Price Discovery in Spot and Futures Market: Evidence from Selected Sensex Companies

Dr. Karamjeet Kaur,
Assistant Professor,
Department of Commerce & Business Management,
ASSM College, Mukandpur, India.
College of GNDU, Amritsar, SBS Nagar, India.

ABSTRACT

Present study is conducted on selected 10 sensex companies and BSE-Sensex by taking daily spot and futures price data from Jan 1, 2011 to Dec 31, 2015. The aim of the study is to find out lead-lag relationship between spot and futures market and price discovery role of these markets in India. Econometric techniques like Unit root test, Johansen Co-integration test, VECM and Granger Causality test have been used for this study. The study found that there is an existence of co-integration between spot and futures market suggesting the presence of long run equilibrium between the two markets. The results show that spot market is playing the price discovery role because causality runs from spot to futures in case of all securities except one. Also, spot market is leading the futures market in India implying that it may contain useful information for the investor.

Keywords: Causality, Co-integration, Lead-lag, Price Discovery.

INTRODUCTION:

Introduction of futures has offered much flexibility to the investors to construct their portfolios. Futures as derivatives have contributed in economic functions such as price discovery, liquidity, portfolio diversification, speculation and hedging against the risk of adverse price movements. Price movements in cash markets are greatly affected by speculation, hedging and arbitraging activities in futures market. So it becomes important to understand the influence of one market over the other and their reaction to flow of new information. The market which reacts quickly to the new information is said to lead the other market. Price discovery is the process wherein new information is incorporated to the equilibrium prices of assets traded and new equilibrium price is determined (Pathak et al., 2014). According to efficient market hypothesis it is not possible to earn abnormal profits because new information is quickly absorbed in prices. So, the prices of securities in spot and futures market should move simultaneously without any delay and hence will not provide any arbitrage opportunities. However, due to market imperfections such as transaction costs, diverse capital markets microstructure, significant lead-lag relationship between the markets has been observed. Trading incentives like reduced capital requirement, lesser transaction cost, absence of short selling restrictions and limited downside risk, make derivatives market a preferred place to trade for informed traders (Black, 1975). Though diverse theoretical arguments are given regarding the role of both markets in price discovery, it is still a major question that which market reacts (leads) first and has the role in price discovery.

Most of the studies on the relationship between spot and futures prices have been carried out in the developed market and only few have focused on the emerging markets. Because of difference in the level of economic as well as the stock market developments, findings from the developed markets cannot be generalized for the emerging markets. Therefore, this paper investigates empirically the dynamics of interdependence relationship between spot market and futures market in case of India. Present study is conducted on selected 10 Sensex companies and BSE-Sensex by taking daily spot and futures price data from Jan 1, 2011 to Dec 31, 2015. There
are two main objectives of this paper. The first objective is to examine the existence of long run, steady-state equilibrium between spot and futures prices index using co-integration analysis. It enables us to distinguish between short-run deviations from equilibrium indicative of price discovery and long-run deviations that account for efficiency and stability. The second objective is to test the causality relationship between spot prices and futures prices by using Granger causality test. The causality analysis enables us to understand the interdependence relationship between these two markets especially their lead-lag relationships. The rest of the paper is organised as follows: Section II reviews the relevant literature, Section III explains the data and methodology, Section IV includes the analysis and Section V concludes.

**REVIEW OF LITERATURE:**

The role of futures markets as a main source of market information is usually explained by the existence of market frictions such as transaction costs, leverage effect of margin trading, short-sale restrictions, liquidity differences etc. which may induce lead-lag relationship between the futures contract and its underlying spot market. Black (1975) was the first to suggest that the higher leverage benefits available in the futures market might induce informed traders to transact in futures rather than in stocks in spot market. A number of studies have been conducted in various markets to examine the price discovery role of futures and spot markets.

Chan (1992) studied the intraday lead lag relation using returns of Major Market Index (MMI), MMI futures and S&P 500 futures index. Multiple regression frameworks were used where lead and lag terms of future index returns were explanatory variables and return on the index was endogenous. Moreover, the study also explored if the relationship for the individual constituent stocks differs from that of the index. Strong evidences of futures market leading or impounding the information first were reported, but the lead pattern was found changing with change in conditions.

Jong and Donders (1998) studied the lead lag relationship between Amsterdam Exchange (AEX) cash index, index futures and index options market over the period July 1992 to June 1993. They reported a prominent leading of futures market compared to cash and options market. However, they also found evidences of strong contemporaneous relationship. The lead of options over cash market was found to be symmetric meaning neither of the markets leads systematically. They attributed the results to the trading benefits associated with derivatives and argued that reason of futures leading both cash and options could simply be the leverage. They argued that the leverage of futures is almost twice as large as that of a short maturity at-the-money call options.

Gwyylim and Buckle (2001) studied the lead lag relationship between FTSE 100 stock index, its futures and options using hourly return. They reported both the futures and options market leading spot market but call market being the most prominent among all three. Gardbade and Silber (1983) also suggested that futures markets lead the spot market. Thenmozhi (2002) found that futures market leads the cash market while studying Nifty futures and Nifty index in Indian markets. Hsieh et al. (2008) studied the relationship in Taiwan market between spot, futures and options implied price of index and reported that the derivatives market was informationally non trivial.

On the other hand, Gupta and Singh (2006) found no lead lag relationship in a study on Nifty futures and Nifty cash during the period June 2000 to Jan, 2005. Mukherjee and Mishra (2006), Sah and Kumar (2006) and Thomas (2006) found that cash market leads the futures market in Indian context. Bhattacharaya (1987), Stephen and Whaley (1990), Chan, Chung and Johnson (1993), Holowczak, Simman and Wu (2007) also reported conflicting views about information content of derivatives prices.

From the above survey of literature, it is observed that there is no consensus among researchers about the direction and speed of information flow between the spot market and the futures market. Also, majority of the studies have adopted index futures for the purpose of analysing the price discovery process between the spot and futures price. Therefore, there exists a scope for further analysis of employing the stock futures on individual securities. This can give the detail analysis of price discovery between the spot and futures on each individual security. Hence the present study is undertaken.

**DATA AND METHODOLOGY:**

In this paper, the relationship between spot price and future prices will be examined by using Johansen’s Co-integration test, VECM and Granger causality test. These tests require that the variables used in a given model should be stationary. Thus, the time series analysis that is appropriate for this study includes unit root tests to test the stationary properties of the series, co-integration test and causality tests. This section gives a brief explanation of these tests and their appropriateness for this study. The data used for this study is daily values of 10 selected Sensex companies and BSE Sensex representing the spot market and near month futures of these...
companies as well as of Sensex representing futures market from Jan1, 2011 to Dec 31, 2015. For estimation, all price series are transformed to logarithm.

**Unit Root Test:**
The unit root tests are used to establish the stationarity properties of the time series. Existence of unit roots in a variable denotes that a series is not stationary. In this paper, the unit root tests will be performed using the Augmented Dickey-Fuller (ADF) tests. The ADF test for unit roots indicates whether an individual series is stationary by running an OLS regression or not. In the ADF tests, the null hypothesis is to test that the series contains a unit root and is therefore non-stationary. If the t-statistic associated with the estimated coefficient is greater than the critical values, the null hypothesis of presence of a unit root is rejected in favour of stationarity.

**Co-integration Tests:**
A co-integration test is applied to determine the existence of a long-run relationship between series of economic variables. Presence of long-term relationship means that the variables move together over time so that short-term relationship disturbances from the long-term trend will be corrected. The basic idea behind co-integration is that, if in the long run two or more series move closely together, even though the series themselves are trended, the difference between them is constant. It is possible to regard these series as a long-run equilibrium relationship, as the difference between them is stationary. Absence of co-integration implies that such variables have no long-run relationship and hence, they can wander arbitrarily far away from each other (Dickey et al. 1991).

**Vector Error Correction Model (VECM):**
In the event of presence of cointegration between the time series, there exists a long-term equilibrium relationship between them. In that case, VECM is applied in order to evaluate the short run properties of the cointegrated series. In case of absence of cointegration VECM is not required and we directly proceed to Granger causality tests to establish causal links between variables. The error correction coefficient is very important in the error correction estimation as greater the co-efficient indicates higher speed of adjustment of the model from the short-run to the long-run. On the other hand, the lagged terms as explanatory variables, indicate short-run cause and effect relationship between the two variables. A negative and significant coefficient of the ECM indicates that any short-term fluctuations between the independent variables and the dependant variable will give rise to a stable long run relationship between the variables.

**Granger Causality:**
If Spot and Futures prices are cointegrated, then causality must exist in at least one direction (Granger, 1988). Granger causality can identify whether two variables move one after the other or contemporaneously. When they move contemporaneously, one provides no information for characterising the other. If “X causes Y”, then changes in X should precede changes in Y. In a bi-variate framework, the variable X is said to cause the variable Y in the Granger sense if the forecast for Y improves when lagged variables X are taken into account in the equation. Four findings are possible in a Granger causality test. First, neither variable Granger causes the other. In other words, independence is suggested when the set of X and Y coefficients are not statistically significant in both regressions. Second, unidirectional causality from Y to X, which means Y causes X but not vice versa. Third, unidirectional causality from X to Y that means X causes Y but not vice versa. Fourth, bilateral causality between two variables, which means X and Y Granger cause each other (feedback effect). Usually, the standard F-test is used to determine the joint significance and hence the causal relationship between variables. The null hypothesis that Y does not Granger cause X or vice-versa is rejected if the value of F statistic is significant.

**RESULTS AND DISCUSSION:**

**Unit Root Tests:**
Results from the unit root tests are presented in Table 1. We found that all computed values of ADF statistics for all series at level are not significant at 1%. Therefore, the test fails to reject the null hypothesis of unit root of the series at level, which indicates that all series being studied are not I (0). Subsequently, the unit root test has been carried out at first difference of the series. From Table 2 we find that all ADF statistics for first difference series i.e Spot Return and Futures Return are significant at 1%. The results from unit root tests indicate that the series are stationary at first difference or I (1).
Table 1: Unit Root Test (at level)

| Company       | LSPOT  | Probability | LFuture | Probability |
|---------------|--------|-------------|---------|-------------|
| SBI           | -1.008031 | 0.2818      | -0.993565 | 0.2875      |
| Reliance      | -0.130630 | 0.6385      | -0.126861 | 0.6399      |
| Coal India    | -0.129001 | 0.6387      | -0.127016 | 0.6394      |
| Hero Motors   | 0.203039  | 0.7450      | 0.207023  | 0.7461      |
| ICICI         | -0.775695 | 0.3801      | -0.771402 | 0.3820      |
| ITC           | 0.896723  | 0.9012      | 0.980541  | 0.9139      |
| LT            | -2.868253 | 0.0495      | -0.155073 | 0.6300      |
| Tata Motors   | 1.156617  | 0.9250      | 1.032192  | 0.9211      |
| Tata Steels   | -0.489625 | 0.5039      | -0.771292 | 0.3820      |
| Wipro         | 1.061696  | 0.9250      | 1.032192  | 0.9211      |
| Sensex        | 0.585117  | 0.8426      | 0.613662  | 0.8488      |

*denotes significant at 1%

Table 2: Unit Root Tests (at first difference)

| Company       | Spot Return | Probability | Futures Return | Probability |
|---------------|-------------|-------------|---------------|-------------|
| SBI           | -28.82375   | 0.0000*     | -28.78204     | 0.0000*     |
| Reliance      | -27.73967   | 0.0000*     | -28.12537     | 0.0000*     |
| Coal          | -19.98120   | 0.0000*     | -19.90126     | 0.0000*     |
| Hero Motors   | -25.74856   | 0.0000*     | -26.13228     | 0.0000*     |
| ICICI         | -28.09556   | 0.0000*     | -28.01727     | 0.0000*     |
| ITC           | -25.41607   | 0.0000*     | -26.94723     | 0.0000*     |
| LT            | -30.05886   | 0.0000*     | -31.07777     | 0.0000*     |
| Tata Motors   | -27.89623   | 0.0000*     | -28.39165     | 0.0000*     |
| Tata Steels   | -19.19595   | 0.0000*     | -28.28769     | 0.0000*     |
| Wipro         | -26.04973   | 0.0000*     | -27.16698     | 0.0000*     |
| Sensex        | -31.93037   | 0.0000*     | -32.95036     | 0.0000*     |

*denotes significant at 1%

Co-integration Tests:
The co-integration tests in this study have been carried out for Spot Price Series and Futures Price Series of Sensex and related companies. The co-integration between non-stationary variables has been tested by the Johansen's trace statistics and maximum Eigen value tests. The results from the tests are presented in Table 4. Statistics in Table 4 for the co-integration rank tests (Trace) and Eigen value tests indicate that at least there is one co-integration equation between the two variables at 1% level.

Table 3: Co-integration Test

| Series           | Hypothesized No. of CE(s) | Max Eigen Value | Probability | Trace | Probability | Conclusion               |
|------------------|---------------------------|-----------------|-------------|-------|-------------|-------------------------|
| SBI Spot and Future | None*                     | 64.70595        | 0.0000      | 65.72012 | 0.0000      | 1 Cointegration equation |
|                  | At most 1                 | 1.014170        | 0.3644      | 1.014170 | 0.3644      |                         |
| Reliance Spot and Future | None*                 | 118.4492        | 0.0001      | 118.4994 | 0.0001      | 1 Cointegration equation |
|                  | At most 1                 | 0.050179        | 0.8544      | 0.050179 | 0.8544      |                         |
| Coal India Spot and Future | None*               | 58.94102        | 0.0000      | 58.94864 | 0.0000      | 1 Cointegration equation |
|                  | At most 1                 | 0.007616        | 0.9433      | 0.007616 | 0.9433      |                         |
| Hero Motors Spot and Future | None*              | 56.16091        | 0.0000      | 56.24448 | 0.0000      | 1 Cointegration equation |
|                  | At most 1                 | 0.083574        | 0.8123      | 0.083574 | 0.8123      |                         |
Schwarz Information Criterion (SIC). Lag length is 2 in all cases except Hero Motors, ITC, LT, Tata Motors and establishes causal links between variables. Before applying VECM appropriate lag length is selected according to relationship between them. So, VECM is applied in order to evaluate the short run properties of the cointegrated series. In the absence of cointegration, VECM is no longer required and Granger causality tests is applied to establish causal links between variables. Before applying VECM appropriate lag length is selected according to Schwarz Information Criterion (SIC). Lag length is 2 in all cases except Hero Motors, ITC, LT, Tata Motors and Tata Steel where it is taken as 1 as per SIC.

Vector Error Correction Model (VECM):

In the event of presence of cointegration between the time series, there exists a long-term equilibrium relationship between them. So, VECM is applied in order to evaluate the short run properties of the cointegrated series. In the absence of cointegration, VECM is no longer required and Granger causality tests is applied to establish causal links between variables. Before applying VECM appropriate lag length is selected according to Schwarz Information Criterion (SIC). Lag length is 2 in all cases except Hero Motors, ITC, LT, Tata Motors and Tata Steel where it is taken as 1 as per SIC.

### Table 4: Estimates of VECM Regression

| Series | Hypothesized No. of CE(s) | Max Eigen Value | Probability | Trace | Probability | Conclusion |
|--------|---------------------------|-----------------|-------------|--------|-------------|------------|
| ICICI Spot and Future | None* | 59.83045 | 0.0000 | 60.35868 | 0.0000 | 1 Cointegration equation |
| ITC Spot and Future | None* | 91.48316 | 0.0001 | 92.46787 | 0.0001 | 1 Cointegration equation |
| LT Spot and Future | None* | 93.80393 | 0.0001 | 93.83175 | 0.0001 | 1 Cointegration equation |
| Tata Motors Spot and Future | None* | 97.39875 | 0.0001 | 98.75962 | 0.0001 | 1 Cointegration equation |
| Tata Steels Spot and Future | None* | 164.1582 | 0.0001 | 164.6565 | 0.0001 | 1 Cointegration equation |
| Wipro Spot and Future | None* | 43.89958 | 0.0000 | 45.26256 | 0.0000 | 1 Cointegration equation |
| Sensex Spot and Future | None* | 97.57484 | 0.0001 | 98.13583 | 0.0001 | 1 Cointegration equation |

*denotes significant at 1%

**International Journal of Management Studies**

ISSN(Print) 2249-0302 ISSN (Online)2231-2528

http://www.researchersworld.com/ijms/
In case of Tata Steel, causality runs from spot to futures as dependent variable. In case of Wipro, causality runs from futures to spot. Results reveal that only futures returns respond to correct an error correction term, suggesting that only futures returns respond to correct an error correction term. As far as the lead or lag relationship is concerned, spot market is leading the futures market in all cases except Tata Steel and Sensex because the adjustment made by the spot prices to obtain its equilibrium is less significant than futures.

**Granger Causality:**

Based on the results from unit root tests and co-integration tests, the pairwise Granger causality tests are conducted between different Spot Price and Futures Price series at first difference. The results from the test are presented in Table 4. F-Statistics in Table 4 show that in case of SBI, Reliance, Coal India, Hero Motor Corp., ICICI, November 2019 [75]

| Independent Variable | SBI | Reliance | Coal India | Hero Motors | ICICI |
|----------------------|-----|----------|------------|-------------|-------|
| ∆S_{t} | ∆F_{t} | ∆S_{t} | ∆F_{t} | ∆S_{t} | ∆F_{t} | ∆S_{t} | ∆F_{t} |
| Constant | 0.000245 | 0.000244 | 0.00000 | 0.000115 | 0.000430 | 0.000249 | 0.000364 | 0.000034 |
| [p-value] | [0.3276] | [0.3207] | [0.5273] | [0.5336] | [0.491615] | [0.5234] | [0.2290] | [0.2381] |
| ∆S_{t-1} [1-statistic] | 0.254180 | 0.347584 | 0.233901 | -0.250836 | 0.169924 | 0.192270 | 0.010093 | 0.002420 | 0.089147 | 0.417709 |
| [p-value] | [2.347258] | [3.271386] | [0.8526] | [0.0000] | [0.1431] | [0.0876] | [0.7705] | [0.6984] | [0.5415] | [0.0040] |
| ∆S_{t-2} [1-statistic] | -0.153795 | -0.268575 | 0.225572 | 0.206957 | -0.084152 | -0.130084 | -0.988813 | 0.010860 | -0.092459 | -0.405955 |
| [p-value] | [1.473970] | [0.0089] | [0.8569] | [0.3957] | [0.4579] | [0.2369] | [0.7607] | [0.0000] | [0.5252] | [0.0050] |
| ∆F_{t-1} [1-statistic] | -0.108415 | -0.240697 | 0.220572 | 0.206957 | -0.084152 | -0.130084 | -0.988813 | 0.010860 | -0.092459 | -0.405955 |
| [p-value] | [1.473970] | [0.0089] | [0.8569] | [0.3957] | [0.4579] | [0.2369] | [0.7607] | [0.0000] | [0.5252] | [0.0050] |
| ∆F_{t-2} [1-statistic] | -0.108415 | -0.240697 | 0.220572 | 0.206957 | -0.084152 | -0.130084 | -0.988813 | 0.010860 | -0.092459 | -0.405955 |
| [p-value] | [1.473970] | [0.0089] | [0.8569] | [0.3957] | [0.4579] | [0.2369] | [0.7607] | [0.0000] | [0.5252] | [0.0050] |

Table 4: Estimates of VECM Regression

VECM results suggest that short run causality runs from spot to futures in case of SBI, Reliance, Coal India, Hero Motors, ICICI, ITC, LT, Tata Motors and Sensex because coefficients of lagged values of independent variables are significant in case of futures (as dependent variable). In case of Tata Steel causality runs from futures to spot while in case of Wipro, there is feedback (bi-directional) causality. Error correction coefficient is used to find out the lead or lag relationship between spot and futures prices of the securities. Results reveal that 8 securities i.e. SBI, Reliance, Coal India, Hero Motors, ICICI, ITC, LT, Wipro and Sensex are showing significant error correction terms for futures suggesting that only futures returns respond to correct a shock in order to reach the long-run equilibrium. In case of Tata Steel, it is the spot market which respond to correct a shock in order to reach the equilibrium. In case of Tata Motors, both the markets make adjustments to reach the equilibrium. As far as the lead or lag relationship is concerned, spot market is leading the futures market in all cases except Tata Steel and Sensex because the adjustment made by the spot prices to obtain its equilibrium position is lesser than the futures prices.

**Granger Causality:**

Based on the results from unit root tests and co-integration tests, the pairwise Granger causality tests are conducted between different Spot Price and Futures Price series at first difference. The results from the test are presented in Table 4. F-Statistics in Table 4 show that in case of SBI, Reliance, Coal India, Hero Motor Corp.,
ICICI, ITC, LT, Tata Motors and Sensex spot market granger cause futures market indicating that the flow of information is from spot market to futures market. In case of Wipro, bi-directional causality is found suggesting that both the spot and futures markets are said to be informationally efficient and reacts more quickly to each other. Tata steel is the unique case where futures returns granger cause spot return implying that futures market reacts first and leads the spot market. Hence, it may be concluded that spot market helps in price discovery. These results are consistent with VECM test presented in Table 3 above.

Table 4: Results of Pairwise Granger Causality Tests between Spot Return and Futures Return

| Null Hypothesis                                      | F-Statistic | Probability |
|------------------------------------------------------|-------------|-------------|
| SBI Freturn does not Granger Cause Sreturn           | 0.04858     | 0.9526      |
| SBI Sreturn does not Granger Cause Freturn           | 0.93915     | 0.0003*     |
| Reliance Freturn does not Granger Cause Sreturn      | 0.04332     | 0.9576      |
| Reliance Sreturn does not Granger Cause Freturn      | 20.9243     | 1.E-09*     |
| Coal India Freturn does not Granger Cause Sreturn    | 0.39942     | 0.6710      |
| Coal India Sreturn does not Granger Cause Freturn    | 8.67353     | 0.0002*     |
| Hero Motors Freturn does not Granger Cause Sreturn   | 0.96143     | 0.3829      |
| Hero Motor Sreturn does not Granger Cause Freturn    | 1.33934     | 0.0009*     |
| ICICI Freturn does not Granger Cause Sreturn         | 1.07871     | 0.3405      |
| ICICI Sreturn does not Granger Cause Freturn         | 0.61397     | 0.0001*     |
| ITC Freturn does not Granger Cause Sreturn           | 1.02130     | 0.3606      |
| ITC Sreturn does not Granger Cause Freturn           | 25.2788     | 2.E-11*     |
| LT Freturn does not Granger Cause Sreturn            | 1.76871     | 0.1712      |
| LT Sreturn does not Granger Cause Freturn            | 0.48872     | 0.0023*     |
| Tata Motors Freturn does not Granger Cause Sreturn   | 4.02686     | 0.4182      |
| Tata Motors Sreturn does not Granger Cause Freturn   | 26.3851     | 7.E-12*     |
| Tata Steel Freturn does not Granger Cause Sreturn    | 4.71186     | 0.0092*     |
| Tata Steel Sreturn does not Granger Cause Freturn    | 0.12160     | 0.8855      |
| Wipro Freturn does not Granger Cause Sreturn         | 5.83382     | 0.0031*     |
| Wipro Sreturn does not Granger Cause Freturn         | 25.2711     | 3.E-11*     |
| Sensex Freturn does not Granger Cause Sreturn        | 0.19611     | 0.8219      |
| Sensex Sreturn does not Granger Cause Sreturn        | 9.70656     | 7.E-05*     |

CONCLUSION:

Present study makes an attempt to find out the role of spot and futures markets in the assimilation of information and price discovery in the Indian stock market. Using daily closing prices of spot and futures of 10 securities and Sensex for the period of 2011-2015, the results of the cointegration test supports the presence of long-run relationship between the two markets. This means that information flows from one market to another market. The results are very useful to market participants. Market participant such as investors can use these results to predict impact of shocks to the futures market on spot market. VECM results show that in case of 9 securities, spot market is leading the futures and only one security and Sensex are showing that they are being led by futures market. As far as, causality is concerned, VECM results are consistent with the results of Granger causality suggesting that all securities, except Tata Steel are showing unilateral causality. It may be concluded that spot markets are playing an important price discovery role implying that spot prices may contain useful information about futures prices. The results are in contradiction with the findings from the previous studies in the case of other stock markets which generally found that futures prices lead stock spot prices. However, the findings are consistent with the findings from other studies such as by Stephen and Whaley (1990) that found the opposite, cash prices lead futures prices. The results may be affected by the infrequent trading in futures contract.

REFERENCES:

Bhattacharya, A.K. (1987). Option expirations and treasury bond futures prices, The Journal of Futures Markets, Vol. 7, No. 1, pp. 49-64.

Black, F. (1975). Fact and fantasy in the use of options, Financial Analysts Journal, Vol. 31, No. 4, pp.36-72.

Chan, K. (1992). A further analysis of the leadlag relationship between the cash market and stock index futures
market, *The Review of Financial Studies*, Vol. 5, No. 1, pp.123 - 152.
Chan, K., Chung, Y.P., and Johnson, H. (1993). Why option prices lag stock prices: A trading based explanation,* The Journal of Finance*, Vol.48, No.5, pp.1957-1967.
Choudhary, K., Bajaj, S. (2012). Intraday Lead/Lag Relationships between the Futures and Spot Market, *Eurasian Journal of Business and Economics*, Vol. 5, No. 9, 165-186.
De Jong, F., and Donders, M.W. (1998). Intraday lead-lag relationships between the futures-, options and stock market, *European Finance Review*, Vol.1, No.3, pp.337-359.
Dickey, D. A., Jansen, D. W. and Thornton, D. C. (1991). A Primer on Cointegration with an Application to Money and Income, *Review Federal Reserve Bank of St. Louis*, Vol. 73, No.2, pp. 58-78.
Garbade, K. and Silber, W.L. (1983). Price Movements and Price Discovery in Futures and Cash Markets, *The Review of Economics and Statistics*, Vol. 65, No. 2, pp. 298-297.
Gupta, K. and Singh, B. (2006). Price Discovery and Causality in Spot and Futures Markets in India, *The ICFAI Journal of Derivatives Markets*, Vol. 3, No. 1, pp.30-41.
Gupta, K. and Singh, B. (2009). Price discovery and arbitrage efficiency of Indian equity futures and cash markets, accessed from www.nseiindia.com/content/research/res_paper_final185.pdf.
Gwilym, O.A., and Buckle, M. (2001). The lead-lag relationship between the FTSE100 stock index and its derivative contracts, *Applied Financial Economics*, Vol.11, No.4, pp.385-393.
Holowczak, R., Simman, Y. E., and Wu, L. (2007). Price discovery in the U.S. stock and stock options market: A portfolio approach, *Review of Derivative Research*, Vol. 9, No. 1, pp.37 - 65.
Hsieh, W., L. G., Lee, C., S. and Yuan, S. F. (2008). Price discovery in the options markets: An application of put- call parity, *Journal of Futures Markets*, Vol.28, No. 4, pp.354-375.
Jackline, S. and Deo, M. (2011). Lead – lag relationship between the futures and spot prices, *Journal of Economics and International Finance*, Vol. 3, No. 7, pp. 424-427.
Mukherjee, K. N. and Mishra, R. K. (2006). Lead-Lag Relationship Between Equities and Stock Index Futures Market and It’s Variation Around Information Release: Empirical Evidence from India, *NSE Research Paper, NSE India*.
Pandey, N.S., Vembu, E. and Pandey, M. (2017). The Relationship between Spot and Future Markets in India: Evidence from BSE Sensex and S&P CNX Nifty, *Pacific Business Review International*, Vol.10 No.2, pp. 7-13 accessed from www.pbr.co.in on Feb 2, 2018.
Pathak, R., Ranajee, R. and Kumar, S. (2014). Price Discovery in the Equity Derivatives Market : A Literature Survey, *Indian Journal of Finance*, Vol 8, No. 6, pp.47-57.
Patra, G.C, Mohapatra, S.R (2011). A Testing of Lead-lag Relationship between Nifty Spot and Futures Index Returns and Volatility, *International Journal of Financial Management*, Vol. 1, No. 4, pp. 13-22.
Pradhan, K.C. and Bhatt, K.S. (2018). Price Discovery and Causality in the NSE Futures Market, accessed from www.igidr.ac.in. on Sep, 11.
Raju, M.T. (2003). Price Discovery and Volatility on NSE Futures Market, Working Paper No. 7, accessed from www.sebi.gov.in/cms/sebi_data/attachdocs/1293096997650.pdf.
Sah, A. N. and Kumar, A. A. (2006). Price Discovery in Cash and Futures Market: The Case of S&P Nifty and Nifty Futures, *The ICFAI Journal of Applied Finance*, Vol.12, No.4, pp.55-63.
Srinivasan, P. (2010). Price Discovery in NSE Spot and Futures Markets of India: Evidence from selected IT Industries, *Dharama- Bhavan’s International Journal of Business*, Vol. 4, No.1, pp. 16-27.
Stephen, J.A. and Whaley, R.A. (1990). Intraday Price Change and Trading Volume Relations in the Stock and Stock Option Markets, *Journal of Finance*, Vol. 45, No.1, pp.191-220.
Thenmozhi, M. (2002). Futures Trading, Information and Spot Price Volatility ofNSE-50 Index Futures Contract, NSE Research Paper, www.nseiindia.com.
Thomas, S. (2006). Interdependence and Dynamic Linkages Between S&P CNX Nifty Futures and Spot Market: with Specific Reference to Volatility, Expiration Effects and Price Discovery Mechanism, Unpublished PhD Thesis, Department of Management Studies, IIT Madras.
Zakaria Z. and Shamsuddin S. (2012). Relationship between Stock Futures Index and Cash Prices Index: Empirical Evidence Based on Malaysia Data, *Journal of Business Studies Quarterly*, Vol. 4, No. 2, pp. 103-112.