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A study on granger causality between spot and futures prices for selected companies in India

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ABSTRACT

The main objective of the study is to examine the directional causality between spot and futures market in Indian scenario. For this purpose, the study has used pair wise Granger Causality test. The study has used daily prices series in both spot market and futures market for the 40 sample individual stocks drawn from six leading sectors namely Automobiles, Banking, Cement, Gas, Oil & Refineries, Information Technology and Pharmaceutical. The period of study is from 1st January 1997 to 31st May 2009. The study finds that with the exception of Tata Motors, all the remaining Automobile companies showed bi-directional causality between spot and futures prices. Seven (out of selected nine) Banks showed bi-directional causality between spot and futures prices. In the Gas, Oil & Refineries sector, BPCL, HPCL, IOC and Reliance Industries showed bi-directional causality between spot and futures prices. Out of the seven IT firms, four companies did not show any causality between spot and futures prices. All the six selected Pharmaceutical companies witnessed bi-directional causality between spot and futures prices.

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Introduction

The advent of stock index futures has profoundly changed the nature of trading on stock exchanges. The concern over how trading in futures contracts affects the spot market for underlying assets has been an interesting subject for investors, market makers, academicians, exchanges and regulators alike. These markets offer investors flexibility in altering the composition of their portfolios and in timing their transactions. Futures markets also provide opportunities to hedge the risks involved with holding diversified equity portfolios. As a consequence, significant portion of cash market equity transactions are tied to futures and options market activity. However, it is yet to be known if the introduction of stock index futures has served the purpose claimed by the regulators. India is almost unique in having started trading in individual stock futures in a big way with relatively higher trading volume as compared to the underlying cash market. Equity derivatives trading started on June 9, 2000 with introduction of stock index futures by Bombay Stock Exchange (BSE). National Stock Exchange (NSE) also commenced its trading on 12 June, 2000 based on S&P Nifty. Trading on NIFTY futures was introduced on the 12th of July 2000. Trading on stock futures was introduced in the NSE in the 9th November, 2001. Subsequently, other products like stock futures on individual securities, index options and options on individual securities were introduced.

Investigation of causal relationship between futures and cash prices is not a new phenomenon. At the international as well as at national level, significant efforts have been made to evaluate the price discovery efficiency of different futures markets like commodity futures, currency futures, equity futures, and others. Garbade and Sibley (1983), Protopapadakis and Stoll (1983), Fatimah (1994), Thomas and Karande (2001) and Isabel and Gilbert (2004) investigated the price discovery

efficiency of commodity futures market in different countries viz; America, United Kingdom, Malaysia, India, Mexico and others. Most of these studies found that equity and futures prices were cointegrated and the causality from the futures to cash market was significant as compared to the causality from reverse side.

In this study, a pair wise Granger Causality test was done to establish the cause and effect relationship between spot and futures market. Testing causality, in the Granger sense, involves using F-test to examine whether lagged information on a variable Y provides any statistically significant information about a variable X in the presence of lagged X. If not, then "Y does not Granger-cause X."

Pair-Wise Granger Causality Test

Granger (1988) pointed out that if a pair of time series is cointegrated, then there must be causation in at least one direction. According to the Granger Causality (Granger, 1969) approach a variable Y is caused by X, if Y can be predicted better from past values of Y and X, than from past values of Y alone. Four patterns of causality can be distinguished: a) unidirectional causality from X to Y; b) unidirectional causality from Y to X; c) feedback or bi-directional causality; and d) no causality. For a simple bivariate model, the pattern of causality can be identified by estimating regression of Y and X on all the relevant variables including the current and past values of X and Y respectively and by testing the appropriate hypothesis.

Formally a time series x_t Granger-causes another time series y_t if series y_t can be predicted with better accuracy by using past values of x_t rather than not doing so, other information being identical. In other words variable x_t fails to Granger-cause y_t if

$$\Pr(y_t + m | \Omega_t) = \Pr(y_t + m | \Psi_t)$$

Where $\Pr(y_t + m | \Omega_t)$ denotes conditional probability of y_t where Ω_t is the set of all information available at time t , and \Pr

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$(y_t + m | \Psi_t)$ denotes conditional probability of y_t , obtained by excluding all information on x_t from y_t . This set of information is depicted as Ψ_t .

The causal relations between stationary series x_t and y_t can be established based on the following equations:

$$x_t = \alpha_0 + \sum \gamma_j x_{t-j} + \sum \beta_j y_{t-j} + u_{xt}$$

$$y_t = \alpha_0 + \sum \gamma_j x_{t-j} + \sum \beta_j y_{t-j} + u_{yt}$$

where k is suitably chosen positive integer; γ_j and β_j , $j=0,1,\dots,k$ are parameters and α is constant and u_t is disturbance terms with zero means and finite variances. The null hypothesis that y_t does not Granger-cause x_t is accepted if the β_j , (with $j>0$) in equation (21) is jointly significantly different from zero using a standard joint test (like F test). Similarly x_t Granger-causes y_t if the γ_j (with $j>0$) coefficient in equation (22) are jointly different from zero.

Objectives of the Study

The main objective of the study is to examine the directional causality between spot and futures market. For this purpose, the study has used pair wise Granger Causality test.

Literature Review

The study of Kutner and Sweeney (1999) examined whether the S&P 500 index cash and futures markets were causally related in the statistical sense of Granger (1969). Intraday minute-by-minute returns were examined over the period August to December 1987. A two stage filter technique was employed to reduce the raw returns to white noise and eliminate any autocorrelation in the regression residuals. Given the nonsynchronous trading in the index and the use of intraday data, this could be a serious problem that may invalidate any statistical inferences. The findings indicated a strong causal relationship, with the futures leading the cash. Different filtering mechanisms were explored that yielded similar results.

Granger et al., (1998), Covrig and Melvin (2001) and Anderson et al., (2002) examined the price discovery efficiency of currency futures market in various developing and developed economies and they observed strong bilateral causality between spot and futures markets. Most of their studies found that futures market was efficient for underlying currencies, in the sense that it led the cash market.

Raju and Karande (2003) investigated the causality relationship between equity futures and cash market on NSE, but found mixed results regarding the causality relationship between two markets. The reason for the confusing results may be the short time period (i.e. three years) considered for the study but when the same market was examined by considering lengthy time frame (i.e. five years) by Gupta and Singh (2006), they found strong bilateral causality between cash and futures market. Thus, the review of literature provides sufficient evidences that equity futures market have been an efficient price discovery vehicle.

By using intra-day data from April to September 2004, Mukherjee and Mishra (2004) made an effort to investigate the possible lead-lag relationship, both in terms of return and volatility, among the NIFTY spot index and index futures market in India and also to explore the possible changes (if any) in such relationship around the release of different types of information. Their results suggested that though there is a strong contemporaneous and bi-directional relationship among the returns in the spot and futures market, the spot market was found to play comparatively stronger leading role in disseminating information available to the market, and therefore said to be more efficient. Apart from this, there was also interdependence

(in both direction) and therefore more or less symmetric spillovers among the stock return volatility in the spot and futures market. The results relating to the informational effect on the lead-lag relationship exhibited that though the leading role of the futures market would not strengthen even for major market-wide information releases, the role of the futures market in the matter of price discovery was found to be weaker and sometimes disappeared after the release of major firm-specific announcements.

Sah and Omkarnath (2005) examined the nature and extent of relation between NSE-50 Futures and volatility of S&P CNX Nifty. They used Granger causality test to study relationship between volatility and futures market activity. The sample data consisted of daily closing prices of S&P Nifty and turnover from June 12, 2000 through March 25, 2004 for near month and from June 12 through January 29, 2004 for middle month and far month contracts. Their empirical study suggested that futures market activity destabilized the underlying market. The direction of causation was bi-directional in case of near month; however, causality ran from Nifty Futures to volatility of S&P Nifty in case of far month contract.

Kakati and Kakati (2006) examined two issues: (1) Price dynamics between spot and futures prices for stock (i.e., whether futures market leads the spot market or vice-a-versa in price discovery) and (2) Informational content of the basis (i.e., whether or not that information revealed by the basis has a signaling role in determining the direction of change in spot and futures prices). Using S&P CNX Nifty Index Futures, CNX IT index and ten stock futures, their study found that the basis reveals the direction of changes in futures prices and also to a much lesser extent, that of cash/spot prices. They however, failed to find evidence that futures prices lead spot prices on a day-to-day basis. It appeared that the information was mostly aggregated in the spot markets and then transmitted to the futures market. Bi-directional causality with moderate feedback was noticed when longer lag periods were considered. The futures market converged much faster than the spot market does to the deviation of the equilibrium.

Praveen and Sudhakar(2006) studied the price discovery mechanism in India's rapidly growing commodity futures market. Granger Causality Test was used for the study that focuses on the Indian stock and commodity market. A comparison was drawn for price discovery between the grown stock market and the growing commodity market. Their study highlighted as to how the futures market influenced the spot market and facilitates better price discovery in the spot market. The spot and/or futures market dominated the price discovery, but it appeared that a better price discovery occurred when there was a mature futures market for the commodity.

Overall, the above studies show that the effect of futures trading on the volatility of spot markets varies depending on time period, model specification, and/or country examined. Considering the short history of futures and options trading and the presence of several market frictions and restrictions that might have hindered the efficient operation of Indian securities markets, a study of the effect of futures trading on spot market volatility is highly required for the Indian stock markets.

Data and Sources

The study has used daily prices series in both spot market and futures market for the 40 sample individual stocks drawn from six leading sectors namely, Automobiles, Banking, Cement, Gas, Oil & Refineries, Information Technology and

Pharmaceutical. The results of the 40 selected companies are presented in the section Analysis and Findings.

In terms of market capitalization, the leading stocks under each of the six selected sectors were shortlisted. On the basis of complete data availability of spot prices during the study period and a minimum 24 months of continuous daily futures data, we finalized the selected 40 companies. The spot prices and the one-month futures prices of the selected stocks are taken for the study. The futures time series analyzed here uses data on the near month contract as they are most heavily traded. The study used data on daily opening, low, high and closing prices of the selected indices and individual stocks traded in the spot market. The futures data include the near-month prices of daily opening, low, high and closing.

The study was entirely based on time series data from secondary sources and collected from official website of National Stock Exchange (www.nse-india.com). The period of study is from 1st January 1997 to 31st May 2009.

Research Methodology

Methodology directs the researcher to conduct the research in a systematic manner and deals with sampling plan and various tools to carry out the analysis on the data collected. In the first place, the daily returns based on spot and futures prices were computed. The price series consisted of open price, low, high, and closing prices for both spot and futures market. The returns for the futures contract and the spot index are defined as $R_{Ft} = \{\ln(F_t / F_{t-1})\}$ and $R_{St} = \{\ln(S_t / S_{t-1})\}$, respectively where F_t and S_t are the futures prices and spot prices on day t , respectively.

Since our objective is to detect causal relationship between spot price and futures prices series, pair-wise Granger Causality Tests have been applied. Testing causality, in the Granger sense, involves using F-tests to test whether lagged information on a variable Y (futures prices) provides any statistically significant information about a variable X (spot prices) in the presence of lagged X . If not, then "Y does not Granger-cause X." The study tests the directional causality between spot and futures prices using Pairwise Granger Causality.

In Granger Causality analysis, we test two sets of null hypotheses namely,

- i) Futures price does not Granger Cause Spot price
- ii) Spot price does not Granger Cause Future price

Both these null hypotheses are tested using F-test for statistical significance at 1% or 5% level.

If only the first hypothesis is rejected, we conclude that futures price 'Granger cause' spot price, whereas rejection of only second hypothesis implies that spot price 'Granger cause' futures price. In both these cases, we evidence unidirectional causality between spot prices and futures prices. But on the other hand, if both the above hypothesis is rejected simultaneously, we conclude bi-directional causality. This implies that there exists a two-way feedback relationship between spot and futures market. The study employed Granger Causality test as provided in the econometric software package Eviews version 3.0.

Analysis and Findings

Granger Causality Analysis between Spot and Futures Market for companies in Automobile sector

The results of the Granger causality study for the six selected Automobile companies are presented in table-1. It is observed that the first hypothesis namely, 'Futures price does not Granger Cause Spot price' is rejected for all these companies with statistical significance. This implies that futures prices

'granger causes' the spot prices. Further, it can be seen that for first null hypothesis highest value of F-test is witnessed for Hero Honda (35.46) followed by Maruti Udyog (31.69) and Bajaj Auto (29.49), each of them found to be significant at 1% level. With respect to the first hypothesis lowest value of F-test is seen for TVS Motors (28.63).

Further, the second hypothesis namely 'Spot price does not Granger Cause Futures price' is rejected for the selected Automobile companies (except Tata Motors) with statistical significance. It can be seen that for second hypothesis highest value of F-test is observed for M & M (21.39) followed by Maruti Udyog (18.85) and TVS Motors (18.12), all being significant at 5% level. Least value of F-test for second hypothesis is seen for Bajaj Auto (15.59).

Thus, with the exception of Tata Motors all the remaining Automobile companies showed bi-directional causality between spot and futures prices. Tata Motors is observed to have unidirectional causality from futures to spot i.e., futures prices 'granger causes' spot prices.

Granger Causality Analysis between Spot and Futures Market for companies in Banking sector

Table 2 provides the results of the Granger causality study for the nine selected banks. It is observed that the first hypothesis namely, 'Futures price does not Granger Cause Spot price' is rejected for eight banks (except Canara Bank) with statistical significance. This implies that Futures prices does causes the spot prices. Further, it can be seen that for first hypothesis highest value of F-test is witnessed for Oriental Bank (65.85) followed by Union Bank of India (56.94) and ICICI Bank (43.68), all being significant at 1% level. Least value of F-test for first hypothesis is seen for IDBI (23.56) followed by Bank of Baroda (31.52) and PNB (32.61), all being significant at 1% or 5% level.

Further, the second hypothesis namely 'Spot price does not Granger Cause Futures price' is rejected for seven banks (except Canara Bank and PNB) with statistical significance. It can be seen that for second hypothesis highest value of F-test is observed for Oriental Bank (38.69) followed by ICICI Bank (26.39) and SBI (25.63), all being significant at 1% or 5% level. Least value of F-test for second hypothesis is seen for Bank of Baroda (17.65) followed by IDBI (20.68) and HDFC Bank (21.89). s. PNB is observed to have unidirectional causality from futures to spot i.e., futures prices 'granger causes' spot prices with F-value of 32.61 significant at 1% level. In case of Canara Bank, both the null hypothesis could not be rejected implying that neither futures prices 'Granger causes' spot prices nor the vice-versa.

Thus, with the exception of Canara Bank and PNB all the remaining banks showed bi-directional causality between spot and futures price.

Granger Causality Analysis between Spot and Futures Market for companies in Cement sector

Table 3 provides the results of the Granger causality study for the selected four Cement companies. It is observed that the first hypothesis namely, 'Futures price does not Granger Cause Spot price' is rejected for the selected Cement companies (except ACC) with statistical significance. This implies that futures prices does cause the spot prices. Further, it can be seen that for first hypothesis highest value of F-test is witnessed for Gujrat Ambuja Cements (56.42) and lowest value of F-test is seen for India Cements (25.69), being found significant at 1% and 5% level, respectively.

For ACC, the first hypothesis could not be rejected with significant thereby implying that futures prices do not 'Granger Cause' spot prices. Further, the second hypothesis namely 'Spot price does not Granger Cause Futures price' is rejected for all the selected Cement companies with statistical significance. It can be seen that for the second hypothesis the highest value of F-test is observed for Grasim Cements (38.69) and the lowest value of F-test for India Cements (17.65), being found significant at 1% and 5% level, respectively.

Thus, bi-directional causality between spot and futures prices is observed for three Cement companies namely, Grasim Cements, Gujrat Ambuja Cements and India Cements. But for ACC, only unidirectional causality from spot prices to futures prices is observed since only the second hypothesis (i.e., 'Spot price does not Granger Cause Futures price') is rejected at 5% level with F-value of 21.59.

Granger Causality Analysis between Spot and Futures Market for companies in Gas, Oil & Refineries sector

Table 4 provides the results of the Granger causality study for the selected eight companies in the Gas, Oil & Refineries sector. It is observed that the first hypothesis namely, 'Futures price does not Granger Cause Spot price' is rejected (with statistical significance) for only five companies, namely BPCL, Bongaigaon Refineries, HPCL, IOC and Reliance Industries. This implies that futures prices does 'granger cause' the spot prices for these five companies. For the remaining three Companies namely, Bongaigaon Refineries, GAIL and ONGC the first hypothesis could not be rejected indicating that futures prices do not cause the spot prices. Further, it can be seen that for first hypothesis highest value of F-test is witnessed for Reliance Industries (65.85) and lowest F-value for HPCL (21.36), being significant at 1% and 5% level respectively.

Further, the second hypothesis namely 'Spot price does not Granger Cause Futures price' is rejected for five of the selected companies (except Bongaigaon Refineries, GAIL and IPCL) with statistical significance either at 1% or 5% level. It can be observed that for second hypothesis highest value of F-test is witnessed for IOC (38.69) and least F-test value for first hypothesis is seen for BPCL (16.89), both found to be significant at 5% level. Thus, only four of the selected companies showed bi-directional causality between spot and futures prices. These are BPCL, HPCL, IOC and Reliance Industries, in which cases both the null hypothesis were rejected with statistical significance. For GAIL and IPCL, none of the hypothesis could be rejected thus implying no causality between spot and futures prices. For Bongaigaon Refineries, only the first hypothesis could be rejected (and not the second hypothesis), indicating unidirectional causality from futures to spot (i.e., futures prices 'granger causes' spot prices). On the other hand, for ONGC a unidirectional causality from spot to futures is witnessed as evidenced from the rejection of second hypothesis of 'Spot price does not Granger Cause Future price' (and not the first hypothesis).

Granger Causality Analysis between Spot and Futures Market for companies in Information Technology (IT) sector

Table 5 presents the values of the F-test associated with of the Granger causality study for the selected seven IT companies. Unlike other sectors, it is witnessed that more number of selected IT companies does not show any causality between spot and futures prices. These are I-Flex, Infosys Tech, Patni Computers and Satyam Computers. In all these four IT companies, both the null hypothesis could not be rejected with

statistical significance as seen from the probability values (attached with F-test) which are observed to be higher than 0.05 (5% level of significance). In case of WIPRO, there was bi-directional causality between spot and futures prices series, since both the hypothesis could be rejected with significance.

The first hypothesis 'Futures price does not Granger Cause Spot price' is rejected (at 5% level) for WIPRO with F-value of 22.53, and the second hypothesis 'Spot price does not Granger Cause Future price' was also found to be rejected with F-value of 18.65, significant at 5% level. On the other hand, unidirectional causality was seen for two IT companies namely, Polaris and TCS. For both these companies, the first hypothesis (i.e., 'Futures price does not Granger Cause Spot price') could be rejected with F-value of 23.52 (for Polaris at 5% level of significance) and 21.36 (for TCS at 5% level of significance). This implies that for Polaris and TCS, futures 'Granger causes' spot prices, but the reverse is not found to be true.

Granger Causality Analysis between Spot and Futures Market for companies in Pharmaceutical sector

The results of the Granger causality study for the six selected Pharmaceutical companies are presented in table 6. This is the only sector in which all the selected companies witnessed bi-directional causality, implied by the combined rejection of both the null hypothesis, with statistical significance. This implies that futures prices do 'Granger cause' the spot prices, and spot prices also do 'Granger cause' futures prices. Further, it can be seen that for the first hypothesis highest value of F-test is witnessed for Wockhardt (74.39) followed by Dr. Reddy's (46.85) and CIPLA (38.69), all being significant at 1% level. Lowest value of F-test for first hypothesis is seen for DABUR (24.85), followed by GLAXO Pharma (31.28) and Ranbaxy (35.68), all being significant at 1% level.

Moreover, the second hypothesis namely 'Spot price does not Granger Cause Futures price' is rejected for all the Pharmaceutical companies, with statistical significance. It can be seen that for second hypothesis highest value of F-test is observed for Ranbaxy (25.18) followed by DABUR (22.97) and CIPLA (21.38) each being found to be significant at 5% level. Lowest value of F-test for first hypothesis is seen for Dr. Reddy's (16.67), followed by GLAXO Pharma (18.69) and Wockhardt (19.19), all being significant at 5% level.

Conclusion

The pair-wise Granger Causality test was undertaken to establish the cause and effect relationship between spot and futures market. With the exception of Tata Motors, all the remaining Automobile companies showed bi-directional causality between spot and futures prices. Seven (out of selected nine) Banks showed bi-directional causality between spot and futures prices. In case of PNB, futures prices 'granger causes' spot while futures 'granger causes' spot prices for Canara Bank. In the cement sector, unidirectional causality is observed from spot prices to futures prices, with the exception of ACC for which futures prices do not 'Granger cause' spot prices. In the Gas, Oil & Refineries sector, BPCL, HPCL, IOC and Reliance Industries showed bi-directional causality between spot and futures prices. Out of the seven IT firms, four companies did not show any causality between spot and futures prices. These are I-Flex, Infosys Tech, Patni Computers and Satyam Computers. All the six selected Pharmaceutical companies witnessed bi-directional causality between spot and futures prices. The results of this study are especially important to stock exchange officials and regulators in designing trading mechanisms and contract

specifications for derivative contracts, thereby enhancing their value as risk management tools.

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Table-1 : Pairwise Granger Causality Results for the selected companies in Automobile sector

Sl.No.	Companies	Null Hypothesis	F-statistic	Result
1	Bajaj Auto	Futures price does not Granger Cause Spot price	29.49* (0.0031)	Rejected
		Spot price does not Granger Cause Future price	15.59** (0.0455)	Rejected
2	Hero Honda	Futures price does not Granger Cause Spot price	35.46* (0.0012)	Rejected
		Spot price does not Granger Cause Future price	15.85** (0.0489)	Rejected
3	Maruti Udyog	Futures price does not Granger Cause Spot price	31.69* (0.0049)	Rejected
		Spot price does not Granger Cause Future price	18.85** (0.0362)	Rejected
4	M & M	Futures price does not Granger Cause Spot price	28.11* (0.0000)	Rejected
		Spot price does not Granger Cause Future price	21.39** (0.0135)	Rejected
5	Tata Motors	Futures price does not Granger Cause Spot price	23.19* (0.0036)	Rejected
		Spot price does not Granger Cause Future price	12.36 (0.0761)	Accepted
6	TVS Motors	Futures price does not Granger Cause Spot price	28.63** (0.0213)	Rejected
		Spot price does not Granger Cause Future price	18.12** (0.0433)	Rejected

Note: Value in parenthesis indicates the probability values of accepting the null hypothesis; * denote significance at 1% level; ** denote significance at 5% level.

Table-2 : Pairwise Granger Causality Results for the selected companies in Banking sector

Sl.No.	Companies	Null Hypothesis	F-statistic	Result
1	Bank of Baroda	Futures price does not Granger Cause Spot price	31.52** (0.0126)	Rejected
		Spot price does not Granger Cause Future price	17.65** (0.0355)	Rejected
2	Canara Bank	Futures price does not Granger Cause Spot price	20.51 (0.0625)	Accepted
		Spot price does not Granger Cause Future price	11.36 (0.1125)	Accepted
3	HDFC Bank	Futures price does not Granger Cause Spot price	36.54 * (0.0016)	Rejected
		Spot price does not Granger Cause Future price	21.89** (0.0269)	Rejected
4	ICICI Bank	Futures price does not Granger Cause Spot price	43.68* (0.0001)	Rejected
		Spot price does not Granger Cause Future price	26.39* (0.0036)	Rejected
5	IDBI	Futures price does not Granger Cause Spot price	23.56** (0.0359)	Rejected
		Spot price does not Granger Cause Future price	20.68** (0.0463)	Rejected
6	Oriental Bank	Futures price does not Granger Cause Spot price	65.85* (0.0000)	Rejected
		Spot price does not Granger Cause Future price	38.69* (0.0000)	Rejected
7	PNB	Futures price does not Granger Cause Spot price	32.61* (0.0046)	Rejected
		Spot price does not Granger Cause Future price	16.58 (0.0839)	Accepted
8	SBI	Futures price does not Granger Cause Spot price	42.61 (0.0052)	Rejected
		Spot price does not Granger Cause Future price	25.63 (0.0059)	Rejected
9	Union Bank of India	Futures price does not Granger Cause Spot price	56.94* (0.0000)	Rejected
		Spot price does not Granger Cause Future price	23.48* (0.0048)	Rejected

Note: Value in parenthesis indicates the probability values of accepting the null hypothesis;* denote significance at 1% level; ** denote significance at 5% level.

Table-3 : Pairwise Granger Causality Results for the selected stocks in Cement sector

Sl.No.	Companies	Null Hypothesis	F-statistic	Result
1	ACC	Futures price does not Granger Cause Spot price	13.65 (0.0844)	Accepted
		Spot price does not Granger Cause Future price	21.59** (0.0128)	Rejected
2	Grasim Cements	Futures price does not Granger Cause Spot price	45.69* (0.0006)	Rejected
		Spot price does not Granger Cause Future price	32.38* (0.0159)	Rejected
3	Gujrat Ambuja Cements	Futures price does not Granger Cause Spot price	56.42* (0.0000)	Rejected
		Spot price does not Granger Cause Future price	28.69* (0.0003)	Rejected
4	India Cements	Futures price does not Granger Cause Spot price	25.69** (0.0363)	Rejected
		Spot price does not Granger Cause Future price	17.83** (0.0469)	Rejected

Note: Value in parenthesis indicates the probability values of accepting the null hypothesis;* denote significance at 1% level; ** denote significance at 5% level.

Table-4 : Pairwise Granger Causality Results for the selected companies in Gas, Oil & Refineries sector

Sl.No.	Companies	Null Hypothesis	F-statistic	Result
1	BPCL	Futures price does not Granger Cause Spot price	23.69** (0.0239)	Rejected
		Spot price does not Granger Cause Future price	16.89** (0.0359)	Rejected
2	Bongaigaon Refineries	Futures price does not Granger Cause Spot price	42.39* (0.0003)	Rejected
		Spot price does not Granger Cause Future price	16.97 (0.0539)	Accepted
3	GAIL	Futures price does not Granger Cause Spot price	18.46 (0.0645)	Accepted
		Spot price does not Granger Cause Future price	11.39 (0.1326)	Accepted
4	HPCL	Futures price does not Granger Cause Spot price	21.36** (0.0452)	Rejected
		Spot price does not Granger Cause Future price	18.26** (0.0338)	Rejected
5	IOC	Futures price does not Granger Cause Spot price	42.39** (0.0025)	Rejected
		Spot price does not Granger Cause Future price	38.69** (0.0189)	Rejected
6	IPCL	Futures price does not Granger Cause Spot price	17.86 (0.0865)	Accepted
		Spot price does not Granger Cause Future price	11.39 (0.1152)	Accepted
7	ONGC	Futures price does not Granger Cause Spot price	20.52 (0.0563)	Accepted
		Spot price does not Granger Cause Future price	19.56** (0.0368)	Rejected
8	Reliance Industries	Futures price does not Granger Cause Spot price	77.58* (0.0000)	Rejected
		Spot price does not Granger Cause Future price	33.56* (0.0000)	Rejected

Table-5: Pairwise Granger Causality Results for the selected companies in Information Technology (IT) sector

Sl.No.	Companies	Null Hypothesis	F-statistic	Result
1	I-Flex	Futures price does not Granger Cause Spot price	12.36 (0.0965)	Accepted
		Spot price does not Granger Cause Future price	9.45 (0.1568)	Accepted
2	Infosys Tech	Futures price does not Granger Cause Spot price	13.65 (0.0784)	Accepted
		Spot price does not Granger Cause Future price	10.86 (0.1148)	Accepted
3	Patni Computers	Futures price does not Granger Cause Spot price	14.69 (0.0684)	Accepted
		Spot price does not Granger Cause Future price	13.52 (0.0568)	Accepted
4	Polaris	Futures price does not Granger Cause Spot price	23.52** (0.0346)	Rejected
		Spot price does not Granger Cause Future price	11.38 (0.1781)	Accepted
5	Satyam Computers	Futures price does not Granger Cause Spot price	13.59 (0.0711)	Accepted
		Spot price does not Granger Cause Future price	7.56 (0.1863)	Accepted
6	TCS	Futures price does not Granger Cause Spot price	21.36** (0.0452)	Rejected
		Spot price does not Granger Cause Future price	14.25 (0.0856)	Accepted
7	WIPRO	Futures price does not Granger Cause Spot price	22.53** (0.0412)	Rejected
		Spot price does not Granger Cause Future price	18.65** (0.0397)	Rejected

Note: Value in parenthesis indicates the probability values of accepting the null hypothesis; * denote significance at 1% level; ** denote significance at 5% level.

Table-6 : Pairwise Granger Causality Results for the selected companies in Pharmaceutical sector

Sl.No.	Companies	Null Hypothesis	F-statistic	Result
1	CIPLA	Futures price does not Granger Cause Spot price	38.69* (0.0086)	Rejected
		Spot price does not Granger Cause Future price	21.38** (0.0125)	Rejected
2	Dr. Reddy's	Futures price does not Granger Cause Spot price	46.85 (0.0000)	Rejected
		Spot price does not Granger Cause Future price	16.67** (0.0183)	Rejected
3	DABUR	Futures price does not Granger Cause Spot price	24.85* (0.0000)	Rejected
		Spot price does not Granger Cause Future price	22.97** (0.0076)	Rejected
4	GLAXO Pharma	Futures price does not Granger Cause Spot price	31.28** (0.0156)	Rejected
		Spot price does not Granger Cause Future price	18.69** (0.0359)	Rejected
5	Ranbaxy	Futures price does not Granger Cause Spot price	35.68* (0.0054)	Rejected
		Spot price does not Granger Cause Future price	25.18** (0.0236)	Rejected
6	Wockhardt	Futures price does not Granger Cause Spot price	74.39* (0.0000)	Rejected
		Spot price does not Granger Cause Future price	19.19* (0.0000)	Rejected

Note: Value in parenthesis indicates the probability values of accepting the null hypothesis; * denote significance at 1% level; ** denote significance at 5% level.