A Study on Empirical Analysis of Price Discovery and causality between NSE Spot and Future Market in India

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1 Introduction

The Indian capital market has witnessed many changes in the past decade. A major reform undertaken by SEBI was the introduction of derivate products: Index future, Index options, stock options and stock future, in a phased manner starting from June 2000.

The temporal relation between stock index and Index futures has been and continues to be of interest of regulators, academicians and practitioners alike for a number of reasons such as market efficiency volatility and arbitrage. In perfectly efficient markets profitable arbitrage should not exist as the price adjusts instantaneously and fully to new information. Hence, new information disseminating in to the market place should be no systematic lagged responses. However, there is yet another reason that future market potentially provide an important function of price discovery to help to improve efficiency of the market. If so, then future prices and movement thereof should contain useful information about subsequent spot prices beyond that already embedded in the current spot price.

Futures and cash market contribute to the discovery of a unique and common unobservable price that is efficient price. The contribution of each market to the price discovery depends, at least in part, on the micro structure of these markets, including the level of transparency, the liquidity supply mechanism, the rules governing the priority of orders, the constraints on short sales and settlement mechanism.

Considering the information exchange and price discovery rules of the future market, many theoretical as well as empirical attempts have been made and regulatory bodies, market makers, academicians and practitioners have unanimously have agreed upon the common notion that organized future market contain significant information for the prospective cash market price changes in the short run, irrespective of the fact that in the long run both market observe strong and stable co-movement. Price discovery is expected first take place in the future markets and then it transmitted to underlying cash market. (Pizzi et al; 1998). However, Wahab and Lashgari (1993), Chan and Lien (2001). Chen et al; (2002) Lin et al; (2002) Mukherjee and Mishra (2006), and Thomas (2006) have found contrary evidence suggesting that cash market serves as dominant market and future market behaves like satellite market. So there exists a dilemma. Thus this study seeks to analyze empirically the price discovery and causal relationship between spot and future market. Following are the main objectives of the study.

1.1 Objectives of the Study

1. To empirically examine the price discovery and causal relationship between spot and future market.
2. To empirically verify whether future market or spot market respond faster to the deviation from equilibrium price

1.2 Data and Methodology

The present study seeks to analyze the price discovery and causality between NSE spot and future market. The study is based on secondary data. Study has used daily closing values of S & P CNX nifty futures and spot S & P CNX nifty index, which are considered from June 12 2000 to 10 November 2008. The data consist of 2200 observation for both future prices and spot prices. The required data is obtained from National Stock Exchange website (www.nseindia.com). The time series econometrics analysis seeks to check stationarity of selected variables and to verify whether there is any long run relationship. To check the stationarity, unit root test like Dickey Fuller (DF) Test and Augmented Dickey Fuller (ADF) tests are employed. To verify the long run cointegrating relationship between spot and future market, Johansen's co integration test is employed. To empirically examine the price discovery process and causal relationship between spot and future prices Johansen's (1988) Vector Error Correction Model (VECM) employed. The methodology followed for the study will be discussed in detail in fourth Chapter.

1.3 Organization of the study

The study is segmented in to four chapters.Chapter one is introductory section expresses objectives and motivation behind the study and brief note of data and methodology used in the study. Chapter two gives a review of some useful and relevant earlier literature pertaining to these issues on a chronological basis. Each study has its own theoretical pinning. In the third Chapter, attempts are made to discuss the key terms related to this topic, and theoretical debate on price discovery process between spot and future market. Fourth chapter gives the empirical analysis part, which explains the methodology, nature and source of data and also the results and interpretation part.

2. REVIEW OF LITERATURE

2.1 Introduction

The introduction of future trading in India in June 2000 was a major step taken by the regulators of the financial market to enhance the efficiency of trading in Indian financial market. Since then many studies have attempted to analyse the impact of future trading on price discovery process and on the spot market volatility. The causal relationship between spot and future market and the price discovery process undertaking in these markets have been analysed by both foreign and Indian studies. The present chapter gives a review of earlier literature pertaining to these issues on a chronological basis.

2.2 Review of Related Studies

Charles (1976) investigated the effect of organised future trading on information in spot market. He developed a model that relates spot price behaviour and market information. The model can be viewed as a particular efficient market model. This connection provides additional implication about price behaviour and information. The empirical evidence on price behaviour clearly shows an information effect of future trading. Price series of six different commodities are investigated for an information effect of future trading. For each commodity the empirical evidence indicates that the future trading increases trader's information about forces affecting demand and supply

Kenneth and William (1983) made an effort to examine the characteristics of price movements in cash and future market for storable commodities. Their study presents an analytical model of simultaneous price dynamics which suggests that over short intervals of time the correlation of price changes is a function of elasticity of arbitrage between physical commodities and its counterpart future contracts. Their study suggests that future contract will not provide risk transfer facilities over short time horizons. The empirical estimates of the parameters of the model of seven different storable commodity shows that future market dominates the cash market with respect to price discovery function cash prices do not merely echo future prices. There reverse information flows from cash market to future market.

Kawaller et al (1987) examined the intraday price relationship between S&P 500 INDEX and S&P 500INDEXfutures. Their results show that both spot and future markets are simultaneously related on a minute to minute basis throughout the trading day, and that a lead lag relationship exists. The lead from futures to cash appears to be more pronounced relative to cash to future market.

Stoll and Whaley (1990) investigate causal relationship between spot and futures markets using intraday data for both S&P 500 INDEX and major market index. They could find a tendency towards large price swings in the spot market on the future market onexpiration day that was to be reversed on the day following expiration activity. This is an indication that expiration day future treading activities results intemporary spot market pressure. Price swings in the spot markets are reversed when profit seekers attempt to buy or sell shares that are subsequently misruled in terms of fundamental information feedback was detected but the future lead was stronger that cash index lead.

Chan (1991) investigated intraday lead lag relation between returns of major market cash index and returns of major market cash index futures and S&P 500 INDEX futures between two sample period august 1984 to through June 1985 and January through September 1987. Empirical results show strong evidence that the future leads the cash index and week evidence that the cash index leads the future. The asymmetric lead lag relation holds between the futures and all components stocks including those that trade in almost in every five minute interval. This study shows that when more stocks move together the futures lead the cash index to a greater degree. The study suggests that future market is the main source of market wide information.

Wahab and Lshgari (1993) used daily data cointegration analysis to examine the causal linkage between index and stock future price for both S&P 500 and the FTSE 100 index for the period 1988 to 1992. They found that although the feedback exist between spot and future market for both S&P 500 and FTSE 100 indices. The spot to future lead appears to be more pronounced across days relative to the future to spot lead.

Anderson et al (1994) made an effort to characterise the conditional means of US dollar spot exchange rate by using new data set consisting of six years real time exchange rate quotation, Macroeconomic expectation macroeconomic realisation. Their empirical study revealed that announcements surprises produce conditional mean jumps, hence high frequency exchange rate dynamics are linked to fundamentals. The details of linkages are intriguing and include announcement timing and sign effects. The sign effect refers to the fact that market reacts to the news in asymmetric fashion. Sad news has greater impact than good news which relates to the recent theoretical work on information processing and price discovery.

Deb et al (1995) estimate an Error Correction model to investigate whether each of the exchange is contributing to price discovery by using synchronous transaction data for IBM from the New York Pacific, and Mid West stock exchanges, Johansens tets yield two cointegrating vectors which together verify the expected long run equilibrium of equal prices across three exchanges. The empirical results reveal that two error correction terms specified as the difference from IBM prices on the NYSE indicate that adjustment maintaining the long run cointegration equilibrium take place \on all three exchanges, that ib IBM prices on the NYSE adjust towards IBM prices on the Midwest and pacific exchanges just as Midwest and pacific price adjust to the NYSE.

Quentin et al (1999) examine the price discovery function in three S&P 500 INDEX market, this spot index futures and S&P depositary receipts market. They proposed four hypothesis regarding market structure and security design to differentiate the price discovery function performed by three index instruments. They used matched synchronous trading data johansen's maximum likelihood estimator employed tom disclose the cointegration relationship among three markets. The results indicate that three price series are a cointegrated system with a long run stochastic trend. It is found that future market serves the dominant price discovery function when a common stochastic trend is decomposed. They also used leverage hypothesis and the uptic rules hypothesis to explain its superior price discovery function.

Kavussanos (1999) investigates the unbiased ness hypothesis of future prices in the Freight future market. They employed cointegration technique to examine this hypothesis which indicate that future prices one and two months before maturity are unbiased forecasts of the realised spot prices where as a biased exist in the three months future prices. This mixed evidence is in agreement with the studies in other market and suggest that the acceptance and rejection of unbiasedness depends up on the idiosyncrasies of the market under investigation and of the time to the maturity of the contract. They argued that despite of the existence of the bias in the three months price future price for all maturities are found to provide forecast of the realised spot price that are superior to formats generated from Error correction ARIMA and Exponential smoothing and random walk models. It appears that users of BIFFEX market receives accurate signals from the future prices and can use information generated by these prices to guide their physical market decisions.

Yiuman Tse (1999) examines the minute by minute price discovery process and volatility spill over between the DJIA index and index futures launched by CBOT. The Hasbruck 1995 cointegrating model suggests that the most of the price discovery take place in future market. By examining the volatility spillovers between markets based on a Bivariate EGARCH model he found a significant Bidirectional information flow that is the innovation in one can market predict the future volatility in another market. But the future market volatility spillovers to stock market more than vice versa. His study reveals that both markets also exhibits asymmetric volatility effects with bad news having greater impact on volatility than good news.

Lin and Stevenson (1999) studied how one can employ the Wavelet analysis to reconstruct price series based only on a subset of information that differentiate the two fundamentally related process. This analysis not only allow a focus on examining process, but also enables examination and comparison of reconstructed process based on different level of information in detail. The empirical evidence confirms non contemporaneousrelationship between price changes which has been argued to have implication for price-discovery in both market as well as putting the question of validity of COC Model. It is found that the lead lag relationship shall exist between spot and future prices. Such a relationship is more persistent when more detailed information is used for true reconstruction. The main implication of their study is that of the market information is to be blamed for non-contemporaneousrelationship between index prices from the two markets. One should only concentrate on that imperfection that is likely to occur within very short time period.

Yang and Leathan (1999) examined the price discovery function for three US wheat future market, the charge Board of Trade Kansas City Board of Trade and Minneapolis Grain exchange. The maintained Hypothesis is that futures markets react more for information than cash markets find an equilibrium price, thus greatly improving price discovery function. The test reveal the existence of one equilibrium price across the three futures markets in the long run, but no cointegration among process three representative cash market.

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

Booth et al (1999) studied intraday price discovery among stock index. Index futures and index option in Germany using DAX Index securities and intraday transaction data. They find that spot Index and Index future have substantially larger information shares than Index option.

Pascal Alphonse (2000) examined the aggregation information in the French stock Index and cash future markets. It has been recalled that efficient price discovery process is well related to two specification of a set of co-integrated variables, the error correction form and common trend form.

The empirical study shows that mispricing originate mainly from information arrivals in the future markets and that in turn these mispricing induce stock price adjustments related to information transmission from the futures to spot market. The study shows that price discovery process has been dominated by future market in a way that at least 95% of price discovery is achieved in the future market. As a whole, his study indicates that the arrival and aggregation of new information into prices is achieved primarily through future trading and that the stock market adjusts quickly to the new equilibrium.

Susan and Karnade (2001) analysed price discovery in India's castorseed market. This market has unusual settings. There is a spot and future market in Ahmedabad, the region where castorseed is grown. In addition, there is spot and futures market in Bombay, from where castorseed is exported. The commercial centre is in the same time zone as the production centre. The empirical analysis shows that for three of fair contracts, the future market in Bombay dominates in price discovery, however, for the March Contract which expires near harvest, the spot market in the production centre dominates price discovery. It appears that the spot and future market in the production centre are the first to impound information about harvest.

Park (2001) investigated the interrelation and information flows between the Won Dollar spot and off shore forward, that is NDF markets. He focuses on the impact of the reform in the Korean exchange rate system, which occurred in 1997 in response to the currency crisis, on the relation between the two markets. Using the augmented GARCH formulation, he finds that during the pre-reform period a mean spillover effect exist from the spot to the NDF market but not vice versa and a volatility spillover effect exists in both directions. But after the reform, the results are reversed and a mean spillover effect exists from the NDF to spot market and volatility spill over exist only in the same direction. His findings suggest that there are information flows between two markets and the reform has changed the direction of dynamic relation.

Roopeet al (2002) made a comparison of the information effective efficiencies between the Singapore exchange and the Taiwan future exchange for Taiwan index used to test whether price discovery mechanism with in Niger Millet markets were a head of the early warning systems. The results suggest that as early as October 2005 markets in Arlit and the Dosso province had animals that appeared to begin signaling the Upcoming food crisis. This futures listed in both markets. The results provide strong evidence to suggest that price discovery primary originates from Singapore future market.

Raju and Karnade (2003) made an attempt to study the price discovery and volatility in the context of introduction of nifty futures at the NSE in tune 2000. Cointegration and Generalised Auto Regressive Conditional

Hetrosce dasticity (GARCH) models are used to study price discovery and volatility respectively. The major findings of their study are that the future market (and not the spot market) responds to derivation from equilibrium; price discovery occurs on both future and spot market, especially in the later half of the study period. The results also show that volatility in the spot market has comedown after the introduction of stock index futures.

Antoniou and Violars (2003) investigate the important relationship between stock index and stock index futures markets in an international context. The main contribution of them to improve the understanding of the pricing relationship between spot and futures market in the light of international market interdependencies. By using multivariate VAR-EGARCH methodology, this paper investigates stock index and stock index future market interdependence, that is lead lag relationships and volatility interactions between the stock and future markets of three main European countries namely, France, Germany and U.K. This paper also accounts for potential asymmetries that may exist in volatility transmission mechanism between three markets. The main conclusion of this paper suggests that investors need to account for market interaction across countries to fully and correctly exploit the potential for hedging and diversification.

Marisettly (2003) attempts to measure the production efficiency of Stock Exchanges by using price adjustment coefficients. Stock exchange efficiency can be measured by its liquidity and price discovery mechanism. An exchange that provides price discovery will have high liquidity. Author points out that, by measuring the speed of stock prices adjustment to its intrinsic value with the arrival of new information, one can understand the price discovery process and productive efficiency of stock exchange. The study is based on 23 stock exchanges, 20 of them have almost become dysfunctional due to negligible trading during last five years of study. Using the corrected Damodaran Model (1993) a new model is proposed in this paper. The empirical study reveals that information adjustment in Indian Market is very slow. Contrary to the developed market, in Indian stock market, the stock prices over react before adjusting to their intrinsic Values. The author also point out that market wide information adjusts faster than firm-specific information.

Mattos et al (2004) investigate the relationship between cash and futures prices in the Brazilian agricultural market, focusing on the effects of trading activity on the price discovery mechanism of future markets. The empirical study reveals mixed results. Higher trading activity & linked to the presence of long Run relationship between cash and future prices. In these cases future price appears to play a dominant role in the pricing process. In more lightly traded market, neither long run relationships nor shot run lead and lags can be found. Where short run interactionsexist, they are simultaneous in nature, but weak. Overall, their findings suggest that the level of market activity necessary to develop interactive cash and future market is surprisingly small.Brandt and Kavajecz (2004) examined the role of price discovery in the US Treasury market through the empirical relationship between overflow. Liquidity and the yield curve. They find that overflow imbalances (excess buying or selling pressure) account for up to 26% of the day to day variation in yields on days without major macroeconomic announcements. The effect of order flow on yields is permanent and strongest when liquidity is low. All evidents point toward an important role of price discovery in understanding the behaviour of yield curve.

Illueca and Lafuente (2004) analysed the effect of introduction of minifutures contract in Spanish index future market. The objective the papers is twofold, one is to analyse potential destabilising effect of the minifutures trading activity on distribution of spot returns and another is to test whether minifutures contract significantly contribute to the price discovery process. A non parameter function is employed to estimate the density function of spot return conditional to both spot and futures trading volume. Empirical findings using 15 minutes intraday data reveal that the minifutures trading activity enhances the price discovery function of the derivative market and does not destabilize spot prices.

Kenourgios (2004) examines the relationship between price movement FTSE/ASE 20 three north future indexes and underlying cash market in Athens stock Exchange by using co-integration test and error correction model. The investigation of acts price discovery mechanism has been motivated by the existing paucity of similar research in such newly established (emerging) future markets and the growing importance of the markets for both investors and the Greek Capital Market. The empirical study reveals that the presence of directional causality between stock index spot and future markets, Indicating that the newly established ADEX can provide future contracts that serve as Focal point of information, assimilation fulfil their price discovery.

Vitale et al (2006) examined whether market prices and price discovery could have played an active role on detecting 2004 Niger food crisis directed acyclic graphs are market based discovery came about two months earlier than the warning issued by the regional early warning networks.

Narayan and Anil (2006) investigated whether or not the future trading in India is performing its primary role of price discovery. It employs co integration and error correlation method using data from June 2000 to March 31 2005. The results establish that there exist long run relationship between Nifty spot and Nifty future prices. Further, the error correction model leads to the conclusion that there exists a feedback mechanism between Nifty spot and Nifty futures.

Rosenberg and Traub (2006) examined price discovery in the foreign exchange futures and spot markets during a period in which spot market was less transparent but had higher volume than future market. They develop a foreign exchange order flow measure that is a proxy for the order-flow observed by Chicago Mercantile exchange Pit traders. They find that both foreign currency futures and spot order flow contain unique information relevant to exchange rate determination. The empirical study suggests that the amount of information contained in currency futures process in 1996 is much greater than one would expect based on relative market size. Using data from 2006, they obtain quite different results, perhaps because of an increase in spot market transparency. They also find that the spot market has the dominant information share.

Chung et al (2007) look at the relative information content of cash and future prices for Canadian Government bond. They follow the information share approaches introduced by Hasbrouck (1995) and Haris et al (1995), applying techniques in Gonzalo-Granger (1995) to evaluate relative contributions of trading in the cash and future markets to the price discovery process. Both the approaches estimate a vector error correction model that permits the separation of long run price movements from short –run market micro structure effects. They also follow Yan and Zirot (2004) who introduce size measure of a market adjustment to a new equilibrium during the price discovery. Their study show that on an average day, just over 70% price discovery occurs on the future market where bid-ask-spreads are power and trading activity is higher. The size of responses to shock and time taken to adjust new equilibrium are found to be significantly larger for cash market.

Nardella (2007) evaluates the efficiency of price discovery mechanism in cocoa future markets. The empirical study shows that price discovery mechanism in both LIFFE and NYBOT Cocoa market is efficient. They rule out the existence of any casual relationship between speculate activity and cocoa price at least for the NYBOT. This evidence supports the hypothesis that successful speculators are reaching quicker than any other market participant to new information emerging from market. That is why profitable speculative buying (selling) occurs just before the market makes a more.

Barclay et al (2008) compares trading and non trading mechanism for price discovery during Nasdaq pre open and examines whether prices discovered through trading. As Nasdaq pre-open trading volume increased, the opening price became more efficient and price discovery shifted from the opening trade to pre-open. Price discovery shifted from the trading day to pre-open only for the best volume stocks. These results suggest that Pre-open trading contributes to the efficiency of opening price, but that a critical threshold of trading volume is required to increase the amount of information on the opening price.

Salvadr and Ramasundaram (2008) investigated the price discovery in future market in agriculturalcommodities in India. The statistical analysis of data on price discovery in a sample of four agricultural commodities traded in future exchanges have indicated that price discovery does not occur in agricultural commodity future market. The econometric analysis of the relationship between price return, volume, market depth & Volatility has shown that market volume and depth are not significantly influenced by the return and validity of futures as well as spot market. The Bartlett's statistics has been found in significant in both the exchanges, signifying that thefuture and spot market are not integrated. The exchange specific problems like low volume and low market depth,

infrequent trading, lack of effective participation of trading members, non awareness of future market among farmers, poor physical delivery, absence of well developed grading and standardization system and market imperfections have been found as the major deficiencies regressing growth of future market. To facilitate future trading in amore convenient way for agricultural commodities more focused and pragmatic approach from the government is needed. The Forward Market Commission and SEBI have a greater role in addressing all the instructional and policy level constricts so as to makes agricultural commodity futures and derivatives a meaningful, purposeful, and vibrant segment for price risk management in Indian agriculture.

Kailash and Bhat (2009) investigated pricediscovery information and forecasting in Nifty futures markets. Johansen's (1988) Vector Error Correction Model (VECM) is employed to investigate causal relationship between spot and futures prices. This study compares the forecasting ability of futures prices on spot price with three major forecasting techniques namely ARIMA, VAR, and VECM Model. The Johansen's VECM perform well on a post sample basis against the univariate ARIMA Modeland VAR Model. The result show clearly the importance of taking into account the Long run relationship between futures and the spot price in forecasting future spot price.

3. EMPIRICAL STUDY

3.1 Introduction

Study seeks to analyze the price discovery process and causal nexus between spot and future market. The long run relationship and short run dynamics between spot and future market can be studied with econometric techniques such as Unit Root Tests, Johansen's cointegartion analysis and Vector Error correction model. Therefore, the study employs all these techniques. This chapter gives a discussion on all these techniques, and also presents the empirical analysis.

3.2 Nature and Sources of Data

The National Stock Exchange of India Limited (NSE) is a Mumbai based exchange. It is the largest stock exchangein India in terms of daily turnover and number of trades for both equities and derivative trading.The NSE's key index is the S&P CNX Nifty. It is an index of fifty major stocks weighted by market capitalization. The derivatives trading on NSE commenced with S&P CNX Nifty Index futures on 12th June, 2000. Study has used the daily closing values of the S&P CNX Nifty futures and spot S&P CNX Nifty index, which are considered from June 12, 2000 to November 10, 2008. The data consists of 2200 observations for both future prices and spot prices. The required data is obtained from National Stock Exchange website (www.nseindia.com).

3.3 Methodology

Most of the time series data are nonstationary. The basic assumption of simple regression analysis is that the underlying time series is stationary. A time series is said to be stationary if it's mean, variance and autocovarince (at various lags) remain the same no matter at what point we measure them that is they are time invariant. However, this is not the case for most of time series data. That is the mean, variance and autocovarince of a time series are time variant. Such a series is said to be nonsationary. A nonstationary time series will have an infinite variance. In such a case if we use simple regression analysis to study the relationship between variables, then the results will give unreliable't' and 'F' statistics. Therefore it is important to verify whether the time series data is stationary or nonstationary. For this purpose Unit Root tests like Dickey Fuller and Augmented Dickey Fuller can be employed.

Unit Root tests-Dickey Fuller Test and Augmented Dickey Fuller Test

Now let us see what unit stochastic process is. Consider the following equation,

Y

$Y_t = \rho Y_{t-1} + u_t \qquad -1 \le \rho \le 1$ --------- (1)

If , (1) becomes a Random Walk Model without drift. If , we face what is known as the unit root problem that is the situation of nonstationarity. The name unit root is due to the fact that . If the absolute value of is less than 1 then it can be shown that the time series is stationary in the sense we have defined it.

The presence of unit root can be examined using unit root tests like Dickey Fuller test (DF) and Augmented Dickey Fuller Test (ADF). In unit tests we try to find if estimated is statistically equal to 1. Subtracting from both sides of equation (1) we have

$Y_t - Y_{t-1} = \rho Y_{t-1} - Y_{t-1} + u_t$ ---------- (2) Which can be alternatively written as

$\Delta Y_t = \delta Y_{t-1} + u_t$ ---------- (3)

Where $\delta = (\rho - 1)$

Dickey Fuller have shown that under the null hypothesis the estimated t value of the coefficient of in (3) follows the (tau) statistics and they have computed the critical values of tau statistics. How ever Mackinnon has prepared more extensive tables. In the literature the tau statistics or test is known as Dickey Fuller test. In this test, if the hypothesis (that is) is accepted, then there is unit root that means the series is nonstationary. Dickey Fuller test is estimated in there are three different forms, one is without constant and trend variables, second is with constant and without trend and third is with constant and trend. They are given below

$\Delta Y_t = \delta Y_{t-1} + u_t$ ---------- (4)

$\Delta Y_t = \beta_1 + \delta Y_{t-1} + u_t$ ---------- (5)

$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + u_t$ ---------- (6)

In conducting Dickey Fuller test as in (4), (5) or (6) it was assumed that the error term was uncorrelated. But in case the are correlated Dickey and Fuller have developed a test known as the Augmented Dickey Fuller test (ADF). Augmented Dickey Fuller test consist of estimating the following regression with null hypothesis

$\delta = 0$ (that is $\rho = 1$).

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + u_t \alpha i \sum_{i=1}^{m} \Delta Y_{t-1} + \varepsilon_t \text{ ---------- (7)}$$

Johansen's Cointegration Test

If the two time series (logged spot price and logged future price) are non-stationary at level and stationary at first difference, then they are integrated of order (1). A set of time series variables are said to be cointegrated if they are integrated of the same order and a linear combination of them is stationary. Such linear combination then would point to the existence of long term relationship among the variables. The theory of cointegration is introduced first by Granger (1981) and developed further by Granger (1986) and Engle and Granger (1987) integrate the short run dynamics with long run equilibrium relationship. The usefulness of cointegrtion is thus seen in the estimation of short run or disequilibrium parameters that will bring long run equilibrium through the adjustment process known as the Error Correction Model.

The development of cointegration has allowed examining the equilibrium relationships between economic variables (Granger 1986).

This study has assessed the long run relationship between spot and future market by using the cointegration test developed by Johansen (1991), the number of significant cointegrating vectors is estimated by using maximum likelihood, based on

$$\lambda_{trace} \text{ and } \lambda_{\max} \text{ s}$$

statistics introduced by Johansen (1991), (1995). If we have 'k' endogenous variables, each of which is first order integrated there can be from '0' to 'k-1' linearly independent, cointegrating vectors.

The Johansen procedure is to decompose $\prod$ in to two matrices α and β, both of which are k $\times$ r matrices (r <k) such that $\prod = \alpha \times \beta$ and so the rows of β may be defined as the r distinct cointegratin vectors. Then a valid contegrating vector will be given by the corresponding Eigen value (Johansen 1995). Johansen proposes a trace test for determining the contegrating rank r such that $\lambda_{trace} = -T \sum_{i=r+1}^{k} In(1-\hat{\lambda}_i)$ and also proposes another likelihood ratio (LR) test to assess whether there is a maximum number of cointegrating vectors against $r+1$ such that $\lambda_{\max}(r, r+1) = -TIn(1-\hat{\lambda}_i)$ with critical values in Johansen(1995).

Johansen's Vector Error Correction Model (VECM)

If the spot and futures prices are co integrated, the causality must exist atleast in one direction. To test causality the following vector error correction model is estimated by using ordinary least squire (OLS).

$$\Delta S_t = C_s + \sum_{i=1}^{k} \beta_{si} \Delta S_{t-i} + \sum_{i=1}^{k} \lambda_{si} F_{t-i} - \alpha_s Z_{t-1} + e_{stt} \text{ ---------- (8)}$$

$$\Delta F_t = C_f + \sum_{i=1}^{k} \beta_{fi} \Delta S_{t-i} + \sum \lambda_{fi} \Delta F_{t-i} - \alpha_f Z_{t-1} + e_{fi} \text{ ----------(9)}$$

Where S_t is logged value of daily closing price of CNX nifty Index and F_t is logged value of daily closing price of CNX nifty Index futures. Here we take logged value of these series because CNX Nifty is an index which is geometric series. Therefore to get its mean value we have to take geometric mean. For this purpose we change closing price of CNX Nifty in log series. It makes it necessary that future series also to be changed in to log series. Z is error correcting term, α_s and α_f can be interpreted as speed of adjustment factors and measures how quickly each market reacts to the deviation from the long-run equilibrium relationship. The coefficient and show the direction of causality.

3.4 Results and interpretation

The first step in time series analysis is to plot the graph of a series. Figures 4.1 and 4.2 give the graphical representation of logged spot prices and future prices respectively in levels. It is evident that both series show an upward trend over time, though there has been short term fall and the regularity of the upward movements differ between the series. However, from 2007 onwards both series show a declining trend. It is a result of the ongoing global crisis and the consequent fall in stock market indices. It is evident from the graph that the trend is not a simple deterministic one, there appears to be a random element from one observation to the next. One possible explanation of the trend is that this is an outcome of a stochastic process where the mean and variance may be changing over time. The two graph look like a graph of random walk model with drift. For a random walk model with drift the mean as well as variance increases over time, violating conditions of stationarity. Therefore they exhibit a random walk that is they have unit root and they are nonstationary in levels. However, when we take the first difference of two series they are stationary.

Figure 3.1
Graph of logged Spot Price in Levels
Figure 3.2
Graph of logged Future Price in Levels

Figure 3.3
raph of logged Spot Prices in First Difference

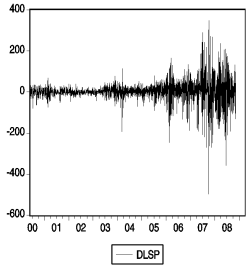
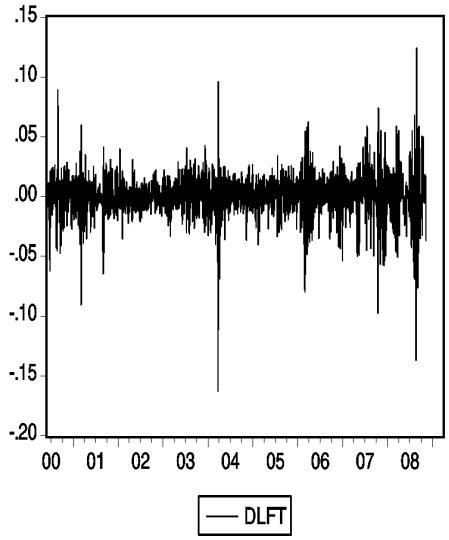


Figure 3.4

Graph of logged Future Prices in First Difference



Graphs of the logged spot and future prices in their first difference are given in figure 3. 3 and figure 3.4 respectively. The figures look like that of a stationary series since their means and variances are constant over time. Therefore logged spot and future prices are stationary in their first difference, that is they are I (1) process and integrated of order 1. The integration of spot and future prices is further empirically verified with the help of unit root tests such as Dickey Fuller and Augmented Dickey Fuller tests.

Tables 3.1and 3.2 report the results of Dickey Fuller and Augmented Dickey Fuller tests. Results of these two tests with intercept and with intercept and trend are given.

Table: 3.1
Results of Dickey Fuller (DF) and Augmented Dickey Fuller (ADF) Tests for Logged Future Prices.

Constraints	DF Test statistics		ADF Test statistics	
	Levels	First Difference	Levels	First Difference
Intercept	-0.2256 (-2.5615)	-20.816* (-3.4331)	-0.6851 (-3.4331)	-11.8905* (-2.566)
Intercept and Trend	-1.0622 (-3.4800)	-20.812* (-3.962)	-1.9659 (-3.9622)	-15.6594* (-3.480)

Note: Values in parenthesis are't' statistics for 1% level of significance.
*denotes significant at '1'% level

Table: 3.2
Results of Dickey Fuller (DF) and Augmented Dickey Fuller (ADF) Tests for Logged Spot Prices

Constraints	DF Test statistics		ADF Test statistics	
	Levels	First	Levels	First
		Difference		Difference
Intercept	-0.14920 (-2.5660)	-16.6147* (-2.56601)	-0.68356 (-3.4331)	-20.6692* (-3.4331)
Intercept and Trend	-1.1113 (-3.480)	19.160* (-3.4800)	-1.89349 (-3.9622)	-20.6653* (-3.9622)

Note: Values in parenthesis are 't' statistics for 1% level of significance.

*denotes significant at '1'% level

The results reveal that the null hypothesis that the spot and future price have unit root that is cannot be rejected in level 1% level of significance. This indicates that both these series have unit root and they are nonstationary at level. However when we take their first difference the results reveal that both series are stationary. The null hypothesis the series has unit root can be rejected at 1 % level of significance for both series. This provides evidence for the argument that both future and spot prices are nonstationary at level and stationary at first difference. Therefore they are integrated of order (1).

If a set of series are integrated of the same order, then it would point to the existence of long term relationship among the variables. Johansen's cointegration test is employed to find out the number of cointegrating equations. Table 3.3 presents the results of Johansen's cointegration test. The results indicate that there exists one cointegrating equation. Therefore there exists a long run relationship between spot market and future market.

Table: 3.3
Results of Johansen's Cointegration Test

Null Hypothesis	Alternative Hypothesis			5% Critical Value	Probability value **
Λ Trace test		Eigen value	λ Trace statistics		
$r = 0$ *	$r > 0$	0.073455	168.1523	15.49471	0.0001
$r \leq 1$	$r > 1$	0.000210	0.461423	3.841466	0.4970
Λ Max test		Eigen value	λ Max statistics		
$r = 0$ *	$r = 1$	0.073455	167.6909	14.26460	0.0001
$r = 1$	$r = 2$	0.000210	0.461423	3.841466	0.4970

Note: Trace test indicates 1 cointegrating equation(s) at the 5 % level

*denotes rejection of the hypothesis at the 5 % level of Significance

** indicates MacKinnon-Haug-Michelis (1999) p-values

The next step is to verify the direction of causality and to identify the short run dynamics. For this the Vector Error Correction Model (VECM) is employed. Using Akaike's Information Criteria (AIC) and Schwarz Criteria (SC) two lags

Table: 3.4
Results of Vector Error Correction Model

$$\Delta S_t = C_s + \sum_{i=1}^{k} \beta_{si} \Delta S_{t-i} + \sum_{i=1}^{k} \lambda_{si} F_{t-i} - \alpha_s Z_{t-1} + e_{stt} \quad \text{----------(8)}$$

$$\Delta F_t = C_f + \sum_{i=1}^{k} \beta_{fi} \Delta S_{t-i} + \sum \lambda_{fi} \Delta F_{t-i} - \alpha_f Z_{t-1} + e_{fi} \quad \text{----------(9)}$$

	ΔS_t		ΔFt	
Variable	Coefficient	t-statistics	Coefficient	t-statistics
C	0.000335	0.92922	0.000365	1.00138
ΔS_{t-1}	0.086535*	3.95043	-0.082478*	-3.72590
ΔS_{t-2}	-.062069*	-2.81263	-0.095230*	-4.27016
ΔF_{t-1}	-0.03824**	-1.87993	0.026280	1.27815
ΔF_{t-2}	0.024395	1.19851	-0.031131	-1.51343
Z_{t-1}	-0.001681	-0.32583	-0.068664*	-13.1684

are selected for VECM model. Table 4.4 presents the results of Vector Error Correction Model. In the table the coefficient of Error Correction term ( ) indicates the speed of adjustment of future and spot prices form a short run deviation from the long run equilibrium value. Only the Error Correction term of future prices is found statistically significant and the Error Correction term of spot prices is statistically insignificant. Therefore future prices respond to the short run deviations or disequilibrium. A proportion of disequilibrium in the one period is corrected in the next period. The results of VECM indicate that future has greater speed of adjustment to the previous period's deviation from long-run equilibrium than the spot price series.

Therefore at the delivery date of each contract the futures price has to adjust itself to the prevailing spot price. The negative value of the coefficient means that a positive shock or increase to the equilibrium in future prices lowers next period future prices and a proportion of disequilibrium is corrected.Note: * denotes significant at '1'% level of significance.

* * denotes the 5 % level of significance.

Even if there was a hike in future prices due to changes in spot prices last period, the future price will have to adjust itself to the prevailing spot price by reducing its value on the delivery date.

Therefore the positive error in previous day will be corrected by a fall in today's future prices. As the value indicates about 6 percent of disequilibrium is corrected in each day. On the other hand, though the coefficient of spot price is statistically insignificant it reveals only a negligible amount of error iscorrected in spot prices.

In table 3.4 the coefficients of and are statistically significant in equation (9) where future is dependent variable. It reveals that there is causality from spot to future. That is future depends on spot. In the same token coefficients of is statistically significant in equation (8)where spot is dependent variable. It reveals that there is causality from future to spot. That is spot depends on future. Result indicates that there is two way (bidirectional) causality between spot and future market. Price discovery occurs in both markets. Future markets changes depend on two period lagged values of spot. But change in spot depends only on one period lagged future price. Therefore there is good information flow between these two markets and both future and spot market are dependent on each other.

3.5 Conclusion

This Study attempted to examine the price discovery and causal relationship between spot and future market and also to verify whether future or spot market has greater sped of adjustment to the long term equilibrium value. For this purpose study has employed unit root tests such as Dickey Fuller and Augmented Dickey Fuller tests, Johansen's cointegration test and Johansen's Vector Error Correction Model (VECM). Results reveal that there exists a long run relationship between spot market and future market. Future price has greater speed of adjustment to the previous period's deviation from long-run equilibrium than the spot price series. Result indicates that there is two way (bidirectional) causality between spot and future market. Price discovery occurs in both markets.

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