

## Intraday Lead/Lag Relationships between the Futures and Spot Market

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### **Abstract**

*This study investigates whether spot and futures markets are playing an important role in the assimilation of information and price discovery in the Indian stock market. For accomplishing this purpose, high frequency price data of 31 individual securities, observed at five minutes interval for the time period of April 2010 to March 2011 have been used. The present study applies the Johansen's cointegration and Engle and Granger's residual based approach to determine the long-run equilibrium between the two markets. Besides this, Granger causality test and VECM (Vector Error Correction Model) have been applied to determine the direction of causality and the leading market. The results of the study depict that there is a bi-directional information flows or feedback between the spot and futures markets in case of 30 securities and one security i.e. Wipro is showing unilateral relationship from spot to futures. As far as price discovery role of spot and futures markets is concerned, both markets are playing an important role implying that futures (spot) prices may contain useful information about spot (futures) prices. Besides this it is also evidenced that futures market is leading the spot market in case of 12 securities whereas 19 securities are being led by the spot market.*

**Keywords:** Cointegration, Causality, Price Discovery

**JEL Code Classifications:** C22, C32

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## 1. Introduction

Trading in financial market is getting popular. The main aim of trading is to ascertain the rational price of the constituents of portfolio. A market is considered to be efficient only if it is able to forecast the future price with fair amount of accuracy by taking into account the current and future scenario. But this price does not remain constant because new information keeps pouring in the economy making impact on the overall sentiment of the market. This variability in price is known as volatility. The purpose of futures contracts is to reduce volatility by increasing the speed of flow of information between the two markets i.e. spot and futures. Still an equivocal situation exists i.e. which market is a leading market, whether spot market is leading the futures or vice versa? Price discovery is a process that allows market prices of the security to be determined by taking into account the information available in the market. Whenever any information related to an asset comes into the market, theoretically, it is assumed that both the markets (i.e. spot and futures) having the same information should react at the same time. If both the markets do not react at the same time, then one market leads the other. Here, leading market is viewed as generating the price of an asset. Historically, it has been observed that futures market reacts faster to the information and is expected to play a dominant role in price discovery due to its trading cost advantage, greater liquidity and fewer restrictions. Furthermore, empirical evidence also indicates that futures markets provide function of price discovery which means futures prices should contain useful information about the subsequent spot prices. Basically, the contribution of each market in the determination of price of an asset depends on various factors i.e. settlement mechanism, degree of transparency etc. Number of studies has empirically examined the price discovery mechanism in various markets. For instance, Koch, Kawaller and Koch (1987) examined the price discovery role of markets in US and concluded that futures play a dominant role. Bose (2007) conducted the same analysis on Indian stock market and found equal contribution of two markets to the price discovery process. Having an estimate of contribution of futures and spot market in the price discovery is of great significance for investors, portfolio managers, brokerage houses and regulators. The present study tries to identify the issue of relative contribution of spot and futures markets to the process of price discovery in the Indian stock market. The purpose of this study is to examine the price discovery by taking the intraday five minutes interval data of 31 Indian individual securities and its corresponding futures. The period analyzed is from April 2010 to March 2011. The study applies the VECM (Vector Error Correction Model) to identify the relative contribution of the spot and futures market in the price discovery process.

## 2. Literature Review

A vast body of academic and professional research has been devoted towards the lead-lag relationship in returns and volatilities between spot and futures markets,

particularly in developed economies. Koch, Kawaller and Koch (1987) studied the intraday price lead-lag relationship between S&P 500 futures and S&P 500 index using three-stage least squares regression and concluded that futures price movements lead the index movements by twenty to forty-five minutes while movements in the index rarely affect futures beyond one minute. Almost similar results exhibited by Kutner and Sweeney (1991) and Chan (1992) by taking into account the intraday (minute by minute) data. Jong and Nijman (1995) examined the lead-lag relationship by considering the high frequency data of S&P 500 index and futures market and evidenced that futures market leads the cash index at least by ten minutes whereas cash index leads the futures market by two minutes. Jong and Donders (1998) used the high frequency data of cash, futures and options market of Netherland to determine the lead-lag relationship among the markets and found that due to the infrequent trading in the cash market, smaller transactions cost and larger leverage effect in the futures market cause options and cash market to be led by the futures market. Frino and West (1999) investigated the lead-lag relationship between the stock indices and stock index futures for the Australian market and concluded that futures market leads the cash market, though presence of feedback from the cash market to the futures market is also observed. Alphonse (2000) investigated the price discovery mechanism of cash index and futures market of France and concluded that at least ninety five percent of the price discovery is achieved in the futures market. Similar results are shown by Asche and Guttormsen (2002) by taking into account the commodity market. So and Tse (2004) supported the principle that the futures market contains the most information, followed by the cash market in price discovery process in the Hang Seng spot and futures Index. Gupta and Singh (2006) examined the efficiency of Indian equity futures market by considering price discovery feature as the predominant feature of the efficient futures market and argued that in the event of high fluctuations, futures market provides significant information regarding the prospective move in the cash market. Mukherjee and Mishra (2006) exhibited the strong contemporaneous and bi-directional relationships between Nifty spot and futures market. Floros and Vougas (2007) examined the lead-lag relationship between the futures and spot markets in Greece. With the application of Bivariate GARCH model it was evidenced that due to lower transaction costs and higher liquidity in the futures market, futures market (ADEX) leads the cash market (ASE). Debashish and Mishra (2008) demonstrated the leading role of futures and options in price discovery process using the intraday data, besides this, feedback relationship is also found between the cash market and the put option with a lead and lag of up to an hour. Kim, Nam and Kim (2008) empirically investigated the intraday relationship between stock index returns and implied index returns estimated from the Korean KOSPI 200 index options market and revealed that the stock index strongly leads both call and put options. Aydemir and Demirhan (2009) examined the causal relationship between Turkey's stock prices and exchange rates and indicated a bi-directional causal relationship between exchange rate and all

stock market indices. Karmakar (2009) examined the price discovery role of Nifty futures and spot market and concluded that besides lower transaction costs and ease of leverage, futures market's absence of short selling restriction feature has made futures market more attractive which causes very high volume of trade in this market. Therefore, due to the high volume of trade in the futures market, information is coming into this market more rapidly than the spot market that makes futures market a leading market. Mahalik, Acharya and Babu (2009) examined price discovery in Indian spot-futures commodity markets by using Johansen's cointegration and VECM model and reported the flow of information from futures to the spot commodity markets but the reverse causality does not exist. Moonis (2009) investigated the lead-lag relationship between Nifty futures and Nifty spot index and empirical findings suggested that spot market leads the futures market. Pati and Pradhan (2009) investigated the long-term and short-term dynamics of prices between Indian spot and futures market. Results supported the existence of a long-run relationship between spot and futures prices. Further, VECM indicates short-run unidirectional causality from futures to spot market. Pradhan and Bhat (2009) found that derivatives market is in immaturity stage and traders and investors are still confused about this market due to the complexity of the derivatives contracts. Therefore, spot market leads the futures market. Mallikarjunappa and Afsal (2010) analysed information-based superiority of markets for exploring arbitrage opportunities and attempted to determine the lead-lag relationship between spot and futures markets by considering high frequency price data of twelve Indian securities and found a contemporaneous and bidirectional lead-lag relationship between the spot and futures markets and price discovery occurs in the both the markets simultaneously. Overall, the above mentioned literature on dynamics of futures and cash market conclude that various factors such as lower transaction costs, ease of leverage and absence of short selling restriction in the futures market, encourage investors and traders towards the futures market and that is increasing the number of trades in the futures market which causes processing of information in the futures market faster than the spot market. Some research has shown spot market is leading the futures market, the possible reason behind this output could be the complexity of the derivatives market, due to which investors and traders prefer to trade in the spot market that increases the flow of information in the spot market.

### **3. Research Methodology**

#### **3.1. Data Source and Time Period**

Index futures on S&P CNX Nifty (Indian Index) were permitted for trading on National Stock Exchange (NSE) in June, 2000 and on individual securities, derivatives trading started on November 9, 2001. NSE accounts for nearly 70 percent of the total stock exchange trading value in India in equities and 99 percent in equity derivatives. NSE's trading facility is available through more than 2, 50,000 trading terminals in over 1500 cities across India. It ranks fourth in the world in

terms of number of transactions and third in terms of number of contracts traded in index futures, and index options. For the purpose of present study, 31 securities listed on NSE have been considered as per the availability of the data. Five minutes interval closing values of the spot and futures market of 31 securities have been obtained from the year April 2010 to March 2011. In case of Indian derivatives market, three period contracts are available i.e. near month contract, mid month and far month contract. The present study has used the near month contract as the maximum trading is being done in the near month only. The data has been taken from the financial market database Meta stock.

Returns have been calculated as given in the equation (1)

$$R_t = \ln(P_t / P_{t-1}) \quad (1)$$

Where,  $P_t$  is the present price and  $P_{t-1}$  is the previous period's price.

### 3.2. Unit Root Test

As this study is dealing with the time series data, the biggest issue with the time series data is non-stationarity. In the absence of stationarity, hypothesis test results will be spurious. In order to check the presence of unit root and determining the order of differencing required to bring stationarity, this study has used the Augmented Dickey-Fuller (ADF), 1979 and Phillip Perron (PP), 1988 tests.

### 3.3. Engle and Granger's Cointegration Test (Residual Based Approach)

The concept of cointegration was first introduced by Granger (1981). According to Engle and Granger (1987), cointegration is an econometric technique for testing the relationship between non-stationary time series variables. If two time series are non-stationary, that is they have stochastic trend but their linear combination is stationary,  $I(0)$ . So to speak, the linear combination cancels out the stochastic trends in the two time series. In this case, the two time series are said to be cointegrated (Gujarati, 2007). Following the idea, this study has run the regression (equation 2) mentioned below. Residuals are then tested for cointegration. Augmented Dickey-Fuller (ADF) and Phillip Perron (PP) tests have been used for this purpose.

With two time-series, futures price series ( $F_t$ ) and spot price series ( $S_t$ ), each of which is  $I(1)$ , the cointegration regression equation is:

$$F_t = \alpha + \beta S_t + \mu_t \quad (2)$$

Where,  $F_t$  is regressed on a constant  $\alpha$  and  $S_t$ .  $\beta$  is the regression coefficient and  $\mu_t$  is the residuals or error terms. Now the spot price series and futures price series are said to be cointegrated only if  $\mu_t$  is stationary.

### 3.4. Granger Causality Test

A statistical approach proposed by Clive W Granger (1969) to infer cause and effect relationship between two (or more) time series is known as Granger causality.

Granger causality is based on the simple logic that effect cannot precede cause. Granger causality test is based on bi-variate regression model:

$$S_t = \sum_{i=1}^n \alpha_i F_{t-i} + \sum_{j=1}^n \beta_j S_{t-j} + \mu_{1t} \tag{3}$$

$$F_t = \sum_{i=1}^n \lambda_i F_{t-i} + \sum_{j=1}^n \delta_j S_{t-j} + \mu_{2t} \tag{4}$$

Where,  $F_t$  is the future price return series and  $S_t$  is spot price return series.  $\lambda_i, \delta_j, \alpha_i$  and  $\beta_j$  are the coefficients of the respective variables.  $\mu_{1t}$  and  $\mu_{2t}$  are the error terms assumed to be uncorrelated. If all the coefficients of  $F_t$  in the regression equation (3) of  $S_t$ , i.e.  $\alpha_i$  for  $i = 1, \dots, n$  are significant that the null hypothesis  $F_t$  does not cause  $S_t$  is rejected, then it can be said there is a causality from futures to spot. If only one of the two variables causes the second variable but the second variable does not cause the first variable, it is called one-way causality. If both the variables cause each other, it is called the feedback causality. However, the significance of the coefficient is evaluated by the help of F-statistic.

**3.5. Johansen’s Cointegration and Vector Error Correction Model**

An alternative approach to test for cointegration was proposed by Johansen (1988) and Johansen and Juselius (1990) using Maximum Likelihood approach. Johansen’s test is considered to be the most powerful test among the various tests presently available. The test for cointegration between the two series is done by considering the rank of the  $\Pi$  matrix via its eigen values. In Johansen’s procedure, the eigen values are arranged in descending order.

$$\lambda_1 \geq \lambda_2 \geq \lambda_3 \geq \dots \geq \lambda_n \tag{5}$$

Where,

$\lambda_1$  is the largest value and  $\lambda_n$  is the smallest one.

There are two test statistics for cointegration under the Johansen approach using maximum likelihood statistics:

**3.6. The Lamda Max ( $\lambda_{max}$ ) Test**

This test examines the null hypothesis that the cointegration rank is equal to  $r$  against the alternative hypothesis that the cointegration rank is equal to  $r+1$ . The test statistic is calculated as follow:

$$\lambda_{max}(r, r + 1) = -T \ln(1 - \lambda_{r+1}) \tag{6}$$

Where,

$\lambda$  is the eigen value. The test is repeated for  $r = 1, \dots, k$  until one fails to reject the null hypothesis.

**3.7. The Lamda Trace ( $\lambda_{trace}$ ) Test**

This test examines the null hypothesis that the cointegration rank is equal to  $r$  against the alternative hypothesis that cointegration rank is  $k$  or greater than  $r$ .

The test is conducted in inverse sequence, that is  $r = k, k-1, k-2, \dots, 0$ . The test statistic is computed as follows;

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^k \ln(1 - \lambda_i) \quad (7)$$

In the above two equations,  $r$  is the number of cointegration vectors and  $\lambda_i$  is the estimated value for the  $i^{\text{th}}$  ordered eigenvalue from the  $\Pi$  matrix. The test of cointegration basically tests whether; there exists a stationary linear combination of non-stationary variables. If such combination is found, it is inferred as an equilibrium relationship between the variables. This equilibrium relationship is then used to construct an error correction model. An error correction model is a statistical specification of economic dynamics through which the pull and push forces restore the equilibrium relationship whenever disequilibrium takes place. Engle and Granger (1987) state that if spot and futures price series are cointegrated, then causality must exist at least in one direction. This causality can be identified by the help of Vector Error Correction Model (VECM). To test the causality VECM may be estimated using OLS in each equation.

$$\Delta S_t = \alpha_{s,0} + \sum_{i=1}^{p-1} \alpha_{s,i} \Delta S_{t-i} + \sum_{i=1}^{p-1} b_{s,i} \Delta F_{t-i} + \alpha_s Z_{t-1} + \varepsilon_{s,t} \quad (8)$$

$$\Delta F_t = \alpha_{f,0} + \sum_{i=1}^{p-1} \alpha_{f,i} \Delta S_{t-i} + \sum_{i=1}^{p-1} b_{f,i} \Delta F_{t-i} + \alpha_f Z_{t-1} + \varepsilon_{f,t} \quad (9)$$

Where,

$\alpha_{s,0}$  and  $\alpha_{f,0}$  are intercept terms.  $\alpha_{s,i}, \alpha_{f,i}, b_{s,i}$  and  $b_{f,i}$  are the short-run coefficients.  $Z_{t-1}$  is the error correction term derived from the cointegration equation. In the above two VECM equations (8) and (9),  $F_t$  Granger causes  $S_t$  if some of the  $b_{s,i}$  coefficients are significant and  $\alpha_s$  is also significant. Similarly  $S_t$  Granger causes  $F_t$  if some of the  $b_{f,i}$  are significant and  $\alpha_f$  is also significant.  $t$ -test is used to test the hypothesis for the significance of the error correction coefficients and  $F$ -test is used to test the joint significance of lagged estimated coefficients. Number of lags in the model is identified by using the Akaike and Schwarz Bayesian Information Criterion. If both  $\alpha_s$  and  $\alpha_f$  are significant, it means there is two way or feedback relation between the two markets. By the help of  $\alpha_s$  and  $\alpha_f$ , direction of causality, speed with which correction is being taken place and identification of leading/lagging market is possible.

## 4. Empirical Results and Discussion

### 4.1. Descriptive Statistics

Table 1 shows the results of descriptive statistics. In case of spot market, Bajaj Hind has shown the negative mean return (-0.00337 per cent), which is the smallest one among all the sample securities whereas Tata Motors (0.00504 per cent), Sesagoa (0.00296 per cent) and Infosystech (0.00262 per cent) have shown the highest mean returns respectively. In the futures market, Bajaj Hind again shows the

smallest and negative mean return having a similar value i.e. -0.00337 per cent whereas Tata Motors (0.00509 per cent), Sesagoa (0.00299 per cent) and Infosystech (0.00262 per cent) are showing the highest mean returns.

Standard deviation measures the riskiness of the security. In case of equity, Maruti (0.2176 per cent), Axis Bank (0.2216 per cent) and Infosystech (0.2267 per cent) are the safest security and Unitech is proved to be the riskiest one by showing the highest standard deviation among all the securities i.e. 0.4955 per cent. The futures market results regarding descriptive statistics again depicted the Axis Bank (0.2183 per cent), Maruti (0.2183 per cent) and Infosystech (0.2267 per cent) as the safest security and again Unitech (0.5278 per cent) is found to be the riskiest security. As far as, skewness is concerned, 30 per cent securities in spot market and 32 per cent securities in futures are negatively skewed, thus violating the assumption of normal distribution. All the securities' log returns series evidence flat tail since the kurtosis value exceeds 3.

**Table 1: Descriptive Statistics**

Company	Returns	Minimum	Maximum	Mean	Standard Deviation	Skewness	Kurtosis
ABAN	Futures	-0.207428	0.128433	-0.0000163	0.003699	-4.280190	402.5992
	Equity	-0.207624	0.131839	-0.0000165	0.003506	-5.076171	498.2591
AXIS BANK	Futures	-0.025289	0.064557	0.00000828	0.002183	1.204185	56.01495
	Equity	-0.026033	0.066564	0.00000805	0.002216	1.366743	60.52657
BAJAJ HIND	Futures	-0.039221	0.042944	-0.00003370	0.003196	0.095446	17.25667
	Equity	-0.039821	0.042964	-0.00003370	0.003051	0.271328	21.00446
BANK OF BARODA	Futures	-0.026233	0.035516	0.00002010	0.002358	0.224844	18.32727
	Equity	-0.024693	0.037926	0.00001950	0.002280	0.539651	20.99928
BHEL	Futures	-0.053490	0.201359	0.00001040	0.003042	7.351822	524.7754
	Equity	-0.051183	0.198966	0.00001050	0.003022	7.253335	516.6016
DLF	Futures	-0.058721	0.049260	-0.00001270	0.003332	-0.188364	20.87755
	Equity	-0.057575	0.049260	-0.00001270	0.003252	-0.151941	24.47478
HDFC BANK	Futures	-0.057214	0.115383	0.00002050	0.003098	1.540702	98.86436
	Equity	-0.054083	0.106215	0.00002040	0.003071	1.453690	88.19610
HINDALCO	Futures	-0.052077	0.041253	0.00000656	0.002740	-0.289677	29.02300
	Equity	-0.051991	0.035068	0.00000663	0.002738	-0.306733	29.74399
HINDUSTAN UNILEVER	Futures	-0.071949	0.058373	0.00000611	0.002856	0.005966	79.89083
	Equity	-0.076227	0.062089	0.00000635	0.002865	0.135146	85.63328
ICICI BANK	Futures	-0.072425	0.193238	0.00002150	0.004082	3.070994	183.9040
	Equity	-0.070348	0.196567	0.00002140	0.004069	3.423378	200.5162
IDBI	Futures	-0.075343	0.069274	0.00000876	0.004153	0.149637	63.47731
	Equity	-0.072357	0.074562	0.00000872	0.004058	0.272827	69.25650
IDFC	Futures	-0.049156	0.044650	-0.00000205	0.002522	-0.070245	27.61862
	Equity	-0.049403	0.041839	-0.00000214	0.002527	-0.124829	26.77455
INFOSYS TECH	Futures	-0.085261	0.092520	0.00002620	0.002296	-0.437574	164.4050
	Equity	-0.062520	0.043219	0.00002620	0.002267	-0.534452	67.19193
JINDAL STEEL	Futures	-0.031290	0.036034	-0.00000312	0.002290	-0.062707	22.58820
	Equity	-0.030340	0.036341	-0.00000326	0.002275	0.067908	22.94393
JP ASSOCIATES	Futures	-0.407297	0.160041	0.00000159	0.004742	-15.55123	1435.106
	Equity	-0.403748	0.129265	0.00000142	0.004613	-16.83857	1529.029
JSW STEEL	Futures	-0.042077	0.066925	-0.00001720	0.002959	0.330521	37.39487
	Equity	-0.039779	0.068026	-0.00001710	0.002889	0.603200	41.25209
L&T	Futures	-0.081346	0.184913	0.00001820	0.003038	5.584251	396.6968
	Equity	-0.086540	0.282590	0.00001800	0.003127	18.23924	172.7326
MARUTI	Futures	-0.072915	0.039254	-0.00000969	0.002183	-2.274077	99.11378



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	Equity	-0.084536	0.033195	-0.0000988	0.002176	-3.251911	149.3274
PNB	Futures	-0.051645	0.217185	0.0000196	0.003016	9.448317	699.0194
	Equity	-0.056833	0.201773	0.0000195	0.002936	8.217229	587.3449
RANBAXY	Futures	-0.058244	0.068963	-0.0000044	0.003521	0.179865	65.50296
	Equity	-0.058977	0.073895	-0.0000044	0.003509	0.457140	69.27763
RCOM.	Futures	-0.090497	0.166442	-0.0000196	0.003942	1.434920	118.1168
	Equity	-0.092075	0.194838	-0.0000196	0.003891	2.694980	204.4309
RELIANCE CAPITAL	Futures	-0.098253	0.183419	0.0000013	0.003983	2.675927	156.3945
	Equity	-0.0092205	0.267855	0.0000013	0.003945	7.996347	573.7271
RELIANCE INFRA	Futures	-0.096147	0.076624	-0.0000202	0.003284	-0.423028	57.62817
	Equity	-0.097423	0.077240	-0.0000204	0.003208	-0.329278	66.72766
RELIANCE POWER	Futures	-0.052302	0.096096	-0.0000117	0.002763	1.318642	72.85083
	Equity	-0.050879	0.101409	-0.0000118	0.002718	1.959927	92.17572
SAIL	Futures	-0.064649	0.166085	0.0000190	0.003606	2.849921	152.0586
	Equity	-0.081493	0.148715	0.0000190	0.003462	2.260225	128.8465
SBI	Futures	-0.064550	0.197996	0.0000184	0.003359	5.556978	361.9623
	Equity	-0.065000	0.200478	0.0000183	0.003371	5.848453	379.5347
SESAGOA	Futures	-0.077613	0.167427	0.0000299	0.004007	2.287374	128.1551
	Equity	-0.087907	0.141111	0.0000296	0.003849	1.438640	85.77404
TATA MOTORS	Futures	-0.075778	0.137611	0.0000509	0.004548	1.391871	76.75825
	Equity	-0.069437	0.118283	0.0000504	0.004498	1.337138	66.83561
TATA STEEL	Futures	-0.077613	0.133991	0.0000259	0.004280	0.842738	70.73648
	Equity	-0.076718	0.122886	0.0000258	0.004188	0.836151	69.35847
UNITECH	Futures	-0.182322	0.181830	0.0000005	0.005278	0.104117	106.4407
	Equity	-0.142233	0.240603	-0.00000010	0.004955	2.249073	192.6080
WIPRO	Futures	-0.47004	0.050940	-0.0000238	0.004613	-5.65707	576.5956
	Equity	-0.478902	0.049175	-0.0000241	0.004667	-5.77408	593.0632

#### 4.2. Unit Root Test

In the initial stage of any time series analysis, the properties of the time series must be examined for the presence of stationarity. In the literature, usually this is accomplished by using two most widely used tests i.e. ADF (Augmented Dickey-Fuller) and PP (Phillip Perron). The present study also has used these tests and results are reported in Table 2. Both the tests found that spot and futures price series are non-stationary at their levels but have attained stationarity after taking the first difference. Taking cue from the results, the analysis will therefore proceed further under the assumption that all the price series are integrated of order one.

**Table 2: Unit Root Test**

Company		Closing Price			Returns		
		Without Intercept	With Intercept	With Intercept and Trend	Without Intercept	With Intercept	With Intercept and Trend
ABAN	Futures(DF)	-0.811531	-8.02827	-3.253605	-76.79047	-76.79415	-76.79990
	Futures(PP)	-0.779388	-0.777659	-3.334979	-178.1449	-178.1458	-178.1492
	Equity (DF)	-0.814851	-0.758119	-3.257279	-76.16650	-76.17059	-76.17705
	Equity (PP)	-0.788858	-0.724993	-3.318561	-176.6751	-176.6758	-176.6790
AXIS BANK	Futures(DF)	0.325021	-2.041685	-1.979234	-59.85892	-59.85991	-59.86091
	Futures(PP)	0.328321	-2.051920	-1.987752	-142.1560	-142.1544	-142.1528
	Equity (DF)	0.296626	-2.115085	-2.050112	-59.68583	-59.68659	-59.68773
	Equity (PP)	0.295708	-2.130381	-2.065324	-141.8012	-141.7993	-141.7977
BAJAJ HIND	Futures(DF)	-1.538038	-0.527180	-0.116490	-62.49334	-62.51558	-62.52237
	Futures(PP)	-1.498996	-0.527558	-1.136454	-145.1201	-145.1418	-145.1466
	Equity (DF)	-1.554782	-0.485266	-0.088172	-62.28727	-62.31061	-62.31806
	Equity (PP)	-1.517676	-0.485058	-1.106599	-142.1200	-142.1399	-142.1446
BANK OF	Futures(DF)	0.990007	-1.489953	-1.845561	-62.66815	-62.68305	-62.68494

BARODA	Futures(PP)	0.988697	-1.492439	-1.853252	-150.4881	-150.5056	-150.5063
	Equity (DF)	0.961156	-1.523851	-1.861847	-62.39836	-62.41258	-62.41472
	Equity (PP)	0.963110	-1.519001	-1.860282	-146.7901	-146.8040	-146.8045
BHEL	Futures(DF)	0.189261	-2.591023	-2.153808	-92.01908	-92.02147	-92.03727
	Futures(PP)	0.241191	-2.529779	-2.003600	-209.4202	-209.4233	-209.4487
	Equity (DF)	0.194399	-2.613406	-2.201851	-91.74407	-91.74651	-91.76174
DLF	Equity (PP)	0.249922	-2.552322	-2.048287	-209.0227	-209.0258	-209.0497
	Futures(DF)	-0.905856	-1.665653	-2.449988	-80.57013	-80.57258	-80.57213
	Futures(PP)	-0.898882	-1.706066	-2.501895	-188.6294	-188.6294	-188.6272
HDFC BANK	Equity (DF)	-0.914504	-1.631060	-2.418301	-80.33781	-80.34042	-80.33996
	Equity (PP)	-0.907659	-1.680900	-2.479761	-189.1855	-189.1855	-189.1833
	Futures(DF)	0.917722	-1.478363	-2.873980	-90.83388	-90.84635	-90.84874
HINDALCO	Futures(PP)	1.071861	-1.407717	-2.565862	-214.5386	-214.5605	-214.5640
	Equity (DF)	0.903200	-1.501520	-2.878434	-91.19199	-91.20451	-91.20721
	Equity (PP)	1.052976	-1.436735	-2.575202	-212.1209	-212.1419	-212.1456
HINDUSTAN UNILEVER	Futures(DF)	0.140285	-1.117443	-2.041185	-59.79096	-59.79041	-59.78975
	Futures(PP)	0.148903	-1.111946	-2.021719	-141.8588	-141.8560	-141.8531
	Equity (DF)	0.140937	-1.128508	-2.063896	-59.50809	-59.50757	-59.50693
ICICI BANK	Equity (PP)	0.147259	-1.124746	-2.049808	-141.7404	-141.7375	-141.7346
	Futures(DF)	0.088825	-2.10604	-2.990223	-68.74168	-68.74112	-68.74103
	Futures(PP)	0.161224	-1.888540	-2.541921	-156.0345	-156.0325	156.0316
IDBI	Equity (DF)	0.101622	-2.161897	-3.123757	-69.23993	-69.23941	-69.23928
	Equity (PP)	0.174725	-1.935144	-2.658470	-154.1844	-154.1825	-154.1815
	Futures(DF)	0.485804	-1.780856	-2.774722	-87.62047	-87.62690	-87.62863
IDFC	Futures(PP)	0.616025	-1.681373	-2.481332	-205.5825	-205.5891	-205.5899
	Equity (DF)	0.471048	-1.799854	-2.803181	-87.67170	-87.6781	-87.67991
	Equity (PP)	0.605673	-1.695762	-2.495333	-205.6749	-205.6815	-205.6823
INFOSYS TECH	Futures(DF)	-0.043389	-2.429613	-2.932738	-79.31332	-79.31311	-79.31249
	Futures(PP)	0.052673	-2.144784	-2.524959	-183.9817	-183.9806	-183.9788
	Equity (DF)	-0.035187	-2.411617	-2.902725	-79.36577	-79.36559	-79.36508
JINDAL STEEL	Equity (PP)	-0.061946	-2.132145	-2.495306	-182.7977	-182.7967	-182.7950
	Futures(DF)	-0.262885	-1.310957	-1.487304	-60.89663	-60.89514	-60.90084
	Futures(PP)	-0.259911	-1.312269	-1.489420	-144.0882	-144.0845	-144.0874
JP ASSOCIATE	Equity (DF)	-0.263536	-1.350626	-1.542563	-60.70368	-60.70219	-60.70784
	Equity (PP)	-0.265347	-1.348663	-1.539751	-141.8082	-141.8046	-141.8068
	Futures(DF)	1.743849	-1.816960	-2.312769	-91.13867	-91.17881	-91.19980
JSW STEEL	Futures(PP)	1.779033	-1.827383	-2.279003	-217.7925	-217.8486	-217.8777
	Equity (DF)	1.694366	-1.828616	-2.332755	-90.70128	-90.74017	-90.76105
	Equity (PP)	1.733778	-1.845194	-2.297344	-211.7325	-211.7801	-211.8054
L&T	Futures(DF)	-0.360404	-2.675722	-2.686443	-62.82011	-62.81884	-62.81775
	Futures(PP)	-0.356862	-2.670491	-2.680818	-146.9134	-146.9099	-146.9066
	Equity (DF)	-0.370733	-2.708077	-2.714657	-62.52146	-62.52024	-62.51901
MARUTI	Equity (PP)	-0.364188	-2.680647	-2.686762	-144.9501	-144.9466	-144.9432
	Futures(DF)	-0.439449	-1.404999	-2.010184	-87.67902	-87.67794	-87.69399
	Futures(PP)	-0.446579	-1.422800	-2.020888	-208.4515	-208.4490	-208.4612
MARUTI	Equity (DF)	-0.436956	-1.385772	-1.998078	-87.40711	-87.40603	-87.42257
	Equity (PP)	-0.443195	-1.400421	-2.006032	-206.6765	-206.6740	-206.6850
	Futures(DF)	-0.963156	-1.249566	-1.526324	-60.22592	-60.23077	-60.23119
MARUTI	Futures(PP)	-0.956430	-1.260799	-1.539697	-142.9228	-142.9251	-142.9230
	Equity (DF)	-0.965158	-1.225075	-1.518015	-59.82967	-59.83469	-59.83527
	Equity (PP)	-0.958795	-1.237969	-1.532552	-143.1229	-143.1250	-143.1230
MARUTI	Futures(DF)	0.497433	-2.018981	-1.279544	-86.60904	-86.61736	-86.63441
	Futures(PP)	0.486598	-2.005202	-1.287093	-201.6057	-201.6091	-201.6179
	Equity (DF)	0.519215	-2.012525	-1.210774	-88.31890	-88.32747	-88.34538
MARUTI	Equity (PP)	0.496292	-2.004396	-1.245679	-211.9531	-211.9589	-211.9727
	Futures(DF)	-0.736568	-1.622199	-1.643354	-60.25140	-60.25336	-60.25264
	Futures(PP)	-0.754283	-1.640708	-1.660081	-144.6675	-144.6672	-144.6642
MARUTI	Equity (DF)	-0.746675	-1.599277	-1.623213	-60.54451	-60.54669	-60.54634
	Equity (PP)	-0.761689	-1.631424	-1.653502	-144.4117	-144.4115	-144.4089

Intraday Lead/Lag Relationships between the Futures and Spot Market

PNB	Futures(DF)	1.052481	--1.153350	-1.591155	-90.69879	-90.71096	-90.71231
	Futures(PP)	1.028829	-1.162855	-1.630525	-210.1224	-210.1351	-210.1353
	Equity (DF)	1.044177	-1.179695	-1.547258	-90.69852	-90.71077	-90.71249
	Equity (PP)	1.020210	-1.187157	-1.586341	-207.5266	-207.5379	-207.5382
RANBAXY	Futures(DF)	-0.375205	-1.717554	-1.594885	-65.06009	-65.05872	-65.06173
	Futures(PP)	-0.366357	-1.483055	-1.257299	-143.7465	-147.7427	-147.7480
	Equity (DF)	-0.375672	-1.738221	-1.620650	-64.84080	-64.83944	-64.84239
RCOM.	Equity (PP)	-0.364793	-1.493962	-1.266704	-146.8853	-146.8814	-146.8868
	Futures(DF)	-1.065103	-1.279538	-1.946308	-87.90509	-87.91046	-87.91172
	Futures(PP)	-1.071701	-1.296314	-1.956986	-202.1678	-202.1701	-202.1693
RELIANCE CAPITAL	Equity (DF)	-1.068604	-1.238388	-1.915379	-88.18351	-88.18920	-88.19059
	Equity (PP)	-1.07201	-1.271088	-1.945729	-205.5409	-205.5436	-205.5429
	Futures(DF)	-0.331934	-1.726229	-1.689244	-87.88820	-87.88712	-87.89191
RELIANCE INFRA	Futures(PP)	-0.333091	-1.715121	-1.677929	-201.8254	-201.8230	-201.8243
	Equity (DF)	-0.319935	-1.658493	-1.621385	-87.33201	-87.33093	-87.33612
	Equity (PP)	-0.324714	-1.679138	-1.642196	-208.2344	-208.2319	-208.2340
RELIANCE POWER	Futures(DF)	-1.236416	-1.360699	-2.514370	-79.32633	-79.33420	-79.33601
	Futures(PP)	-1.218898	-1.348441	-2.522791	-185.8674	-185.8709	-185.8704
	Equity (DF)	-1.267378	-1.334297	-2.482895	-79.47322	-79.48167	-79.48349
RELIANCE SAIL	Equity (PP)	-1.248942	-1.321646	-2.491285	-185.0740	-185.0775	-185.0770
	Futures(DF)	-0.999086	-2.356972	-2.609182	-81.6603	-81.76950	-81.76846
	Futures(PP)	-0.999668	-2.396595	-2.649074	-189.4116	-189.4129	-189.4102
SAIL	Equity (DF)	-1.008351	-2.350426	-2.607769	-81.88421	-81.88780	-81.88678
	Equity (PP)	-1.011121	-2.390952	-2.647375	-188.1029	-188.1041	-188.1015
	Futures (DF)	0.266037	-2.238006	-1.560539	-89.05318	-89.05962	-89.08356
SBI	Futures(PP)	0.270801	-2.273091	-1.587682	-209.0375	-209.0427	-209.0659
	Equity (DF)	0.280174	-2.246068	-1.554891	-88.19609	-88.20281	-88.22795
	Equity (PP)	0.273703	-2.280348	-1.579321	-204.7299	-204.7343	-204.7555
SESAGOA	Futures(DF)	0.549310	-1.506361	-2.364179	-87.85982	-87.86686	-87.86838
	Futures(PP)	0.708092	-1.415696	-2.012995	-205.2293	-205.2377	-205.2385
	Equity (DF)	-0.513880	-1.535405	-2.410391	-88.04609	-88.05294	-88.05451
TATA MOTORS	Equity (PP)	0.675058	-1.435103	-2.040159	-205.2668	-205.2752	-205.2762
	Futures(DF)	0.285630	-1.971245	-0.920754	-90.88759	-90.90267	-90.94245
	Futures(PP)	0.285833	-1.984857	-0.931016	-206.5826	-206.5976	-206.6398
TATA STEEL	Equity (DF)	0.295889	-1.953299	-0.866468	-89.80431	-89.81961	-89.86094
	Equity (PP)	0.291093	-1.964483	-0.883399	-203.9303	-203.9432	-203.9808
	Futures(DF)	0.925894	-1.193296	-3.440544	-91.02844	-91.06355	-91.07634
UNITECH	Futures(PP)	1.192229	-1.121289	-2.920139	-206.5037	-206.5600	-206.5800
	Equity (DF)	0.879728	-1.215054	-3.528307	-90.50681	-90.54129	-90.55379
	Equity (PP)	1.144225	-1.136964	-2.990927	-204.7606	-204.8123	-204.8305
WIPRO	Futures(DF)	0.444147	-1.938056	-2.155261	-90.27227	-90.28142	-90.28808
	Futures(PP)	0.555841	-1.893426	-1.970370	-204.8873	-204.8987	-204.9067
	Equity (DF)	0.452460	-1.938997	-2.126235	-89.71717	-89.72650	-89.73342
WIPRO	Equity (PP)	0.562065	-1.897605	-1.947885	-204.3263	-204.3375	-204.3456
	Futures(DF)	-0.432789	-1.443654	-1.305694	-89.84288	-89.84174	-89.85984
	Futures(PP)	-0.432595	-1.446383	-1.307680	-203.0574	-203.0548	-203.0679
WIPRO	Equity (DF)	-0.425701	-1.393629	-1.273182	-89.29855	-89.29743	-89.31799
	Equity (PP)	-0.431184	-1.422607	-1.303254	-203.8094	-203.8069	-203.8215
	Futures(DF)	-1.303261	-2.348025	-2.067465	-62.62808	-62.63179	-62.64156
WIPRO	Futures(PP)	-1.319159	-2.327100	-2.022163	-141.7091	-141.7111	-141.7199
	Equity (DF)	-1.296445	-2.362103	-2.111463	-62.65360	-62.65723	-62.66635
	Equity (PP)	-1.315843	-2.340718	-2.061931	-140.1395	-140.1413	-140.1490

### 4.3. Cointegration Test

Since all price series are non-stationary and integrated of the same order, cointegration is therefore the preferred tool when analyzing the relationship

between the price series. One of the ways to investigate the presence of cointegration is the residual based approach which indicates that linear combination ( $U_t$ ) of non-stationary spot and futures price series of all the individual securities i.e. residual, is stationary. Table 3 reports the results of residual based approach. In case of all the individual securities ADF and PP tests rejected the null hypothesis of presence of unit root in residuals. Thus, from the results, it appears that two time series are having a long-term or equilibrium relationship.

**Table 3: Unit Root Tests for Residual**

Company	Augmented Dickey Fuller Test			Phillip Perron Test		
	Without Intercept	With Intercept	With Intercept and Trend	Without Intercept	With Intercept	With Intercept and Trend
ABAN	-12.38984	-12.38964	-12.77511	-18.01795	-18.01736	-18.83890
AXIS BANK	-6.939447	-6.939257	-7.862264	-9.624426	-9.623767	-11.34446
BAJAJ HIND	-14.56869	-14.56829	-14.85633	-44.93147	-44.93039	-46.11242
BANK OF BARODA	-5.962193	-5.962028	-6.011116	-8.678429	-8.677743	-8.760629
BHEL	-18.53814	-18.53790	-18.53780	-44.04228	-44.04164	-44.04124
DLF	-10.94980	-10.94963	-11.28662	-15.44997	-15.44944	-16.18237
HDFC BANK	-14.97696	-14.97677	-14.97557	-26.13707	-26.13652	-26.13831
HINDALCO	-8.744121	-8.743887	-8.763254	-14.05317	-14.05238	-14.10035
HINDSUTANLEVER	-10.13393	-10.13371	-10.18994	-13.21253	-13.21189	-13.32086
ICICI BANK	-11.61557	-11.61542	-11.66409	-14.78715	-14.78672	-14.86779
IDBI	-49.39321	-49.39239	-49.41515	-45.39878	-45.39791	-45.41223
IDFC	-28.63518	-28.63442	-30.07941	-39.79572	-39.79467	-41.89471
INFOSYSTECH	-13.66309	-13.66292	-13.68462	-25.02204	-25.02149	-25.07395
JINDAL STEEL	-10.25085	-10.25057	-10.49635	-19.42990	-19.42901	-20.09843
JP ASSOCIATE	-18.03568	-18.03545	-19.32035	-44.19294	-44.19231	-49.18554
JSW STEEL	-7.790200	-7.789994	-8.415274	-15.02521	-16.89775	-16.02435
L&T	-15.22204	-15.22184	-15.51185	-31.01581	-31.01522	-31.95078
MARUTI	-7.777270	-7.777036	-7.774865	-11.13751	-11.13682	-11.14747
PNB	-11.69784	-11.69769	-11.71321	-19.95724	-19.95671	-20.02214
RANBAXY	-15.08169	-15.08129	-15.13341	-44.05008	-44.04901	-44.88471
RCOM.	-20.16612	-20.16587	-22.25127	-72.02094	-72.02026	-82.75619
RELIANCECAPITAL	-13.80720	-13.80702	-14.05695	-35.30542	-35.30481	-36.32154
RELIANCE INFRA	-13.46278	-13.46259	-14.18446	-30.23504	-30.23435	-33.00380
RPOWER	-14.44083	-14.44061	-14.76274	-30.95465	-30.95399	-32.02966
SAIL	-36.47094	-36.47048	-36.73350	-101.2444	-101.2436	-101.8765
SBI	-31.55595	-31.55555	-31.74954	-143.0581	-143.0572	-143.8153
SESAGOA	-8.044331	-8.044232	-8.677849	-9.487786	-9.487452	-10.42896
TATA MOTORS	-13.40128	-13.40112	-13.41981	-30.93275	-30.93215	-31.00776
TATA STEEL	-12.38298	-12.38282	-12.60868	-24.66949	-24.66892	-25.38925
UNITECH	-8.418961	-8.419750	-9.206417	-9.673238	-9.672979	-10.71300
WIPRO	-11.85807	-11.85774	-11.85870	-20.12452	-20.12364	-20.12974

#### 4.4. Granger Causality Test

The information inputs regarding Granger causality test i.e. the cause and effect relationship between the two return series are reported in table 4. The results exhibited that out of 31 sample securities, 30 securities have shown bi-lateral (feed-back) relationship. Therefore, we may say that futures (spot) prices may contain additional information for the prediction of prices in the spot (futures) market. Whereas, only one security i.e. Wipro shows that only spot prices contain

information for the prediction of prices in the futures market but not the vice versa. It is also worthwhile to mention here that Granger causality depends critically on the number of lagged terms introduced in the model\*. Due to this reason, results derived from Granger causality may not be authentic. It is pertinent to mention here that number of lags chosen for Granger causality test are based on AIC (Akaike Information Criteria) and SIC (Schwartz Information Criteria).

**Table 4: Granger Causality Test**

Symbol	Dependent \ Independent	F-Value	
		Futures	Equity
ABAN	Futures		34.5014 (0.0000)
	Equity	10.5874 (0.0000)	
AXIS BANK	Futures		22.2769 (0.0000)
	Equity	11.3858 (0.0000)	
BAJAJ HIND	Futures		63.4269 (0.0000)
	Equity	28.9560 (0.0000)	
BANK OF BARODA	Futures		52.5344 (0.0000)
	Equity	27.4158 (0.0000)	
BHEL	Futures		248.034 (0.0000)
	Equity	7.87081 (0.0000)	
DLF	Futures		29.0572 (0.0000)
	Equity	16.3348 (0.0000)	
HDFC BANK	Futures		33.7492 (0.0000)
	Equity	13.3545 (0.0000)	
HINDALCO	Futures		18.5329 (0.0000)
	Equity	8.87663 (0.0000)	
HINDUSTAN UNILEVER	Futures		76.9478 (0.0000)
	Equity	20.0658 (0.0000)	
ICICI BANK	Futures		15.4155 (0.0000)
	Equity	14.7125 (0.0000)	
IDBI	Futures		946.820 (0.0000)
	Equity	10.8076 (0.0000)	
IDFC	Futures		169.667 (0.0000)
	Equity	304.721 (0.0000)	
INFOSYS TECH	Futures		66.7571 (0.0000)
	Equity	16.1569 (0.0000)	
JINDAL STEEL	Futures		36.8124 (0.0000)
	Equity	11.1230 (0.0000)	
JP ASSOCIATE	Futures		34.2084 (0.0000)
	Equity	9.71874 (0.0000)	
JSW STEEL	Futures		15.9423 (0.0000)
	Equity	31.4658 (0.0000)	
L&T	Futures		77.0700 (0.0000)
	Equity	20.8793 (0.0000)	
MARUTI	Futures		41.6440 (0.0000)
	Equity	17.9837 (0.0000)	
PNB	Futures		170.687 (0.0000)
	Equity	26.29992 (0.0000)	
RANBAXY	Futures		14.8325 (0.0000)
	Equity	55.9398 (0.0000)	
RCOM	Futures		610.798 (0.0000)
	Equity	7.75849 (0.0000)	
RELIANCE CAPITAL	Futures		140.049 (0.0000)

\* Gujarati fourth edition, Example 17.13, pp. 714

	Equity	26.7534 (0.0000)	
	Futures		30.2486 (0.0000)
RELIANCE INFRA	Equity	26.4366 (0.0000)	
	Futures		69.9685 (0.0000)
RELIANCE POWER	Equity	21.1946 (0.0000)	
	Futures		1964.26 (0.0000)
SAIL	Equity	9.05568 (0.0000)	
	Futures		21990.1 (0.0000)
SBI	Equity	6.20721 (0.0000)	
	Futures		36.6150 (0.0000)
SESAGOA	Equity	29.7871 (0.0000)	
	Futures		3.22174 (0.0020)
TATA MOTORS	Equity	683.051 (0.0000)	
	Futures		226.596 (0.0000)
TATA STEEL	Equity	3.37831 (0.0007)	
	Futures		77.0508 (0.0000)
UNITECH	Equity	9.70384 (0.0000)	
	Futures		19.8942 (0.0000)
WIPRO*	Equity	0.70849 (0.6844)	

(\*) Testifies that securities are having Unilateral Causality and Values in ( ) Parentheses are P-Values

#### 4.5. Johansen's Cointegration Test

In addition to residual based approach and Granger causality test, another technique to test the cointegration between the spot and futures price series is, Johansen's cointegration test. Johansen's cointegration test has two parts i.e.  $\lambda_{\max}$  and  $\lambda_{\text{Trace}}$  to determine the rank of the coefficient  $\Pi$  matrix. The results of above mentioned two variables are reported in table 5. The maximum eigen value and trace test suggest that all the securities are showing one cointegration relationships. The conclusion must therefore be that spot and futures prices are cointegrated and hence there is a long-run relationship between the price series. In other words, spot and futures prices share common long-run information. The results are consistent with the results of (Gupta and Singh, 2006; Pradhan and Bhat, 2009).

**Table 5: Johansen's Cointegration Test**

Symbol	Vector	Test Statistics		Critical Value (5%)		Critical Value (1%)	
		$\lambda_{\text{Trace}}$	$\lambda_{\text{Max}}$	$\lambda_{\text{Trace}}$	$\lambda_{\text{Max}}$	$\lambda_{\text{Trace}}$	$\lambda_{\text{Max}}$
ABAN	0	168.8353	158.1258	25.32	18.96	30.45	23.65
	1	10.70942	10.70942	12.25	12.25	16.26	16.26
AXIS BANK	0	57.26193	52.67269	25.32	18.96	30.45	23.65
	1	4.589233	4.589233	12.25	12.25	16.26	16.26
BAJAJ HIND	0	123.0127	121.3058	25.32	18.96	30.45	23.65
	1	1.706877	1.706877	12.25	12.25	16.26	16.26
BANK OF BARODA	0	35.81629	31.86595	25.32	18.96	30.45	23.65
	1	3.950336	3.950336	12.25	12.25	16.26	16.26
BHEL	0	222.7638	215.9683	25.32	18.96	30.45	23.65
	1	6.795449	6.795449	12.25	12.25	16.26	16.26
DLF	0	108.7552	103.1336	25.32	18.96	30.45	23.65
	1	5.621543	5.621543	12.25	12.25	16.26	16.26
HDFC BANK	0	189.5011	184.2798	25.32	18.96	30.45	23.65
	1	5.221264	5.221264	12.25	12.25	16.26	16.26
HINDALCO	0	66.80557	62.46989	25.32	18.96	30.45	23.65
	1	4.335685	4.335685	12.25	12.25	16.26	16.26

### Intraday Lead/Lag Relationships between the Futures and Spot Market

HINDUSTAN UNILEVER	0	113.4574	104.8538	25.32	18.96	30.45	23.65
	1	8.603636	8.603636	12.25	12.25	16.26	16.26
ICICI BANK	0	121.6510	117.1343	25.32	18.96	30.45	23.65
	1	4.516702	4.516702	12.25	12.25	16.26	16.26
IDBI	0	121.6510	117.1343	25.32	18.96	30.45	23.65
	1	4.516702	4.516702	12.25	12.25	16.26	16.26
IDFC	0	828.6432	825.3868	25.32	18.96	30.45	23.65
	1	3.256413	3.256413	12.25	12.25	16.26	16.26
INFOSYS TECH	0	155.4959	147.4033	25.32	18.96	30.45	23.65
	1	8.092532	8.092532	12.25	12.25	16.26	16.26
JINDAL STEEL	0	81.85329	74.99364	25.32	18.96	30.45	23.65
	1	6.859650	6.859650	12.25	12.25	16.26	16.26
JP ASSOCIATE	0	297.9766	292.0157	25.32	18.96	30.45	23.65
	1	5.960981	5.960981	12.25	12.25	16.26	16.26
JSW STEEL	0	55.36337	52.70976	25.32	18.96	30.45	23.65
	1	2.653610	2.653610	12.25	12.25	16.26	16.26
L&T	0	205.1305	201.0496	25.32	18.96	30.45	23.65
	1	4.080973	4.080973	12.25	12.25	16.26	16.26
MARUTI	0	58.19721	55.24974	25.32	18.96	30.45	23.65
	1	2.947475	2.947475	12.25	12.25	16.26	16.26
PNB	0	108.1021	106.0367	25.32	18.96	30.45	23.65
	1	2.065338	2.065338	12.25	12.25	16.26	16.26
RANBAXY	0	130.1391	128.3546	25.32	18.96	30.45	23.65
	1	1.784498	1.784498	12.25	12.25	16.26	16.26
RCOM	0	316.1302	312.6926	25.32	18.96	30.45	23.65
	1	3.437565	3.437565	12.25	12.25	16.26	16.26
RELIANCE CAPITAL	0	141.4336	138.4730	25.32	18.96	30.45	23.65
	1	2.960617	2.960617	12.25	12.25	16.26	16.26
RELIANCE INFRA	0	173.1133	167.9921	25.32	18.96	30.45	23.65
	1	5.121157	5.121157	12.25	12.25	16.26	16.26
RELIANCE POWER	0	177.0109	170.5667	25.32	18.96	30.45	23.65
	1	6.444250	6.444250	12.25	12.25	16.26	16.26
SAIL	0	452.1671	445.2390	25.32	18.96	30.45	23.65
	1	6.928147	6.928147	12.25	12.25	16.26	16.26
SBI	0	193.9441	190.3639	25.32	18.96	30.45	23.65
	1	3.580219	3.580219	12.25	12.25	16.26	16.26
SESAGOA	0	85.44681	77.95118	25.32	18.96	30.45	23.65
	1	7.495626	7.495626	12.25	12.25	16.26	16.26
TATA MOTORS	0	122.9096	118.2857	25.32	18.96	30.45	23.65
	1	4.623937	4.623937	12.25	12.25	16.26	16.26
TATA STEEL	0	104.4078	100.6588	25.32	18.96	30.45	23.65
	1	3.748946	3.748946	12.25	12.25	16.26	16.26
UNITECH	0	108.5630	104.6643	25.32	18.96	30.45	23.65
	1	3.898756	3.899756	12.25	12.25	16.26	16.26
WIPRO	0	114.3364	109.1068	25.32	18.96	30.45	23.65
	1	5.229564	5.229564	12.25	12.25	16.26	16.26

## 5. Vector Error Correction Model

Since, cointegration is found between the spot and futures price series; VECM is an appropriate model to determine the direction of causality and lead-lag relationship between the spot and futures price series. The results of above mentioned two variables are reported in Table A1 (Appendix). The results retained and presented here based on VECM with one lag for Reliance Infra, Rpower and Tata Motors; two lags for JP Associates, Ranbaxy, Reliance Capital, ICICI Bank, IDBI, Infosystech, Sesagoa, Tata Steel, Wipro, Jindal Steel, L&T, Maruti, ABAN, Bank of Baroda,

Hindalco and SBI; three lags for Bajaj Hind, JSW Steel, Rcom, HDFC bank, Hindustan Unilever and SAIL; four lags for BHEL, DLF and Unitech; seven lags for PNB; eight lags for Axis bank and IDFC. Numbers of lags are chosen on the basis of AIC and SIC criteria.

The VECM results reveal that there is a feedback relation between two markets in case of 30 securities i.e. JP Associates, Ranbaxy, Reliance Capital, ICICI Bank, IDBI, Infosystech, Reliance Infra, Unitech, Axis bank, IDFC, PNB, SBI, RPower, Tata Motors, Bajaj Hind, JSW Steel, Rcom, HDFC bank, Hindustan Unilever, BHEL, DLF, SAIL, Sesagoa, Tata Steel, Jindal Steel, L&T, Maruti, ABAN, Bank of Baroda and Hindalco, since coefficients of lagged values of independent variable are significant in both the cases (spot and futures) and single stock is showing unilateral causality from spot to futures i.e. Wipro because coefficients of lagged value of spot price series as an independent variable are significant but not the vice versa. Results are consistent with the results of Granger causality test which suggests the bilateral causality in the same above mentioned 30 securities and unilateral causality in one stock i.e. Wipro. Error correction coefficient is used to find out the lead/lag relationship between spot and futures price series of the securities. Results reveal that 6 securities i.e. Tata Motors, Hindustan Unilever, L&T, JSW Steel, Unitech and Axis Bank are showing positive and significant error correction terms for spot while for futures it is negative and insignificant. This suggests that only spot returns respond to correct a shock in order to reach the long-run equilibrium.

Similarly 10 securities i.e. ICICI Bank, RCOM, HDFC Bank, Sesa Goa, Tata Steel, Maruti, Bank of Baroda, Hindalco, DLF and PNB are showing negative and significant error correction terms for futures while for spot it is positive but insignificant depicting that only futures return respond to correct a shock in order to reach the long-run equilibrium. 14 securities i.e. JP Associates, Ranbaxy, Reliance Capital, IDBI, Infosystech, Reliance Infra, RPower, Bajaj Hind, SAIL, Wipro, Jindal Steel, ABAN, BHEL and IDFC are showing significant positive/negative error correction terms for both spot and futures returns indicating that when cointegration vector is below/above equilibrium, both the returns (spot and futures) make adjustments to acquire the equilibrium positions.

As far as lead/lag relationship is concerned, futures is leading the spot price incase of 12 securities i.e. JP Associate, Ranbaxy, Reliance Infra, RPower, Tata Motors, Bajaj Hind, JSW Steel, Hindustan Unilevr, Wipro, L&T, Unitech and Axis Bank because the adjustment made by the futures prices to obtain its equilibrium position is lesser than the spot prices and 19 securities i.e. Reliance Capital, ICICI Bank, IDBI, Infosystech, RCOM., HDFC Bank, SAIL, Sesagoa, Tata Steel, Jindal Steel, Maruti, ABAN, Bank of Baroda, Hindalco, BHEL, DLF, IDFC, PNB and SBI are being led by the spot price series because adjustment made by the spot prices to obtain equilibrium position is lesser than the futures prices. F-Values given in the tables are used to check the overall significance of the model. Results depict that all 31 securities' VECM equations are having joint significance.



## 6. Conclusion

Present study tries to find out the role of spot and futures markets in the assimilation of information and price discovery in the Indian stock market. Using the high frequency (five minutes interval) data, the results of the study evidence the presence of long-run relationship between the two markets and therefore justify the use of VECM (Vector Error Correction Model). VECM results depict that in case of 12 securities, futures market is leading the spot and 19 securities are showing that they are being led by spot market. As far as, causality is concerned, VECM results are consistent with the results of Granger causality which suggest that 30 securities are showing feed-back (bi-lateral) causality whereas 1 security i.e. Wipro is depicting unilateral causality. Since most of the securities are showing causality either unilateral or bilateral, it appears that spot and futures markets are playing an important price discovery role implying that futures (spot) prices may contain useful information about spot (futures) prices.

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Appendix

Table A1: Vector Error Correction Model

Company Variables	JP ASSOCIATE		RANBAXY		RELIANCE CAPITAL	
	$\Delta F_t$	$\Delta S_t$	$\Delta F_t$	$\Delta S_t$	$\Delta F_t$	$\Delta S_t$
C	0.0000017 [ 0.06974]	0.0000014 [ 0.06132]	-0.00000465 [-0.18074]	-0.00000449 [-0.17645]	0.00000136 [ 0.06858]	0.00000130 [ 0.06565]
$E_{t-1}$	-0.031687* [-2.99861]	0.039003* [ 3.78987]	-0.030548* [-2.85660]	0.07526* [ 7.11803]	-0.028106* [-5.31701]	0.013291* [ 2.51898]
$\Delta F_{t-1}$	-0.265285* [-12.2608]	0.144094* [ 6.83810]	-0.138206* [-7.50437]	0.265736* [ 14.5937]	-0.336771* [-25.7396]	0.139835* [ 10.7072]
$\Delta S_{t-1}$	0.230482* [ 10.3940]	-0.184384* [-8.53797]	0.0952080* [ 5.16685]	-0.2895680* [-15.8939]	0.3528900* [ 26.7028]	-0.1775940* [-13.4629]
F-Statistics	<b>77.9268</b>	<b>47.38389</b>	<b>33.7899</b>	<b>134.1093</b>	<b>280.9381</b>	<b>76.40071</b>

  

Company Variables	ICICI BANK		IDBI		INFOSYSTECH	
	$\Delta F_t$	$\Delta S_t$	$\Delta F_t$	$\Delta S_t$	$\Delta F_t$	$\Delta S_t$
C	0.0000219 [ 1.06638]	0.0000217 [ 1.06342]	0.0000098 [ 0.41949]	0.0000091 [ 0.39037]	0.000028** [ 2.44771]	0.000028** [ 2.41433]
$E_{t-1}$	-0.009469*** [-1.88592]	0.004725 [ 0.94438]	-0.126971* [-41.5447]	0.031556* [ 10.2913]	-0.016175* [-3.74068]	0.008852** [ 2.05861]
$\Delta F_{t-1}$	-0.191772* [-8.01832]	0.197284* [ 8.27785]	0.003365 [ 0.53325]	-0.012028*** [-1.89980]	-0.377371* [-25.5319]	0.128209* [ 8.72287]
$\Delta F_{t-2}$	-0.081789* [-3.43840]	0.06835* [ 2.88355]	0.025877* [ 4.12120]	-0.020061* [-3.18459]	-0.151689* [-10.3912]	0.061254* [ 4.21961]
$\Delta S_{t-1}$	0.164215* [ 6.84159]	-0.225584* [-9.43153]	-0.0631330* [-9.53500]	-0.0162720** [-2.44953]	0.3088760* [ 20.7535]	-0.1824510* [-12.3276]
$\Delta S_{t-2}$	0.0896530* [ 3.75735]	-0.0599160** [-2.51992]	-0.0726010* [-11.0372]	0.0048910 [ 0.74113]	0.15115* [ 10.2987]	-0.057766* [-3.95800]
F-Statistics	<b>19.88803</b>	<b>23.42226</b>	<b>360.1908</b>	<b>31.02798</b>	<b>163.3921</b>	<b>48.29222</b>

  

Company Variables	RELIANCE INFRA		RPOWER		TATA MOTORS	
	$\Delta F_t$	$\Delta S_t$	$\Delta F_t$	$\Delta S_t$	$\Delta F_t$	$\Delta S_t$
C	-0.000020 [-1.12521]	-0.000021 [-1.17967]	-0.000012 [-0.78411]	-0.000012 [-0.80992]	0.000052** [ 2.27220]	0.000047** [ 2.16265]
$E_{t-1}$	-0.01737** [-2.10021]	0.039731* [ 4.91649]	-0.01962* [-3.56795]	0.029085* [ 5.35837]	-0.00042 [-0.14029]	0.036743* [ 12.9992]
$\Delta F_{t-1}$	-0.23216* [-12.3014]	0.17606* [ 9.54779]	-0.26136* [-18.8723]	0.135244* [ 9.89519]	-0.05152* [-6.18159]	0.423537* [ 53.5699]
$\Delta S_{t-1}$	0.228408* [ 11.8465]	-0.1875* [-9.95286]	0.246361* [ 17.5176]	-0.15864* [-11.4301]	0.025959* [ 3.10285]	-0.36169* [-45.5719]
F-Statistics	<b>58.58989</b>	<b>50.30732</b>	<b>137.5689</b>	<b>63.87268</b>	<b>16.30338</b>	<b>11.58091</b>

  

Company Variables	BAJAJ HIND		JSW STEEL		RCOM.	
	$\Delta F_t$	$\Delta S_t$	$\Delta F_t$	$\Delta S_t$	$\Delta F_t$	$\Delta S_t$
C	-0.000035 [-1.50915]	-0.000036 [-1.59909]	-0.000018 [-0.82127]	-0.000018 [-0.84774]	-0.000017 [-0.89929]	-0.000019 [-0.99461]
$E_{t-1}$	-0.02856* [-2.88373]	0.042196* [ 4.42543]	-0.00374 [-0.52526]	0.017071** [ 2.46435]	-0.07651* [-12.5792]	0.005628 [ 0.88745]
$\Delta F_{t-1}$	-0.38312* [-20.1950]	0.190491* [ 10.4304]	-0.24253* [-10.0126]	0.346708* [ 14.7242]	-0.54294* [-49.4607]	0.072971* [ 6.37557]
$\Delta F_{t-2}$	-0.23087* [-11.4109]	0.116457* [ 5.97917]	-0.16769* [-6.29937]	0.189061* [ 7.30604]	-0.31308* [-26.7524]	0.040605* [ 3.32764]
$\Delta F_{t-3}$	-0.10882* [-6.13991]	0.068733* [ 4.02830]	-0.10389* [-4.35589]	0.054725** [ 2.36034]	-0.12137* [-12.6385]	0.008462 [ 0.84511]
$\Delta S_{t-1}$	0.369411* [ 18.8669]	-0.22002* [-11.6727]	0.215389* [ 8.65876]	-0.38349* [-15.8588]	0.590692* [ 54.8327]	-0.09412* [-8.37916]
$\Delta S_{t-2}$	0.214974* [ 10.2816]	-0.13717* [-6.81470]	0.165805* [ 6.08276]	-0.19155* [-7.22873]	0.36047* [ 30.0532]	-0.02871** [-2.29591]
$\Delta S_{t-3}$	0.120201* [ 6.52578]	-0.05957* [-3.35937]	0.106664* [ 4.39232]	-0.04977** [-2.10841]	0.162602* [ 15.7888]	0.008689 [ 0.80914]
F-Statistics	<b>78.80444</b>	<b>33.13354</b>	<b>17.35279</b>	<b>41.67204</b>	<b>671.9403</b>	<b>19.14151</b>

Company Variables	HDFC BANK		HINDUSTAN UNILEVER		SAIL	
	$\Delta F_t$	$\Delta S_t$	$\Delta F_t$	$\Delta S_t$	$\Delta F_t$	$\Delta S_t$
C	0.000022 [ 1.40352]	0.000022 [ 1.40221]	0.000063 [ 0.32734]	0.000067 [ 0.34384]	0.0000134 [ 0.85811]	0.0000186 [ 1.07117]
$E_{t-1}$	-0.01826* [-3.48005]	0.006353 [ 1.21848]	-0.00711 [-1.54394]	0.009746** [ 2.10314]	-0.133078* [-33.0114]	0.008132*** [ 1.81650]
$\Delta F_{t-1}$	-0.31134* [-17.5863]	0.166328* [ 9.45477]	-0.270943* [-13.4040]	0.120808* [ 5.93920]	-0.263715* [-42.1475]	0.044929* [ 6.46632]
$\Delta F_{t-2}$	-0.16525* [-8.71640]	0.083509* [ 4.43266]	-0.141808* [-6.67282]	0.046773** [ 2.18715]	-0.238824* [-43.8294]	0.011794*** [ 1.94921]
$\Delta F_{t-3}$	-0.07652* [-4.39987]	0.036276** [ 2.09907]	-0.063973* [-3.19689]	0.003143 [ 0.15610]	-0.091535* [-17.7391]	0.003139 [ 0.54784]
$\Delta S_{t-1}$	0.256253* [ 14.3745]	-0.21639* [-12.2151]	0.246214* [ 12.2439]	-0.137518* [-6.79582]	0.217446* [ 34.8861]	-0.046892* [-6.77480]
$\Delta S_{t-2}$	0.163311* [ 8.57569]	-0.0871* [-4.60274]	0.128202* [ 6.07370]	-0.062543* [-2.94451]	0.4671690* [ 78.2299]	-0.0028240 [-0.42580]
$\Delta S_{t-3}$	0.074483* [ 4.25590]	-0.04153** [-2.38788]	0.058577* [ 2.93866]	-0.01164 [-0.58030]	0.177468* [ 29.1150]	-0.019917* [-2.94256]
<b>F-Statistics</b>	<b>62.63796</b>	<b>32.35951</b>	<b>28.61865</b>	<b>9.466355</b>	<b>1921.637</b>	<b>15.07743</b>

  

Company Variables	SESAGOA		TATA STEEL		WIPRO	
	$\Delta F_t$	$\Delta S_t$	$\Delta F_t$	$\Delta S_t$	$\Delta F_t$	$\Delta S_t$
C	0.000031 [ 1.52281]	0.000030 [ 1.55824]	0.0000249 [ 1.18013]	0.0000262 [ 1.24066]	-0.0000245 [-0.72923]	-0.0000246 [-0.72290]
$E_{t-1}$	-0.00949* [-3.89836]	-0.00056 [-0.23989]	-0.021698* [-5.60820]	0.00298 [ 0.77205]	0.02209*** [ 1.83567]	0.056061* [ 4.58774]
$\Delta F_{t-1}$	-0.21318* [-14.5828]	0.182215* [ 12.9658]	-0.471767* [-36.3922]	0.053421* [ 4.13106]	-0.466112* [-12.8727]	-0.012938 [-0.35187]
$\Delta F_{t-2}$	-0.09603* [-6.58153]	0.046097* [ 3.28647]	-0.197531* [-15.6705]	0.030781** [ 2.44794]	-0.165821* [-4.65660]	0.031324 [ 0.86623]
$\Delta S_{t-1}$	0.194253* [ 12.7727]	-0.20352* [-13.9199]	0.487139* [ 37.3040]	-0.074533* [-5.72164]	0.436564* [ 12.2450]	-0.008197 [-0.22642]
$\Delta S_{t-2}$	0.089893* [ 5.94618]	-0.04946* [-3.40300]	0.214372* [ 16.4042]	-0.034576** [-2.65233]	0.159786* [ 4.54355]	-0.031635 [-0.88584]
<b>F-Statistic</b>	<b>50.78997</b>	<b>39.60269</b>	<b>319.7172</b>	<b>9.086272</b>	<b>34.07605</b>	<b>6.337438</b>

  

Company Variables	JINDAL STEEL		L&T		MARUTI	
	$\Delta F_t$	$\Delta S_t$	$\Delta F_t$	$\Delta S_t$	$\Delta F_t$	$\Delta S_t$
C	-0.0000035 [-0.21044]	-0.0000036 [-0.21822]	0.000018 [ 1.19033]	0.000019 [ 1.20657]	-0.000010 [-0.61141]	-0.000010 [-0.63981]
$E_{t-1}$	-0.021171* [-3.28814]	0.011709*** [ 1.82076]	-0.008444 [-1.59935]	0.025894* [ 4.75397]	-0.010382* [-2.95977]	0.0042536 [ 1.21098]
$\Delta F_{t-1}$	-0.323483* [-16.6610]	0.15577* [ 8.03232]	-0.32176* [-20.4478]	0.141973* [ 8.74485]	-0.284512* [-17.5096]	0.1611871* [ 9.90614]
$\Delta F_{t-2}$	-0.146961* [-7.69903]	0.067605* [ 3.54586]	-0.1457440* [-9.64951]	0.0682570* [ 4.38017]	-0.11792* [-7.32327]	0.0629748* [ 3.90555]
$\Delta S_{t-1}$	0.277682* [ 14.2632]	-0.198612* [-10.2137]	0.3145530* [ 20.5615]	-0.1949510* [-12.3514]	0.2555113* [ 15.7048]	-0.1969048* [-12.0858]
$\Delta S_{t-2}$	0.1263130* [ 6.58451]	-0.0852730* [-4.45037]	0.169338* [ 11.2672]	-0.065439* [-4.22020]	0.131638* [ 8.12443]	-0.063437* [-3.90977]
<b>F-Statistics</b>	<b>68.24586</b>	<b>27.86298</b>	<b>96.08535</b>	<b>60.6252</b>	<b>68.13847</b>	<b>31.75939</b>

Intraday Lead/Lag Relationships between the Futures and Spot Market

Company Variables	ABAN		BANK OF BARODA		HINDALCO	
	$\Delta F_t$	$\Delta S_t$	$\Delta F_t$	$\Delta S_t$	$\Delta F_t$	$\Delta S_t$
C	-0.00001650 [-0.78203]	-0.00001710 [-0.85080]	0.00002180 [1.27807]	0.00002070 [1.24673]	0.000006650 [0.33378]	0.000006700 [0.33602]
$E_{t-1}$	-0.016350* [-2.80652]	0.013672** [2.46910]	-0.008705* [-3.20394]	0.002242 [0.84721]	-0.018118* [-2.68911]	0.002781 [0.41255]
$\Delta F_{t-1}$	-0.282817* [-15.1357]	0.131897* [7.42658]	-0.321431* [-22.7064]	0.176846* [12.8251]	-0.259290* [-10.2100]	0.208437* [8.20404]
$\Delta F_{t-2}$	-0.114465* [-6.21081]	0.073289* [4.18381]	-0.133259* [-9.46806]	0.083923* [6.12137]	-0.135085* [-5.37243]	0.070092* [2.78643]
$\Delta S_{t-1}$	0.286734* [14.6108]	-0.148145* [-7.94223]	0.269157* [18.4905]	-0.229310* [-16.1722]	0.233652* [9.19265]	-0.233450* [-9.18074]
$\Delta S_{t-2}$	0.133253* [6.86552]	-0.062851* [-3.40695]	0.114943* [7.93422]	-0.100372* [-7.11275]	0.137683* [5.47246]	-0.065535* [-2.60367]
<b>F-Statistics</b>	<b>53.99913</b>	<b>17.40520</b>	<b>111.7261</b>	<b>55.4012</b>	<b>26.25265</b>	<b>18.73109</b>

  

Company Variables	BHEL		DLF		UNITECH	
	$\Delta F_t$	$\Delta S_t$	$\Delta F_t$	$\Delta S_t$	$\Delta F_t$	$\Delta S_t$
C	0.0000105 [0.69752]	0.0000111 [0.73342]	-0.0000125 [-0.68718]	-0.0000128 [-0.71835]	-0.000000380 [-0.01442]	-0.000001150 [-0.04614]
$E_{t-1}$	-0.020837* [-4.10105]	0.01775* [3.45623]	-0.010649** [-2.04897]	0.004912 [0.96759]	0.001109 [0.64055]	0.007969* [4.86886]
$\Delta F_{t-1}$	-0.44765* [-34.4985]	0.061171* [4.66370]	-0.263096* [-12.1871]	0.1937* [9.18548]	-0.282396* [-22.8531]	0.070091* [6.00129]
$\Delta F_{t-2}$	-0.34701* [-24.7350]	-0.0029 [-0.20464]	-0.19984* [-8.51194]	0.039564*** [1.72516]	-0.048068* [-3.67175]	0.086655* [7.00339]
$\Delta F_{t-3}$	-0.20436* [-14.7754]	0.016999 [1.21588]	-0.124513* [-5.32168]	0.006904 [0.30207]	0.038317* [2.92757]	0.022888*** [1.85023]
$\Delta F_{t-4}$	-0.10337* [-8.41268]	-0.01323 [-1.06480]	-0.077826* [-3.65580]	-0.015294 [-0.73547]	-0.036376* [-2.97502]	0.004041 [0.34964]
$\Delta S_{t-1}$	0.426526* [33.0986]	-0.09675* [-7.42728]	0.240542* [10.8868]	-0.228488* [-10.5867]	0.305742* [23.4142]	-0.09411* [-7.62528]
$\Delta S_{t-2}$	0.338486* [24.0806]	-0.01765 [-1.24249]	0.221471* [9.20510]	-0.025003 [-1.06387]	0.045654* [3.27224]	-0.084992* [-6.44526]
$\Delta S_{t-3}$	0.227208* [16.2672]	-0.00557 [-0.39469]	0.150363* [6.26444]	0.011975 [0.51075]	-0.01944 [-1.39558]	-0.00918 [-0.69748]
$\Delta S_{t-4}$	0.093882* [7.48667]	-0.00788 [-0.62134]	0.075589* [3.46150]	0.009947 [0.46632]	0.044246* [3.37842]	-0.018447 [-1.49028]
<b>F-Statistics</b>	<b>173.1666</b>	<b>17.88685</b>	<b>25.22461</b>	<b>18.75764</b>	<b>75.25676</b>	<b>15.91557</b>

Company Variables	AXIS BANK		IDFC		PNB	
	$\Delta F_t$	$\Delta S_t$	$\Delta F_t$	$\Delta S_t$	$\Delta F_t$	$\Delta S_t$
C	0.0000078 [ 0.49246]	0.0000072 [ 0.44620]	-0.0000020 [-0.11509]	-0.0000016 [-0.09232]	0.000020 [ 1.34483]	0.000020 [ 1.38209]
$E_{t-1}$	-0.003507 [-0.70202]	0.008452*** [ 1.66282]	-0.09575* [-23.5408]	0.044631* [ 11.1118]	-0.012019* [-4.30638]	0.000944 [ 0.34196]
$\Delta F_{t-1}$	-0.30307* [-13.1320]	0.201769* [ 8.59283]	-0.019954* [-2.65128]	0.324076* [ 43.6054]	-0.414669* [-36.2255]	0.141075* [ 12.4652]
$\Delta F_{t-2}$	-0.193083* [-7.52008]	0.105794* [ 4.04979]	0.006312 [ 0.79977]	0.029043* [ 3.72663]	-0.278004* [-21.4392]	0.046227* [ 3.60567]
$\Delta F_{t-3}$	-0.173248* [-6.54042]	-0.003339 [-0.12389]	0.000545 [ 0.06924]	-0.00231 [-0.29720]	-0.157031* [-11.7244]	0.066017* [ 4.98532]
$\Delta F_{t-4}$	-0.122102* [-4.57457]	-0.010905 [-0.40154]	0.028114* [ 3.59573]	-0.004236 [-0.54858]	-0.077886* [-5.75328]	0.043517* [ 3.25127]
$\Delta F_{t-5}$	-0.09698* [-3.63750]	-0.019173 [-0.70681]	-0.000647 [-0.08291]	-0.016818** [-2.18114]	-0.02949** [-2.21045]	0.076783* [ 5.82107]
$\Delta F_{t-6}$	-0.075725* [-2.86810]	-0.019775 [-0.73614]	-0.024394* [-3.12963]	-0.011664 [-1.51533]	-0.009845 [-0.76641]	0.051506* [ 4.05546]
$\Delta F_{t-7}$	-0.056584** [-2.21683]	-0.032331 [-1.24496]	-0.01046 [-1.35494]	-0.020272* [-2.65913]	-0.010584 [-0.94902]	0.006227 [ 0.56468]
$\Delta F_{t-8}$	-0.037792*** [-1.65915]	-0.024581 [-1.06067]	-0.026249* [-3.45145]	-0.013624*** [-1.81406]	-	-
$\Delta S_{t-1}$	0.272597* [ 12.0058]	-0.222704* [-9.64029]	-0.006912 [-0.84623]	-0.076498* [-9.48460]	0.402751* [ 34.7523]	-0.171041* [-14.9272]
$\Delta S_{t-2}$	0.196703* [ 7.79250]	-0.089982* [-3.50361]	0.040788* [ 5.00660]	0.0177** [ 2.20016]	0.249956* [ 18.9681]	-0.078681* [-6.03895]
$\Delta S_{t-3}$	0.192817* [ 7.41408]	0.029164 [ 1.10216]	-0.047347* [-5.85368]	0.009827 [ 1.23038]	0.168403* [ 12.3805]	-0.059726* [-4.44103]
$\Delta S_{t-4}$	0.130312* [ 4.97210]	0.017062 [ 0.63985]	-0.036629* [-4.54470]	0.032586* [ 4.09425]	0.06276* [ 4.56219]	-0.058537* [-4.30383]
$\Delta S_{t-5}$	0.102274* [ 3.90375]	0.0234 [ 0.87786]	0.013425*** [ 1.66872]	0.014809*** [ 1.86410]	0.045972* [ 3.38582]	-0.066085* [-4.92278]
$\Delta S_{t-6}$	0.07368* [ 2.83698]	0.022286 [ 0.84339]	-0.033183* [-4.14662]	-0.0019 [-0.24046]	0.008476 [ 0.64571]	-0.052627* [-4.05484]
$\Delta S_{t-7}$	0.068369* [ 2.72360]	0.050017*** [ 1.95837]	-0.002067 [-0.25988]	0.02164* [ 2.75482]	0.02273** [ 1.97380]	0.007642 [ 0.67118]
$\Delta S_{t-8}$	0.033173 [ 1.47969]	0.024948 [ 1.09376]	0.194534* [ 26.4668]	0.02904* [ 4.00101]	-	-
<b>F-Statistics</b>	<b>13.00835</b>	<b>8.330528</b>	<b>119.0054</b>	<b>154.3916</b>	<b>105.2657</b>	<b>21.95452</b>

Company Variables	SBI	
	$\Delta F_t$	$\Delta S_t$
C	0.0000039 [ 0.51547]	0.0000183 [ 1.08139]
$E_{t-1}$	-0.052585* [-26.2897]	0.011567* [ 2.59789]
$\Delta F_{t-1}$	-0.420597* [-90.3807]	0.013355* [ 1.28928]
$\Delta F_{t-2}$	-0.033965* [-14.8090]	0.009058*** [ 1.77420]
$\Delta S_{t-1}$	0.840909* [ 283.411]	-0.018899* [-2.86155]
$\Delta S_{t-2}$	0.410281* [ 88.6292]	-0.00739 [-0.71720]
<b>F-Statistics</b>	<b>30.99707</b>	<b>9.180974</b>

Note: (\*) testifies that values are significant at 1% level (critical Value: 2.58). (\*\*) testifies that values are significant at 5% level (Critical Value: 1.96). (\*\*\*) testifies that values are significant at 10% level (Critical Value: 1.65).