Available online at www.elixirpublishers.com (Elixir International Journal)

Finance Management

Elixir Fin. Mgmt. 66 (2014) 20709-20716

ISSN: 2229-712X

Role of Futures in Price Discovery Process in Indian Stock Market

Govind Chandra Patra[1,*] and Shakti Ranjan Mohapatra[2]

[1]Asia Pacific Institute of Management, New Delhi, India, PIN – 110025.

[2]Faculty of Management, Biju Patnaik University of Technology (BPUT), Rourkela, Orissa.

ARTICLE INFO

Article history:

Received: 21 October 2013;

Received in revised form:

25 November 2013;

Accepted: 13 January 2014;

Keywords

Stock,

Market,

Granger,

Volatility.

ABSTRACT

After more than a decade of derivatives trading in Indian bourses, our markets have experienced a sea change in activity, behavior and trade in different instruments and products available. Here in this paper, we have examined and compared which market among cash and futures reacts to the flow of information faster and hence leads the other. A cross correlation test followed by Granger casualty, VAR and GARCH models establish relationship between returns and volatilities being experienced by some of the blue chip sensex stocks in two different markets. Our results suggest that there exists a strong bi-directional and contemporaneous relationship among the returns in the spot and futures market. The results for few stocks indicate lagged futures return coefficient is significant which means futures play a leading role in explaining the movement in the spot market. Also for some other stocks, exact reverse situation is observed showing significant leading futures return coefficient which means spot market returns lead the other. As far as interdependence among stock return volatility is concerned, it has been found that for more number of stocks, volatility spillover from futures to spot market is significant. This implies that stock futures market play a leading role both in terms of return and volatility thereby contributing in price discovery process.

Introduction

With an objective of achieving greater stabilization in markets, price discovery and tools to manage risk, derivatives instruments were introduced in Indian stock exchanges in the beginning of twenty first century. Worldwide, activity and trade in futures market has grown rapidly since it contributes in achieving economic functions such as price discovery, liquidity enhancement, portfolio diversification, speculation and hedging. Thus, here it is our objective to study whether futures trade has achieved its major objective discovering price of underlying assets and leading the other markets. It becomes pertinent to understand the influence of one market over the other and their reaction to flow of information. Whichever market reacts faster to the information flow is termed to lead the other market. In an efficient market condition, it is expected that all available information is fully and instantaneously absorbed to determine market price of securities. Thus, derivatives and spot markets should move simultaneously without any lead-lag. However, due to market frictions such as transaction costs, capital market microstructure effects etc., significant lead-lag relationship between different markets is observed. Thus, we have regressed high frequency data of five minutes interval in cash and futures markets to establish the lead-lag relationship between the two.

Literature Review

Some of the studies that have thrown light on price discovery process in volatile markets are Kawaller, Koch and Koch (1987), Stoll and Whaley (1990), Chan (1991), Jong and Nijman (1997), De Jong (1998), Chatrath (1998), Abhyankar (1998), Pizzi et al (1999), Min (1999), Booth et.al. (1999), Frino (2000) and Roope et.al. (2002). Prominent studies made in Indian stock markets after the introduction of derivatives are Thenmozhi (2002), Anand Babu (2003), Mukherjee and Mishra (2006), Pati and Padhan (2009), Srinivasan (2009) etc. Almost all of these studies have concluded that there exists a significant lead-lag relationship between spot and futures and/or options market. Some of them have also tried to establish the possible explanation behind this. Most of the studies have suggested that the leading role of futures varies from five to thirty minutes, while the spot market rarely leads the other beyond five minutes.

Kawaller et.al. (1987) examined the intra day price relationship between S&P 500 index and index futures. Their results show that both S&P 500 spot and futures markets are simultaneously related on a minute to minute basis throughout the trading day, and that a lead lag relationship also exists. The lead from futures to cash appears to be more pronounced relative to cash to futures markets. Chan (1991) and Ghosh (1993) further report the dominant role of S&P 500 futures index in the price discovery process.

Stoll and Whaley (1990) investigated casual relationship between spot and futures markets using intraday data for both S&P 500 and the Major Market Index (MMI). Feedback was detected, but the futures lead was observed to be stronger.

Chan (1991) had examined the intraday relationship among price changes and volatility of price changes in the stock index and index futures markets. Unlike the fact that the index futures markets served as the primary market for price discovery as already found in previous studies, they had found stronger interdependence in both the directions in the volatility of return between the cash and futures markets than that observed in case of return only. Their evidence supported that the price innovations originate in one market, e.g. cash (futures) market, can predict the future volatility in the other, such as futures (cash) market. In other words, both cash and futures markets serve important role in price discovery.

Jong and Nijman (1997) in their paper have developed a method for estimating co variances of non-stationary time series

Tele:

E-mail addresses: govindpatra@yahoo.com

with irregularly spaced observations to test the lead lag relationship among the financial markets. Their main aim was precisely to estimate the auto co-variances and cross co-variances between the true return processes, purged for the spurious correlations induced by non-synchronous trading. The analysis on one minute frequency data revealed that the futures lead the cash market by at least ten minutes, whereas the cash index leads the futures by at most two minutes.

Chatrath (1998) had examined the intra-day behaviour of the spot and futures market following the release of information and also investigated the role of such information in the volatility spillover among the two markets. Their results have supported that one market leading to greater volatility in the other is partly driven by information and therefore the leading role played by the futures market may be the result of new information efficiently reflected in the futures market.

Abhyankar (1998) had tried to capture the linear and non-linear casual relationship between the index futures and spot market. Their results evidenced that the index futures tend to lead the spot index by about five to fifteen minutes. The linear lead-lag relationship was found to persist even after the return series were adjusted for volatility persistence. Their most important finding was that if non linear effects are taken into consideration, neither market was found to lead or lag the other.

De Jong (1998) have confirmed that even in the presence of significant contemporaneous correlation among the spot, futures and the options market, the futures price changes lead both the changes in the cash index and index option by five to ten minutes. But, among the cash and the options market, the relations are largely symmetrical and neither market consistently leads the other.

Pizzi et.al. (1999) examined price discovery in S&P 500 spot index and its three and six month index futures using intraday minute by minute data. Co-integration analysis is used. The results show that both the three and six months futures markets lead the spot market by at least twenty minutes. There is bidirectional casualty but the futures do have a stronger lead effect.

Min and Najand (1999) had investigated the possible lead-lag relationship in return and volatilities between cash and futures market in Korea. Their results have suggested that unlike the lead-lag relationship in the returns of spot and futures markets, there is significant but time dependent bidirectional casualty between the markets, as far as volatility interaction among the markets is concerned.

Booth et.al. (1999) study intra day price discovery process among stock index, index futures and index options in Germany using DAX index securities and intraday transaction data. They found that spot index and index futures have substantially larger information share than index options.

Frino (2000) had examined the temporal relationship among the spot and futures market around the release of different types of information. They had found that the lead of the futures market strengthens significantly around the release of macro-economic information. While, the leading role of the futures market weakens around stock specific information release.

Roope et.al. (2002) make a comparison of the information efficiencies between the Singapore exchange and the Taiwan futures exchange for Taiwan index futures listed in both markets. The results provide strong evidence to suggest that price discovery primarily originates from Singapore futures market.

By looking at the Indian Markets, Thenmozhi (2002), had found that the futures market in India has more power in disseminating information and therefore has been found to play the leading role (for one or two days) in the matter of price discovery.

Anand Babu and Bhole (2003) attempted to examine the temporal relationship between the index futures and its underlying cash index by using daily price observations. Their results had supported the fact that the index futures market in India leads the underlying Nifty index market and the lead-lag pattern between those two markets keeps on changing over different periods.

Mukherjee and Mishra (2006) used intraday data from April to September 2004 to investigate the lead lag relationship between Nifty spot index and Nifty futures. They found that there was a strong bidirectional relationship among returns in the futures and the spot markets. The spot market was found to play a comparatively stronger leading role in disseminating information available to the market and therefore is said to be more efficient.

Pratap Chandra Pati and Purna Chandra Pradhan (2009) attempted to examine the lead-lag relationship and price discovery function between NIFTY spot and futures index using daily closing prices for a period from beginning of calendar year 2004 to end of calendar year 2008 utilizing Vector Error Correction Model (VECM). Their findings suggest that futures price leads the spot price and hence perform the price discovery function. Also from the Johansen-Juselius test, they observed there was only one co-integrating vector suggesting the long run co-movement of both spot and futures prices.

P Srinivasan (2009) attempted to examine the casual relationship between NSE spot and futures market prices of selected nine oil and gas industry stocks in India using the same Johansen's co-integration technique followed by Vector Error Correction model (VECM) on daily data series from 2005 to 2009. The analysis reveals that there exists a long run relationship between spot and futures prices for each security. Besides, the study established a bi-directional relationship between spot and futures market prices in case of four oil industry stocks, spot leading the futures price in case of three stocks and the futures exhibiting leading role for two selected gas and oil industry stocks.

Research Objectives

The present research is carried out with a specific objective of determining intraday lead- lag relationship both in terms of return and volatility, among Indian spot and futures market for certain underlying bluechip sensex stocks. If such relationship exists, then the focus will be to test which market leads the other and by how much time gap.

Sample Data

We have here taken into consideration ten blue chip sensex stocks representing to diverse sectors in the economy such as RELIANCE INDUSTRIES, INFOSYS, HINDUSTHAN UNILEVER, HDFC, HINDALCO, ACC, TISCO, L&T, SBI and TELCO. Stock prices traded in NSE in five minutes intervals during a period of twelve months for the calendar year 2012 have been taken into consideration for determining interrelationship, both in terms of return and volatility, among the spot and futures markets. Data on futures market for stocks comprise price series only for the near month contract. All the relevant data relating to the spot and futures market in India has been collected from NSE website, i.e. www.nseindia.com and also the CD-ROM provided by NSE, Mumbai. The intraday price series both in the spot and futures market have been sorted out in MATLAB version 6.5 and in MS-EXCEL.

Table 1: VAR Results among Spot and Futures Stock Returns

$$R_{S,t} = \alpha_0 + \sum_{i=1}^{2} \alpha_i R_{S,t-i} + \sum_{j=1}^{2} \beta_j R_{F,t-j} + \delta Z_{t-1} + \epsilon_t$$

(Dependent Variable = Spot Return)

	SPOT(-1)	SPOT(-2)	FUTURE (-1)	FUTURE (-2)	CONSTANT	ECT	Chi-Square-Futures
RELIANCE INDS	0.1403	0.2219	-0.1621	-0.2017	0.0013.	0.0001	8.8674
	(1.5494)	(2.5681)	-(1.6783)	-(2.2768)	(1.8641)	(0.6433)	(0.0043)
INFOSYS	0.2556	0.1375	-0.2481	-0.1154	0.0009	0.0003	10.2317
	(1.9678)	(1.0189)	-(2.0356)	-(1.1373)	(1.3576)	(0.8811)	(0.0041)
HUL	-0.0988	0.0166	0.1054	-0.0189	0.0001	0.0000	2.8672
	-(1.0677)	(0.3187)	(1.2388)	-(0.3764)	(0.0657)	(0.1589)	(0.0847)
HDFC	0.1456	0.0578	-0.1319	-0.0521	-0.0005	0.0005	4.7124
	(0.9765)	(0.9864)	-(0.9899)	-(0.9543)	-(0.5912)	(0.6153)	(0.0093)
HINDALCO	-0.0585	-0.0854	0.0615	0.0867	-0.0011	-0.0002	3.9896
	-(0.7633)	-(1.0192)	(0.8433)	(1.0058)	-(1.6437)	-(0.8782)	(0.0682)
ACC	-0.0211	-0.0164	0.0189	0.0123	0.0001	-0.0006	11.3421
	-(0.3498)	-(0.1855)	(0.3056)	(0.2068)	(0.0845)	-(1.0054)	(0.0037)
TISCO	-0.1565	-0.0792	0.1436	0.0775	0.0008	0.0005	9.8127
	-(1.1346)	-(0.8669)	(1.1982)	(0.8831)	(1.0348)	(1.2178)	(0.0048)
L&T	0.1176	0.1457	-0.1089	-0.1297	0.0003	0.0000	4.5419
	(1.4693)	(1.8992)	-(1.5165)	-(1.7342)	(0.0516)	(0.9567)	(0.0712)
SBI	0.0448	0.0233	-0.0538	-0.0245	-0.0007	0.0009	3.1781
	(0.9017)	(0.6157)	-(0.8951)	-(0.5753)	-(0.9462)	(1.6783)	(0.0843)
TELCO	-0.0754	-0.1316	0.0631	0.1283	0.0007	-0.0003	10.8418
	-(0.9762)	-(1.5534)	(0.9823)	(1.7641)	(0.8817)	-(0.7653)	(0.0086)

Table 2: VAR Results among Spot and Futures Stock Returns

$$R_{F,t} = \alpha_0 + \sum_{i=1}^{2} \alpha_i R_{F,t-i} + \sum_{j=1}^{2} \beta_j R_{S,t-j} + \delta Z_{t-1} + \epsilon_t$$

(Dependent Variable = Futures Return)

	SPOT(-1)	SPOT(-2)	FUTURE (-1)	FUTURE (-2)	CONSTANT	ECT	Chi-Square-Futures
RELIANCE INDS	0.2978	0.0987	-0.1854	-0.1058	0.0012	0.0002	4.4583
	(2.3674)	(0.9354)	-(1.9457)	-(1.1574)	(1.6453)	(0.9867)	(0.0125)
INFOSYS	0.1456	-0.0612	-0.1887	0.0487	0.0006	-0.0002	1.2719
	(1.7801)	-(0.5123)	-(1.6543)	(0.4819)	(1.1897)	-(0.8053)	(0.3711)
HUL	0.1073	0.0238	-0.1121	-0.0191	0.0001	0.0001	3.0095
	(1.3875)	(0.2457)	-(1.0097)	-(0.2954)	(0.0608)	(0.2023)	(0.1652)
HDFC	-0.0823	0.0127	0.1247	-0.0201	-0.0004	-0.0005	10.4459
	-(0.5489)	(0.2098)	(0.9086)	-(0.2168)	-(0.4837)	-(0.8089)	(0.0017)
HINDALCO	-0.1592	-0.0367	0.1266	0.0412	-0.0009	-0.0008	2.2674
	-(1.4681)	-(0.4598)	(1.0057)	(0.4916)	-(1.4451)	-(4.3876)	(0.2879)
ACC	0.0453	-0.1058	-0.0356	0.0768	0.0001	0.0001	9.8855
	(0.7154)	-(0.9013)	-(0.3167)	(0.5478)	(0.0708)	(0.1086)	(0.0056)
TISCO	-0.2201	0.1063	0.1891	-0.0783	0.0010	0.0008	12.8498
	-(1.8756)	(1.0058)	(1.0017)	-(0.8562)	(1.1953)	(1.1988)	(0.0027)
L&T	-0.0928	0.1598	0.1037	-0.1300	0.0003	-0.0002	3.8315
	-(0.8675)	(1.7346)	(1.0074)	-(0.9167)	(0.0419)	-(0.8636)	(0.1015)
SBI	-0.0127	0.0115	0.0087	-0.0209	-0.0008	0.0005	8.1764
	-(0.3633)	(0.2097)	(0.0983)	-(0.8145)	-(0.9816)	(1.0092)	(0.0363)
TELCO	-0.0253	-0.0843	0.0332	0.1546	0.0007	0.0004	7.5132
	-(0.5177)	-(0.6791)	(0.4589)	(1.1211)	(0.8036)	(0.7677)	(0.0120)

Table 3 : VAR Results among Spot and Futures Stock Return Volatility

$$\sigma^2_{S,t} = \alpha_0 + \sum_{i=1}^{2}\alpha_i\sigma^2_{S,t-i} + \sum_{j=1}^{2}\beta_j\sigma^2_{F,t-j} + \epsilon_t$$

(Dependent Variable = Spot Return Volatility)

	SPOT VOL(-1)	SPOT VOL(-2)	FUTURES VOL(-1)	FUTURES VOL(-2)	CONSTANT	Chi-Square-Futures
RELIANCE INDS	-0.2657	-0.1943	0.2324	0.1453	0.0008	10.6764
	-(2.9321)	-(2.1587)	(1.9857)	(1.9012)	(1.0003)	(0.0054)
INFOSYS	-0.3167	1.6107	0.3287	-1.8622	-0.0005	7.2906
	-(3.4982)	(2.0376)	(2.9801)	-(2.0076)	-(0.6897)	(0.0176)
HUL	0.0953	-0.0184	-0.7073	0.0233	0.0003	1.5438
	(0.7782)	-(0.1653)	-(0.6841)	(0.2335)	(0.2613)	(0.4543)
HDFC	0.1847	-0.0327	-0.1823	0.0196	0.0004	5.6132
	(1.9075)	-(0.2456)	-(1.5879)	(0.2168)	(0.4056)	(0.0107)
HINDALCO	-0.0276	-0.0867	0.0592	0.0767	0.0007	2.3218
	-(0.3078)	-(0.9023)	(0.4532)	(0.7537)	(1.0351)	(0.2452)
ACC	-0.0914	-0.0322	0.0765	0.0543	0.0002	1.8855
	-(1.0289)	-(0.4178)	(0.7904)	(0.6365)	(0.1267)	(0.5314)
TISCO	0.1597	-0.1064	-0.2221	0.1063	-0.0007	9.4864
	(1.0023)	-(1.3798)	-(1.9658)	(1.0058)	-(0.9537)	(0.0056)
L&T	-0.1346	0.0196	0.0921	0.1631	0.0008	5.1896
	-(1.1081)	(0.2168)	(0.8431)	(1.5326)	(1.0419)	(0.0823)
SBI	0.0943	0.0767	-0.1207	-0.1015	-0.0005	3.5984
	(0.9489)	(0.7537)	-(1.0089)	-(0.9687)	-(0.4816)	(0.0861)
TELCO	-0.1462	0.2098	0.1853	-0.1849	0.0003	7.1897
	-(1.9346)	(2.6481)	(1.5091)	-(1.6795)	(0.4689)	(0.0342)

Table 4: VAR Results among Spot and Futures Stock Return Volatility

$$\sigma^2_{F,t} = \alpha_0 + \sum_{i=1}^{2}\alpha_i\sigma^2_{F,t-i} + \sum_{j=1}^{2}\beta_j\sigma^2_{S,t-j} + \epsilon_t$$

(Dependent Variable = Futures Return Volatility)

	SPOT VOL(-1)	SPOT VOL(-2)	FUTURES VOL(-1)	FUTURES VOL(-2)	CONSTANT	Chi-Square-Futures
RELIANCE INDS	0.1963	-0.2312	-0.1741	0.2057	-0.0009	5.1472
	(1.8347)	-(1.9063)	-(1.6895)	(1.8655)	-(1.5371)	(0.0785)
INFOSYS	-0.1319	-0.1297	0.1457	0.1640	0.0001	3.6813
	-(0.9899)	-(1.6301)	(1.3678)	(1.8147)	(0.0612)	(0.0778)
HUL	0.0563	-0.0376	-0.0519	0.0213	0.0009	7.9870
	(0.5471)	-(0.4592)	-(0.4678)	(0.2794)	(1.2876)	(0.0361)
HDFC	0.1189	0.0732	-0.1396	-0.0698	-0.0005	9.8674
	(1.3056)	(0.8845)	-(1.3472)	-(0.7167)	-(0.9263)	(0.0023)
HINDALCO	0.0453	0.0822	-0.0711	-0.0546	0.0008	2.9986
	(0.7154)	(0.8311)	-(0.8672)	-(0.6387)	(1.2058)	(0.3045)
ACC	-0.2201	-0.0676	0.2015	0.0489	-0.0005	8.4765
	-(1.8756)	-(0.6479)	(1.6891)	(0.5431)	-(0.3756)	(0.0067)
TISCO	-0.0196	0.1566	0.0212	-0.1278	0.0002	10.1189
	-(0.2346)	(1.2463)	(0.2589)	-(1.1583)	(0.5017)	(0.0049)
L&T	0.1036	0.7127	-0.1357	-0.8164	0.0015	2.9186
	(0.9837)	(0.8573)	-(1.0486)	-(0.8897)	(1.0321)	(0.0732)
SBI	0.0541	-0.0798	-0.0883	0.0642	0.0009	3.5576
	(0.6037)	-(0.8145)	-(0.7150)	(0.6794)	(1.0242)	(0.0108)
TELCO	-0.0767	0.1546	0.0545	-0.1467	0.0002	3.1657
	-(0.8149)	(1.6971)	(0.8219)	-(1.6899)	(0.2708)	(0.0567)

Table 5: Stock Return among Spot & Futures Markets through GARCH(1,1) Model

Conditional Mean Equation $R_{S,t}= \alpha_0+ \alpha_1 R_{S,t-1}+ \Sigma_{j=-1}^{1} \beta_j R_{F,t+j}+ \delta Z_{t-1}+ \epsilon_t$						
	SPOT (-1)	FUTURES (-1)	FUTURES*	FUTURES (+1)	CONSTANT	ECT (-1)
RELIANCE INDS	-0.2867	0.2794	0.9567	0.0059	0.0003	-0.0002
	-(7.9931)	(7.3650)	(235.8671)	(0.6873)	(1.2354)	-(5.2313)
INFOSYS	-0.3021	0.2975	1.0127	0.0083	-0.0001	-0.0016
	-(9.5435)	(9.0016)	(342.9914)	(0.5416)	-(1.0985)	-(8.7694)
HUL	-0.1052	0.1098	0.9489	-0.0012	0.0000	-0.0010
	-(1.8963)	(1.9865)	(86.8432)	-(0.3904)	(0.0387)	-(7.5429)
HDFC	-0.1874	0.1821	0.9952	0.0074	-0.0005	-0.0006
	-(4.0057)	(3.9163)	(127.5528)	(2.0122)	-(3.1583)	-(5.6989)
HINDALCO	-0.0763	0.0696	0.9755	0.0006	0.0001	-0.0012
	-(1.0078)	(0.9568)	(50.3674)	(0.8394)	(0.8356)	-(6.6176)
ACC	-0.2071	0.2016	1.0089	-0.0033	0.0001	-0.0005
	-(5.0345)	(4.9896)	(102.9873)	-(0.9857)	(0.9278)	-(4.9738)
TISCO	-0.1781	0.1822	1.0123	0.0043	0.0009	-0.0007
	-(3.8974)	(4.0163)	(187.3745)	(0.7315)	(6.7896)	-(4.3498)
L&T	-0.2364	0.2392	0.9860	0.0038	-0.0002	-0.0019
	-(5.8956)	(6.0075)	(283.8719)	(0.2655)	-(2.0018)	-(10.9871)
SBI	-0.1089	0.1121	0.9914	0.0089	-0.0001	-0.0001
	-(2.0061)	(2.3572)	(313.6190)	(2.0021)	-(1.1582)	-(3.2786)
TELCO	-0.2746	0.2708	1.0032	-0.0017	0.0000	-0.0009
	-(7.5482)	(7.0089)	(240.5418)	-(0.5975)	(0.0419)	-(7.3137)

- * - Contemporaneous

Table 6: Volatility Spillover among Spot & Futures Markets through GARCH(1,1) Model

Conditional Variance Equation $h_t^2=\acute{\omega}+\gamma_1 \epsilon^2_{S,t-1}+ \gamma_2 h^2_{S,t-1}+\gamma_3 \epsilon^2_{F,t-1}$				
	ARCH(1)	GARCH(1)	CONSTANT	FUTURES RESIDUALS (1)
RELIANCE INDS	0.7567	0.8581	0.0000	-0.0002
	(2.3789)	(18.0189)	(4.6871)	-(3.5189)
INFOSYS	0.5893	0.6734	0.0000	0.0000
	(3.0142)	(14.6818)	(5.3322)	-(0.8976)
HUL	0.1347	0.1287	0.0000	0.0000
	(1.5786)	(1.6834)	(1.5972)	(0.4178)
HDFC	0.6590	0.2397	0.0000	0.0000
	(4.9812)	(1.9754)	(0.8973)	-(0.6471)
HINDALCO	0.0954	0.0733	0.0000	0.0000
	(2.8821)	(0.6892)	(1.1945)	(0.1086)
ACC	0.3763	0.1496	0.0000	0.0001
	(1.0156)	(2.2178)	(3.8166)	(18.5674)
TISCO	0.5541	0.5698	0.0000	-0.0002
	(2.8673)	(10.3146)	(9.5674)	-(1.5896)
L&T	0.7184	0.3855	0.0000	0.0000
	(4.2213)	(4.8943)	(6.2178)	(0.5785)
SBI	0.1591	0.2027	0.0000	0.0001
	(1.5978)	(2.1893)	(3.8859)	(3.6179)
TELCO	0.4576	0.3897	0.0000	0.0000
	(2.3657)	(5.4971)	(8.4154)	(0.7541)

Methodology

If $R_{S,t}$ represents periodic five minutes interval stock returns in underlying spot market and $R_{F,t}$ represents returns in futures market, then the VAR model used for investigating the stock return interdependence among the two markets are given below :

$$R_{S,t}= \alpha_0+\Sigma_{i=1}^{p} \alpha_i R_{S,t-i}+ \Sigma_{j=1}^{q}\beta_j R_{F,t-j}+ \delta Z_{t-1}+Є_t \quad \text{----------(1)}$$

$$R_{F,t}= \alpha_0+\Sigma_{i=1}^{p} \alpha_i R_{F,t-i}+ \Sigma_{j=1}^{q}\beta_j R_{S,t-j}+ \delta Z_{t-1}+Є_t \quad \text{-- --------(2)}$$

Here, only 2 lag periods are considered for both 'p' and 'q'.

Now, the interdependence among the periodic five minutes interval stock return volatility among the spot and futures markets has been derived through the following VAR model :

$$\sigma^2_{S,t} = \alpha_0+\Sigma_{i=1}^{p}\alpha_i\sigma^2_{S,t-i}+\Sigma_{j=1}^{q}\beta_j\sigma^2_{F,t-j}+Є_t \quad \text{----------(3)}$$

$$\sigma^2_{F,t} = \alpha_0+\Sigma_{i=1}^{p}\alpha_i\sigma^2_{F,t-i}+\Sigma_{j=1}^{q}\beta_j\sigma^2_{S,t-j}+Є_t \quad \text{----------(4)}$$

Wherein, $\sigma^2_{S,t}$ and $\sigma^2_{F,t}$ represent the residuals of their concerned return series drawn through a simple OLS model on the respective stock returns in both the markets. Chi square test has been conducted here to test the pair wise Granger casualty of both the variables.

Another attempt has been made to test the return and volatility interdependence or the volatility spillover in spot and futures markets for the underlying stocks through a simple GARCH (1,1) model as depicted below :

$$R_{S,t}= \alpha_0+ \alpha_1 R_{S,t-1}+ \Sigma_{j=-1}^{1}\beta_j R_{F,t+j}+ \delta Z_{t-1}+Є_t \quad \text{------(5)}$$

$$h_t^2=ώ+\gamma_1\varepsilon^2_{S,t-1}+ \gamma_2 h^2_{S,t-1}+\gamma_3\varepsilon^2_{F,t-1} \quad \text{----------(6)}$$

Wherein, $R_{S,t}$ represents periodic five minutes interval stock returns in underlying spot market and $R_{F,t}$ represents returns in futures market. Spot return for one period at 't' is regressed on its own lagged return along with the futures return for one lagged period and one lead period assuming any of the markets can not lead the other for more than five minutes in an efficient market and speedy flow of information. ε_t^2 is an exogenous variable in the conditional variance equation and denotes the periodic return residuals from the stock futures market.

Empirical Findings

The inter relationship among the intraday returns of spot and futures stocks are presented in Tables 1 and 2. Here, the periodical stock returns are modeled through a VAR framework where the five minutes interval returns in one market is regressed on its own lagged return along with the lagged returns in other market up to a lag of two periods, i.e ten minutes. Since, the stock returns in spot and futures markets are co-integrated, so both the regression equations include a lagged error correction term to account for the co-integration among the markets. The first table here depicts the impact of the futures stock returns on the stock return of spot market, i.e. spot return here becomes the dependent variable and futures return is the independent variable. On the other hand, the impact of spot stock return on the return of future stocks is shown in the second table. Spot return here becomes the independent variable and futures return is the dependent variable.

The results reveal that the interrelationship among the underlying stock returns in spot and futures markets is found to be significant for a few stocks. That means the interrelationship is not significant for some stocks in these two markets. For some stocks, lagged futures stock returns are found to play significant role in explaining the movement of stock return in spot market, which means futures leads the spot market for those stocks. And for some other, lagged spot stock returns are found to play significant role in explaining the movement of stock return in futures market, which signify spot leads the futures market for those underlying stocks.

The results from Table 1 reveal that the lagged coefficients in the stock futures market are found to have a significant power in explaining the spot stock returns for five out of ten stocks taken here for study. These stocks are RELIANCE INDUSTRIES, INFOSYS, ACC, TISCO and TELCO.

At the same time, reverse results as found in Table 2 shows leading power of spot market over futures market for again five no. of stocks. These stocks are HDFC, ACC, TISCO, SBI and TELCO. The joint significance tests carried out only for the lagged coefficients of the counter market for all the stocks are exhibited through the chi-square test. This signify that the stocks ACC, TISCO and TELCO exhibit bi-directional relationship between spot and futures markets. That means both spot influencing the futures and futures influencing the spot markets for these three underlying stocks.

Interrelationship among Spot and Futures Stock return Volatility

Interdependence of the stock return volatility among the spot and futures markets is examined through a VAR framework and is presented in tables 3 and 4. Table 3 represents the impact of lagged futures stock return volatility in explaining the volatility of the spot stock market. At the same time, the impact of lagged stock return volatility in spot market over the volatility of stock futures is presented in table 4.

The results of Table 3 suggest that lagged futures return volatility for six out of ten stocks show statistical significance in explaining the movements of spot return volatility. These stocks are RELIANCE INDUSTRIES, INFOSYS, HDFC, TISCO, L&T and TELCO. Simultaneously, the results of Table 4 reveal that five stocks exhibit lagged coefficients of spot return volatility showing statistical significance in explaining the futures return volatility. These stocks are RELIANCE INDUSTRIES, HUL, HDFC, ACC and TISCO. Thus, there is bidirectional volatility spillover experienced from one market to other for certain stocks like RELIANCE INDUSTRIES, HDFC and TISCO.

Interrelationship among Spot and Futures Stock Returns & Volatility Utilizing GARCH Model

Another effort has been made to explore the return and volatility interdependence among the stocks in spot and futures markets in a simple GARCH(1,1) framework wherein the spot return is regressed on its own lagged return and lagged, contemporaneous and futures returns in the futures market in the conditional mean equation. On the other hand, the series of residuals derived from the futures return series is also used as an exogenous variable in the conditional variance equation of the spot market. The results relating to return and volatility spillover among NIFTY spot and futures stocks are depicted in Tables 5 and 6. Table 5 represents the results of conditional mean equation in a GARCH (1,1) framework and the results of conditional variance equation are presented in table 6. Table 5 depicting results of conditional mean equation checks for the significance of lagged, contemporaneous and the lead coefficient of futures return. The results clearly reveal that apart from a significant contemporaneous effect, either futures return can

significantly lead or lag the returns in spot market depending upon its lead or lag coefficients. The results of Table 6 is to find out the significance of the exogenous variable, i.e the lagged futures return residual series. This will determine whether the lagged futures return volatility has any impact on the volatility of the spot market for the considered stocks.

Table 5 representing results of conditional mean equation of GARCH (1,1) model clearly reveal that the contemporaneous future coefficients are found to be significant for almost all the stocks. This signifies that there is a strong and significant contemporaneous relationship among the stock returns in both spot and futures markets. Also, apart from the strong contemporaneous interdependence, the statistical significance of futures lag coefficients for almost all the stocks except HUL and HINDALCO shows the leading role of futures market for the underlying stocks in explaining the stock returns in the spot market. Thus futures market for stocks is found to be playing the leading role for most of the stocks. On the other hand, the lead futures return coefficients in the conditional mean equation is found to be significant for SBI and HDFC only which means that for these stocks, spot return exhibit leading role over futures market returns. There are two stocks such as SBI and HDFC for which both the lead and lag futures return coefficients are found to be significant. Thus, there is a bi-directional interrelationship among the spot and futures markets for these stocks, even though it has been observed that the interdependence from the futures to spot market is comparatively stronger than that in the reverse direction.

Now, as far as volatility spillover is concerned, we have tested the spillover only from futures to the spot market. This is because only the lagged futures return volatility is included in the volatility equation of the spot market. These spillover results of futures return volatility is shown in Table 6 representing the conditional variance equation. The results clearly reveal that unlike return interdependence, there is no significant volatility spillover from the futures to spot market for most of the stocks. The coefficient of lagged futures residuals included in the conditional variance equation of spot return is found to be significant only for stocks named RELIANCE INDUSTRIES, ACC and SBI, which means there exists significant volatility spillover from futures to spot market. Thus, we can assume that for remaining stocks there exists either significant volatility spillover from spot to futures market or a bi-directional volatility spillover.

Conclusion

In an era of advancement of technology and speedy information dissemination, it is hard to believe that any market will lead the other beyond ten minutes. Since we are taking here five minute interval returns for stocks, so only two lags are taken into consideration for VAR analysis. The results for few stocks show lagged futures return coefficient is significant which means futures play a leading role in explaining the movement in the spot market. Also for some other stocks, leading futures return coefficient is significant which means spot market returns lead the futures market. From the results, it is observed that the lag coefficients in either market is hardly found to be significant beyond one lag. That means, no market leads or lags the other for more than five minutes.

Though there is observation of mixed results, the no. of futures stock returns significantly leading the spot market stock returns is slightly higher than vice versa. But at the same time, the spot market for certain stocks has been found to be playing a stronger leading role even for more than five minutes. As far as interdependence among stock return volatility in spot and futures markets are concerned, it has been observed that in more no. of stock cases, volatility spillover from futures to spot market is more significant than that of reverse direction. This fact clearly reveals that the stock futures market plays a significant leading role both in terms of return and volatility for more no. of stocks.

Another attempt has been taken here for derivation of return and volatility spillover from futures to the spot market in a GARCH framework. This test is restricted only to the spillover from the futures to spot market and not vice versa. As far as the return interdependence among the stocks in spot and futures markets are concerned, the contemporaneous coefficients for the stock futures return, for almost all the stocks, are found to be significant to a maximum degree. This signifies the presence of a strong contemporaneous relationship among the stock returns in spot and futures markets. But apart from a strong contemporaneous relationship, the lagged futures return coefficient for almost all the stocks, show statistical significance in explaining the movement of stock price in the spot market. There are also some stocks for which both the lead and lag futures return coefficients are found to be significant, which means there exists a significant bi-directional relationship among the spot and futures markets. Now, the results of volatility spillover in the common GARCH framework reveal that the volatility spillover from the futures to spot market is significant only for three out of ten underlying stocks.

Thus, it can be concluded that the interrelationship among the spot and futures markets for the underlying stocks shows some mixed evidence. The lagged returns as well as volatility of returns in futures market has been found to be playing significant role in explaining the movement in spot market for only a few stocks. At the same time, there are also some stocks for which the spot market has been found to play the leading role. So, it is not possible to assume here which market leads the other, rather it is stock specific.

References

- Abhyankar, A.H.1998. Linear and Nonlinear Granger causality: evidence from the U.K stock index futures market. *The Journal of Futures Markets*, 18(5):519-540
- Anand Babu P. et al. (2003) , The Temporal Price Relationship between the index Futures and the Underlying Cash Index : Evidence from the Indian Stock Market , Paper presented at the *International Conference on Business and Finance 2003* , Hyderabad , India
- Bollerslev T (1986), Generalized Autoregressive Conditional Hetroscedasicity, *Journal of Econometrics 31* (3) , 307-327.
- Booth G G, R W So and Y Tse (1999), Price Discovery in the German equity Index derivatives markets, *The Journal of Futures Markets*, Vol 19, No. 6, p 619 – 643
- Chan, K.1992. A further analysis of the lead-lag relationship between the cash market and stock index futures market. *Review of Financial Studies*, 5(1): 123-152.
- Chatrath A. and Song F. (1998), Information and volatility in Futures and Spot Markets : The case of Japanese Yen, Journal of Futures Market 18(2), 201-223
- De Jong F. and Donders M.W.M. (1998), Intraday Lead-Lag Relationship between Futures, Options and Stock Market, European Finance Review 1, 337-359
- De Jong F. and Nijman T. (1997), High Frequency Analysis of Lead –Lag Relationship between Financial Markets, Journal of Empirical Finance 4, 259-277
- Engle, R.F. and Granger, C.W.G. 1987. Co-integration and Error Correction Representation, Estimation and Testing. *Econometrica* , 55: 251-276.

- Frino A. & Others (2000) : The Lead-Lag relationship between Equities and Stock Index Futures Markets Around Information Releases, Journal of Futures Market 20(5), 467-487
- Kawaller I.G, Koch P.D and Koch T.W. 1987. The temporal price relationship between S&P 500 futures and S&P 500 index. *Journal of Finance*, 42(5):1309-1329
- Min, J.H and Najand, M.1999. A further investigation of lead-lag relationship between the spot market and stock index futures: Early evidence from Korea. *The Journal of Futures Markets*, 19(1):217-232
- Mukherjee, K.N and Mishra, R.K. 2006. Lead-Lag Relationship between Equities and Stock Index Futures Market and its Variation around Information Release: Empirical Evidence from India. www.nseindia.com
- Pati Pratap Chandra and Padhan Purna Chandra (2009), "Information, Price Discovery and Casualty in the Indian Stock Index Futures Market", The ICFAI University Journal of Financial Risk Management, Vol. 6, Nos. 3 &4, pp 7-21
- Pizzi M.A. et al. (1998): An Examination of the Relationship between Stock Index Cash and Futures Markets:A cointegration approach, Journal of Futures Market 18(3), 297-305
- Roope M and R Zurbruegg (2002) The intra day price discovery process between the Singapore exchange and Taiwan futures exchange, *The Journal of Futures Markets*, Vol 22, No. 3, p 219 – 240
- Srinivasan P (2009), "Price Discovery in NSE Spot and Futures Markets of Selected Oil and Gas Industries in India : What Causes What ?", The ICFAI University Journal of Financial Risk Management, Vol. 6, Nos. 3 &4, pp 22-37
- Stoll H R and R Whaley (1990), The dynamics of stock Index and stock Index futures returns, *Journal of Financial and Quantitative Analysis*, Vol 25, p 441 – 468
- Thenmozhi M.(2002): Futures Trading, Information and Spot Price Volatility in Nifty Index Futures Contract, NSE Research Paper, Source: www.nseindia.com