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Research Paper

Futures trading of maize in India: A tool for price discovery and risk management

■ **Rekha Rani and P. K. Singh**

Correspondence to :

Rekha Rani
Department of Agricultural Economics, Institute of Agricultural Sciences, Banaras Hindu University, **Varanasi (U.P.) India**
Email : tamtarekha10@gmail.com

ABSTRACT : The historic green revolution, which targeted at increasing crop yield, established India as one of the world's biggest agricultural producer. Although India is an agricultural economy, farmers are not getting remunerative prices for their crops because of price fluctuation and market imperfections prevailed all over the country. Futures trading, as a tool for price discovery and risk management can pave the way for improving such market imperfections. The present study was conducted to examine the impact of futures trading on spot market of maize in India. The secondary data of maize spot and futures prices for the year 2005 to 2015 were collected from NCDEX. Johansen cointegration test was employed to access the relationship between futures and spot prices of maize. Further the direction of relationship was studied by using granger causality test and to investigate the long run causality and speed of price adjustment VECM was employed. The study found that spot and futures prices were independent and there was unidirectional causality between them. Further, results unveiled the long run causality from futures to spot market and it was the spot market which adjust itself to attain the long run equilibrium. The study concluded that futures are the market where framer can hedge their price risk and can explore the maximum possible profit from volatile prices. Therefore, policy measures should be adopted to bring the more agricultural crops under the network of futures trading.

KEY WORDS : Cointegration, Futures trading, Granger causality, Price discovery, VECM

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INTRODUCTION :

The agriculture and allied sectors continues to play an important role in achieving sustainable growth and development of the Indian economy. With its significant share (15.11% in 2015-16) in total GDP, it not only providing the food and nutritional requirement of the population but at the same time contributes significantly to employment generation, agro tourism, and international trade etc. through various forward and backward linkages. Although, India is an agricultural economy but, it has always been a country of market imperfections and price fluctuations. After, seventy years of independence, the government of India has taken an historical step towards it and launched e-NAM in April 14, 2016 to serve the farmers as one nation one market.

Commodity futures market, where the futures contracts are traded, provide similar common market for participants all over the country. The futures contract is a pre-determined and standardized contract to buy or sell commodities for a particular price and for a certain date in the future. Futures market performed two main functions *viz.,* to mitigate the price risk and to discover the prices for commodities, which are two foremost problems confronted by the farmers in India. The boom bust cycle is endemic to Indian agriculture which has a bidirectional causality with the price risk. In a bumper crop year when farmers across the country have been battered by lower crop prices, futures contracts can be used to hedge against price dips during the harvest season (Bera, 2017). These futures prices can also be used as an estimate of the spot price of a commodity at some future date. Thus, with the help of continuous flow of information prices are discovered in the commodity futures market.

In India, history of futures trading began on 1875, by establishment of first organized futures market for cotton by the Bombay Cotton Trade Association. In late 1960s due to the post drought consequences, the Government of India suspended futures trading in several commodities such as jute, cotton and edible oil seeds. Later, in the post liberalization period, on the advice of World Bank, UNCTAD and the recommendation of Kabira Committee Report, the Government ofIndia lifted the ban (Mahajan and Singh, 2015). It was the year 2003, in which actual beginning of the futures trading started with the registration of national and regional exchanges with Forward Market commission, which was later merged with Securities and Exchange Board of India (SEBI), in September 2015, for better regulation. Currently, 113 commodities are notified for futures trading in India. The National Commodity and Derivative Exchange (NCDEX) holds a major share in the agricultural commodity. The statistics shows a declining share for agricultural commodities in the total value of futures trading. Agricultural commodities constituted 68.18 per cent of total value of trade in 2004-05 and the rest was in bullion and other metals with 31.47 per cent and energy with 0.35 per cent. In 2013-14, the share of agricultural commodities declined to 16 per cent and increased in case of bullion and other metals to 60 per cent and energy by 24 per cent (FMC, Annual Report, 2013-14).

The maize in India contributes about nine per cent of total volume of cereals produced and is the third most important food grain after rice and wheat. The importance of a crop can be judged by the statistics of its area, production, utilization and its share in trade. The acreage of maize has touched 9.2 million hectares in 2014-15 which is the highest so far in the history of maize production in India. Production has increased from 14.98 million tons in 2003-04 to 24.17 million tons in 2014-15, which again shows increase in its demand. Maize as a crop has multiple uses but is chiefly grown for human and livestock consumption. Despite having low productivity as compared to world, India is still among the top 5 exporters of maize globally (Mahajan, 2016).

With this background, present study was conducted to glisten again the importance of futures trading in the agricultural economy of India. The objectives taken for the study were:

– To investigate the efficiency of futures market in price discovery.

– To examine the direction of relationship between futures and spot prices of maize.

– To study the short run dynamics and speed of price adjustment between the futures and spot prices of maize.

MATERIALS AND METHODS :

The National Commodity Derivative Exchange (NCDEX) contributes maximum share in the trading of agricultural commodities in India. The present study was based on the secondary data published by the NCDEX. The daily data of maize spot and futures prices from January, 2005 to December, 2015 were taken for the study. The monthly average of the data were then calculated and used for the analysis. Before analyzing the time series data, it is of utmost importance to check for the unit root *i.e.* stationarity of the data. To test the same ADF test as well as Phillips Perron test was used for the study. Further, optimum lag length wasselected on the basis of different criteria *viz.*, sequential modified LR test statistic, final prediction error (FPE), akaike information criterion (AIC), schwarz information (SC), and hannan-quinn information criterion (HQ). Efficiency of futures market in price discovery was investigated by Johansen Cointegration test. Further, Granger causality test was employed to determine the direction of relationship between two price series. Speed of price adjustment between spot and futures prices of maize towards long run equilibrium was assessed by Vector Error Correction Model (VECM).

Johansen's cointegration test:

The efficiency of futures market in discovering the spot prices was assessed by examining the long run assosiationship between the price series. For this Johansen's cointegration test was employed, general form of which can be written as:

$$\Delta Y_t = \mu + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-1} + \Pi Y_{t-1} + \varepsilon_t$$

Where Γ and Π are matrices of parameters, p is the number of lags selected by lag length selection criteria, ε_t is an (n × 1) vector of innovations. To detect the number of cointegrating vectors, Johansen proposed two likelihood ratio tests: The trace test and maximum eigenvalue teststatistic which can be formulated as:

$$\int trace = -T \sum_{i=r+1}^{n} In(1-\lambda_i)$$

$$\int max = -T \; In \; (1 - \lambda_r + 1),$$

where, T is the sample size and λ_i is the i^{th} largest canonical correlation. The trace test examines the Null hypothesis of r cointegrating vectors against the alternative hypothesis of n cointegrating vectors. The Null hypothesis for maximum eigen value test is r cointegrating vectors against the alternative hypothesis of r+1 cointegrating vectors (Beag and Singla, 2014).

Granger causality tests:

Granger (1969) approach predicts how much of the current value of one variable canbe explained by past values of other variable and then tries to see whether adding laggedvalues of prior variable can improve the explanation. Thus, to analyze the direction of relationship among price series Granger causality test was used which can be represented as:

$$X_t = C_0 + \sum_{i=1}^{p} a_i X_{t-i} + \sum_{j=1}^{p} b_j Y_{t-j} + \varepsilon_t$$

$$Y_t = \text{¥}_0 + \sum_{i=1}^{p} \alpha_i Y_{t-i} + \sum_{j=1}^{p} \;_j X_{t-j} + \text{«}_t$$

where, p is the number of lags of both variables in the system. The acceptance of Null hypothesis *i.e.* $b_1 = b_2 = \ldots = b_p = 0$ means Y_{t-1} does not granger cause X_t. Similarly, H_0: $\beta_1 = \beta_2 = \ldots \beta_p = 0$ if accepted, indicates that X_{t-1} does not granger cause X_{t-1} (Ali and Gupta, 2011).

Vector error correction model (VECM):

Once the series were cointegrated, the short run relationships and speed of price adjustment towards long run equilibrium was examined by using vector error correction model. The model can be represented as:

$$\Delta X_t = \alpha_0 + \sum \beta_1 \Delta Y_{t-1} + \sum \beta_2 \Delta X_{t-1} + \gamma\, ECT_{t-1}$$

$$\Delta Y_t = \;_0 + \sum \sim_1 \Delta X_{t-1} + \sum \sim_2 \Delta Y_{t-1} + \gamma\, ECT_{t-1}$$

where, ECT_{t-1} is the error correction term lagged one period generated by the error correction model. The negative and significant values of its co-efficient *i.e.* γ depicts the speed of adjustment in restoring equilibrium after disequilibria. It also represent the long run impact whereas short run impact is given by the lagged variables (Paul *et al.*, 2015).

RESULTS AND DATA ANALYSIS :

The descriptive statistics of futures and spot prices of maize are presented in Table 1. Mean and median describes the center of the distribution of data. Table shows that the mean and median are almost same for both spot and futures prices. The different figures of mean and median unveils the asymmetric nature of the data. To assess the spread of data, minimum and maximum values of both spot and future prices were compared and result shows that both figures are not very far from each other which indicates the absence of extreme values in the data. Table further reveals the figures of standard deviation, a common measure of the dispersion of data about the mean, which is lower in case of futures prices

Table 1: Descriptive statistics futures and spot prices of (Rs./ quintal) of maize

Particulars	Futures prices	Spot prices
Mean	986.4106	986.7795
Median	1001.917	1003.111
Maximum	1534.667	1549.313
Minimum	524.0417	509.3826
Standard deviation	275.2245	285.7933
Skewness	-0.098756	-0.037151
Kurtosis	1.937845	1.850052
Jarque-Bera	6.419508	7.303455
Probability	0.040367	0.025946
Observations	132	132

as compared to spot prices. It affirms that there is less spread in the futures prices. Table further discloses the skewness results which measures the extent to which data are asymmetric. The results unveil the negatively skewed prices in both the market. Kurtosis results shows that both the price series are platykurtic. The Jarque-Bera test statistic was used to test the normality of both the price series which was found to be significant at one per cent level of significance.

Stationarity results:

To test the stationarity of the data, ADF as well as Phillips Perron test were employed and results are presented in Table 2. While conducting the ADF test, intercept and trend specification was selected for both spot and futures price series, as the co-efficients were found to be significant. The results of both the tests revealed that at level, Null hypothesis *i.e.* price series are having unit root and are non-stationary is accepted for both futures and spot price series. Further, the perusal of table reveals that at first difference, Null hypothesis of having unit root is not accepted for both the price series in case of both ADF and PP test. Thus, the first difference of both the price series were found to be stationary. Stationarity of futures and spot price series were also presented graphically in Fig. 1.

Once the both futures and spot price series become stationary and integrated of the same order *i.e.*, one the lag length was selected to proceed for the cointegration test. The results of VAR lag order selection criteria are presented in Table 3. The results revealed that the lag order of two was selected by three criterion *i.e.* FPE, AIC and HQ, whereas lag order of one was selected by SC and LR criteria. So going with majority, the lag order of two were selected to test the cointegration.

Efficiency of futures market results:

The efficiency of futures market in discovering the prices for spot market was investigated by examining the cointegration between two prices series. The results of Johansen cointegration test are presented in Table 4. Table uncovers the findings of both tests proposed by Johansen *i.e.* trace and maximum Eigen value. The Null hypothesis of none hypothesized number of cointegrating

Table 2: Unit root test results

Variable	Level/first difference	Augmented dickey fueller test		Phillips perron test		Remarks
		t-Statistic	Prob.	t-Statistic	Prob.	
Futures prices	At level	-3.527*	0.041	-3.128*	0.104	Non-stationary
	At first difference	-6.743	0.000	-10.138	0.000	Stationary
Spot prices	At level	-2.741*	0.222	-3.518*	0.042	Non-stationary
	At first difference	-9.671	0.000	-11.120	0.000	Stationary

*denotes rejection of Null hypothesis at one per cent level of significance

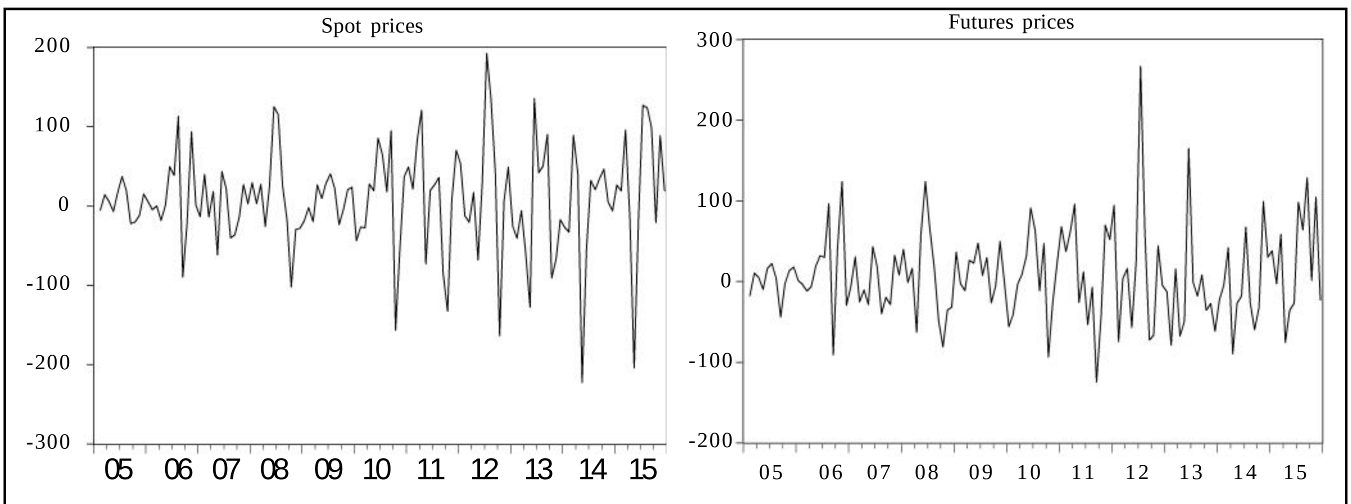

Fig. 1 : First difference series of spot and futures prices of maize

equations if accepted, indicates that there is no cointegration between the variables. This Null hypothesis was rejected by both trace and eigen value tests at one per cent level of significance. It indicates that both the futures and spot prices of maize are in a long run assosiationship. Further table discloses, the Null hypothesis of at most one cointegrating equation is accepted as the test statistic value is smaller than the critical value in case of both tests. The results thus, confirm the futures market were efficient in predicting the prices for spot markets.

Direction of causality results :

Cointegration only tells about the existence of

Table 3: VAR lag order selection criteria results

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1514.529	NA	1.44e+08	24.460	24.506	24.478
1	-1296.155	426.180	4532447.	21.002	21.139*	21.057
2	-1288.735	14.242	4289497.*	20.947*	21.175	21.039*
3	-1286.725	3.794	4430034.	20.979	21.298	21.109
4	-1285.543	2.191	4637328.	21.025	21.434	21.191
5	-1283.299	4.089	4772578.	21.053	21.553	21.256
6	-1276.814	11.611*	4587836.	21.013	21.604	21.253
7	-1274.453	4.150	4714693.	21.039	21.722	21.317
8	-1271.366	5.328	4789860.	21.054	21.828	21.368

* indicates lag order selected by the criterion, LR: Sequential modified LR test statistic (each test at 5% level); FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion

Table 4 : Johansen cointegration test results

Hypothesized no. of CE (s)	Trace test			Maximum eigen value test		
	Trace statistic	Critical value	Prob. value	Max-eigen statistic	Critical value	Prob. value
None* (H_0: r = 0)	30.073*	15.495	0.000	29.075	14.265	0.000
At most one (H_0: r<1)	0.998	3.841	0.318	0.998	3.841	0.318

*denotes rejection of the hypothesis at one per cent level of significance

Table 5 : Granger causality test results

Null hypothesis	F-statistic	Prob.	Direction	Relationship
Spot does not granger cause futures	2.663	0.074	Unidirectional	Futures ⟶ Spot
Futures does not granger cause spot	26.046*	0.000		

*denotes rejection of Null hypothesis at one per cent level of significance

Table 6: Vector error correction model results

Variables		Co-efficient	Std. error	t-statistic	P value
Δ spot	ECT_{t-1}	-0.625943*	0.155387	-4.028278	0.0001
	Δ spot (-1)	0.088414	0.145463	0.607807	0.5444
	Δ spot (-2)	-0.196862	0.123968	-1.588006	0.1149
	Δ futures (-1)	0.136552	0.171269	0.797295	0.4268
	Δ futures (-2)	0.060456	0.156878	0.385366	0.7006
Δ futures	ECT_{t-1}	0.099722	0.165989	0.600778	0.5491
	Δ futures (-1)	0.199181	0.176962	1.125562	0.2625
	Δ futures (-2)	0.063270	0.162093	0.390332	0.6970
	Δ spot (-1)	-0.145705	0.150299	-0.969434	0.3342
	Δ spot (-2)	-0.169565	0.128089	-1.323811	0.1880

Δ denotes first difference; * denotes significance at 0.01 level assosiationship between two variables but in what direction they caused to each other is examined by Granger causality test. The results of the direction of causality between futures and spot prices of maize are presented in Table 5. Table bring to light that the Null hypothesis *i.e.* spot prices does not Granger cause futures prices is accepted at five per cent level of significance as the probability value is more than 0.05. Further, second Null hypothesis shown by the table is rejected at one per level of significance. It affirms that spot prices can be predicted with greater accuracy by taking the lagged values of futures prices rather than not taking such lagged values, all other terms remaining unchanged.The study thus revealed that there was unidirectional causality between the spot and futures prices of maize. The past values of futures prices can be used to forecast the prices of spot market (Easwaran and Ramasundaram, 2008 and Singh *et al*., 2009).

Short run dynamics and speed of price adjustment results:

Once the markets are cointegrated, next step is to find the short and long run causality between them and speed of price adjustment towards equilibrium. To examine the same, VECM model was employed and results are presented in Table 6. Table shows two error correction models, one with Δ Spot and another with Δ Futures as dependent variable. The co-efficient of error correction term in first model, where Δ Spot is a dependent variable, is negative and significant at 0.01 level. It indicates that there was long run causality running from futures to spot market. Further, the co-efficient value indicates that in case of deviation from equilibrium between both markets, it would be spot prices which adjust itself at the speed of 62 per cent towards long run equilibrium. The short run causality from futures to spot market was examined by Wald test. To check the same Null hypothesis was co-efficients of Δ Futures (-1) and Δ Futures (-2) are same and equal to zero. The results revealed the acceptance of Null hypothesis which implies that futures prices of two lag can't jointly influence spot prices. Thus, there was no short run causality from futures to spot prices. Further, to examine the efficiency of model, it has to test for normality, ARCH effect and serial correlation. Jerque-Bera test was employed to test the normality, which resulted into acceptance of Null hypothesis *i.e.* residuals were normally distributed, Heteroscedasticity test was conducted which resulted into acceptance of Null hypothesis of no ARCH effect and Breusch-Godfrey Serial Correlation LM Test resulted into no serial correlation. Thus, the model with "Spot as a dependent variable was efficient. Table further bring to light that error correction term in second model with "Futures as a dependent variable is non negative and insignificant. The results revealed that there was no long run as well as short run causality from spot to futures market.

Conclusion:

The present study was conducted to investigate the impact of commodity trading on spot market of maize in India. The spot and futures price series data for the period 2005 to 2015 were collected from NCDEX as it contributes maximum share in agricultural commodity trading. To examine the integration and long run causality, Johansen cointegration model and Vector Error Correction model were used, respectively. Further to know the direction of relationship between two, Granger causality tests was used. The results revealed that both the price series were cointegrated with at most one cointegrating equation and there was unidirectional causality from futures to spot price series. Further, study found that there was long run causality running from futures to spot market. In case of deviation from equilibrium it would be the spot prices which adjust itself at the speed of 62 per cent to attain the long run equilibrium. The results were consistent with the findings of Singh *et al*. (2005); Sendhil *et al*. (2013) and Ali and Gupta (2011). Futures market are thus, a platform for farmers to hedge their prices risk and to take the advantage of price volatility of the commodity for maximizing their profit. As both the markets are "Cointegrated", farmers can use the price signals from futures market to plan the cropping pattern, their quantity as well as quality of crop so that maximum profit can be explored from future spot prices of commodity grown. Despite of such usefulness, farmer participation in the Indian commodity futures markets is very low because of reasons *viz.*, high fee for maintaining trading account, large minimum lot size for trading, lack of skills needed for trading on electronic exchanges and poor grading facility etc. Keeping an important role played by futures trading inmanaging price risk, study suggested the policy makers to work on these hurdles and make it farmers' friendly so that they can maximize their farm income.

Authors' affiliations:
P. K. Singh, Department of Agricultural Economics, Institute of Agricultural Sciences, Banaras Hindu University, **Varanasi (U.P.) India**

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