCH effects of futures market ($\alpha_{ff}$) are larger than those of spot ($\alpha_{ss}$) in four stocks (i.e. DLF, GAIL, RELIANCE and RANBAXY). The estimated coefficients of cross-market ARCH effects ($\alpha_{sf}$ and $\alpha_{fs}$) indicate that the volatility of futures market is more influenced by past shocks of spot market than the reverse direction in all of the stocks except AXISBANK. The statistically significant estimated coefficients of $b_{sf}$ and $b_{fs}$ indicate that there is a bi-directional volatility spillover between spot and futures market as evidenced in stocks like DLF, HCLTECH, INFY, RELIANCE and RANBAXY. Out of them, some stocks (i.e. INFY, RELIANCE and RANBAXY) indicate that the volatility spillover from spot to futures is relatively higher than the opposite.

In brief, the findings of price discovery show that there is a bi-directional lead-lag relationship between futures and underlying spot market in one minute resolution. In other words, it is evidenced that no market (either spot or futures) plays a predominant role in the price discovery process. The overall results also show that there is a bi-directional volatility spillover between spot and futures markets. Therefore, it could be concluded that new information is disseminated to spot and futures market simultaneously. Besides, a long-run cointegration is found between spot and futures markets. However, one market deviates from equilibrium in the short-run; it quickly corrects the deviation in the next period. In total, the analysis of this study support the relative higher efficiency of spot compared to futures market. Therefore, the null hypothesis is accepted that there is no evidence of futures market efficiency in the price discovery process. However, the results show that futures market delays in responding to the new
information, it could be concluded that neither of the markets has a dominant leading role in the price discovery process. Theoretically speaking, our results are not in line with the arguments of Stoll and Whaley (1990) who discussed that as new information arrives spot and futures markets at the same time and futures prices are instantaneously updated to that information, the delays in the adjustment of stock index prices cause the futures prices leading the spot prices. In addition, the results of our study are not consistent with the empirical findings of Grabade and Silber (1983) and Brooks et al. (2001) who suggested that the futures price should quickly reflect all available information and the underlying stock should respond in a similar fashion but must be revalued.

The ARCH effects are present in most cases, while it is evidenced that the effects of lagged shocks on spot market are stronger than futures market. The overall results of ARCH and GARCH effects of both markets (spot and futures) indicate that the volatility of stocks is more sensitive to the old news than the recent innovation. However, there is a clear evidence of spot market inefficiency as it responds to the old news more effectively than the recent news. This contradicts the earlier analysis of this study as evidenced the higher information efficiency of spot market. However, this may be due to the nature of high frequency data. The volatility spillover is present either from spot to futures or from futures to spot. The statistically significant negative estimates of volatility spillover imply that an increase in the volatility of one market results in a decrease in the volatility of other market.

7.3 Suggestions for the Improvement of Indian Derivatives Market

The effectiveness of a futures contract in risk management process depends on the ability of the hedger to forecast the long-run dynamics, lead-lag relationships and volatility spillover between spot and futures prices. In addition, the role of futures prices in the price discovery is of significant attractiveness to the arbitrageurs, since mispricing of futures price offers a short-run risk free profit-making opportunity. The speculative activities of derivatives markets have been accused for the recent financial crisis. With the aim of improving and transparency in Indian derivatives markets, supervisory bodies and financial regulators of Indian market should take remedial actions and put more surveillance on trading issues in F&O segment. Therefore, we recommend some points in this regard as follows:
1. The speculative activities of F&O segment need to be distinguished from hedging activities.
2. To add all potential individual stocks and indices to derivatives market, the selection criteria need to be modified.
3. Timely training is suggested to enhance the skills and competency at the dealer and client levels.
4. The market lot size, margin requirements and settlement system need to be periodically realigned.
5. Due to the recent introduction of derivatives global indices in Indian market such as S&P 500, DJIA and FTSE 100, the more effective cooperation is needed among regulatory authorities of India, USA and UK to find periodic integration effects.

7.4 Conclusions
The findings of impact of futures trading on spot market show that the volatility of underlying stock market has statistically reduced after the commencement of futures trading in Indian market. Overall, the results of this study are consistent with the findings of some investigations done in Indian derivatives market (Debasish, 2009; Gupta and Singh, 2009; Singh and Kansal, 2010; Gahlot et al., 2010; and Singla, 2012). The results of GARCH family models indicate that Indian stock market is more sensitive to old news than to the recent information, which is an indication of less efficient market. However, with respect to asymmetric effects, the market appears to become more efficient as informational asymmetries relatively reduced over post-futures sub-period. The results of different GARCH models show that persistence level and unconditional volatility has decreased after the introduction of futures. The results of this study are consistent with original theories argued that the provision of information by futures markets provides efficient forecasts which facilitate stabilization in spot market prices (Turnovsky, 1979; Bray, 1981; and Turnovsky and Campbell, 1985). Therefore, it can be concluded that Indian spot market has stabilized after the introduction of futures. In addition, EGARCH model might be more useful than the other two models (simple GARCH and GJR-GARCH) when implementing risk management and optimal hedging strategies for Indian stock market returns.

The overall results show that there is a bi-directional lead-lag relationship and volatility spillover between spot and futures markets. Therefore, it could be concluded that new
information is disseminated to spot and futures market simultaneously. There is long-run cointegration between spot and futures series. One market deviates from the other market in the short-run; however, it adjusts the relation quickly. The bi-directional volatility spillovers and past shock transmissions are in support of significant integration between spot and futures in Indian market.

7.5 Suggestions for Further Research

The following areas of the study are suggested for further research:

1. To find the impact of introduction of futures on spot market volatility, we incorporated a dummy variable in GARCH model. This effect can be explored using futures trading activity (represented by trading volume and open interest) in an appropriate GARCH model.

2. The impact of derivatives (futures and options) on the underlying spot market can be investigated using expiration day’s effects of derivatives on trading volume and the volatility of spot returns.

3. It is suggested to explore the impact of derivatives trading on underlying spot market volatility during bull and bear phases of the market.

4. An investigation on the intraday lead-lag relationship between commodity futures and underlying spot market is suggested. This might provide helpful information for the investors to design an optimal hedging strategy.

5. The intraday causal relationship between Indian spot and futures market using simultaneous equation model (SEM) can be studied. This has an important implication for the portfolio managers, regulators and stakeholders.