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<b>ARTICLE INFO</b>	Namita Rajput, Ruhi Kakkar, Geetanjali Batra and Meenakshi Gupta (2012). Price discovery in Indian stock market: case of S&P CNX Nifty index. <i>Investment Management and Financial Innovations</i> , 9(3)
<b>RELEASED ON</b>	Friday, 28 September 2012
<b>JOURNAL</b>	"Investment Management and Financial Innovations"
<b>FOUNDER</b>	LLC “Consulting Publishing Company “Business Perspectives”



NUMBER OF REFERENCES

0



NUMBER OF FIGURES

0



NUMBER OF TABLES

0

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## Price discovery in Indian stock market: the case of S&P CNX Nifty index

### Abstract

This paper examines the relationship between the futures market and spot market of S&P CNX Nifty during the sample period from January 2003 to March 2011 and enumerate the price discovery function of futures prices in relation to spot prices of the sample series. The Cointegration tests and Vector Error Correction Models (VECM), Variance Decomposition Analysis (VDA) and Granger causality is employed to ascertain the long and short-term dynamics of the selected spot market and the futures market. From the results of the study it was also found that the futures price series had a greater speed of adjustment to the previous deviations and hence the price discovery was achieved first in the spot market. These findings may provide insights on the information transaction and index arbitrage between the CNX Nifty and futures markets.

**Keywords:** cointegration, price discovery, S&P CNX Nifty index, Vector Error Correction Models.

**JEL Classification:** G12, G14.

### Introduction

Futures contracts are initially developed as new financial instruments for price discovery and risk transfer. The essence of the price discovery functions depends on whether new information is reflected first in the cash markets or futures markets. Both markets contribute to the discovery of a unique and common unobservable price, which is the efficient price. The analysis of price discovery and information flow across cash and futures markets has received much attention from academicians, regulators and practitioners. The global liberalization and integration of financial markets has shaped new investment opportunities, which in turn require the development of new instruments that are more efficient to deal with the increased risks. Institutional investors who are actively engaged in industrial and emerging markets need to hedge their risks from these internal as well as cross-border transactions. Agents in liberalized market economies who are exposed to volatile stock price and interest rate changes require appropriate hedging products to deal with them. And the economic expansion in emerging economies demands that corporations find better ways to manage financial and commodity risks. The most desired instruments that allow market participants to manage risk in the modern securities trading are known as derivatives. The history of derivatives may be new for developing countries but it is old for the developed countries. The history of derivatives is surprisingly longer than what most people think. The derivatives contracts were done not formally in the old times in the informal sectors. The advent of modern day derivative contracts is attributed to the need for farmers to protect themselves from any decline in the price of their crops

due to delayed monsoon, or overproduction. Numerous studies advocate the critical role of futures markets in price discovery for the underlying spot market (Chatrath et al., 1999; Lien and Tse, 2000; Yang et al., 2001). It is one of the most important function of financial markets that market prices incorporate the new information, this process is called as price discovery process. Price discovery refers to the use of future prices for pricing cash market transactions. This implies that futures price serves as market's expectations of subsequent spot price. Understanding the influence of one market on the other and the role of each market segment in price discovery is the central question in market microstructure design and is very important to academia and regulators. In efficient markets, new information is impounded simultaneously into cash and futures markets (Zhong et al., 2004). In other words, financial market pricing theory states that market efficiency is a function of how fast and how much information is reflected in prices. The rate at which prices exhibit market information is the rate at which this information is disseminated to market participants (Zapata et al., 2005). In reality, institutional factors such as liquidity, transaction costs, and other market restrictions may produce an empirical lead-lag relationship between price changes in the two markets. Moreover, all the markets do not trade simultaneously for many assets and commodities. Besides being of academic interest, understanding information flow across markets is important for hedge funds, portfolio managers and hedgers for hedging and devising cross-market investment strategies.

The market that provides the greater liquidity and low trading cost as advocated by Fleming, Ostdiek and Whaley (1996) is likely to play a more important role in price discovery. Generally, price discovery is the dynamic process by which market prices incorporate new information, and is arguably one of

the most important functions of financial markets. This price discovery function implies that prices in the futures and spot markets are systematically related in the short run and/or in the long run. In the cointegration jargon, the price discovery function implies the presence of an equilibrium relation binding the two prices together. If a departure from equilibrium occurs, prices in one or both markets should adjust to correct the disparity. One of the important issues that are related to price discovery are determining which market first incorporates new information about the underlying fundamental asset, and how the efficacy of price discovery depends on trading mechanisms. It has been argued that effective futures markets should generate prices that express consciously-formed opinions on cash prices in the future, and should transmit that information throughout the marketing system in a timely manner (Working, 1948). Because of its importance, the effectiveness of futures markets in performing this function has been investigated extensively in the literature.

The more recent studies have shown that futures prices play a dominant role in the discovery and transmission of price information. Whether this situation holds good for all markets is a question of debate for several years. Derivatives enable better risk management as they help to diversify as well as trade risk. The derivative market helps to transfer risks. Before getting into any contract, each party trading in derivative is required to know the risk involved. The transfer of risk enables market participants to expand their volume of activity.

Price of the derivative is derived from the underlying asset, any change in price of the underlying asset leads to change in the value of the asset. Derivatives facilitate investment and arbitrage strategies that straddle market segments. It helps to increase asset substitutability, both domestically and internationally. Derivatives help to improve liquidity. It helps to facilitate the creation of pay off characteristics at a lower cost that would result from the acquisition of underlying assets. Derivative markets help increase savings and investment in the long run.

The derivative market performs a number of economic functions. Some of them are given below:

- ◆ The prices of derivatives converge with the prices of the underlying at the expiration of derivative contract. Thus derivatives help in discovery of future as well as current prices.
- ◆ An important incidental benefit that flows from derivatives trading is that it acts as a catalyst for new entrepreneurial activity.
- ◆ Derivatives markets help increase savings and investment in the long run. Transfer of risk

enables market participants to expand their volume of activity.

For answering this question, this study makes an attempt taking into consideration the S&P CNX Nifty index and its underlying futures prices. Issues like price discovery have been extensively researched for mature markets. Most of the above studies have been conducted in developed countries more particularly in the US. In India and emerging economies there are very few studies which have investigated the lead-lag relationship in the first moment of the spot and futures market. In this backdrop, an attempt has been made to revisit the debate on price discovery in Indian commodities market. It covers fairly longer study period compared to prior research of the subject and also analyzes how the price discovery is established in two markets. The study attempts to address the following questions, if futures prices are useful in price discovery mechanism of spot prices or vice versa?

The remainder of the paper is organized as follows. Section 1 gives extensive review of literature. Section 2 contains description of data and the methodology employed. Section 3 exhibits analysis and interpretation of the data through a variety of tables into which relevant details have been compressed and summarized under appropriate heads and presented in the tables. The final section provides brief summary, conclusion of the main findings and policy implications.

## 1. Literature review

There are numerous studies that have been explored in the ascertainment of whether the price information is reflected in the spot market or in its underlying futures market under various interval of time since the introduction of futures in Indian stock market. Derivatives trading in the stock market have been a topic of enthusiasm of research in the field of finance. There have been contrary views on impact of derivatives trading, lead-lag relationship or price discovery process. From a controlled economy, India has moved towards a world where prices fluctuate every day. The introduction of risk management instruments in India gained momentum in the last few years due to liberalization process and Reserve Bank of India's (RBI) efforts in creating currency forward market. Derivatives are an integral part of liberalization process to manage risk. NSE gauging the market requirements initiated the process of setting up derivative markets in India. In July 1999, derivatives trading commenced in India. The introduction of derivatives segment from the early 2000s onwards has led both to interactions between the spot and futures markets, and to an

interest by regulators in controlling any possible harmful influences of this new trading segment. There was a huge gap between the investors' aspirations of the markets and the available means of trading. Herbst (1987) deliberate a study of S&P index futures and Value Line Index (VLI) futures taking a time period from February 1982 to September 1991 and establish a lead role of futures price. The results of the study convey that the information is quickly absorbed in the spot market; hence profitable trading strategies using lead lag relationship could not be used as an important tool to generate huge profits. Kawaller, Koch and Koch (1987) examine the high frequency data intraday price relation between S&P 500 futures and the S&P index using minute by minute data for the period of 1984-1985. The results of this study also convey the dominant role of futures market and their results suggest that futures price movement led index movement by 20 to 45 minutes while movement in the index rarely affected futures beyond one minute. They expect the stronger futures leading spot relation to infrequent trading in the stock market. Cheung and Ng (1990) did a study on 15 minutes frequency data starting from April 1982 to June 1987. Results showed that futures led spot by 15 minutes with weak evidence of spot leading futures. Stoll and Whaley (1990) examined the time series properties of five minute intra-day returns of stock index futures and stock index. They found that the S&P 500 and Major Market Index (MMI) futures returns led stock market returns by 15 to 20 minutes, even after exclusion effect of infrequent trading. The results reveal that the lead lag relation was not completely unidirectional, with lagged stock index returns having a serene positive prognostic bang on futures returns in the beginning period of futures trading. They found much stronger bi-directional dependence between stock index and stock index futures price change when the volatility of price change was also considered. At the global as well as at national level, many efforts have been made to assess the price discovery competence of different futures markets (equity futures, currency futures, commodity futures, etc.). Stensis (1983), Garbade and Sibley (1983), Protopapadakis and Stoll (1983), French (1986), Kawaller (1987), Mohd. Fatimah (1994), Cheung and Fung (1997), Hall (2001), Yang Jian (2001), Singh (2001), Thomas and Karande (2001), Sahadevan (2002), Campbell and Diebold (2002), Zhong (2004), and Isabel and Gilbert (2004) examined the price discovery efficiency of commodity futures market in different countries: America, the United Kingdom, Malaysia, India, Mexico, etc. respectively. Almost all studies found strong lead-lag relationship between the futures and spot prices with

an exception for Sahadevan (2002). Granger et al. (1998), Covrig and Melvin (2001), Anderson et al. (2002) and Yan and Zivot (2004) examined the price discovery efficiency of currency futures market in various economies like: Hong Kong, Indonesia, Japan, South Korea, Malaysia, Philippines, Singapore, Thailand, Taiwan, America. They observed strong bilateral causality between both markets. Moreover, they found that futures market is efficient for underlying currencies, in the sense that it leads the cash market. Chan (1992), Hasbrouck (1995), Jong and Donders (1998), Booth (1999), Turkington and Walsh (1999), Menkveld (2003), Chuang (2003), Raju and Karande (2003), Barclay and Hendershott (2004), Sharma and Gupta (2005), So and Tse (2005) and Gupta and Singh (2006) assessed the prices discovery efficiency of equity futures in different countries namely: America, the Netherlands, Germany, Australia, Taiwan, India, Hong Kong, respectively. Except for Barclay and Hendershott (2004), in almost all the research studies significant evidence of efficient price discovery through equity futures market is observed. They all found that equity and futures prices were cointegrated and the causality from the futures to cash market was significant as compared to the causality from reverse side. For many markets in different economies at different time frames, price discovery efficiency of the futures market has been investigated and the review of literature provides strong evidence favoring the argument that futures market is an efficient price discovery vehicle.

Raju and Karande (2003) investigated the causality relationship between equity futures and cash market on NSE, but found mixed results regarding the causality relationship between two markets. The reason for the confusing results may be the short time period (i.e. Three Years) considered for the study but when the same market was examined by considering lengthy time frame (i.e. Five Years) by Gupta and Singh (2006), they found strong bilateral causality between cash and futures market. Moreover by applying Impulse Response Analysis, they found that the causality from the futures to cash market was stronger as compared to the causality from cash market to futures market. Chuang (2003) examined the price discovery efficiency of TAISEX (Taiwan Stock Exchange Capitalization Weighted Index Futures) and MSCI (Morgan Stanley Capital International Taiwan Index Futures) during 1998-1999 and found strong statistical evidence of bilateral causality and inferred that basis movement was an efficient predictor of the prospective cash market price movements. So and Tse (2005) made an attempt to examine the causality relationship between cash and futures market on Hang Seng Index Mar-



ket, and by considering the time frame of three years (i.e. 1999-2002), they found significant bilateral causality between these two markets. Booth et al. (1999) and Upper and Werner (2002) conducted studies on German stock markets and found strong evidence of information travelling from the futures market to the spot market and they clearly highlighted the dominant role of the futures market. Thus, the review of literature provides sufficient evidences that equity futures market has been an efficient price discovery vehicle. Even in India, the studies conducted by Raju and Karande (2003) and Gupta and Singh (2006) found significant causal relationship between these two markets. The current study examines specifically the price discovery efficiency of Indian equity futures market during high volatility periods i.e. period around September 11, 2001 (Terrorist attack on America) and May 17, 2004 (the highest Indian stock market crash) and to the best of author's knowledge, there is no study available which examined the same hypothesis. Thus, the current study will be of great benefit for the traders and will help to fill the gap in the literature.

## 2. Data and methodology

The sample used in the study consists of daily spot and futures prices. The period of the study is from November 2003 to March 2012. The data comprises daily closing spot and futures prices of the sample commodities. Natural logarithm of daily prices is taken to minimize the heteroscedasticity in data. Middle month prices are taken into account as in this period trading volumes are the highest. These returns are applied to examine the aggregate behavior with regards to price discovery mechanism. This study adds to the existing literature in this field using some of the econometric tools like co-integration, VECM models and Block Exogeneity Test (Causality Test) to bring conclusiveness to the subject. Given the nature of the problem and the quantum of data, we first study the data properties from an econometric perspective and find that co-integration and error correction models are required

to establish the equilibrium relationship between the markets. The regression analysis would yield efficient and time invariant estimates provided that the variables are stationary over time. However, many financial and macroeconomic time series behave like random walk. We first test whether or not the spot and futures price series are co-integrated. The concept of co-integration becomes relevant when the time series being analyzed are non stationary. The time series stationarity of sample price series has been tested using Augmented Dickey Fuller (1981) test. The ADF test uses the existence of a unit root as the null hypothesis. To double check the robustness of the results, Phillips and Perron (1988) test of stationarity has also been performed for the series.

## 3. Analysis and interpretation of results

In perfectly efficient futures and spot markets, informed investors are unresponsive between trading in either market, and new information is reflected in both, simultaneously. However, if one market reacts faster to information, and the other market is slow to react, due to market frictions such as transactions costs or market microstructure effects, a lead-lag relation in returns is observed. The market that provides greater liquidity, lower transaction costs, and less restriction, is likely to play a more important role in price discovery. To establish whether spot leads or future we first employ unit root test to test the stationarity of data. The results of stationarity tests are given in Table 1. It confirms non stationarity of stock market data; hence we repeat stationarity tests on return series (estimated as first difference of log prices) which are also provided in Table 1. The table describes the sample price series that have been tested using ADF (1981) test. The ADF test uses the existence of a unit root as the null hypothesis. To double check the robustness of the results, Phillips and Perron (1988) test of stationarity has also been performed for the price series and then both the test are performed on return series also as shown in Panel A (price series) and Panel B (return series) are integrated to  $I(1)$ .

Table 1. Stationarity test for sample series

Name	Panel A		Panel B	
	(Price-series) ADF test	Phillips-Perron test	Inference on (return series) integration $I(1)$ ADF test	Phillips-Perron test
Commodity indexes	t-statistics	t-statistics	t-statistics**	t-stat**
(A) NIFTY future price	-1.09	-0.51	-41.98 **	-41.98 **
(B) NIFTY spot prices	1.12	-1.38	-41.35 **	-41.32 **

Note: The table describes the sample price series that have been tested using ADF (1981). The ADF test uses the existence of a unit root as the null hypothesis. To double check the robustness of the results, Phillips and Perron (1988) test of stationarity has also been performed for the price series and then both test are performed on return series also as shown in Panel A (price series) and Panel B (return series) are integrated to  $I(1)$ . All tests are performed using 5% level of significance (\*\*).

If two or more series are themselves non-stationary, but a linear combination of them is stationary, then the series is said to be co-integrated. Given that each

sample series spot and futures prices are integrated of the same order, co-integration techniques are used to determine the existence of a stable long-run

relationship between the price pairs. Arrival of new information results in price discovery for short intervals of time between futures and spot market due to communication cost. Increased availability and lower cost of information account together for faster assimilation of information in the futures market than a spot market (Koontz et al., 1990). The price linkage between futures market and spot market is examined using cointegration (Johansen, 1991) analysis that has several advantages. First, cointegration analysis reveals the extent to which two markets have moved together towards long run equilibrium. Secondly, it allows for divergence of respective markets from long-run equilibrium in the short run. The co-integrating vector identify the existence of long run equilibrium while error correction dynamics describes the price discovery process that helps the markets to achieve equilibrium (Schreiber and Schwartz, 1986). Co-integrating methodology fundamentally proceeds with non-stationary nature of level series and minimizes the discrepancy that arises from the deviation of long-run equilibrium. The observed deviations from long-run equilibrium are not only guided by

the stochastic process and random shocks in the system but also by other forces like arbitrage process. As a result, the process of arbitrage possesses dominant power in the commodity future market to minimize the very likelihood of the short run disequilibrium. Moreover, it is theoretically claimed that if futures and spot price are cointegrated, then it implies presence of causality at least in one direction. On the other hand, if some level series are integrated of the same order, it does not mean that both level series are cointegrated. Cointegration implies linear combinations of both level series cancelling the stochastic trend, thereby producing a stationary series. Johansen’s cointegration test is more sensitive to the lag length employed. Besides, inappropriate lag length may give rise to problems of either overparameterization or underparameterization. The objective of the estimation is to ensure that there is no serial correlation in the residuals. Here, Akaike Information Criterion (AIC) is used to select the optimal lag length and all related calculations have been done embedding that lag length. The cointegration results are reported in Table 2.

Table 2. Johansen’s cointegration test

Name	Hypothesis		Lag length	Trace	Critical value**	R = 0	
	Null	Alternative				Accept	R = 1 Reject
	Null	Alternative	Criterion (Sc)	Max Eigen value	Statistic	5% sig level	
NIFTY			-13.03				
Future prices & Spot prices	$r=0$	$r \geq 1$	2 lags*	37.78	39.53	15.49	Reject
	$r = 0$	$r \geq 1$		1.75	1.75	3.84	

Note: The table provides the Johansen’s co-integration test, maximal Eigen value and trace test statistics are used to interpret whether null hypothesis of  $r = 0$  is rejected at 5% level and not rejected where  $r = 1$ . Rejection of null hypothesis implies that there exists at least one co-integrating vector which confirms a long run equilibrium relationship between the two variables, spot and future prices in our case.

Maximal Eigen value and trace test statistics are used to interpret whether null hypothesis of  $r = 0$  is rejected at 5% level and not rejected when  $r = 1$ . Rejection of null hypothesis implies that there exists at least one co-integrating vector which confirms a long run equilibrium relationship between the two variables, spot and future prices in our case. The null hypothesis is rejected in our case which reveals that one cointegration relationship exists between spot and futures prices. Thus, spot and futures prices of Nifty share common long-run information. Our cointegration result confirms that in general there is a price *discovery process* in the spot and future commodity markets. Despite determining a co-integrating vector of Nifty, it is customary to produce the diagnostic checking criterions before estimating the ECM model. Diagnostic tests are performed only for sample series for which long run relation-

ship between spot and future prices is confirmed based on Johnson cointegration test. Vector Auto Regression (VAR) estimated with various lags selected by AIC is used to check whether the model satisfies the stability, normality test as well as no serial correlation criterion among the variables in the VAR Adequacy model. Testing the VAR adequacy of the sample series as shown in Table 3, it was revealed that the sample series satisfied the stability test. In normality test sample series are found to be normal. In verifying the VAR Residual Serial Correlation LM tests it was found that in all sample series no serial correlation was present. Therefore, it leads us to take the position that our model fulfils the adequacy criterion for the sample which exhibited a long run relationship between spot and futures prices as shown by Johansson cointegration test (see Table 3).

Table 3. Adequacy test for VaR model

Name		VaR Adequacy test	Critical values	Lags
NIFTY	1	Stability (modulus values of roots of characteristics polynomials)	0.94, .89, 0.24, 0.081 (stable)	2*
Future-price & Spot-price	2	Normality Chi-square values	4.81 (Jarque-Bera) p-val. (0.0900)(normal)	2*
	3	Serial Correlation LM test	18.55 (p-val. 0.0806) (no serial correlation)	2*

Note: The asterisk (\*) shows significance at 1, 2, 3 and 4 lags. Diagnostic tests are performed for sample series. Vector Auto Regression (VAR) estimated with various lags selected by AIC is used to check whether the model satisfies the stability, normality test as well as no serial correlation criterion among the variables in the VaR Adequacy model. The results reveal that all the sample series satisfied the stability test. In normality test both the sample series are found to be normal. In verifying the VaR Residual Serial Correlation LM tests it was found that in sample series no serial correlation was present. Therefore, it leads us to take the position that our model fulfils the adequacy criterion.

The error correction model takes into account the lag terms in the technical equation that invites the short-run adjustment towards the long run. This is the advantage of the error correction model in evaluating price discovery. The presence of error correction dynamics in a particular system confirms the price discovery process that enables the market to converge towards equilibrium. In addition, the model shows not only the degree of disequilibrium from one period that is corrected in the next, but also the relative magnitude of adjustment that occurs in both markets in achieving equilibrium. Moreover, cointegration analysis delivers the message saying how two markets (such as futures and spot stock markets) reveal pricing information that are identified through the price difference between the respective markets. The implication of cointegration is that the commodities in two separate markets respond disproportionately to the pricing information in the short run, but they converge to equilibrium in the long run under the condition that both markets are innovative and efficient. In other words, the root cause of disproportionate response to the market information is that a particular market is not dynamic in terms of accessing the new flow of information and adopting better technology. Therefore, there is a consensus that price change in one market (futures or spot stock market) generates price change in the other market (spot or commodity futures) with a view to bring a long run equilibrium relation is:

$$F_t = \alpha + \beta S_t + \varepsilon_t. \quad (1)$$

Equation (1) can be expressed as in the residual form as  $\hat{e}$ :

$$F_t - \alpha - \beta S_t = \hat{e}_t. \quad (2)$$

In the above equations  $F_t$  and  $S_t$  are futures and spot prices of Nifty at time  $t$ . Both  $\alpha$  and  $\beta$  are intercept and coefficient terms, where as  $\hat{e}_t$  is estimated white noise disturbance term. The main advantage of cointegration is that each series can be represented by an error correction model which includes last period's equilibrium error with adding intercept term as well as lagged values of first difference of each variable.

Therefore, casual relationship can be gauged by examining the statistical significance and relative magnitude of the error correction coefficient and coefficient on lagged variable. Hence, the error correction model is:

$$\Delta F_t = \delta_f + \alpha_f \hat{e}_{t-1} + \beta_f \Delta F_{t-1} + Y_f \Delta S_{t-1} + \varepsilon_{ft}, \quad (3)$$

$$\Delta S_t = \delta_s + \alpha_s \hat{e}_{t-1} + \beta_s \Delta S_{t-1} + Y_s \Delta F_{t-1} + \varepsilon_{st}. \quad (4)$$

In the above two equations, the first part  $\hat{e}_{t-1}$  is the equilibrium error which measures how the dependent variable in one equation adjusts to the previous period's deviation that arises from long run equilibrium. The remaining part of the equation is lagged first difference which represents the short run effect of previous period's change in price on current period's deviation. The coefficients of the equilibrium error,  $\alpha_f$  and  $\alpha_s$  signify the speed of adjustment coefficients in future and spot markets that claim significant implication in an error correction model. At least one coefficient must be non zero for the model to be an error correction model (ECM). The coefficient acts as an evidence of direction of casual relation and reveals the speed at which discrepancy from equilibrium is corrected or minimized. If,  $\alpha_f$  is statistically insignificant, the current period's change in future prices does not respond to last period's deviation from long run equilibrium. If both,  $\alpha_f$  and  $\beta_f$  are statistically insignificant; the spot price does not Granger cause futures price. The justification of estimating ECM is to know which sample markets play a crucial role in price discovery process.

The VECM results are reported in Table 4. It shows the short-run dynamics in the price series and price movements in the two markets. The lag length of the series is selected in Vector Error Correction Model (VECM) on the basis of Akaike's Information Criteria. The residual diagnostics tests, indicate the existence of heteroscedasticity in the sample series which exhibit cointegration. Thus, t-statistics are adjusted, as well as the Wald test statistics which are

employed to test for Granger causality, by the White (1980) heteroscedasticity correction. After correction, we re-estimate VECM and from empirical results and it is noticed that in the VECM model, error correction coefficients are significant in both equations (1) and (2) with correct signs, suggesting a bidirectional error correction in relevant sample series Error Correction Terms (ECTS) also known as mean-reverting price process, provide some insights into the adjustment process of spot and future prices towards long-run equilibrium. For the entire period, coefficients of the ECTs are statistically significant between one to two lags, in both equations of spot and future markets as suggested by Akaike Information Criterion (AIC). This implies that once the price relationship of spot and futures market deviates away from the long-run cointegrated equilibrium, both markets will make adjustments to re-establish the equilibrium condition during the next period except with little drifts in one or two lags of the sample series. The results reveal that error correction term of future market is greater in magnitude than that of spot market which implies that future price makes greater adjustment in order

to re-establish the equilibrium. In other words, spot leads the future market in price discovery mechanism; see Table 4 (Panel A). The results are reconfirmed of VECM using Variance Decomposition Analysis, as is confirmed under VAR specification; the variance decomposition explains the relative impact of one variable on another variable. This analysis measures the percentage of the forecast error of one endogenous variable that is explained by other variables. Based on estimated VARs, the variance decomposition and orthogonalized impulse response function of forecast error are estimated. According to Hasbrouck (1995), information share of a market is defined as the proportional contribution of that market to price innovation variance. In case of near month futures, the average information share of spot market is 99.395% ( $= (99.82\% + 98.97\%)/2$ ), while that of futures is only 0.605% ( $= (0.18\% + 1.03\%)/2$ ). This structure of information share means that most of the price changes of spot and futures are because of spot innovation, and more information flows from spot to futures. The information share and variance decomposition confirms the dominant role of S&P CNX spot in price discovery (see Table 4, Panel B).

Table 4. Results of VECM, Variance Decomposition Analysis

Panel A		
Indexes	Nifty future	Nifty spot
Error correction:	$\Delta FT$	$\Delta ST$
	-0.42**	-0.24**
CointEq1	(-0.13)	(-0.12)
	[-3.23]	[-1.98]
D(FUTURES_CLOSING_PRICE__L(-1))	-0.12**	0.24
	(0.19)	(0.18)
	[-0.63]	[1.3]
D(FUTURES_CLOSING_PRICE__L(-2))	0.24	0.3
	(0.17)	(-0.17)
	[1.3]	[1.8]
D(SPOT_PRICES_LN_(-1))	0.17**	-0.17**
	(0.20)	(0.19)
	[0.8]	[-0.9]
D(SPOT_PRICES_LN_(-2))	-0.24**	-0.3**
	(0.18)	(0.17)
	[-1.9]	[-1.8]
C	2.3	2.3
	(1.6)	(1.5)
	[1.3]	[1.4]
Panel B: Variance Decomposition Analysis		
Name	NIFTY future	NIFTY spot
Variance Decomposition Analysis	0.63%	99.8%

Note: Panel A exhibits short-run dynamics using VECM MODEL using Akaike's Information Criteria. The error correction coefficients are significant suggesting a bidirectional error correction and spot price leads the future price at 5% (\*\*) level of significance. Panel B presents Variance Decomposition Analysis showing dominant information share of spot market.

Now we see the impulse response, this function simulates the effect of a shock to one variable in the system on the conditional forecast of other va-

riables. We use the impulse-response function to analyze this relationship and is a graphical representation of Variance Decomposition Analysis.



Response to Generalized One S.D. Innovations

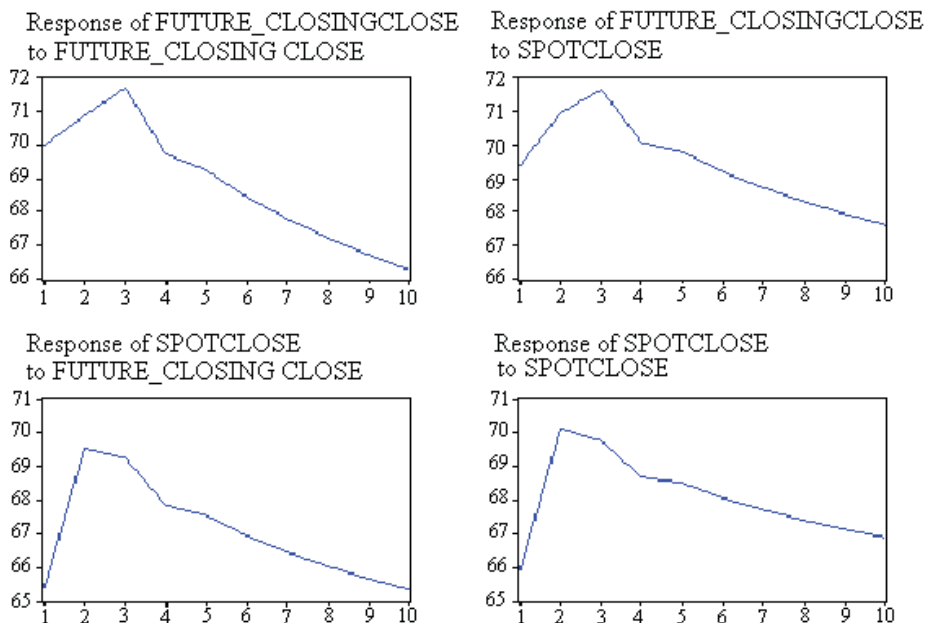


Fig. 1. Response to Generalized One S.D. innovations

After confirming cointegration and VECM model and variance decomposition it is clear that price discovery takes place in spot and spot market leads and there are more adjustments in futures market to strive equilibrium. To check the causality, Granger Causality test is performed, the results confirm unidirectional causality from spot to future and not vice-versa with significant p-value in spot market leading futures value i.e., spot market granger cause futures market (see Table 5), which shows that spot prices granger cause future price (\*\*) at 5% level of significance. The other relationship is not significant that is futures price does not granger cause spot price.

Null hypothesis	Observation	F-statistics	p-val.
Spot close does not granger cause future closing close	1743	8.90907	0.00014*
Future closing price does not granger cause spot close		1.32517	0.26603

To reconfirm the causality test VAR Granger Causality/Block Exogeneity Wald tests is also performed and the results confirm that there is a price discovery in spot market or spot market is leading and futures market is lagging. Unidirectional causality is observed in spot market causing changing in futures market as was observed in granger causality.

Excluded	Chi-sq	Df	Prob.
SPOTCLOSE (Future dependent)	17.81815	2	0.0001**
FUTURE CLOSING (Spot dependent)	2.650336	2	0.2658

Summary, conclusions and implications

In a perfectly running world, every bit of information should be reflected simultaneously in the underlying spot market and its futures markets. However, in reality, information can be disseminated in one market first and then transmitted to other markets due to market imperfections. This paper examined the price discovery, causality in the S&P CNX Nifty futures prices and spot market. The results from unit root tests indicate that Nifty index and Nifty futures are not stationary at their levels. But they are stationary at their first difference. The cointegration test results reveal that there is a long run relationship between spot and futures prices. The findings of the study suggest that the Nifty spot are more important to indicators of stock movements. The VECM provides evidence to support the dominant role of Nifty spot in price discovery, i.e., spot prices tend to discover new information more rapidly than future prices. The results indicate that spot market leads the futures market and spot market serves as a primary market for price discovery. Futures market is now in immature stage, which has been started from June 2000 and till date there is less clarity about this market. The new traders and investors are still facing difficulty to entry in the futures market as this market is tricky. Therefore, spot market leads futures market. The results show clearly that it is important to take into account the long-run relationship between the futures and the spot prices in forecasting future spot prices. In conclusion, the Nifty spot market is more informationally efficient than the futures market. The results have practical implications for investors who wish to improve portfolio

performance. Investors may use the spot market to discover the new equilibrium price, where the mean of this equilibrium price may be transmitted to the futures market. Greater efficiency of price discovery of spot market may help investors with more effi-

cient strategies for hedging and speculating in futures. Moreover, a better understanding of the interconnectedness of these markets would be useful for those policy makers who coordinate the stability of financial markets.

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