PRICE TRANSMISSION AND INFORMATION ASYMMETRY IN INDIAN STOCK MARKET: SPOT VS FUTURES

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Abstract: *This paper investigates the price discovery process and volatility spillovers between S&P CNX Nifty spot and futures market in India by using Johansen Cointegration technique and the direction of causal relationship between futures and cash market were examined by employing Vector Error Correction Model (VECM) to reveal the long run and short run equilibrium between the variables. Variance decomposition provides insights into the dynamics of the variables into the system to show how each endogenous variable responds over time to shock in one variable and other endogenous variable. Variance decomposition explains the insights into the spot and futures market to measure the relative contribution of forecast error variance of each shock as a function of forecast horizon. Then, we employed Bivariate EGARCH (1,1) model to predict the innovations in one market can explain the volatility in another market. The findings of the study reveal that, in the long run, both the markets are Cointegrated and also there exists a feedback relationship between the two markets. Further, the results show that price discovery takes place in both the market, which indicates that both the market is efficient.*

Keywords: Price Discovery, Volatility Spillovers, Cointegration, VECM, Bivariate EGARCH.

JEL Classification: C22, C51, G13, G14.

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1. Introduction

The financial architecture of India has witnessed a massive change in the present era of globalization. In the present scenario, significant importance is given to financial markets and its relationship with the real world. Hence, the financial market was experiencing a lot of structural and functional reforms that has brought Indian financial institutions towards global standards. Simultaneously far reaching changes have also taken place in the capital markets, resulting in the total integration of securities market, diversification of products and provision of investor friendly with transparent environment. Like banks, stock exchanges have also been in the post reform period, freed from the direct control of the Government and were placed under a professional regulatory authority, i.e. Securities & Exchange Board of India (SEBI). As a result of SEBI, major changes in the capital market have resulted in complete transformation of structure and composition of the market. In addition, many market started trading on derivative products in line with the developed countries.

Over the last decade, corollary to the modernization of markets many emerging and transition economies have started introducing derivative contracts. Among this, India is one of the emerging countries which introduced derivatives trading with a view to curb the volatility of asset prices in financial markets and to provide sophisticated risk management tools leading to higher returns by reducing risk and transaction costs as compared to individual financial assets. A derivative is a product whose value is derived from the value of one or more basic variables called bases in a contractual manner. The underlying asset can be equity, commodities, interest rate or any other asset. Thus, the price of a derivative is contingent on the price of its underlying asset. Derivative products serve the vitally important economic functions of price discovery and risk management. However, the policymakers, practitioners and regulators in these markets are concerned about the impact of derivatives market. One of the reasons for this concern is the belief that derivative trading may attract speculators who then destabilize spot prices.

The purpose of the present study is to examine the price discovery process and volatility spillover between the spot and futures market in India. The essence of spot and futures market volatility in price discovery functions hinges on whether new information is first reflected in futures market or in spot markets. It has been argued, that the lead lag relationship between spot and futures prices series can be attributed to one or more market imperfection like differences in transaction cost, liquidity differences between two market, short selling restriction, dividend uncertainties, non-stochastic interest rate, different taxation regimes and differences in margin requirements. Overall, the findings of these studies indicates that the price discovery and volatility spillovers between spot and futures prices series can run on unidirectional or feedback directions, depending on the market under investigation. The present study assumes significance in the sense that it enables to determine which market is more efficient in processing and reflecting of new information. Studies on the relationship between price discovery and volatility spillovers also provide vital clues to the arbitragers, who are formulating their trading strategies based on market imperfections. Further, most of the studies have carries out in developed markets and supported the view that futures market plays a leading role in price discovery and volatility spillover process by reflecting new information faster than the spot market. Therefore, this study is very useful for the developing markets which have immense potentials for future development.

The remainder of the paper is organized as follows. We present a brief review of antecedent literature on price discovery and volatility spillovers in section 2. Section 3 introduces the data and sample size considered in this study. Section 4 surveys the econometric methodology employed in the paper. Section 5 presents the results and discussion of the paper. Here we begin with descriptive statistics, Johansen Cointegration test, Vector Error Correction Model (VECM) and Bivariate EGARCH (1,1) model for spot and futures markets series were compared and estimated. Section 6 provides a brief summary and conclusions.

2. Review of Literature

An overwhelming number of studies have examined both theoretically and empirically to investigate the causal relationship between spot and futures markets variables in price discovery process. Even though spot and futures markets react to the same information, the major question is which market reacts first. Several studies investigate the informational advantages of markets for single underlying assets or indexes Garbade and Silber (1979), Roell (1992) and Hasbrouck (1995). The consensus has generally been that information disseminates from the more liquid markets where trading volume is concentrated. Kawaller et al. (1987) use minute to minute data on the S&P 500 spot and futures contract and prove that futures lead the cash index by 20-45 minutes. Herbst, McCormack and West

(1987) examine the lead lag relationship between the spot and futures markets for S&P 500 and VLCI indices. They find that for S&P 500 the lead is between zero and eight minutes, while for VLCI the lead is up to sixteen minutes. More sophisticated methods of causality (VAR-VECM) models show evidence that futures prices lead the spot prices. Their results show that futures returns lead spot returns by at least fifteen minutes.

Furthermore, Stoll and Whaley (1990) find that S&P 500 and MM index futures returns lead the stock market returns by about 5 minutes. Similarly, Cheung and Ng (1990) analyze price changes over fifteen minute periods for the S&P 500 index using a GARCH model. Chan, Chan and Karolyi (1991) use a Bivariate GARCH model and find that S&P 500 futures returns lead spot returns by about five minutes. Abhyankar (1995) observed that futures market leads spot market returns during the period of high volatility. Turkington and Walsh (1999) examine the high frequency relationship between SPI futures and AOI in Australia and evidenced bidirectional causality between the two series. Kavussanos and Monikos (2003) investigated the causal relationship between futures and spot prices in the freight futures market and found that futures price tend to discover new information more rapidly than spot prices. Thenmozhi (2002) examined the lead-lag relationship between stock index futures and spot index returns. Raju and Karnde (2003) shows that the futures market responds to deviations from equilibrium and price discovery occurs both in futures and spot market, especially in the latter half of the study period. Finally, he concludes that the volatility in spot market has come down after the introduction of stock index futures. So and Tse (2004) have examined the price discovery and spillovers effects for Hang Seng futures and tracker fund market using Grange common factor models and the M-GARCH models. In contrast to the above results and their possible explanations, the studies by Wahab and Lashgari (1993), Turkington and Walsh (1999), Pattarin and Frrethi (2004), and Mukherjee and Mishra (2006) reports that the spot market has a leading role over futures market. They also reported that in some cases, there exists a strong bi-directional relationship between the two markets. Operational inefficiencies in futures market, open outcry system of trading etc., are cited as the possible explanations for the lag of futures markets. These studies have investigated the role of futures and spot market in price discovery in the countries like the US, UK, Germany, Japan and India etc.

Another line of research has focused on volatility spillovers between spot and futures markets variables with varying results. The early studies by King and Wadhwani (1990) find in support of their contagion model for the New York, London and Tokyo stock markets. Hamao et al. (1990) evident the volatility spillovers for U.S and U.K stock markets to the Japanese stock markets. Susmel and Engle (1994) examined the spillover effect for London and New York stock exchanges and suggested that there is no evidence of spillover effect. Karolyi (1995) supports the spillovers between the New York and Toronto stock markets was envisaged with short-run equilibrium. Theodossiou and Lee (1993) observe statistically significant mean and volatility spillovers between some of the markets in the U.S, U.K, Canada, Germany and Japan. Koutmos and Booth (1995) study the linkages between the developed markets and conclude that the volatility transmission process was asymmetric. Booth et al. (1997) observe price and volatility spillovers in the Scandinavian markets. Kanas (2000) study the spillovers effect between stock returns and exchange rate for six countries and indicate the strength of the volatility spillovers appears to have increased since the October 1987 crash. Assoe (2001) investigate the linkage between stock and foreign exchange markets and finds negative mean spillovers with the absolute value is very small relative to the influence of exchange rate fluctuations on the stock market. Sim & Zurbreugg (1999), Xu & Fung (2005), and Wu, Li & Zhang (2005) suggested the powerfulness of GARCH models was very useful and widely applied to investigate return and volatility spillovers effect. So, the literature pertaining to spillover effect among international level was quite unlimited. But, as far as India is concerned only a few notable studies have made an attempt on Indian equity market. Kumar (2002) examined the volatility spillover effect for U.S to India markets and observed with significant trend. Nath (2003) studied the interdependence of three major stock markets and find no Cointegration exists between the stock market during the period of study by applying Granger causality test. Mukherjee (2005) analyzed the inter-linkage between Indian stock markets with the world equity markets.

There is quite strong body of literature advocating the price discovery and volatility spillovers in spot and futures markets volatility. Tse (1999) investigate minute-by-minute price discovery process for DJIA (Dow Jones Industrial Average) markets and suggests that price discovery concentrates at 88.3 per cent information share in futures market and volatility spillovers were examined through Bivariate EGARCH model to exhibit asymmetric volatility effects, with bad news having a greater impact on volatility than good news. Zhong, Darrat and Otero (2004) envisaged that futures market serves effectively in price discovery function, but the short-run innovations originating in both the market provoke volatility in the other market and that deviation from the long-run price equilibrium also propagates volatility in both markets. Qing and Zhang (2006) examine the long-term symmetrical relationships and significant bidirectional flow of information with futures being dominant. Although innovation in one market can predict the future volatility in another market the volatility spillovers from futures to spot are more significant, whereas in India Karmakar (2009) made an attempt on price discovery and volatility spillovers between S & P CNX Nifty spot and futures market for a period of 7 years and 9 months and concludes that futures market plays a dominant role in price discovery. But, in case of volatility spillovers there exists a bidirectional relationship between spot and futures markets. Several studies have conducted at international level to test the price discovery and volatility spillovers between the spot and futures markets, whereas in India the empirical work are quite limited. Hence, the current study attempts to shed light on the existing literature to examine the relationship between S&P CNX Nifty spot and futures markets.

3. Data & Sample Size

This analysis of information is based upon the daily dataset consist of 2112 observations for the closing price of S&P CNX Nifty spot and futures contracts, sampled from January 2001 to June 2010. The S&P CNX Nifty spot and futures contracts trade on the National Stock Exchange (NSE) and contract specifications and trading details are retrieved from their website (www.nseindia.com). Simultaneously three types of contracts are usually traded in the futures markets. Near month futures contracts are considered for the purpose of analysis, because most trading activities take place in the near month contracts than on the other two types of contracts. The spot and futures return series are transformed to continuously compounded returns, and calculated as $R_t = \ln(P_t/P_{t-1})$ where P_t is the closing price on day t. The use of logarithm price changes prevents non-stationary of the price level series from affecting futures price volatility.

4. Econometric Methodology

4.1 Johansen Cointegration Test

Before estimating for Cointegration, the first step in time-series data is to determine the order of integration of each price series using Augmented Dickey-Fuller (ADF) test and Phillips-Perron tests. Since most of time series have unit roots as many studies indicated including, Nelson and Plosser (1982), and as proved by Stock and Watson (1988) that most of the time series are non-stationary, conventional regression techniques based on non-stationary time series produce spurious regression, Granger and Newbold (1974). The spot and future price series should be examined for *I*(1) first, Johansen (1988, 1991) tests are used to determine whether the series stand in a long-run relationship between them; that is, that they are Cointegrated. The following Vector Error Correction Model (VECM) (Johansen, 1988) is estimated:

$$\Delta Y_t = \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-i} + \Pi X_{t-1} + \varepsilon_t ; e_t \mid \Omega_{t-1} \sim distr(0, H_t) \qquad (1)$$

Where, X_t is the 2 *x* 1 vector (S_t, F_t) of log-spot and log-futures prices, respectively. □denotes the first difference operator, ε_t is a 2 *x* 1 vector of residuals (ε_{St}, ε_{Ft}) that follow an as-yet-unspecified conditional distribution with mean zero and time-varying covariance matrix, H_t. The VECM specification contains information on both the short-run and long-run adjustment to changes in X_t, via the estimated parameters in $□_i$ and □, respectively.

Johansen (1988) show that the coefficient matrix □contains the essential information about the relationship between S_t and F_t. Specifically, if rank (□) = 0, then □is 2 *x* 2 zero matrix implying that there is no Cointegration relationship between S_t and $F_{t,t-n}$. In this case, the VECM reduces to a VAR model in first differences. If □has a full rank, than the rank (□) = 2, then all variables in X_t are *I*(0) and the appropriate modeling strategy is to estimate a VAR model in levels. If □has a reduced rank, that is rank(□) = 1, then there is a single Cointegration relationship between S_t and F_t, which is given by any row of matrix □and the expression □X*t*-1 is the error correction term. In this case, □can be factored into two separate matrices *a* and *ß*, both of dimensions 2 *x* 1, where 1 represents the rank of □, such as □= *aß*', where *ß*' represents the vector of co integrating parameters and *a* is the Vector of Error Correction coefficients measuring the speed of convergence to the long-run steady state.

Since rank (□) equals the number of characteristic roots (or) Eigen values which are different from zero, the number of distinct co integrating vectors can be obtained by estimating the number of these Eigen values, which are significantly different from zero. The characteristic roots of *n x n* matrix □, are the values of λ which satisfy the following equation |□̃*l*In| = 0, where I_n is a n *x* n identity matrix. Johansen (1988) proposes the following two statistics to test for the rank of □:

$$\lambda trace(r) = -T \sum_{i=r+1}^{n} In(1-\hat{\lambda}_i) \tag{2}$$

$$\lambda max(r, r+1) = -TIn(1-\hat{\lambda}_{r+1}) \tag{3}$$

Where, $\hat{\lambda}_1$ are the Eigen values obtained from the estimate of matrix and T is the number of usable observations. The λ_{trace} tests result suggest, that the null are at most r Cointegrated vectors, against the alternative the number of Cointegrating vectors is greater than r and λ_{max} tests statistics state that the null of Cointegrating vectors is r, against the alternative of $r + 1$. Critical values for the λ_{trace} and λ_{max} statistics are provided by Osterwald-Lenum (1992).

4.2 Vector Error Correction Model (VECM)

If spot and futures prices are Cointegrated, then causality must exist in at least one direction Granger (1988). Granger causality tests can identify whether two variables move one after the other or contemporaneously. When they move contemporaneously, one provides no information for characterizing the other. If "X causes Y", then changes in X should precede changes in Y. Consider the VECM specification can be written as follows:

$$\Delta F_t = w_f + d_f Z_{t-1} + \sum_{i=1}^{k} a_{fi} \Delta F_{t-1} + \sum_{i=1}^{k} b_{fi} \Delta S_{t-i} + \varepsilon_{f,t} \tag{4}$$

$$\Delta S_t = w_s + d_s Z_{t-1} + \sum_{i=1}^{k} a_{si} \Delta F_{t-1} + \sum_{i=1}^{k} b_{si} \Delta S_{t-i} + \varepsilon_{s,t} \tag{5}$$

Where, a_{fi}, b_{fi}, a_{si} and b_{si} are the short-run coefficients, $z_{t-1} = S_{t-1} - \alpha F_{t-1} - \beta$ is the Error-Correction Term (ECT), and $\varepsilon_{s,t}$ and $\varepsilon_{f,t}$ are residuals. Apart from this, the above VECM equations (4) and (5), the unidirectional causality from futures Granger causes to spot, if it requires that some of b_{fi} coefficients, i = 1, 2, … p-1, are not zero and d_f the Error Correction coefficient in equation (4), is significant at conventional levels. In the same sense, the unidirectional causality between spot Granger causes to futures requires, that some of the a_{si} coefficients, i = 1, 2… p-1, are not zero and d_s is significant at conventional levels. If both the variables Granger cause each other, then there exists a bidirectional relationship between the spot and futures markets Granger (1986). Moreover, the ECT coefficients are used to explain the speed of adjustment towards the long-run equilibrium by correcting the changes in spot and futures markets.

4.3 Variance Decomposition

Variance decomposition measures the relative contribution of forecast error variance (FEV) of each shock as a function of forecast horizon. While the impulse-response function reveals the dynamic effects of one-time shock, the variance decomposition is a convenient measure of relative importance to such shocks to the system. The innovative analyses are very sensitive to the ordering of spot and futures market variables. Nake & Tufte (1997) consider this is the most common ordering based on theory. The present placement may reflect our priors, and it should be noted that changes in this sequence did not affect results significantly. In this paper, we discuss the effect of future market shocks on spot market.

4.4 Bivariate EGARCH (1,1)

A Bivariate EGARCH (1,1) model is chosen in order to examine, how news from one market affects the volatility behavior of another market. Hamao, Masulis and Ng (1990) describe the correlation in price changes and volatility across the U.S stock market. Koutmos and Booth (1995) report the asymmetric volatility transmission in the U.K stock markets. Chan, Chan and Karolyi (1991) examine the intraday volatility spillovers between the spot and futures markets by applying the GARCH (1,1) models. Although, numerous studies use GARCH type models for modeling the volatility behavior in financial time series, but to study the leverage effect between the spot and future market EGARCH model accurately serves in explaining the volatility dynamics Ramaprasad (2001) and Clinton and Michael (2002). Thus, we propose the following Bivariate EGARCH model to determine the volatility spillover mechanism;

$$\varepsilon_t = \begin{pmatrix} \varepsilon_{f,t} \\ \varepsilon_{s,t} \end{pmatrix} | \Lambda_{t-1} \sim N(0, \Omega_t) \tag{6}$$

$$In(\sigma_{f,t}^2) = \omega_f + \psi_f \left| \frac{\varepsilon_{t-1}}{\sigma_{t-1}} - \sqrt{\frac{2}{\pi}} \right| + \tau_f \frac{\varepsilon_{t-1}}{\sigma_{t-1}} + \alpha_f In(\sigma_{f,t-1}^2) + \gamma_f In(\varepsilon_{s,t-1}^2) \tag{7}$$

$$In(\sigma_{S,t}^2) = \omega_S + \psi_S \left| \frac{\varepsilon_{t-1}}{\sigma_{t-1}} - \sqrt{\frac{2}{\pi}} \right| + \tau_S \frac{\varepsilon_{t-1}}{\sigma_{t-1}} + \alpha_S In(\sigma_{S,t-1}^2) + \gamma_S In(\varepsilon_{f,t-1}^2) \tag{8}$$

Where, the unautocorrelated residuals $\varepsilon_{f,t}$ and $\varepsilon_{s,t}$ is obtained from VECM equation (4) and (5) and Ω_{t-1} is the information set at *t-1*. Thus the VECM and Bivariate EGARCH model is asymptotically equivalent to a joint estimation of the VECM and EGARCH models Greene

(1997). In practical sense, a large number of parameter should be involved in estimating VECM and EGARCH model simultaneously in one step and it will be intricate task. Moreover, for estimating the volatility spillover the resiudals of Error Correction Term should be included in the conditional variance equation. Otherwise the model will be misspecified and the residuals obtained in ECT will be biased.

5. Results & Discussion

To assess the distributional properties of S & P CNX Nifty spot and futures, descriptive statistics are reported in Table 1. The mean return for spot was indicated with .000768 while for futures was .000765. The fluctuation in future and spot market were envisage with .001732 and .018424, respectively. The mean and standard deviation of both prices and returns show clear similarity in both the markets. The series also exhibits an excess kurtosis for spot and future market with 12.119 and 11.625 indicating the returns are not normally distributed. The Jarque-Bera (JB) statistic shows that we have to reject normality with a p-value of one. The Ljung-Box Q- statistics of serial correlation approach significance, supporting the notion that the spot and future market returns series are free from auto correlated. One of the main concerns of the time series is whether the return series contain a unit root. In order to check the stationarity of spot and future market return series, both Augmented Dickey Fuller (ADF) test and Phillip-Perron test are conducted. The result indicates that the null hypothesis of the unit root test is not stationary at their levels but their first differences are stationary at 1 per cent level of significance.

Table: 1 Summary Statistics for NSE Spot & Futures Price Series

Particulars	**Spot Price**	**Particulars**	**Futures Price**
Mean	0.000768	Mean	0.000765
S.D	0.018424	S.D	0.001732
Skewness	-1.44616	Skewness	-0.28604
Kurtosis	12.11940	Kurtosis	11.62591
Jarque - Bera	7388.460	Jarque - Bera	6576.555
Probability	0.00000	Probability	0.00000
LB (5)	342.13	LB (5)	6.3827
LB (10)	348.08	LB (10)	13.842
ADF	-21.7715*	ADF	-21.94500*
PP	-43.2669*	PP	-45.19230*

Sample: January 1, 2001 to June 30, 2010. ADF is the Augmented Dickey – Fuller Test and PP refers to Phillips – Perron Test. * indicates significance at 1 % level.

In order to test for Cointegration between spot and future prices the Johansen (1988) procedure is employed in Table 2. In this case Johansen's Cointegration test is applied and the results displayed are the trace statistic and maximal Eigen value. Taking into account the results from both tests, we can reject the absence of Cointegration relationship and we support for the existence of at least one Cointegration equation. Since there are two variables, we can conclude that there is only one Cointegration relationship exists between spot and futures prices. We can, therefore, proceed with the estimation of a Vector Error Correction Model (VECM). It can be concluded that the S & P CNX Nifty spot and future leads in the long run.

Table: 2 Johansen's Cointegration Test Results

Ho	H1	Eigen Value	Statistic	5 % Critical Value	1 % Critical Value
λ_{trace} test					
r = 0	r ≥ 1	0.316681	63.970**	15.41	24.60
r ≤ 1	r ≥ 2	0.018972	5.0494	9.24	12.97
λ_{max} test					
r = 0	r = 1	0.316681	58.9206**	15.67	20.20
r ≤ 1	r = 2	0.018972	5.0494	9.24	12.97

Note: r shows that the null hypothesis of a unit root is rejected at the 1 % significance level.

In order to estimate the long-run and short-run relationship between spot and future market in VECM, we first determine the appropriate lag length criteria by Akaike Information Criteria (AIC) and the smallest four lag period was considered. The inclusion of the error terms Z_{t-1} in equation (4) and (5) will be used to track the long-run causality between the time series derived from VECM. The significant value of the coefficients of the error terms is based on a standard t-test. Negative and statistically significant values of the coefficients indicate the existence of a long run causality·

The results of VECM are presented in Table 3. The lagged error term coefficient Z_{t-1} is statistically significant at 1 per cent level for both the markets. The value of Z_{t-1} indicates the speed of adjustment of any disequilibrium towards a long-run equilibrium. Simultaneously, both the spot and futures markets were observed with significant trend and indicate that both the markets are adjusting towards market news with each other. Moreover, the significant error term in spot and future market support the evidence of a long-run equilibrium relationship exist between both the markets. The coefficients of spot and future market at lagged period are statistically significant which point out that the presence of short-run equilibrium exists between these markets. In order to confirm the result of long-run and short-run dynamics between spot and future market based on VECM estimates, a standard Granger causality test is run based on R^2, F-statistics and Log Likelihood. Furthermore, the result of VECM reveals the existence of feedback relationship exists between both the market in short and long run.

Table: 3 Estimates of the Vector Error Correction Model (VECM)

Independent Variable	**Dependent Variable**	
	ΔF_t	**ΔS_t**
C	-6.60E-06	-8.37E-06
	(-0.0148)	(-0.0199)
Z_{t-1}	-3.0699**	-1.2183 **
	(-6.8559)	(-2.8748)
ΔF_{t-1}	1.5041**	1.0510**
	(4.0629)	(2.9999)
ΔF_{t-2}	1.0270**	0.7699**
	(3.7447)	(2.9661)
ΔF_{t-3}	0.6936**	0.5998**
	(4.4047)	(4.0250)
ΔS_{t-1}	-2.2217**	-1.7417**
	(-5.5911)	(-4.9361)
ΔS_{t-2}	-1.5544**	-1.2795**
	(-5.5911)	(-4.8630)
ΔS_{t-3}	-0.9708**	-0.8682**
	(-5.9871)	(-5.6576)
R^2	0.3821	0.3443
F-statistics	185.54	175.54
Log likelihood	5219.73	5335.89

Note: Figures in the parenthesis indicate t – statistics. ** and * denote significance at 1 % and 5 % levels, respectively.

Variance decomposition indicates how much the variability of future market is explained by disturbances in spot market and vice-versa. Table 4, the variance decomposition of future market, clearly indicates that most 98.26 per cent of the variation of future market is explained by its own innovations even after the 10th horizon, while 1.73 per cent variation of future market is explained by disturbance of spot market. It implies that spot market does not have a great influence on future market movements. However, variance decomposition of spot market shows quite different trend. In the 10th horizon, 99.28 per cent of the variability in spot market is explained by shock in future market, which means that only 0.73 per cent of variation of spot market, is explained by its own shocks. Therefore, we can conclude that the variance of spot market tends to be explained by the both shocks in spot market and shocks in future market, whereas shocks in future market tend to be explained by its own shocks. In other words, spot market has lesser influence on changes in future market than future market has on changes in spot market.

Table: 4 Forecast Error Variance Decomposition of Spot & Futures

Variance Decomposition of Futures			Variance Decomposition of Spot	
Horizon	**Futures**	**Spot**	**Futures**	**Spot**
1	98.2531	1.7460	0.0000	100.000
2	97.8547	2.1452	0.0497	99.9503
3	97.8503	2.1497	0.1656	99.8343
4	98.0002	1.9997	1.8864	99.8113
5	97.8140	2.1859	0.6893	99.3106
6	97.9943	2.0056	0.6362	99.3637
7	98.0728	1.9271	0.6471	99.3528
8	98.1593	1.8406	0.6617	99.3382
9	98.2034	1.7965	0.7051	99.2948
10	98.2670	1.7329	0.7139	99.2860

Note: Ordering from Futures to Spot and Spot to Futures

The coefficients of Bivariate EGARCH (1,1) model results are reported in Table 5. We obtain the parameter estimates by maximizing the log-likelihood using the Berndt, Hall, Hall and Hausman (1974) algorithm. Most of the results of the present study agree with those of other empirical studies on time - varying volatility. The log likelihood statistics are very large, which indicates that the Bivariate EGARCH formulation is an appropriate presentation of daily return behavior that captures the temporal dependence of return volatility.

The coefficient estimates for volatility spillover are explained by estimating Bivariate EGARCH (1,1) model for γ_f and γ_s. The coefficient parameter γ_f (γ_s) reveals the volatility spillover from the spot (futures) to futures (spot) market. The volatility spillover coefficients are significant at 1 per cent for spot and future markets, respectively. The coefficients of volatility spillover (γ) in future is larger than the spillover (γ) in spot market, although an innovation originated in one market will influence the volatility behavior of the other market, the spillover from spot and futures are insignificant, which indicate that there exists a bidirectional relationship between both the market. Moreover, both the markets play more important price discovery roles and the results are consistent with the spillover results. Therefore, the Bivariate EGARCH model indicates that past innovations in spot and futures are significantly influence both the market volatility. So, the information disseminates in both the market.

Table: 5 Estimates of Bivariate EGARCH (1,1) Model

Variables	Futures	Spot
C	0.8996**	0.9477**
	(38.433)	(39.9897)
R_{t-1}	0.1012**	0.0531*
	(4.3323)	(2.2463)
ω	-0.5197**	-0.4764**
	(-8.6111)	(-9.7044)
ψ	0.2692**	0.2561**
	(13.4551)	[12.5974)
τ	-0.1103**	-0.0947**
	(-8.6375)	(-8.8511)
α	0.9625**	0.9667**
	(15.0678)	(18.4830)
γ	-6.5791	-1.9472
	(-0.4940)	(-0.1356)
Log likelihood	5942.52	5828.59

Note: Figures in the parenthesis indicate t – statistics. ** and * denote significance at 1 % and 5 % levels, respectively.

6. Summary and Conclusion

This paper investigate the role of price discovery and volatility spillovers from between spot and futures market in Indian stock market by employing Johansen Cointegration, VECM, Variance Decomposition and Bivariate EGARCH (1,1) model for the period 1, January 2001 to 30, June 2010. The Cointegration test result confirms existence of long-run equilibrium relationship between the spot and futures prices. In detail, the VECM model was employed to investigate how far the short and long-run dynamics adjusts to the speed of equilibrium between the variables. The findings of the study, explore that both the market were adjust towards market news and observed with bidirectional relationship, it is a sign that, both the market were functioning effectively in the short as well as in the long-run. Our results further imply that all investors are able to grasp their expected future price in spot and futures market due to efficiency of the markets. Apart from this, the result of Variance decomposition concludes that spot market has lesser influence on changes in future market than future market has on changes in spot market.

The Bivariate EGARCH (1,1) model indicate that an innovation originating in one market will have an greater impact on the volatility of other market. Simultaneously, the volatility spillovers take place from one market to another market with bidirectional and asymmetric effect. Therefore, the findings suggest, the noise trading is the main cause of asymmetric responses. Finally, bad news has a greater impact than the good news, which is mainly attributed to investor's behavior and institutional features of the Indian market. These findings are contrary to the findings of Chan and Karolyi (1991) and Karmakar (2009) who found feedback relationship between spot and futures market in volatility spillovers.

The above findings have important policy implications. Understanding the direction of causality and volatility spillovers between spot and futures is crucial for formulating policies that encourage the policy makers to strengthen the rules and regulations for the investors in developing countries. In view of our findings, the conventional view state that the complicated financial sector reforms should be kept into consideration to reduce fluctuation in the capital market. Again, it should be noted that excessive program trading invite information dissemination between two markets, which becomes conducive for arbitragers and makes instability in both the markets. Therefore, understanding the dynamic inter linkage between these markets would be useful for policy makers in making the financial system more stable.

References:

Abhyankar, A.H. (1995), "Return and Volatility Dynamics in the FTSE 100 Stock Index and Stock Index Futures Markets", *Journal of Futures Markets*, Vol. 15, No: 4, 457-488.

Assoe, K., (2001), "Volatility Spillovers between Foreign Exchange and Emerging Stock Markets", *Cahier de Recherche 2001-04*, CETAI, HEC-Montreal.

Berndt, E.K., Hall, H.B., Hall, R.E., Hausman, J.A (1974), "Estimation and Inference in Nonlinear Structural Models", *Annuals of Economic and Social Measurement*, Vol. 4, 653-666.

Booth, G.G., Martikeinan, T. and Tse, Y. (1997), "Price and Volatility Spillovers in Scandanavian Stock Markets", *Journal of Banking and Finance*, Vol. 21, 811-823.

Chan K, Chan KC, Karolyi G (1991), "Intraday Volatility in the Stock Index and Stock Index Futures Market", *Review of Financial Studies*, Vol. 4, 657-684.

Cheung, Y. W. and Ng, L. K., (1990), "The Dynamics of S&P 500 Index and S&P 500 Futures Intraday Price Volatilities", *Review of Futures Markets*, Vol. 2, 458-486.

Clinton W, Michael M. (2002), "Cointegration Analysis of Metals Futures" *Mathematics and Computers in Simulation*, Vol. 59, 207-221.

Garbade, K. D. and Silber, W. L. (1979) Dominant and Satellite Markets: A Study of Dually-Traded Securities, *Review of Economics and Statistics*, Vol. 61, 455-60.

Granger, Clive and Paul Newbold (1974), "Spurious Regressions in Econometrics", *Journal of Econometrics*, Vol. 2, 111-120.

Granger, C. (1986), "Developments in the Study of Cointegrated Variables," *Oxford Bulletin of Economics and Statistics*, Vol. 48, 213-227.

Greene W H. (1997), "Econometric Analysis (3rd Edition)", *Engelwood Cliffs*, NJ: Prentice Hall.

Hamao, Y., R.W. Masulis and V.K. Ng (1990), "Correlation in Price Changes and Volatility across International Stock Markets", *Review of Financial Studies*, Vol. 3, 281-307.

Hasbrouck J (1995), "One Security, Many Markets: Determining the Location of Price Discovery", *Journal of Finance*, Vol. 50, 1175-1199.

Herbst, A. F., McCormack, J. P. and West, E. N., (1987), "Investigation of Lead-Lag Relationship between Spot Stock Indices and their Futures Contract", *The Journal of Futures Markets*, Vol. 7, 373-382.

Johansen, S. (1988), "Statistical Analysis and Cointegrating Vectors", *Journal of Economic Dynamics and Control*, Vol.12, 231-254.

Johansen, S. (1991), "Estimation and Hypothesis Testing for Cointegrating Vectors in Gaussian Vector Autoregressive Models", *Econometrica*, Vol. 59, 1551-1580.

Karmakar Madhusudan (2009), "Price Discovery and Volatility Spillovers in S&P CNX Nifty Futures and its Underlying Index CNX Nifty" Vikalpa, Vol. 34, No: 2, 41-56.

Kanas, A., (2000) "Volatility Spillovers between Stock Returns and Exchange Rate Changes: International Evidence", *Journal of Business Finance & Accounting*, Vol. 27, 447-467.

Karolyi, G.A., (1995), "A Multivariate GARCH Model of International Transmissions of Stock Returns and Volatility: The case of the United States and Canada", *Journal of Business and Economic Statistics*, Vol. 13, 11-25.

Kavussanos. M and Nomikos. N.K (2003), "Price Discovery, Causality and Forecasting in the Freight Futures Market", Review of Derivatives Research, Vol: 6, 203-230.

Kawaller, I.P., Koch, P., and Koch T. (1987), " The Temporal Price Relationship between S&P 500 Futures and S&P 500 Index", Journal of Finance, Vol. 41, 107–125.

King, M.A., Wadhwani, S., (1990) "Transmission of Volatility between Stock Markets", *Review of Financial Studies*, Vol. 3, 5-33.

Koutmos, G., and Booth, G.G. (1995), "Asymmetric Volatility Transmission in International Stock Markets", *Journal of International Money and Finance*, Vol. 14, 747-762.

Kumar K. K. and Mukhopadyay C (2002), "A Case of US and India", *NSE Research Paper*.

Liu. Q and Zhang. J (2006), "Price Discovery and Volatility Spillovers: Evidence from Chinese Spot-Futures Markets", *National Nature Science Funds of China*.

Mukherjee K.N. and Mishra R. K (2005), "Stock Market Inter linkages: A Study of Indian and World Equity Markets", *Indian Journal of Commerce.*

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", http://nseindia.com/content/research/res_papers.htm

Naka, A. and D. Tufte (1997), "Examining Impulse Response Functions in Cointegrated Systems", *Applied Economics*, Vol. 29, 593-603.

Nath G. C. and Verma S (2003), "Study of Common Stochastic Trend and Co-Integration in the Emerging Markets: A Case Study of India, Singapore and Taiwan".

Nelson, Charles & Charles Plosser (1982), "Trends and Random Walks in Macroeconomic Time Series: Some Evidence and Implications, *Journal of Monetary Economics*, Vol. 10, 130-162.

Osterwald-Lenum M (1992), "A note with Quantiles of the Asymptotic Distribution of the Maximum Likelihood Cointegration Rank test Statistics" *Oxford Bulletin of Economics and Statistics*, Vol. 54, 461-72.

Pattarin, Francesco and Riccardo Ferretti (2004), "The Mib30 Index and Futures Relationship: Econometric Analysis and Implications for Hedging", *EFMA 2004 Basel Meetings Paper*.

Raju, M.T. and Kiran Karande (2003), "Price Discovery and Volatility on NSE Futures Market", Working Paper Series No. 7, *Securities and Exchange Board of India*.

Ramaprasad B. (2001), "Return and Volatility Dynamics in the Spot and Futures Markets in Australia: An Intervention Analysis in a Bivariate EGARCH-X framework." *Journal of Futures Markets*, Vol. 21, No: 9, 833-850.

Roell, A. (1992), "Comparing the Performance of Stock Exchange Trading Systems, in: J. Fingleton and D. Schoenmaker (eds), *The Internationalization of Capital Markets and the Regulatory Response,* Graham and Trotman, London.

Susmel, R. and R.F. Engle (1994), "Hourly Volatility Spillovers between International Equity Markets", *Journal of International Money and Finance*, Vol. 13, 3-25.

Stock, J. and Watson, M. (1998), "A Comparison of Linear and Non-Linear Univariate Models for Forecasting Macroeconomic Time Series, *NBER Working Paper*, No. 6607.

Stoll, H.R., and Whaley, R.E (1990), "The Dynamics of Stock Index and Stock Index Futures Returns", *Journal of Financial and Quantitative Analysis*, Vol. 25, 441-468.

Sim, A. B. & Zurbreugg, R (1999), "Intertemporal Volatility and Price Interactions between Australian and Japanese Spot and Futures Stock Index Markets", *Journal of Futures Markets*, Vol. 19, No: 5, 523-540.

Thenmozhi, M (2002), "Futures Trading, Information and Spot Price Volatility of NSE-50Index Futures Contract, http://nseindia.com/content/research/res_papers.htm

Theodossiou, P. and U. Lee (1993): "Mean and Volatility Spillovers across Major National Stock Markets: Further Empirical Evidence," *Journal of Financial Research*, 16, 337-350.

Tse Y. (1999), "Price Discovery and Volatility Spillover in the DJIA Index and Futures Markets" *Journal of Futures Markets*, Vol. 19, No: 8, 911-930.

Tse Y, So R. W. (2004) "Price Discovery in the Hang Seng Index Markets: Index, Futures, and the Tracker Fund." *Journal of Futures Markets*, Vol. 24, No: 9, 887-907.

Turkington, J. and Walsh, D. (1999), "Price Discovery and Causality in the Australian Share Price Index Futures Market", *Australian Journal of Management*, Vol. 24, No. 2, 97-113.

Wahab, M. and Lashgari, M (993) "Price Dynamics and Error Correction in Stock Index and Stock Index Futures Markets: A Cointegration Approach", *The Journal of Futures Markets*, Vol.13, 711-742

Wu, C., Li, J. and Zhang, W., 2005, "Interdaily Periodicity and Volatility Spillovers between International Stock Index Futures Markets," *Journal of Futures Markets*, Vol. 25, 553-585.

Xu X E, Fung H G. (2005), "Cross-Market Linkages between U.S. and Japanese Precious Metals Futures Trading." *Journal of International Financial Markets, Institutions & Money*, Vol. 15, 107-124.

Zhong, M., Darrat, A.F., and Otero, R. (2004), "Price Discovery and Volatility Spillovers in Index Futures Markets: Some Evidence from Mexico", *Journal of Banking and Finance*, Vol. 28, 3037-3054.