EFFICIENCY OF MAIZE FUTURES AND SPOT PRICE VOLATILITY

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ABSTRACT

Considering the growth of maize as an alternative food grain to the production of rice and wheat and large populace of farmers being engaged in its production, this paper makes an attempt to examine whether maize futures traded in NCDEX (during the study period 2015-2019) is efficient, so that maize farmers can mitigate price risk through hedging. Also the study explores the extent of price volatility in maize spot prices. Econometric tools such as ADF test, VAR modeling, WALD test. Granger causality tests, Garch Modeling have been performed to investigate the aforesaid objectives. The tabulated results are suggestive of short term market efficiency and spot price volatility. The outcome of this study shall be relevant for market participants and policy makers.

Key Words: Maize , market efficiency, price volatility, hedging, causality

INTRODUCTION

Maize is the third most important crop in India after rice and wheat. Alternatively Known as “Queen of cereals” for its yield potential, its importance in the Indian context can be gauged by the fact that its production is around 10% of the total food grain production and it is growing at around 5.5% annually. India is currently one of the top 10 maize producers in the world. Though maize is grown in India in both Kharif and Rabi season, yet majority of the production happens in the kharif season. It is also one of the commodities selected by the Government for crop diversification strategy in paddy and wheat growing regions due to less usage of water and power in production. Most of the maize growing farmers are marginal farmers with small land holding. So the output produced by them is small and they often resort to distress selling in post harvesting season. Though Government declares MSP for maize, farmers are unable to take the benefit of that and resort to sale straight out of the farm land. One of the focus area of the NITI Ayog towards doubling farmers income by ensuring remunerative price is through market oriented approach. In this regard the it is suggested that participation in the derivative market can be one of the alternative mechanism. Theoretically farmers can avoid price volatility through hedging in the futures market. But for that to happen, future market should be efficient in price discovery. So this paper sets out to examine the efficiency of Maize futures. Also one of the allegations against the derivative market is that it contributes to the price volatility by encouraging speculative activity. Therefore this paper intends to explore the price volatility of maize in the spot market

LTERATURE REVIEW

The survey of literature on commodity derivatives trading gives us a glimpse of a number of research studies undertaken to investigate the impact and relationship between spot and futures market volatility. Some studies have proved the efficiency of commodity market efficiency while some have expressed their inhibitions through their empirical and econometric approach. However , the present research paper is based upon the findings of many authors and adds to the existing literature survey by making an extensive empirical study on individual commodity namely maize, taking into account 5 years data from NCDEX database. The following section will highlight on some of the major studies conducted in this regard.

Ghosh (2009), in his study has analyzed the growth and performance of commodity futures in Indian economy during 2006-2008, wherein the data reflected that there has been a massive increase in the growth and value of all commodities, in spite of a decline in the volume of trade during the said time period. The study has made a mention that agricultural commodities constituted around 68% of the total value of forward trade until 2005-06 after which for some time there had been a surge in the trading of bullion and metals. However, the findings relating to cointegrating relationship between the spot and futures markets of agricultural commodities tend to be mixed. For example, mustard, guar, sugar (small) and pepper futures market have been found to be efficient in price discovery whereas the markets for castor seed, wheat, sugar(medium) and potato have been found to be inefficient. The reasons for the inefficient functioning of the futures markets of many agricultural commodities is most likely due to asymmetric information, stringent regulations, limited existence of spot markets and lack of awareness amongst farmers consequently leading to their non-participation. The study is suggestive that removing these bottle necks would pave the way for more farmers' participation in the futures market for agricultural commodities.

Sehgal and et al(2012), in their empirical study aimed at examining the effect of futures market efficiency with respect to seven agricultural commodities traded in NCDEX (April 2004 to March 2012) by using econometric tools like GARCH Model, Granger Causality, and Hodrick-Prescott Filter. The results conclude that spot market volatility is driven by futures market liquidity hinting at destabilizing effect, for all the sample commodities namely maize, turmeric, castor seed and soybean except pepper and barley which could be due to the inability of the spot market in collecting information from the futures market. The findings of the study are similar to the output of a research study done by Bessembinder and Seguin(1992); Weaver and Banerjee (1990) and Chatrath and et al(1996).This study in particular might be useful to the policy makers and stake holders involved in the maize supply chain.

Efe-Omojevwe (2013), in his research study has tried to examine the efficacy of futures market relating to commodities namely wheat and maize, actively traded in NCDEX by using co-integration and error correction models and the stationarity of data was determined by the Augmented -Dickey Fuller (ADF) test. The findings of the study depicted that both the maize and wheat futures market was inefficient, and the reason could the presence of additional information that resulted in the traders making speculative gains. The study is also suggestive of the fact that market inefficiency cannot always be blamed on price volatility.

Rani and Singh (2018), in their study on efficacy of maize futures market for the year 2005 to 2010, have made use of Co-integration, Granger causality and VECM model. The results depicted that there is unidirectional causality and both the spot and futures market were co-integrated which is conducive for the farmers to make future planning by making use of price signals and thereby hedge market risk. The authors are of the opinion that the network of futures trading should be extended for more agricultural crops.

Shivkumar and Kotreshwar (2017), in their study focused on the investigation of maize futures efficiency in the duration from 2013 to 2016 based on secondary data collected form NCDEX conclude that there is unidirectional causality from futures to spot price and thus it indicates that maize futures market can lead to price discovery.

OBJECTIVE

The study is an attempt to examine:

1. Efficiency of Maize Futures in price discovery
2. The extent of spot price volatility of Maize

DATA & METHODOLOGY

Data

The daily closing future prices of maize futures are obtained from the website of National Commodity & Derivative Exchange of India (NCDEX) for the period starting from January 2015 to December 2019. The spot prices are taken both from website of NCDEX and Agricultural Information Network (AGMARKNET) of Department of Agriculture, Government of India. For GARCH modeling, the spot prices of two mostly traded Maize mandis in India, Nizamabad (Telengana) and Sangli (Maharastra) were considered. Total no of observations for the study are 758.

Methodology

Markets are considered as efficient if the price reflects all the available information. It means price of one market can be corrected by the other market which means there has to be long term convergence between the future and spot prices. Following methodology has been used to test the market efficiency:

Firstly, the data is tested for sationarity by using Augmented Dicky-Fuller test (ADF) to avoid any spurious result in regression. ADF test has been conducted for both the price series at their level and first difference.

Secondly, Johansen Cointegration test has benn performed to find out whether the data is cointegrated or not. Cointegration is a necessary condition for the market efficiency. If the series are cointegrated, then there exists long term equilibrium between variables i,e future and spot prices. If there is no cointegration, then error correction model cannot be performed. So to check short term association, Vector Auto Regression has to be done. As the Johansen coinegration is sensitive to the lag length, prior to the test, lag length for each year was determined.

Thirdly, as the price series are not cointegrated, simple VAR modeling has been done to find out short run association between the endogenous variables . Joint significance of the lagged variables has been estimated using Wald coefficient test. Tests of VAR and WALD test are further corroborated by performing Granger causality test to ascertain the cause variable.

Fourthly, to test the pattern of spot price volatility, General Autoregressive Conditional Heteroscedasticity (GARCH) (1,1) modeling has been employed.

EMPIRICAL FINDINGS

Table 1 describes the descriptive statistics of maize future and spot price series considered for the study. The average spot price is higher than average future price in all the years except that in 2018. The standard deviation of the price series suggests that the spot price is more volatile compared to future prices except that in 2015. The measured skewness and kurtosis is mostly positive except in 2017 and 2018 spot price series. The negative skewness of the spot price series in 2018 and 2019 indicates the probability of negative returns for the spot in those two years. The measured kurtosis for the price series are platykurtic (<3) except for 2016 Future and 2017 spot price series which are leptokurtic (>3). Kurtosis statistics for the FP series are more than SP series (except in 2017) indicating higher volatility. The probability of Jarque-Bera statistics suggests rejection of null hypothesis for normal distribution.

Table 1: Descriptive Statistics

	2015		2016		2017		2018		2019	
	FP	**SP**	**FP**	**SP**	**FP**	**SP**	**FP**	**SP**	**FP**	**SP**
Mean	1336.16	1390.47	1437.83	1594.83	1456.58	1474.40	1344.01	1310.29	2083.87	2157.76
Std. Dev.	123.11	117.63	70.15	152.87	92.18	102.77	80.69	152.23	268.42	296.60
Skewness	0.47	0.12	1.18	0.63	0.75	-0.77	0.92	-0.04	0.36	0.21
Kurtosis	1.85	1.53	4.28	2.12	2.56	4.38	2.93	1.76	2.03	1.46
Jarque-Bera	15.68	15.83	48.65	16.01	21.32	37.54	12.69	5.75	7.37	13.10
Probability	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.03	0.00
Observations	170	170	163	163	209	209	89	89	123	123

Source: Authors own calculation based on the data collected

Prior to conducting stationarity test and cointegration, optimal lag length has been selected by unrestricted VAR using different criteria like Log likelihood, FPE, Akaikes information criterion, Hannan & Quin information criterion and Schwarz's Bayesian information criterion. Lag length suggested by most of the criterion is considered as the optimal lag length for each price series. Table 2 depicts the selection of optimal lag length for each price series.

Table 3 shows corresponding results of stationarity test for each year spot and future price series. The result indicates that 't' statistics for both spot and future price series at level is higher than the critical 't' at 5% significance. But at first difference, for both spot and future price series the calculated't' statistics is lower than the critical 't' at 5% significance. So for the first difference of the series, Null hypothesis depicting presence of unit root is rejected. Hence both spot and future price series are stationary at first difference i.e I(1). The results of Johansen cointegration test are depicted in Table 4. It clearly reveals that both the null hypothesis $r=0$ & $r \leq 1$ are rejected for all the years except 2016. In absence of cointegrating vector, it can be concluded that there is no long term association between future and spot price of maize. Hence it is not possible to rum Error Correction model. Hence the attempt is made to find the short term influence of one price on the other

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Table 2: Selection of Lag Length

Contract	Lag	Log-Likelihood	Likelihood Ratio	Final Prediction Error	Akaike's Information crtiterion	Hannan & Quinn Information Criterion	Schwarz's Bayesian Information Criterion
2015	0	-1864.569	NA	34910729	23.04406	23.08218	23.05954
	1	-1275.824	1155.685	25571.58	15.82498	15.93934	15.87141
	2	-1262.286	26.24045*	22731.65*	15.70723*	15.89782*	15.78461*
2016	0	-1845.722	NA	77502584	23.84158	23.88085	23.85753
	1	-1380.498	912.4399	201702.7	17.89029	18.0081	17.93815
	2	-1359.802	40.05633	162617.5	17.67487	17.87122*	17.75462*
	3	-1354.921	9.32065	160792.5	17.6635	17.93839	17.77516
	4	-1352.795	4.006174	164749.6	17.68767	18.0411	17.83123
	5	-1349.935	5.313858	167227.3	17.70239	18.13436	17.87784
	6	-1346.884	5.589622	169341.2	17.71463	18.22514	17.92199
	7	-1336.86	18.10798*	156743.5*	17.63691*	18.22596	17.87616
2017	0	-2287.035	NA	26714397	22.77647	22.80934	22.78977
	1	-1755.018	1048.153	139639.3	17.52257	17.62117*	17.56247*
	2	-1752.3	5.301834	141433.5	17.53532	17.69966	17.60182
	3	-1741.877	20.11818	132683.3	17.47142	17.7015	17.56452
	4	-1737.128	9.073318	131706	17.46396	17.75978	17.58366
	5	-1734.865	4.279464	134014.6	17.48124	17.8428	17.62754
	6	-1724.91	18.62057	126323.6	17.42199	17.84929	17.5949
	7	-1717.347	13.99753*	121947.1*	17.38654*	17.87957	17.58604
2018	0	-985.7326	NA	1.34E+08	24.38846	24.44758	24.41218
	1	-796.8602	363.7543*	1394466.*	19.82371*	20.00108*	19.89487*
2019	0	-1598.444	NA	4.20E+09	27.83381	27.88155	27.85318
	1	-1281.341	617.661	18125179	22.38854	22.53176*	22.44667
	2	-1272.015	17.84182*	16523027*	22.29591*	22.5346	22.39279*

*Note : * represents lag length selected under respective criteria. Lag length selected under most of the criteria considered as Optimal Lag Length.*

Source: Authors own calculation

Table 3: ADF Unit Root Test for Future and Spot Price

Year	No of Observations	't' Statistics (Levels)		't' Statistics (1st Difference)		Critical 't' at 5%	Lag Length	Inference
		Spot	Futures	Spot	Futures			
2015	168	-1.065564	-0.738574	-8.76322	-11.35141	2.88	2	I (1)
2016	160	-1.682729	-2.188789	-4.876536	-11.0967	2.88	7	I (1)
2017	202	0.507046	-1.273145	-4.704309	-15.08715	2.88	7	I (1)
2018	88	-2.69325	0.657841	-10.3283	-10.36505	2.88	1	I (1)
2019	122	-1.330902	-1.536334	-14.62658	-9.038741	2.88	2	I (1)

Source: Authors own calculation

Table 4 : Result of Johansen Cointegration Test

Year	Hypothesis		t-statistics	
	Null Hypothesis	**Alternative Hypothesis**	**λ trace**	**λ max**
2015	r = 0	r ≥ 1	6.24	4.95
	r ≤ 1	r ≥ 2	1.28	1.28
2016	r = 0	r ≥ 1	**19.86***	**18.21***
	r ≤ 1	r ≥ 2	1.65	1.65
2017	r = 0	r ≥ 1	6.51	6.15
	r ≤ 1	r ≥ 2	0.35	0.35
2018	r = 0	r ≥ 1	7.83	6.89
	r ≤ 1	r ≥ 2	0.94	0.94
2019	r = 0	r ≥ 1	11.67	8.28
	r ≤ 1	r ≥ 2	3.38	3.38

Note: The asterick (*) represents significance at 5% level
Source: Authors own calculation

The results of Vector Autoregression Model (VAR) can be seen in Table 5. It can be observed that only at two places lagged value of spot influences the future price significantly, once positively and once negatively. But the lag of future influences spot significantly at 4 places, twice positively and twice negatively. So it can be concluded that future prices predominantly influences spot price. Joint significance of lagged values of spot on future and lagged values futures on spot price is investigated through WALD test. The result is depicted in Table 6. It can be observed that in 2015 all lags of spot jointly influence the future price. In 2016 both the lag of future and spot influence each other significantly. But in 2017 & 2019, lagged values of future jointly influence the spot price significantly. Hence it can be concluded that in the short run, lagged values of future is having more influence on the spot price.

The result is further investigated by Granger causality test. The results can be seen in table 7. The null hypothesis (H0) i.e spot does not cause the future and future does not cause the spot has been tested. The F-statistics and corresponding probability value can be observed. The result clearly displays that in 2015 spot is causing the future (S□F). In 2016 there is bidirectional effect that is both spot and future causing each other (S□□F). Whereas in 2017 & 2019, the alternative hypothesis (H1) i.e future is causing spot is accepted (F□S). Only in the year 2018, there is no direction at all. So in the time period of 5 yrs, in three years future is influencing the spot. Therefore it can be concluded that future price is the cause variable influening the spot price.

Table 5: Results of VAR Model

	2015		2016		2017		2018		2019	
	F_t	S_t	F_t	S_t	F_t	S_t	F_t	S_t	F_t	S_t
F_{t-1}	1.031438*	0.059636	0.969461*	0.123662	0.915948*	-0.113868	1.008654*	0.083814	1.154129*	-0.098483
F_{t-2}	-0.081857	-0.058032	-0.179559	-0.099226	-0.028449	**0.237871***			-0.178387	0.165762
F_{t-3}			0.147425	-0.086588	0.076689	0.068575				
F_{t-4}			0.031170	0.06982	0.05059	**-.0215915***				
F_{t-5}			-0.121943	0.074834	-0.191442	0.057702				

F_{t-6}			0.184510	**-0.275312***	0.118232	-0.020047				
F_{t-7}			-0.179913*	**0.138772****	-0.029141	-0.035671				
S_{t-1}	**0.346239****	1.322315**	-0.024844	1.295242*	-0.012385	1.218222*	0.005644	0.838205*	0.086327	0.658906*
S_{t-2}	**-0.297795****	-0.3305**	0.002671	-0.033285	0.186184	-0.499476*			-0.099144	0.272198*
S_{t-3}			0.129893	-0.289014**	0.088895	0.178949				
S_{t-4}			0.062024	0.10324	-0.045702	0.399902*				
S_{t-5}			0.004986	-0.008116	0.133446	-0.649575*				
S_{t-6}			-0.172991	-0.338042*	-0.209199	0.661124*				
S_{t-7}			0.040762	0.271723*	0.108866	-0.280298*				
Const.	0.821482	10.3396	145.8278*	74.55931**	20.47389	-13.00942	-16.65141	102.7797	80.22609	10.45837

Note: indicates significance at 1% level and ** indicates significance at 5% level*

Source: Authors own calculation

Table 6: Joint significance of lagged coefficients - WALD Test

	2015		2016		2017		2018		2019	
	ΔS_{t-i} on F_t	ΔF_{t-i} on S_t	ΔS_{t-i} on F_t	ΔF_{t-i} on S_t	ΔS_{t-i} on F_t	ΔF_{t-i} on S_t	ΔS_{t-i} on F_t	ΔF_{t-i} on S_t	ΔS_{t-i} on F_t	ΔF_{t-i} on S_t
Chi-Square Value	**8.455087**	1.826281	**16.89045**	**21.93677**	9.345645	**22.80248**	0.246975	0.538457	2.748241	**5.754613**
Prob	**0.0146**	0.4013	**0.0181**	**0.0026**	0.2288	**0.0018**	0.6192	0.4631	0.2531	**0.0503**

Source: Authors own calculation

Table 7 : Granger Causality Test Results for cotton

Year	Hypothesis	F-statistics	Probability	Direction	Relation
2015	S/-->F	4.22754*	0.0162	Unidirectional	S-->F
	F/-->S	0.91314	0.4033		
2016	S/-->F	2.41292*	0.0231	BiDirectional	S<-->F
	F/-->S	3.13382*	0.0042		
2017	S/-->F	1.33509	0.2358	Unidirectional	F-->S
	F/-->S	3.25750*	0.0028		
2018	S/-->F	0.24698	0.6205	No Direction	S<-X->F
	F/-->S	0.53846	0.4651		
2019	S/-->F	1.37412	0.2572	Unidirectional	F-->S
	F/-->S	2.87731**	0.0653		

Note: S/-->F represents null hypothesis sp does not granger cause fp and F/-->S represents null hypothesis fp does not granger cause sp

**significant at 5% level, **significant at 10% level*

Source: Authors' own calculation

EXTENT OF PRICE VOLATILITY:

To measure the spot price volatility data ertiaing to spot prices of two largest traded mandis of maize in India, Nizamabad and Sangli have been analysed for a five year period from 2015 to 2019. Average price at Sangli (Rs 1518) is more than average price at Nizamabad (Rs 1421). The observed markets were positively skewed having long right tail. The market prices are leptokurtic. The market prices are having higher peak, having higher value than mean.

Table 8: Estimates of GARCH Model

Particulars	**Nizamabad**	**Sangli**
Mean (INR/100KG)	1421.073	1517.652
Maximum (INR/100KG)	2520	2350
Minimum (INR/100KG)	809	1330
Std. Dev.	281.4473	133.9117
Skewness	1.290941	1.610649
Kurtosis	4.663065	8.291417
Jarque-Bera	300.6417	561.2469
Probability	0	0
Observations	765	351
Garch Estimates		
Mean Equation	0.951385*	0.970410*
	(166.8155)	(73.27122)
Constant	64.39096*	45.54416**
	(7.932879)	(2.286104)
Estimates of ARCH Term (αi)		
ε^2_{t-1}	0.731476	1.166250
	(10.12244)	(5.861205)
Estimates of GARCH Term (βi)		
σ^2_{t-1}	0.505889	0.590935
	(17.90327)	(9.662936)
αι + βι	1.24	1.76
Volatility	Very High	Very High

*Note: *indicates significance at 1% and indicates significance at 5% . Figures in parenthesis()are Z statistics*

Source: Authors' own calculations

The result of GARCH Model is exhibited in table 8. The $\alpha_i + \beta_i$ coefficients of the studied markets are more than 1 indicating continued volatility and explosiveness of maize spot prices. The coefficients of the ARCH terms indicated by P values are significant. It indicates that the present day price of maize in both the markets is dependent upon the preceding day.

CONCLUSION

From the investigations conducted, it is concluded that the future price and spot price of maize is not having long run association as is evident from the Johansen cointegration test. Hence the maize futures market is not efficient for price discovery. However the results of VAR Model, WALD test and Granger causality test concluded that in the short run lagged values of futures influence the spot price. So future prices of the lagged period send the price signal and lead the spot price. Also the results of the GARCH Model indicate high volatility in the spot prices of maize. Futures trading of maize have not caused the price stabilization in the spot market which is one of the objectives of the futures trading. This is one of the limitations of the study which can be used by the policy makers and researcher for the further investigation into the reasons for instability.

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