Price Discovery Mechanism of Spot and Futures Market in India: A Case of Selected Agri-Commodities

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Abstract
In this study an attempt has been made to study the price discovery relationship for 3 of the top traded agricultural commodities on NCDEX namely Soyabean, Castorseed and Chana. The necessary daily data on spot and futures market prices are collected from the NCDEX website for the period 1st January, 2009 to 31st March, 2014. The near month contract of the futures markets of respective commodity was considered for the study, as they are mostly heavily traded as compared to next month and far month futures contracts. Augmented Dickey Fuller test was employed to test stationary of the data series. Besides, Johansen cointegration test was employed to access the long-run relationship between the variables and Vector Error Correction Mechanism (VECM) was employed to examine the short run dynamics. The cointegration results confirm the existence of long-run relationship between spot and futures series of Castor seed, Channa and Soya bean, respectively. The vector error correction model confirms bidirectional causality between spot and futures series of Castor Seed, Channa and Soya bean, suggesting that both the spot and future markets of the selected respective agricultural commodity plays the leading role through price discovery process in India and said to be informationally efficient and reacts more quickly to each other.

Keywords: Price Discovery, Johansen Cointegration test, VECM, Channa, Castorseed, Soyabeen, NCDEX.

Introduction
According to Gonzalo and Figuerola-Ferretti (2007) futures markets contribute in two important manners to the organization of economic activity. Firstly futures markets facilitate price discovery and secondly they offer way of risk transfer and hedging. Easwaran and Ramasundaram (2008) propounded that price discovery is highly useful to all segments of the economy where a producer gets an idea of the price likely to prevail at a future point of time and therefore, can decide between various competing commodities and choose the best that suits him whereas a consumer simply gets an idea of the price at which the commodity will be available in the future thus helping him in buying decisions. To attain exposure to commodities, which are separate asset class, one can consider commodity derivatives as a very important mechanism. Of all the myriad financial instruments such as futures, forwards, options, swaps and the ability to keep physical inventories, future contracts are considered to be of paramount importance as they provide important information about storage and cash markets. As mentioned in research paper by Fleming et al. (1996) financing, hedging, liquidity, price discovery, price stabilization, increasing efficiency, encouraging competition, lack of short sale restriction, fulfilling desires of speculators and inherent leverage are some of the prime economic functions of the futures market.

There have been many scholarly literatures which have studied one markets dominant role on the other for the purpose of price discovery such as Tan and Lim (2001), Diagler (1990), Tse (1999) and although methodologies differ widely but as said in Joel (2003) the important conclusion is that futures...
market have a dominant influence on the cash market and the reverse phenomena (although measurable) is considerably weaker. Chan (1992) rightly concludes that futures market is the main source of market-wide information and there is a price discovery in the futures market. Garbarde and Silber (1983) concluded that risk transfer and price discovery is considered two major contributions of futures market towards organization of economic activity. When one wonders what is price discovery then it can be said that it is the use of futures prices for pricing cash market transactions. It is thus implied that futures prices serve as market expectations of subsequent spot prices. The central question in market microstructure design, and one that is important to scholars and regulators is understanding the role of influence of one market on the other and the role of each market segment in price discovery. Zhong et al. (2004) propounded that in case of efficient markets new information is assimilated simultaneously into futures and cash markets. One can come to a logical conclusion that financial market pricing theory states that market efficiency is a function of how fast and how much information is reflected in prices. The study by Zapata et al. (2005) suggests that rate at which prices exhibit market information is equal to the rate at which this information is disseminated to market participants.

In the real world though factors such as transaction costs, liquidity and various other market restrictions give rise to an empirical lead-lag relationship between price changes in the two markets. Not only is this topic of scholarly interest, understanding the direction and magnitude of information flow is also important to portfolio managers for devising investment strategies and also to hedgers for hedging purposes. Fleming, Ostdiek and Whaley (1996) paper advocated that the greater the liquidity and lower the trading costs and further important will be the role of price discovery in the market. This is the rationale to conduct empirical studies on the impact of financial derivatives on price discovery to spot market. The price discovery issue has been extensively researched for western markets that are more mature and considered more efficient than the Indian market and focus largely has been on equity markets. The academic work on price discovery on Indian markets is sparse and limited. Sehgal et al. (2012) suggested that a commodity future trading has played an important role in economic development because of its eco-system linkages and role in employment generation. These trading platforms have also helped in integrating Indian markets with the world markets, thus, reducing any price distortions.

It is well known that since India is one of the largest consumer as well as producer of many agri-commodities; the time is now for this country to take a central role in price leadership at international level. Given this background the importance of examining price discovery mechanism of select agri-commodities has been established. It is widely believed that compared to International markets like U.S., China the Indian spot markets are underdeveloped, futures market have low market depths, poor delivery systems, restrictions put in by government regulations and policies, markets have thin volumes and low market depth and various other limitations. Having understood these restrictions and defects it becomes important to study the Indian commodity markets extensively to understand the role played by futures market in the price discovery process.

**Rationale for the Study**

The following figure shows the most traded commodities on NCDEX. It can be noted that 70% of the trading volumes have been achieved by the top four commodities namely Refined Soyabean Oil, Soyabean, Castor Seed and Chana. Refined Soyaoil comes under the edible oils complex and hence has been left out of the study. Only Hence other three commodities (Soyabean, Castorseed and Chana) were selected for further study to understand the role played by futures market in the price discovery process.
Commodity Profile: Chana

India’s Chana area fluctuates between 5 and 7.5 million hectares per annum. The production ranges between 4 and 7 million tons per annum. India’s production depends upon the monsoon rains and the moisture availability in the soil since most of the area under this crop falls under rainfed regions. The major use of Chana in India is that it is split and used as Chana dal and it is ground to make flour popularly called as besan and to largely vegetarian population forms a good source of protein and carbohydrates. Chana is the largest produced pulse in India amongst others such as Urad, Tur, Moong etc. The major trading centres for Chana in India are Indore, Mumbai, Delhi, Bikaner, Hyderabad, Latur, Akola, Kanpur, Chennai and Jaipur. Indore is the major market for Chana, which along with Akola, Latur etc set prices for this commodity. Though India is the largest producer of Chana, India continues to be the net importer, so as to meet out its growing domestic demand. India imports Chana mainly from Myanmar, Canada, Australia, Mexico, Turkey and Iran. Normally India imports around 0.15-0.5 million tons of Chana annually. Despite being the largest importer, normally India manages to export some quantity of pulses mainly to Bangladesh, Sri Lanka, UAE, USA, Nepal, Saudi Arabia and Kuwait.

Commodity Profile: Castor Seed

Castor plant (Ricinus communis) is grown in arid and semi-arid regions. It is cultivated in 30 different countries on commercial scale, of which India, China, Brazil, Russia, Thailand, Ethiopia and Philippines are major castor seed growing countries which accounts about 88% of the world's production. In India it is a kharif crop, sowing in July-August and arrivals from December onwards till March. Gujarat is the chief producing state, having a share of 86% of domestic production, followed by Andhra Pradesh and Rajasthan. Bag packed of castor seed contains 75kg by weight. Castor is a non-edible oilseed crop; basically a cash crop, with average 46% oil recovery. Castor seed production in India is around 9-10 lakh MT. Castor oil (extracted from castor seed) and its derivatives have vast and varied applications in the manufacturing of soaps, lubricants, hydraulic and brake fluids, paints, dyes, coatings, inks, cold resistant plastics, waxes and polishes, nylon, pharmaceuticals and perfumes. Castor oil is the largest vegetable oil exported out of India. India is the biggest exporter of castor oil holding about 70% share of the international trade in this commodity followed by China & Brazil. Castor seed due to its high oil content has its various uses. The supply of castor seed and its derivatives is highly fluctuating. Any change in the production trend in any of producing countries leads to a change in the level of the world production. The growing castor-based bio-fuel industry is also resulting in the increasing demand pressure on castor seed. Given that castor seed have considerable price volatility and that the export realizations of castor oil have also vacillated between years, Exchange traded castor seed futures are ideal for price risk management needs of the processors, exporters and end users. Those with no natural exposure to castor seed trade can also benefit by undertaking 'cash-and-carry' arbitrage and 'calendar spread'. Speculators can take directional view on future prices and accordingly take positions in castor seed futures.
Commodity Profile: Soyabean
Soybean (Glycine max) is called as Golden Bean. The plant is classed as an oilseed and is an important global crop. The processed soybean is the largest source of protein feed and second largest source of vegetable oil in the world. The major portion of the global and domestic crop is solvent-extracted with hexane to yield soy oil and obtain Soymeal, which is widely used in the animal feed industry. USA, Brazil, Argentina, China and India are the largest soybean producing countries in the world. Soybean is largest grown oilseeds in the world and other major source of oilseeds are Rapeseed (13%), Cottonseed (10%), Peanut(8%), Sunflower (7%) seed and Palm kernels. Among major oilseeds, higher percentage of meal extracted from Soybean 82%. The Prices of soybean determined by demand and supply of oil and meal. It is estimated that above 75% of the global output is crushed worldwide. A very small proportion of the crop is consumed directly by humans, soybean products appear in a large variety of processed foods. The cultivation of soybean is successful in climates with hot summers, with temperatures between 20°C to 30°C being optimum. It can grow in a wide range of soils, with optimum growth in moist alluvial soils with a good organic content. Soybeans derivatives are found in hundreds of human foods, animal feeds and industrial products.

Literature Review
There have been various studies comprising the literature on futures market where major attention has been given to the topic of price discovery. The landmark study by Gardbade and Silber (1983) used daily spot and futures prices for four storable agricultural commodities namely wheat, corn, oats and orange juice. The study was to understand the price discovery process in storable agricultural commodities. Although their findings were not clear enough for oats they did conclude that spot markets are dominated by futures market prices in the case of orange juice wheat and corn. Schroeder and Goodwin (1991) in their study about live hogs and Oellermann et al. (1989) in their study about feeder cattle studied price discovery in livestock contracts and concluded that the information flow is from the futures market to the spot market that is the futures market captures the information in the beginning and then the transfer happens to the spot market. Brockman and Tse (1995) in their study of the Canadian cash and futures market of agricultural commodities used econometric techniques such as cointegration and vector error correction model and concluded that for all four commodities the spot market is lead by the futures market and hence futures market drives the price discovery. Zapata and Fortenberry (1997) used cointegration techniques to study the lead-lag relationships between spot and futures market in the US for anhydrous ammonia, diammonium phosphate and cheddar cheese and concluded that the cheddar cheese spot and futures markets are not cointegrated where as the anhydrous ammonia and diammonium phosphate futures and spot markets are cointegrated. Tucker and Koutmos (1996) in a study regarding S&P 500 spot index and stock index future inspected the existence of dynamic interactions and temporal relationships by applying the VECM and ECM-EGARCH(1,1). He studied the volatility in the futures and spot market and concluded that volatility spillover effect between two markets in bidirectional and volatility in both the markets is an asymmetric function of past innovations.
Yang et al. (2001) studied the futures market for non-storable (hogs, live cattle, feeder cattle) and storable (corn, oats, soybean, wheat, cotton, and pork bellies) commodities for price discovery performance by applying cointegration procedures and vector error correction models (VECM) and concluded that spot markets and led by the futures market both in case of storable and non-storable commodities. Moosa (2002) studied the crude oil futures market to whether they performed the important functions of risk transfer and price discovery by using daily data of spot and one-month future prices of WTI crude oil covering from January 1985 to July 1996 and concluded in their study that 60% of the price price discovery function is performed in futures market.
Mattos and Garcia (2004) studied the Brazilian agri-commodities market for the existence of any lead-lag relationship between futures and spot market. Their study included futures of spot prices of the following commodities namely corn, cotton, live cattle, soybeans, sugar and coffee (Arabica) and this study concluded with mixed results. For commodities with thinly traded markets such as corn, cotton
and soyabens there was absence of cointegrating relationship and in the case of coffee markets and live cattle futures and spot prices were cointegrated. Tse and Xiang (2005) in a study found that although crude and gas futures contracts account for less than one percent of the volume of standard contracts on the NYNEX E-Mini futures, they chip in for more than 30% of the price discovery. In a study by Zapata et al. (2005) on the eleven futures prices traded in New York and world cash prices of exported sugar, with observations from January 1990 to January 1995, found out that futures market of sugar leads the cash market in price discovery mechanism.

Azizan et al. (2007) examined the Malaysian crude palm oil futures market by using daily price data of crude palm oil futures and spot markets. They investigated for the return and volatility spillovers in the Malaysian crude palm oil futures market using bivariate ARMA(p,q)-EGARCH(p,q) model specifications and found bidirectional information transmission between futures and spot markets for both returns and volatility. Ge et al. (2008) studied the interaction between cotton markets in the US and China and found cointegration between that cotton futures in US and China. The study further showed that the American and Chinese cotton futures market share price transmissions.

Thomas and Karande (2001) investigated the castor seed futures market traded on the regional exchanges in Ahmedabad and Mumbai for the presence of price discovery process and concluded that each regional market reacted differently to information in the price discovery of castor seed. They found that although there was no lead-lag relationship found between the spot and futures market in Ahmedabad market, the futures market in Mumbai heavily dominated the spot market. Kumar and Sunil (2004) employed the Johansen cointegration technique to examine the price discovery phenomena of five Indian agricultural commodities futures market and concluded that futures market were unable to incorporate information from the spot market and further confirmed the Indian agricultural commodities futures markets to be inefficient.

By employing the co-integration test to examine the linkages between Indian castor seeds futures and spot market, Karande (2006) study concluded that the Indian futures markets of Ahmedabad and Mumbai are cointegrated and there exists unidirectional causality from futures to spot market. Praveen and Sudhakar (2006) studied the Nifty futures traded on National Stock Exchange (NSE) and gold futures on Multi Commodity Exchange of India (MCX). In case of the commodity markets they found a unidirectional causal relationship between the gold futures price and the spot gold price meaning that gold futures price influenced the spot gold price but the opposite was not true. In case of stock markets the result concluded that Nifty futures had no effect on the spot Nifty. Roy and Kumar (2007) also employed the Johansen cointegration test to study the lead lag relationship between spot and futures market of wheat in India. Roy’s(2008) study where he investigated thirty two wheat futures contracts in India concluded that wheat futures markets are well cointegrated with their spot markets and also observed bidirectional causality in the majority of the wheat futures contracts. Iyer and Pillai (2010) used two-regime threshold vector autoregression (TVAR) for six commodities to investigate whether futures markets play a dominant role in the price discovery process and concluded that futures market prices play the vital role in the price discovery process. The rate of convergence, for copper, gold and silver, is almost instantaneous during the expiration week of the futures contract affirming the utility of futures contracts as an effective hedging tool. Whereas convergence worsens during the expiration week, in the case of chickpeas, nickel and rubber, signifying that their futures contracts were not useful as a hedging tool.

Shihabudheen and Padhi (2010) studied six Indian commodity markets, namely, Castor seed, Jeera, Sugar, Gold, Silver and Crude Oil for price discovery mechanism and volatility spillovers effect. The findings of the study concluded that futures price acts as an efficient price discovery vehicle for five of the six commodities except for sugar. They also concluded that volatility spillover to spot market from futures market exists for five of the six commodities except sugar. Pavabutr and Chaihetphon (2010) investigated the gold futures contracts in the Multi Commodity Exchange of India (MCX) over the period 2003 to 2007 for price discovery by employing vector error correction model (VECM) to demonstrate that futures prices of both standard and mini contracts lead spot price. The study’s
findings showed that standard and mini futures contracts exhibit a stronger influence over spot prices both in the short-run and long-run. Srinivasan (2012) employed Johansen cointegration, Vector Error Correction Model (VECM) and the bivariate EGARCH model to study the price discovery process and volatility spillovers in Indian spot-futures commodity markets. The results of the study demonstrated that spot markets of MCXCOMDEX, MCXAGRI, MCXENERGY and MCXMETAL serve as effective price discovery vehicle. Furthermore volatility spillovers to futures from sport market are dominant in case of all MCX commodity markets.

Data
The study considered the spot and futures market prices of selected agricultural commodity viz. of Castor Seed, Channa and Soya bean. The daily data on spot and futures market prices are collected from the NCDEX website for the period 1st January, 2009 to 31st March, 2014. The near month contract of the futures markets of respective commodity was considered for the study, as they are most heavily traded as compared to next month and far month futures contracts.

Research Methodology
This paper investigates the price discovery mechanism in spot and futures market prices of selected agricultural commodity viz. of Castor Seed, Channa and Soya bean. Augmented Dickey Fuller (1979) test was employed to test stationary of the data series. Besides, we employ Johansen cointegration test to access the long-run relationship between the variables. Besides, Vector Error Correction Mechanism (VECM) is employed to know the short run dynamics.

One of the preconditions for the cointegration technique is the data series $X_t = (S_t, F_t)$ should be stationary in an identical order. To find the series is stationary, Augmented Dickey Fuller (1979) test were conducted. The ADF test for each of the variables in $X_t$ denoted by $S_t$ and $F_t$ is estimated by the following regression equation:

$$\Delta X_t = \alpha + \gamma t + \rho X_{t-1} + \sum_{i=1}^{k} \beta \Delta X_{t-i} + e_t \quad \text{......... (1)}$$

Where $X_t$ is the set of variable under consideration, the order of $k$ is set large enough to ensure that the residual series, $e_t$ is a white noise process. The null hypothesis that $X_t$ contains a unit root is rejected when the estimated co-efficient of the lagged variable is $-1 < \rho < 1$ for levels and $-2 < \rho < 0$ for the first difference, (Enders, W., 1995).

When all the variables in $X_t$ exhibit the same order of integration, Johansen (1988) and Johansen and Juselius (1990) multivariate cointegration method can be used to examine cointegrating relationship among the variables. Johansen and Juselius propose a maximum likelihood estimation approach for the estimation and evaluation of multiple cointegrated vectors. Johansen and Juselius (1990) consider the following model:

Let $X_t$ be an nx1 vector of $I(1)$ variables, with a Vector autoregressive (VAR) representation of order $k$,

$$X_t = \Pi_1 X_{t-1} + \ldots + \Pi_k X_{t-k} + v + e_t \quad \text{......... (2)}$$

Where $v$ is an intercept vector and $e_t$ is a vector of Gaussian error terms. The first difference from equation (2) takes the following form,
\[ \Delta X_t = \Gamma_{t-1} + \ldots + \Pi X_{t-k} + v + e_t \quad \ldots \ldots \quad (3) \]

Where,
\[ \Gamma_i = -(I - \Pi_1 - \ldots - \Pi_k), \quad \text{for} \quad i = 1, \ldots, k-1 \quad \text{and} \quad \Pi = -(1 - \Pi_1 - \ldots - \Pi_k) \]

\( \Pi \) is an \( nxn \) matrix whose rank determines the number of cointegrating vectors among the variables in \( X \). If matrix \( \Pi \) is of zero rank, the variables in \( X_t \) are integrated of order one or a higher order, implying the absence of a cointegrating relationship between the variables in \( X_t \). If \( \Pi \) is full rank, that is, \( r = n \), the variables in \( X_t \) are stationary; and if \( \Pi \) is of reduced rank, \( 0 < r < n \), \( \Pi = \alpha \beta' \) where \( \alpha \) and \( \beta \) are \( nxr \) matrices, with \( r \) the number of cointegrating vectors. Hence, although \( X_t \) itself is not stationary, the linear combination given by \( \beta' X \) is stationary.

In the Johansen and Juselius (1990) method two likelihood ratio tests are commonly used to determine the number of cointegrating vectors. These are namely the trace test and maximum eigen value test. These tests can be used to test the null hypothesis of at most \( r \) cointegrating relationship among the variables in \( X_t \).

\[ \lambda_{\text{trace}}(r) = -T \sum_{i=r+1}^{n} \ln(1 - \phi) \quad \ldots \ldots \quad (4) \]

\[ \lambda_{\text{max}}(r) = -T \ln(1 - \phi_{r+1}) \quad \ldots \ldots \quad (5) \]

The first statistic known as the \( \lambda_{\text{trace}} \) statistic is designed to test the null hypothesis of at most \( r \) cointegrating relationships among the variables in \( X_t \) against the alternative hypothesis of more than \( r \) cointegrating relationships. The \( \lambda_{\text{max}} \) statistic is designed to test the null hypothesis of at most \( r \) cointegrating relationships in \( X_t \) against the alternative hypothesis of \( r+1 \) cointegrating relationships.

In order to apply the Johansen procedure, a lag length must be selected for the VAR. A lag length is selected on the basis of the Akaike (1974) Information Criterion (AIC).

If there exist at least one cointegrating relationship among the variables in \( X_t \) then the causal relationship among these variables can be determined by estimating the following Vector Error Correction Model (VECM).

\[ \Delta X_t = \alpha + \gamma \beta X_{t-1} + \sum_{i=1}^{k} \Gamma_i \Delta X_{t-1} + \ell_{t} \quad \ldots \ldots \quad (6) \]

Where \( \alpha \) is \( nx1 \) constant vector representing a linear trend, and \( \gamma \) and \( \beta \) both of which are of dimension \( nxr \), respectively, denote the speed of adjustment and the cointegrating vector.

Vector Error Correction Model (VECM) simply assumes that a portion of the disequilibrium for a given period will be corrected in the subsequent period. According to the Granger Representation Theorem, Engle and Granger (1987), the concept of cointegration and Error Correction are equivalent. As such, if all the variables in \( X_t \) are found to be cointegrated then the relationship can be adequately represented by \( n \) VECM.

The vector in this study consider of spot (St) and futures (Ft) market prices of selected agricultural commodity viz. of Castor Seed, Channa and Soya bean. As such, \( X_t = (S_t, F_t) \) and the VECM may be explained as:

\[ \Delta \begin{bmatrix} S_t \\ F_t \end{bmatrix} = A_0 + A_1 \Delta S_{t-1} + \ldots + A_i \Delta S_{t-i} + \rho_n ECM_{t-1} + e_t \quad \ldots \ldots \quad (7) \]

Where \( A_0 \) is the vector of constant terms, \( A_i = 1, \ldots, s \) are all matrix of parameters and \( \rho_n = 1 \ldots j \) is the \( n \) cointegration vector and \( e_t = NI (0, I) \).
Findings and Interpretations

As for the preliminary steps of the analysis, the present study tested the underlying stochastic process that generated the series assumed to be invariant with respect to time. If the stochastic process is stationary, then one can model the process with an Ordinary Least Square (OLS) regression and the fixed coefficient can be estimated from the present data. The investigation of stationary in a time series is closely related to the unit roots test. The study employed Augmented Dickey Fuller (1979) test for unit roots and its result are shown in Table 1. According to the Augmented Dickey Fuller test results, the null hypothesis of non-stationary for spot and futures series of Castor seed, Channa and Soya bean are not rejected at levels. When the series are first differenced, the ADF test statistic of all the variables are significant at one per cent level, signifying that the price series of spot and futures markets of respective agricultural commodity are stationary and integrated at the order of one.

<table>
<thead>
<tr>
<th>NAME OF THE STOCKS</th>
<th>Market</th>
<th>Augmented Dickey-Fuller Test Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Augmented Dickey-Fuller Test Statistics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Level</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intercept &amp; Trend</td>
</tr>
<tr>
<td>CASTORSEED</td>
<td>Spot</td>
<td>-2.41</td>
</tr>
<tr>
<td></td>
<td>Futures</td>
<td>-2.50</td>
</tr>
<tr>
<td>CHANNA</td>
<td>Spot</td>
<td>-1.46</td>
</tr>
<tr>
<td></td>
<td>Futures</td>
<td>-1.62</td>
</tr>
<tr>
<td>SOYABEAN</td>
<td>Spot</td>
<td>-0.75</td>
</tr>
<tr>
<td></td>
<td>Futures</td>
<td>-1.14</td>
</tr>
</tbody>
</table>

Note: * – indicates significance at one per cent level. Optimal lag length is determined by the Schwarz Information Criterion (SIC).

Johansen’s Cointegration test is performed to examine the long-run relationship between spot and future market prices of selected agricultural commodities and its result are presented in Table 2. The table results of Johansen’s maximum eigen value and trace statistic reveals the presence of one cointegrating vector between the future and spot market prices of Castor seed, Channa and Soya bean, respectively. The Johansen cointegration test result confirms that there exists a long-run relationship between spot and futures prices of selected respective agricultural commodities. Besides, the analysis indicates the spot and futures prices of each selected stocks stand in a long-run relationship between them, thus justifying the use of a Vector Error Correction Model (VECM) for showing short-run dynamics. By using the definition of cointegration, the Granger Representation Theorem (Engle and Granger, 1987) which states that if a set of variables are cointegrated, then there exist valid error correction representations of the data.

<table>
<thead>
<tr>
<th>NAME OF THE STOCKS</th>
<th>Vector (r)</th>
<th>Trace Statistics (λ_trace)</th>
<th>Max-Eigen Statistics (λ_max)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CASTORSEED</td>
<td>H₀: r = 0</td>
<td>747.64*</td>
<td>741.04*</td>
</tr>
<tr>
<td></td>
<td>H₁: r ≥ 1</td>
<td>6.6062</td>
<td>6.6062</td>
</tr>
<tr>
<td>CHANNA</td>
<td>H₀: r = 0</td>
<td>53.065*</td>
<td>50.415*</td>
</tr>
<tr>
<td></td>
<td>H₁: r ≥ 1</td>
<td>2.6495</td>
<td>2.6495</td>
</tr>
</tbody>
</table>

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SOYABEAN

<table>
<thead>
<tr>
<th>Ho: $r = 0$</th>
<th>60.443*</th>
<th>53.892*</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_1: r \geq 1$</td>
<td>6.5512</td>
<td>6.5512</td>
</tr>
</tbody>
</table>

Note: *- denote the significance at the one per cent level. $r$ is the number of cointegrating vectors under the null hypothesis (Ho) and $H_1$ represents the alternative hypothesis.

For this purpose the VECM are estimated and it is presented in Table 3. Besides, the vector error correction model is sensitive to the selection of optimal lag length and the necessary lag length of future and spot price series for the respective commodity is determined by the Schwarz Information Criterion (SIC) and it reveals optimal lag of five for Castor seed and two for Channa and Soya bean.

### Table-4: Test Results of Vector Error Correction Model

<table>
<thead>
<tr>
<th>Name of the Stocks</th>
<th>Eqn</th>
<th>C</th>
<th>$\Delta S_{t-1}$</th>
<th>$\Delta S_{t-2}$</th>
<th>$\Delta S_{t-3}$</th>
<th>$\Delta S_{t-4}$</th>
<th>$\Delta S_{t-5}$</th>
<th>$\Delta F_{t-1}$</th>
<th>$\Delta F_{t-2}$</th>
<th>$\Delta F_{t-3}$</th>
<th>$\Delta F_{t-4}$</th>
<th>$\Delta F_{t-5}$</th>
<th>ECT t-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>CASTOR SEED</td>
<td>$\Delta S$</td>
<td>1.92 E-05 (0.039)</td>
<td>0.41 7* (10.40)</td>
<td>0.24 3* (7.628)</td>
<td>0.00 4 (0.272)</td>
<td>0.00 4 (0.290)</td>
<td>-</td>
<td>0.00 6 (-0.050)</td>
<td>1.24 8* (-27.027)</td>
<td>1.24 1* (-28.202)</td>
<td>-</td>
<td>0.33 7* (-11.408)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>$\Delta F$</td>
<td>2.18 E-05 (0.018)</td>
<td>-</td>
<td>0.58 7* (-6.132)</td>
<td>-</td>
<td>0.40 1* (-5.285)</td>
<td>-</td>
<td>0.33 6* (-8.308)</td>
<td>0.22 5* (-6.413)</td>
<td>-</td>
<td>0.12 3* (-1.120)</td>
<td>0.02 4 (-0.069)</td>
<td>-</td>
</tr>
<tr>
<td>CHANNA</td>
<td>$\Delta S$</td>
<td>4.56 E-06 (-0.014)</td>
<td>-</td>
<td>0.03 3 (0.700)</td>
<td>-</td>
<td>0.01 2 (-0.459)</td>
<td>-</td>
<td>--</td>
<td>--</td>
<td>-</td>
<td>0.25 3* (-6.436)</td>
<td>0.14 2* (-5.593)</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>$\Delta F$</td>
<td>4.70 E-06 (-0.010)</td>
<td>-</td>
<td>0.21 5* (-3.067)</td>
<td>-</td>
<td>0.18 6* (-4.588)</td>
<td>-</td>
<td>--</td>
<td>--</td>
<td>-</td>
<td>0.46 9* (-8.028)</td>
<td>0.24 0* (-6.347)</td>
<td>--</td>
</tr>
<tr>
<td>SOYABEAN</td>
<td>$\Delta S$</td>
<td>2.60 E-06 (0.007)</td>
<td>-</td>
<td>0.41 5* (-13.19)</td>
<td>-</td>
<td>0.20 3* (-7.770)</td>
<td>-</td>
<td>--</td>
<td>--</td>
<td>-</td>
<td>0.14 6* (-4.569)</td>
<td>0.08 9* (-3.821)</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>$\Delta F$</td>
<td>1.79 E-06 (-0.004)</td>
<td>-</td>
<td>0.35 1* (-9.492)</td>
<td>-</td>
<td>0.18 4* (-6.003)</td>
<td>-</td>
<td>--</td>
<td>--</td>
<td>-</td>
<td>0.17 3* (-4.595)</td>
<td>0.07 4* (-2.724)</td>
<td>--</td>
</tr>
</tbody>
</table>
By and large, the table result of vector error correction model reveals that the error correction coefficients of spot and futures equation of Castor seed are statistically significant at one percent level, suggesting the existence of long-run equilibrium relationship between spot and futures price series of Castor seed market. Besides, the lags of spot price in futures equation and the lags of futures price are statistically significant at one percent level, implying the existence of feedback relationship between spot and futures series of Caster seed. Furthermore the coefficients of the lagged futures prices and lagged spot prices, for Castorseed, show that the strength of the relationship from futures to spot is stronger than from spot to futures. This indicates information flow is stronger from futures to spot market. Moreover, the findings indicate that the error correction coefficients of spot and futures equation of Channa are statistically significant at one percent level, suggesting the presence of long-run equilibrium relationship between spot and futures price series of Channa market. Specifically, the lags of spot price in futures equation and the lags of futures price are statistically significant at one percent level, implying the existence of bidirectional relationship between spot and futures series of Channa. Furthermore the coefficients of the lagged futures prices and lagged spot prices, for Channa, show that the information flow is largely equal from spot to futures and from futures to spot.

Further, the results show that the error correction coefficients of spot and futures equation of Soya bean are statistically significant at one percent level, suggesting the presence of long-run equilibrium relationship between spot and futures price series of Soya bean market. Most importantly, the lags of spot price in futures equation and the lags of futures price are statistically significant at one percent level, implying the existence of bidirectional relationship between spot and futures series of Soya bean. Furthermore the coefficients of the lagged futures prices and lagged spot prices, for Soyabeans, show that the strength of the relationship from spot to futures is stronger than from futures to spot. This indicates information flow is stronger from spot to futures market.

From the VECM results, we can infer that there is bidirectional causality between spot and futures series of Castor Seed, Channa and Soya bean. This shows both the spot and future markets of the selected respective agricultural commodity plays the leading role through price discovery process in India and said to be informationally efficient and reacts more quickly to each other.

**Limitations**

The study has following limitations:

1. The period taken into the study was only 5 years and not since the product was launched on the NCDEX exchange.
2. The data incorporated in the study were daily closing prices both spot and futures whereas more conclusive results could be generated by using intra-day data.
3. Only 3 commodities were selected out of all the agri-commodities and future scope of study could be extended to the remaining commodities to make the study more complete.

**Conclusion**

In the present study, the attempt has been made to investigate the price discovery mechanism in spot and futures markets of selected agricultural commodity viz. of Castor Seed, Channa and Soya bean. Johansen Cointegration and the Vector Error Correction Model (VECM) were employed to examine the lead-lag relationship between the spot and futures prices. The cointegration results confirm the existence of long-run relationship between spot and futures series of Castor seed, Channa and Soya bean, respectively. The vector error correction model confirms bidirectional causality between spot and futures series of Castor Seed, Channa and Soya bean, suggesting that both the spot and future markets of the selected respective agricultural commodity plays the leading role through price discovery process in India and said to be informationally efficient and reacts more quickly to each other. The findings suggest that these markets are becoming informationally mature and market regulators have taken adequate steps for market development.
References


34. www.ncdex.com