LONG-TERM RELATIONSHIP AND PRICE DISCOVERY IN INDIAN AGRICULTURAL FUTURES MARKET

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ABSTRACT

The present research article studied the long-term relationship and price discovery between two benchmark agricultural futures indices in India, say, NKRISHI and AGRIDEX. Daily closing futures prices of both futures indices from March 31, 2016 to December 31, 2019 were used for analysis. The relationship and price discovery has been examined by the use of Unit Root, Johansen Co-integration and pairwise Granger Causality tests. Present investigation help to realize that the price relationship between AGRIDEX and NKRISHI are not significantly found in short-run as well as in long-run. The Results highlight the efficiency of both the markets, say, NKRISHI and AGRIDEX futures indices, and also establish relevant information for investors, policymakers, researchers and hedgers for future investments and further analysis. It contributes to the market efficiency literature for agricultural futures market.

Keywords: Agricultural Futures market, Granger causality test, Johansen Cointegration test, Price Discovery, Unit Root test.

I. INTRODUCTION

Farming action is characteristically unsafe, attributable to the inelastic demand and supply, and over reliance on weather conditions. India is one the significant players in the worldwide market as far as farming, utilization, creation and exchange of agricultural commodities. Agricultural futures trading is a fundamental area of Indian Financial markets. It is generally perceived that an agricultural futures trading permits business hedgers, for example, agronomists and manufacturers to fence their product value chance. Since the merger of Forward Market Commission (FMC) with Securities exchange Board of India (SEBI) in 2015, farming product futures markets have enrolled colossal development in trading volume, which has been credited to the accessibility of present day electronic platforms; thorough changes in exchanging, clearing and settlement frameworks including autonomous clearing, settlement ensured subsidize, and vigorous hazard the executives stages. Agricultural futures market trading helps to provide platforms for financial instruments to attain price innovation and better default price risk (Bhagwat and Maravi, 2016). Indian economy is based upon agriculture sector, where 52% workforce employed in agriculture and its products; and 35% of GDP (Gross Domestic Product) come from agriculture sector.
The fundamental job or target of derivative is to shield farmers from the decrease of the estimation of their yields from least cost value level. Due to the risk of investment and the risk of volatility in the financial market, investors are more interested in portfolio management. In primary as well as secondary market, commodities are separate asset group for investors to investment and diversify their portfolio of investment as compared to old choices i.e. shares, bonds and portfolio (Kour and Anjum, 2013). Since the start of history, agribusiness has affected the life and culture of India. In India, the increase in derivative trading is found after early 2000s. National commodity and Derivative Exchange Limited (NCDEX) was established on 23rd April 2003 under company Act, 1956. Presently, NCDEX regulated by SEBI under Securities Contracts Regulation (SCR) Act, 1956. The introduction of new and emerging India’s first return based agricultural futures index (AGRIDEX) has increased a lot of consideration among investors, regulators and academicians. This index ensures diversification in selection of the agricultural commodities as constituents of the index. The top 10 constituted commodities are selected as per their liquidity position in NCDEX platform. Besides this, study has used another agricultural futures index, say, NKRIISHI which is also listed on NCDEX from 01 January 2007. This index is calculated as per real time prices of near-month futures contract. To analyse the arbitrage opportunities between these two futures indices, one can examine the relationship and volatility characteristics between these markets. Present research work shows empirical past literature in Part 2 followed by data and research methodology in Part 3 subsequently followed by results and conclusion in Part 4 and Part 5 respectively.

2. LITERATURE REVIEW

In this area, we recognize the present writing on the relationship among spot and futures prices, especially their value building communication and the causal chain they are following inside that instrument. Furthermore, present work outline the writing on the effect on volatility. At last, present work assess the writing about the impact of financialisation on commodity market. However, there are very less studies that shows empirical relationship and price discovery of agricultural commodity futures market of India. Chopra and Bessler (2005) examined cointegration relationship in the sample variable markets. Nearby futures contract market was found to be adjusting to shocks in the long run. So, empirical results showed the futures market as a price discovery vehicle. But the study was not able to find which future market (nearby or next to nearby) was the centre of price discovery. Easwaran and Ramasundaram (2008) showed that there were no price discoveries in agricultural futures markets. Results also showed that there was no relationship between both markets. Elumalai et al. (2009) showed the cointegration, unidirectional lead-lag and unidirectional short run relationship between both markets of pepper, guar seed and chana. Results shows dominance of futures market over spot market in long-run. Kumar and Pandey (2010) showed that volatility and trading volume were highly correlated. The trading volume was affected by overnight volatility but not the open interest. There was a positive impact of open interest on volume but a negative impact of volume existed on open interest. Kumar and Pandey (2011) revealed that the futures markets for all commodities co-integrated except soybean and corn which were traded in CBOT exchange. The Indian market was unidirectionally impacted by world markets and in case of return transmission there was a bidirectional relationship between MCX and LME markets. Mukherjee (2011) attempted to know the impact of futures trading on agricultural market of India. The empirical results showed significant lead of futures market for risk hedging and price discovery function. Sehgal et al. (2012) showed the long run equilibrium, bidirectional granger causality and informational efficiency in nine out of ten commodities. Malhotra and Sharma (2013) showed the long run comovement between spot and futures markets of guar seed and, futures market considered as hedging instrument. The futures market of guar seed led the spot market. Results showed that the error correction mechanism took place in both markets but the futures market made quicker adjustments as compared to spot market. Shakeel and Purankar (2014) revealed the long term relationship and bidirectional causality existed between the spot and futures series of all sample commodities. Vasantha and Mallikarjunappa (2015) showed that the spot market absorbed the information faster than future market and served as an efficient price discovery vehicle. Dhineshni and Dhandayuthapani (2016) showed the long run relationship and bidirectional causality between the futures and spot price series of all sample commodities. Results concluded that both spot and futures markets played dominant roles in price discovery process. Inani (2017) showed the cointegration of all the sample markets played dominant roles in price discovery process.
commodities. Further, futures market led the spot market for the price discovery function in case of six commodities out of ten. Agrawal et al. (2019) concluded that the agricultural futures commodities has great potential because of multiple e-platforms for trading, different lot sizes and tick sizes.

The past literature on agricultural commodities and volatility persistence in Indian agricultural market lead to design objectives of the present research article. The objectives of the present research articles are:

1. To know the existence of co-integration relationship in between NKRISHI and AGRIDEX futures indices in India.
2. To examine the price discovery function in between NKRISHI and AGRIDEX futures indices in India.

3. DATA AND RESEARCH METHODOLOGY

The daily closing time-series data has been casted off ranging from 31 March 2016 to 31 December 2019. The official website of the NCDEX (www.ncdex.com) has been considered for secondary conceptual as well as financial time-series data. To make optimum comparison, selected data is ranging from the initiation of new and India’s first return based agricultural index i.e. AGRIDEX. To begin with, descriptive statistics has been calculated for both the variables under study by taking the natural log for both the sample time-series. Then other econometric tests like Unit Root (ADF), Johansen co-integration and pairwise Granger Causality tests have been applied for further research work.

3.1. Unit Root Test

To investigate the stationarity, say, H₀: Series has unit root in time series, present work employs the Augmented Dickey-Fuller (1979) test. A time series regression for testing unit root (ADF) is defined as follows:

$$\Delta X_t = \delta X_{(t-1)} + \Sigma_{i=1}^{m} \alpha_i \Delta X_{t-i} + \epsilon_t \quad \text{without drift}$$  \hspace{1cm} (3.1)
$$\Delta X_t = \beta_1 + \delta X_{(t-1)} + \Sigma_{i=1}^{m} \alpha_i \Delta X_{t-i} + \epsilon_t \quad \text{with drift}$$  \hspace{1cm} (3.2)
$$\Delta X_t = \beta_1 + \beta_2 t + \delta X_{(t-1)} + \Sigma_{i=1}^{m} \alpha_i \Delta X_{t-i} + \epsilon_t \quad \text{with drift and trend}$$  \hspace{1cm} (3.3)

$\Delta$ = first difference operator. If $\delta=0$; $\rho=1$ which indicates the unit root in $X_t$ series and again if $\delta=0$; then $\Delta X_t = \mu_t$ and $\mu_t$ is a white noise error term, thus, an random walk time series can become stationarity time series by using first difference. Where $\epsilon_t$ is a pure random error term, and the hypothesis and critical statistical value for ADF is same as DF test. The lag order for $\Delta X_t$ selected on the basis of statistical methods. The null hypothesis for the test of unit root set as $\delta=0$ (i.e. the series having unite root) where the alternative one is $\delta<0$ (i.e. series follow stationarity).

3.2. Co-integration test

3.2.1 Johansen’s Co-integration test (Long-term)

To examine the long-term relationship, present research article uses the Johansen’s co-integration test by utilizing the procedure Johansen (1988, 1991) and Johansen and Juselius (1990). The order of integration must be same for both underlying series for employing the Johansen’s co-integration procedure. This test is also helpful to create error-correction based model to know the speed to market adjustment or recovery. To test cointegration between NKRISHI and AGRIDEX in this present study, the two statistical tools, say, ‘trace statistics and eigen value’ given by Johansen (1988) has been considered for calculation co-integrating vectors. The lag-length is optimised as per the SIC (Schwarz Information Criteria). The trace- and max eigen- statistics has been represented as follows:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{n} ln (1 - \hat{\lambda}_i)$$  \hspace{1cm} (3.4)
$$\lambda_{max}(r, r+1) = -T ln (1 - \hat{\lambda}_{r+i})$$  \hspace{1cm} (3.5)
Here, \( T \) = Number of sample daily time-series data. \( \lambda_i \) = calculated value of eigenvalue estimated from II matrix and \( n = 2 \) (NKRISHI and AGRIDEX).

### 3.2.2 Granger Causality test (Short-term)

To examine the short-term cointegration or relationship, the Granger Causality test has been used. To begin with, the natural time-series of both (AGRIDEX and NKRISHI) has been converted into log-difference or log-return series then pairwise Engel and Granger, 1987 test has been employed. In simple terms, present methodology helps to identify which variable lead the market in short-run or which variable lag in the market in short-run. Schwarz Information Criterion has been followed to identify optimum lag. The following regression series has been used to examine causality between the AGRIDEX and NKRISHI futures indices time-series:

\[
A_t = \alpha_1 + \sum_{i=1}^{k} \alpha_{1i}A_{t-i} + \sum_{i=1}^{k} \beta_{1i}N_{t-i} + \varepsilon_{1t}
\]

\[
N_t = \alpha_2 + \sum_{i=1}^{k} \alpha_{2i}N_{t-i} + \sum_{i=1}^{k} \beta_{2i}A_{t-i} + \varepsilon_{2t}
\]

\( A_t \) and \( N_t \) are AGRIDEX and NKRISHI futures log-return series. \( \alpha_i \), \( \beta_i \) are the coefficient values of AGRIDEX and NKRISHI. \( \varepsilon_{1t} \) and \( \varepsilon_{2t} \) are pure white noise terms.

### 4. RESULTS AND INTERPRETATION

#### 4.1 Summary statistics

The methods of central tendency, measures of dispersion and jarque-bera statistics are used to narrate data. Table 1 affirms two properties of the time series, volatility and non-normality. Results exhibit that the mean returns of both sample variables are positive. It is marked that the NKRISHI prices are highly volatile ranging from minimum value of 7.9193 to the maximum value of 8.2033 with mean being 8.0677. Standard deviation of 0.0673 asserts instability in NKRISHI prices. On the other side, AGRIDEX for the period under consideration also evidences instability. Maximum value being 7.1461 and minimum being 6.8285 is revelation of their variability. Both tests (skewness and kurtosis) violate normality assumptions of frequency distribution. It is apparent from the Table 1 that Jarque-Bera statistic further adds to the previous confirmation of non-normality. P-value being zero in both the series means rejection of null hypothesis of Jarque-Bera test at 1 percent significance level.

**Table 1: Descriptive statistics**

<table>
<thead>
<tr>
<th>Particulars</th>
<th>AGRIDEX</th>
<th>NKRISHI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>6.9402</td>
<td>8.0677</td>
</tr>
<tr>
<td>Median</td>
<td>6.9191</td>
<td>8.0561</td>
</tr>
<tr>
<td>Maximum</td>
<td>7.1461</td>
<td>8.2033</td>
</tr>
<tr>
<td>Minimum</td>
<td>6.8285</td>
<td>7.9391</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.0630</td>
<td>0.0673</td>
</tr>
<tr>
<td>Skewness</td>
<td>0.7308</td>
<td>0.3138</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>2.8616</td>
<td>1.9931</td>
</tr>
<tr>
<td>Jarque-Bera</td>
<td>84.4320</td>
<td>55.1349</td>
</tr>
<tr>
<td>Probability</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>Observations</td>
<td>940</td>
<td>940</td>
</tr>
</tbody>
</table>

#### 4.2 Unit Root test

The results of unit root (ADF) test shows that the t-statistics values are more (less) than their absolute critical value in all the three test equations, say, with drift, with drift and trend and no drift at first difference (at level) for both the sample futures index time-series (Table 2). Both time-series are found to be unified at first order
i.e. I(1) and stationary at first difference. All empirical results guide us to implement further methodology to test relationship and volatility persistence.

Table 3: Result of Unit Root test (ADF)

<table>
<thead>
<tr>
<th>Variables</th>
<th>t-statistics (P-value)</th>
<th>t-statistics (P-value)</th>
<th>I(0)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>At level</td>
<td>At first-difference</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>With Drift</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGRIDEX</td>
<td>-1.7960 (0.3827)</td>
<td>-30.5875* (0.0000)</td>
<td>I(1)</td>
</tr>
<tr>
<td>NKRISHI</td>
<td>-1.4910 (0.5379)</td>
<td>-30.4086* (0.0000)</td>
<td>I(1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>With Drift and Trend</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGRIDEX</td>
<td>-2.9229 (0.1556)</td>
<td>-30.5742* (0.0000)</td>
<td>I(1)</td>
</tr>
<tr>
<td>NKRISHI</td>
<td>-2.0547 (0.5699)</td>
<td>-30.3932* (0.0000)</td>
<td>I(1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Without Drift</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGRIDEX</td>
<td>-0.1066 (0.6468)</td>
<td>-30.6633* (0.0000)</td>
<td>I(1)</td>
</tr>
<tr>
<td>NKRISHI</td>
<td>1.0735 (0.9266)</td>
<td>-30.3887* (0.0000)</td>
<td>I(1)</td>
</tr>
</tbody>
</table>

4.3 Johansen’s Co-integration test

To resolve problem of over restrictions or under restrictions, optimum lag-value is assessed as per SIC (2). Trace- and maximal eigen- statistics are casted-off to identify number of cointegrating vectors. The results (Table 4) show no cointegration relationship between AGRIDEX and NKRISHI agriculture futures indices. Results concluded that both the index are working perfectly random and no proof of long-term connection found in between them. In addition to that, both indices does not reflect any price discovery function in long-run.

Table 3: Johansen Cointegration test

<table>
<thead>
<tr>
<th>Agricultural Futures Indices</th>
<th>Data trend →</th>
<th>None</th>
<th>None</th>
<th>Linear</th>
<th>Linear</th>
<th>Quadratic</th>
<th>No of Co-integration relationship</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGRIDEX</td>
<td>Trace</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>+ NKRISHI</td>
<td>Max-eigen</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

4.4 Granger Causality Test

Present article analyses the results of Granger causality test (Table 4) and show lead-lag relationship between two Agricultural futures indices, say, AGRIDEX and NKRISHI in short-run. Empirical results does not reject the null hypothesis (H₀=X does not granger causes Y) at any significant level. F- statistics values are found to be insignificant which show no relationship and no price discovery function in short-run in underlying sample time-series.

Table 4: Pairwise Granger Causality Test

<table>
<thead>
<tr>
<th>Variables</th>
<th>F-Statistic</th>
<th>P-value</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGRIDEX</td>
<td>0.3575</td>
<td>0.6995</td>
<td>H₀= Not Rejected</td>
</tr>
<tr>
<td>+ NKRISHI</td>
<td>0.6505</td>
<td>0.5221</td>
<td>H₀= Not Rejected</td>
</tr>
</tbody>
</table>

5. CONCLUSION
Volatility is always said to be the indicator of optimum trade-off between risk and return in the financial markets. Any unforeseen modification (increased or decreased) in randomness leads to disorganisation in the pricing of commodity prices. If someone is not having proper knowledge of volatility movements then one can not avail the arbitrage benefits. So, studying the relationship and price discovery function help in establishing prior financial behaviour patterns. The secondary data of two Agricultural futures commodities has been explored from 31 March, 2016 to 31 December, 2019 to analyse the stationarity, cointegration and price discovery in Indian agricultural sector. The conclusive results of both tests (for long-term and short-term) reveal that the both the agricultural benchmark indices (AGRIDEX NKRISHI) of NCDEX moves randomly and does not follow each other. Study does not found any short-run as well as long-run cointegration relationship between them. It means there is no question of price discovery function or leading-lagging in these sample variables. This is happened because of one major reason that is AGRIDEX is return based index and NKRISHI is real time nominal index. Present article is only limited to unit root testing and Cointegration but further research work will be extended by incorporating volatility characteristics and non-structural shocks during contagion period.

REFERENCES


