Relationship between Spot and Futures Markets of Selected Agricultural Commodities in India using co-integration and causality tests

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KEYWORDS	ABSTRACT
Spot prices, Future prices, Agricultural commodity derivatives, Granger causality test.	The association between spot & future prices have always been intriguing researchers and financial experts across regions and countries over the past several decades. The phenomenon of agricultural commodity derivatives have transitioned beyond an unprecedented threshold, thus necessitating a robust mechanism and framework wherein predictability of future price movements using spot price data points becomes indispensable for policy makers. The present study makes an attempt to apply granger causality test, unit root test, Philips Perron test, Augmented Dickey Fuller test & Stationarity with respect to Jeera, Barley & Castor seed based on data elicited from daily spot & future prices. It is found that spot prices can be used as a good predictor to ascertain the directionality and strength of movements in the future prices.

Introduction

There has been phenomenal changes in the commodity market in India. The futures trading will take us back to 1857 where Cotton was the first commodity to trade in Commodity market in India. In India for the several decades commodity remained banned till 2003(Fernandez, 2013). From 1952 to 2002 the commodity derivatives trading & cash settlement were banned, very few negligible activities carried on OTC basis. There was unnecessary speculation which might lead to rise in food prices in the country. Khusro committee (1980) and Kabracommittee(1993) recommended introduction of future trading in agricultural committees. Farmers generally don't get good prices & they cannot harvest for long period. Futures contract helps in determination of pricesand management of risk for agricultural commodity.Future market is a place where two partiesenter into a contract to deliver& receive a specific quantity of commodity at a pre-determined future date & price, on the other hand if commodities are bought & sold on spot or immediately it is termed as Spot market.Believing that futures market might take us to right direction to take efficient decisions by farmers & other stakeholders, three national exchanges were established and all of them were permitted to be traded in the market. Price discovery process will help to understand whether the new information influence the futures prices first or the spot prices. This shows the way to lead lag relationship between spot & futures market by dissemination of information. According to (Lien and Tse, 2000) and other study it is said that futures market play a critical role in price discovery for underlying spot market.By assessing the future & spot prices of selected agricultural commodities in India, in this paper we examine the efficiency of agricultural commodity markets.

Review of Literature

Based on a study on 12 major agricultural commodities, Ali and Kriti (2011) observed some reasons behind the lack of integration between rice and wheat includesvery minimal

development of futures commodity exchanges, large traders interference in the market& government authorities intervening in terms of 'minimum support price & procurement'. The study also pointed that despite the futures playing a pivotal role in discovery of prices, the same role is even played in spot market for some of the commodities but for shorter duration. Mallikarjunappa&Afsal (2010) aimed at understanding the price discovery process using 12 individual stocks. Futures market value lag spot values by 5 minutes, neither of the market (i.e. spot & futures)holds the considerable leading role &none of them is supreme in price discovery. In-spite of spot being above its long run relationship with futures, it will come down to reach its equilibrium level & futures market will get adjusted to changes in spot in the same period. Volatility spilloverinfluences the spot market & futures market at 1% level. Tokat&Tokat (2010) in an aim to understand the shock and volatility transmission in futures and spot markets, Tokat and Tokat(2010) observe a bi-directional mechanism for all markets studied. The findings also observe that news affecting the spot market will graduallyinfluence the corresponding futures market or vice versa. Raghavendra et al (2016) focusing on 2 agricultural commodities (Soyabean& Chana) the author said that the relationship direction of futures & spot have unidirectional linkage to spot market prices from futures market. For 3 selected agricultural commodities (Maize, Jeera & Turmeric) there exist the bidirectional relationship between commodity futures & spot market. Kailarasi et al (2023) in an effort to undertake time series analysis on spot and future prices, with the help of correlation results, revealed that positive to negative relation from pre to during covid-19 pandemic, which reveals that the relationship change over the time. Therefore, the Indian commodity futures market can be used as hedging tool with financial instruments for diversifying the risk during crisis period. Nandini (2018) states that agricultural commodity spot markets are leading in price discovery process. Even futures market plays a major role in price discovery process, but in India futures market are not so developed because of high volatility, low participation due to large lot size, high margin & membership fees etc.. Improvement of futures market is essential for the development of an economy. Mishra et al (2017) found that futures & options is dominated continuously by spot market, the option market which is dominated by futures market has drastically fallen due to increase in securities transaction tax& the author considered daily spot, futures & option prices on Nifty & randomly selected 10 stocks. The traded value of corresponding options, however has increased over time. A reduction or elimination of securities transaction tax on purchase has been proposed for hedging purpose. Ray & Panda (2011) analysed that after the implementation of derivative, out of 15 stocks 8 stocks are exposed to changes in their pattern of volatility. Price returns of G Ind, Hindal, L&T, Ranbaxy etc… involves long run equilibrium relationship with market bench mark index. It is also observed that before implementation of derivative the stocks had long run equilibrium relationships but after implementation of derivatives they do not contain long run equilibrium. Minakshi (2018) considers the trend of spot & futures price of Chilly contract of April 2009 which involves 73 observations depicting 2 variables move in different direction. Author conducted the formal test of co-integration to test whether the 2 variables are stationary/non-stationary, if correlation is less for 2 variables then it is not co-integrated & vice versa is not always true. The appearance of long run association between spot price & futures price of Chilly & Cotton is not confirmed from the results of co-integration tests. Pradhan et al (2021) stated that, various economic factors such as 'interest rate, exchange rates, convenience yields, supply of money, uncertainty in monetary policy, stock prices, global & monetary liquidity conditions, spillovers in asset prices& capital flows'are directly & indirectly connected to lead lag association between spot & futures prices in commodity market. From the results of Granger causality test it is said that, focusing on short & long run there is a requirement for alternative

strategies in commodity markets. Findings of the result is that when new information is dispersed in the market the futures respond very quickly compared to spot market, as spot market is exposed to flexibility in short selling & low transaction cost. Vijayakumar (2018) finds no causal effect on futures prices by spot prices and also in domestic market futures contract price of pepper leads to change in spot prices. Hence pepper futures contract prices at MCX can be taken as a benchmark price. It also indicates transparent price discovery mechanism at the Indian derivatives exchange. French (1986) said that the variance of expected spot price changes is a large fraction of variance of actual spot price changes, hence futures price cannot provide better forecasts where an investor/trader can rely on. Both anticipated & unanticipated fluctuations in demand & supply generates the predictable spot price changes, for example (Production seasonal leads to anticipated changes in both supply & spot price agricultural commodity). Guru (2010) stated in her study that, trading in futures market leads to increased volatility in spot market which does not hold empirically true and the hedging activities in futures for currency have no influence on spot market volatility. There is no causality either between futures volumes and spot market volatility or between currency futures open interest spot market volatility. The spot market returns will be caused/driven by futures market returns.

Data and Methodology
In this study we have used daily closing prices of futures & spot for 3 major agricultural commodities (i.e. Castor-seed, Barley & Jeera) and the data was gathered from the leading commodity exchange in India i.e. NCDEX for the duration of 5 years(i.e. 1st January 2018 to 12th October 2023). Descriptive statistics wereemployed such as 'mean, standard deviation, coefficient of variation' etc. In this study to verify the stationarity of all the futures & spot price series we have used 'Unit root tests based on Augmented Dickey Fuller test (ADF) & Non-parametric Phillips-Perron test (PP)'. Co-integration between the spot and future market shows the market efficiency. To study the long term relationship between spot & future agricultural commodities co-integration test wasconducted. Engle Co-Integration test was employed toestimate the lead lag associationbetween spot & futures market for the selected agricultural commodities. To assess the direction of relationship between futures & spot prices we have used Granger causality test.

Unit Root Test
Both 'Augmented Dickey Fuller test (ADF) and Phillips-Perron test (PP)' were used to examine the Unit root and also to evaluate the integration properties we have used both ADF & PP testsby which we can check the stationarity of the variables & reason behind selecting ADF & PP test is that the importance of stationary and order of integration of the variables at levels as well as at first differences. Both the test assumes that non- stationarity robustness against the null hypothesis and stationarity against the alternative hypothesis.
The null hypothesis of non-stationarity is as follows:
H0: A unit root/non-stationarity/$\delta = 0$
Ha: No unit root/stationarity/$\delta < 0$, since $\delta = \varphi - 1$
The 'Unit root test' was applied on the Future price (FUTURE) and Spot price (SPOT).

Granger Causality Test
To verify the usefulness of one variable to forecast another variable we have used the econometric test which is Granger causality test& econometric test was applied to examine

whether there is any speculative causality between the two variables SPOT (Spot Price) and FUTURE (Future Price] for selected agricultural commodities.

The null hypotheses of Granger causality:

H01: SPOT does not cause FUTURE

Ha1: SPOT does cause FUTURE

H02: FUTURE does not cause SPOT

Ha2: FUTURE does SPOT

Engle Granger Co-integration Test

Engle Granger test for co-integration reduces to an ADF unit root test of residuals of co-integration regression. If the residuals contain a unit root then there is no co-integration.

The co-integrating regression is given as:

$Y_t = \beta_0 + \beta_1 Z_t + u_t$

$SPOT_t = \beta_0 + \beta_1 FUTURE_t + u_t$

Results and Discussion

Descriptive Statistics

Table 1: Descriptive Statistics of the agricultural commodities

Where SPOT represents the Spot Price, FUTURE represents the Spot Future, and stands for an error term. The co-integration of two variables occurs if the error term (u_t) is stationary. When the null hypothesis of no co-integration is rejected at the 5% level, we apply the ADF to the residual series (u_t) to confirm stationarity.

The mean value of future prices of Castor and Jeera is higher than Spot prices except the Barley. Standard deviation which measures the volatility shows that future prices of Castor and Jeera more volatility than spot prices except Barley. Normality test using JarqueBera shows that data attained that normality at 1 percent. Normality distribution for Barley and

		Mean	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Probability
Barley	SPOT	2053.267	550.8097	0.9959	3.6383	254.8613	0.0000
	FUTURE	1958.433	510.6948	1.5564	5.6606	976.8391	0.0000
Castor	SPOT	5478.214	1191.86	0.2995	1.8329	100.2481	0.0000
	FUTURE	5523.124	1208.135	0.2745	1.8942	88.8048	0.0000
Jeera	SPOT	21298.68	11489.15	2.3438	7.7559	2597.636	0.0000
	FUTURE	21351.23	11703.61	2.341	7.7769	2606.201	0.0000

Jeera is above 3 ,while Castor is below 3.We found the skewness for Castor, Barley and Jeera to be positive. Kurtosis is the measure of the peakedness of a dataset.

Table 2: Results of Augmented Dickey Fuller (ADF) Test and Philips Perron (PP) test
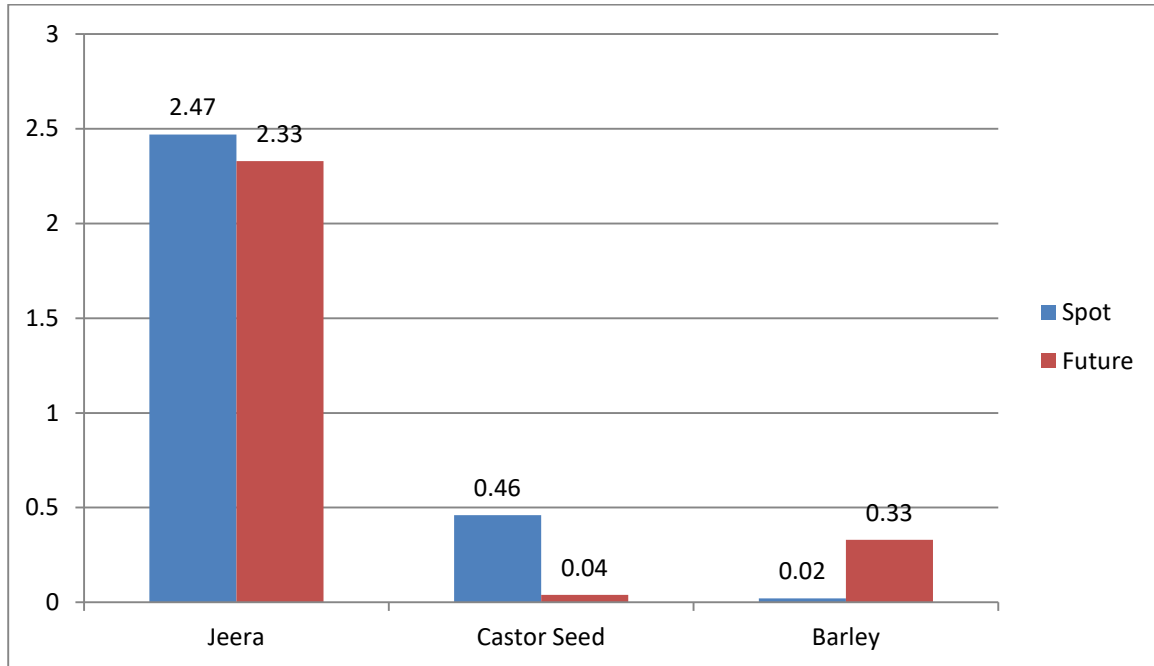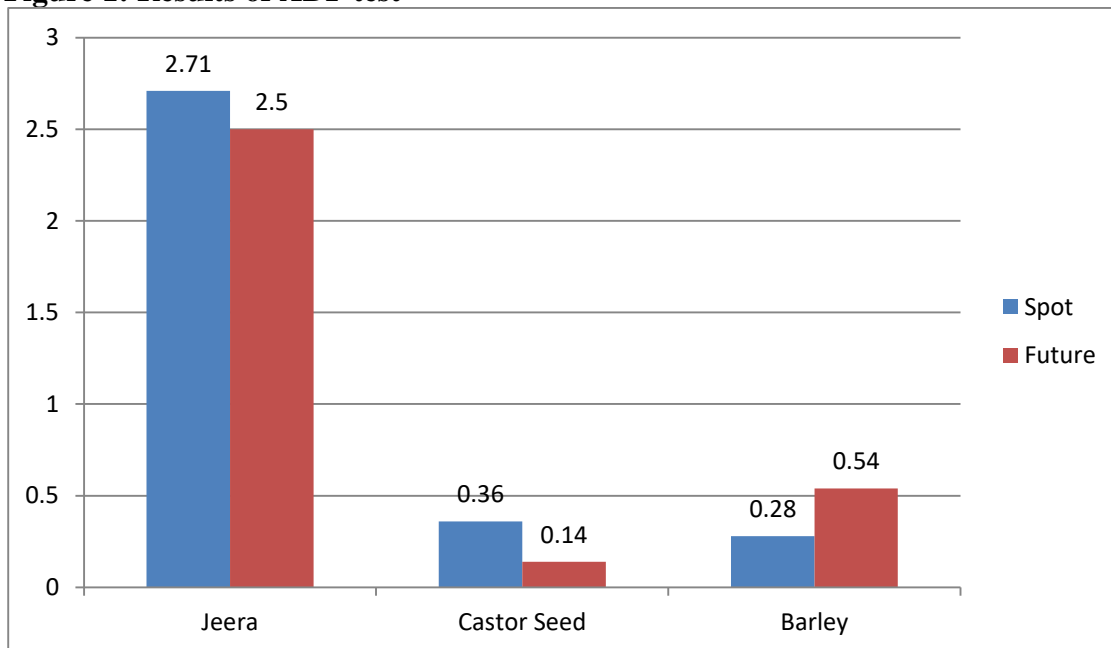
Figure 1: Results of ADF test

Figure 2: Results of PP test

ADF Test			PP Test		
Commodities	Level	1st Difference	Commodities	Level	1st Difference
Jeera	**t-statistic**	**t-statistic**	**Jeera**	**t-statistic**	**t-statistic**
SPOT	2.478624 (0.9971)	-12.86489 (0.0001)***	**SPOT**	2.712821 (0.9986)	-37.19968 (0.0001)***
FUTURE	2.338936 (0.9957)	-17.46097 (0.0001)***	**FUTURE**	2.481283 (0.9971)	-40.91495 (0.0001)***
Castor Seed	**t-statistic**	**t-statistic**	**Castor Seed**	**t-statistic**	**t-statistic**

SPOT	0.468084 (0.8157)	-26.01849 (0.0001)***	**SPOT**	0.361409 (0.7889)	-30.96325 (0.0001)***
FUTURE	0.041559 (0.6959)	-39.87704 (0.0001)***	**FUTURE**	0.144942 (0.7280)	-40.22529 (0.0001)***
Barley	**t-statistic**	**t-statistic**	**Barley**	**t-statistic**	**t-statistic**
SPOT	-0.029283 (0.6729)	-25.18438 (0.0001)***	**SPOT**	-0.280794 (0.5849)	-102.6307 (0.0001)***
FUTURE	-0.332983 (0.5655)	-26.21528 (0.0001)***	**FUTURE**	-0.547859 (0.4799)	-85.24184 (0.0001)***

Notes:,**,and***denote significance at the10%,5%,and1% level ,respectively.*

From ADF test results considering the selected agricultural commodities, it is said that the null hypothesis can be accepted as both spot & futures price were found to be non-stationary because p-value was insignificant at 1% level. After bifurcating spot & futures price and conducting ADF test for the selected agricultural commoditiesit was observed that the coherent series were stationary because 'p value' was significant at the level of 1% hencewe rejected null hypothesis.

Table 2 showed Philips-Perron test for the selected agricultural commodities, thatboth spot & futures price were found to be non-stationary as 'p' value was insignificant at the level of 1% hence we accepted null hypothesis. After bifurcating spot & futures price and conducting PP test for the selected agricultural commodities it was observed that the coherent series were stationary hence 'p value' was significant at the level of 1%,thereforewe rejected null hypothesis.

Results indicate that all commodity price series become stationary after first difference. Hence, we can go forward to test the co integration among spot & futures market using Engle Granger co integration test.

Granger Causality Test
Table 3: Results of the Granger Causality Test

commodity	Direction of causality	F-value	P-value	H_0
Jeera	SPOT →FUTURE	89.9413	0.001	REJECTED
	FUTURE→SPOT	50.7043	0.001	REJECTED
Castor Seed	SPOT →FUTURE	75.7099	0.001	REJECTED
	FUTURE→SPOT	20.3186	0.001	REJECTED
Barley	SPOT →FUTURE	4.04156	0.0446	REJECTED
	FUTURE→SPOT	34.4918	0.001	REJECTED

Table 3 shows causality betwixt SPOT and FUTURE for selected agricultural commodities i.e. Jeera, Castor Seed and Barley. Since P value is less than 0.05 levelwe reject the null hypothesis for the selected commodities i.e. Jeera, Castor Seed and Barley. There is bidirectional correlation betwixt SPOT and FUTURE for the selected agricultural commodities i.e. Jeera, Castor Seed and Barley.

Engle Granger co-integration test
We continued with 'Engle Granger co-integration test' to study the long term connection between the selected agricultural commodities, after fulfilling the pre-condition of non-stationary time series & we found that the series were stationary at their 1st difference.

It is necessary to perform a co-integration test to establish a long run relationship, as we have found out that the variables are stationary at 1st difference. Hence we have employed 'Engle Granger Co-integration test' to examine the long run association between 2 variables (i.e. spot price and future price).

The results of estimated long term relationship between SPOT (Spot price) and FUTURE (Future price) is as follow i.e., co-integration regression as per Engle-Granger testing procedure.

COMMODITY- JEERA

$$SPOT = 404.960 + 0.978(FUTURE) + u_t$$

t = (7.967) (468.739)
 p = (0.001) (0.001)

The outcome of the ADF test on the regression residuals is displayed in Table 5 as a stationary at the 1% level of significance, rejecting the null hypothesis of no co-integration. This demonstrates the Jeera SPOT and FUTURE's long-term co-integration. Since SPOT and FUTURE have a long-term relationship, error correction models are estimated for each variable.

Table5: The result of ADF Test for Stationary on Residuals

Series	t-statistic	p-value	Stationary/Non-stationary
u_t	-7.131	0.001***	Stationary

Notes:*,**,and***denote   significance   at   the10%,5%,and1%   level ,respectively.

The outcome of the ADF test on the regression residuals is displayed in Table 5 as a stationary at the 1% level of significance, rejecting the null hypothesis of no co-integration. This demonstrates the Jeera SPOT and FUTURE has long-term co-integration exists.

COMMODITY-CASTOR SEED

$SPOT = 76.008 + 0.978(FUTURE) + u_t$
t = (3.905) (284.105)
 p = (0.001) (0.001)

Table 6: The result of ADF Test for Stationary on Residuals

Series	t-statistic	p-value	Stationary/Non-stationary
u_t	-7.251	0.001***	Stationary

Notes:*,**,and***denote   significance   at   the10%,5%,and1%   level ,respectively.

The outcome of the ADF test on the regression residuals is displayed in Table 6 as a stationary at the 1% level of significance, rejecting the null hypothesis of no co-integration. This demonstrates the Castor seed 's SPOT and FUTURE has long-term co-integration exists.

COMMODITY-BARLEY

$SPOT = 181.596 + 0.955(FUTURE) + u_t$

t = (6.706) (71.428)

 p = (0.001) (0.001)

Table 7: The result of ADF Test for Stationary on Residuals

Series	t-statistic	p-value	Stationary/Non-stationary
u_t	-4.145	0.0008***	Stationary

Notes:*,**,and***denote significance at the10%,5%,and1% level ,respectively.

The outcome of the ADF test on the regression residuals is displayed in Table 5 as a stationary at the 1% level of significance, rejecting the null hypothesis of no co-integration. This demonstrates the Jeera SPOT and FUTURE's long-term co-integration. Since SPOT and FUTURE have a long-term relationship, error correction models are estimated for each variable.

CONCLUSION AND IMPLICATIONS

The study has been carried out, keeping in mind the critical parameters of descriptive statistics (standard deviation, skewness and kurtosis), which are employed in order to assess the normality of data. The data shows stationarity with the help of ADF & PP test after conducting unit root test, and hence qualifies for further rigorous data analysis. There existthe bidirectional correlation betwixt SPOT and FUTURE for selected agricultural commodities (i.e. Jeera, Castor Seed and Barley). The outcomes of the Engle Granger Causality test reveals that there is a strong evidence to suggest theappearance of long term relationship between spot and future price of Jeera, Barley and Castor-seed. Therefore, spot prices can be used as a good predictor to ascertain the directionality and strength of movements in the future prices.

Conflict of Interest:
NIL

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