Testing Efficiency in Agricultural Commodity Futures Market in India Using Cointegration and Causality Tests

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Abstract

Purpose : As far as the utility of market based instruments is concerned, there is always a dilemma regarding the stability and role of futures contracts in the development of underlying agricultural commodity markets. The objective of the current study was to test whether the agricultural commodity market in India was efficient or not. This objective was achieved by measuring the relationship between futures and spot market prices of seven major agricultural commodities traded at the National Commodity & Derivative Exchange in India.

Research Design : In the current study, the efficiency of the futures market for seven agricultural commodities was explored by using Johansen's cointegration analysis and Granger causality test. Unit root test such as Augmented Dickey-Fuller and non-parametric Phillips-Perron test were initially applied to test stationarity of spot and futures prices.

Findings : The results showed that their existed cointegration in futures and spot prices for all the selected agricultural commodities. This confirms a long-term relationship between futures and spot prices for all the agricultural commodities like wheat, castor seed, chilly, jeera, pepper, mustard, and soybean. The causality test further distinguished and categorized the commodities based on direction of relationship between futures and spot prices. Granger causality results showed unidirectional causality, where futures market prices lead to spot prices for wheat, castor seed, and jeera as compared to chilly, pepper, mustard, and soybean, where bi-directional relationships existed in the short run.

Practical Implications : The findings of this study have some important implications for market participants and policy makers. The direction of relationship between futures and spot prices showed that in general, the direction of causality was stronger for futures prices to spot prices in case of three commodities namely wheat, castor seed, and jeera, suggesting that futures prices tend to affect spot prices in the short run. In case of wheat, castor seed, and jeera, futures price discovery can play an important role in market decision making for stakeholders in these commodities.

Keywords : **agriculture - commodity futures, market efficiency, cointegration, causality, India**

JEL Classification: G1, G14, G15, G10

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In spite of the fact that India has gained incredible ground in the farming segment, however, even after 68 years of freedom, agriculture is still the guideline division in India, giving employment to almost two-third of its populace and contributing to around 16% of its GDP. Instability in product costs has dependably been a noteworthy issue for makers, processors, merchants, and in addition, the customers in an agribusiness commanded nation like India. Earnings from farming can vacillate broadly because of flighty climate conditions, infestations by rodents and pathogens, and unpredictable economic situations.

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Farmers' immediate exposure to price variance makes it excessively risky for them to invest and to make profits. There are different approaches to adapt to this issue. Apart from increasing security of the farm sector, different players can better deal in a situation of fluctuating costs of inputs through commodity exchanges. These exchanges serve a risk shifting function, and can be utilized to lock-in futures prices as opposed to depending on uncertain price movement. Aside from being a vehicle for risk exchange among hedgers and from hedgers to speculators, the commodity derivatives (futures/options) market assumes a noteworthy part in price discovery.

It is surely understood that commodities are economies' establishment of most developing nations by way of providing food, making wage producing opportunities, and fair profit to the general population directly involved in farming exercises. Like others, the Indian commodity sector has additionally been encountering a huge surge towards a more complex structure amid the most recent decade.

Distress sale of agricultural commodities immediately after harvesting due to lack of farmers' capacity to wait for opportune time for getting remunerative prices and also because of the uncertainty involved in possible future prices has always been one of the major concerns for producers as well as consumers (Gupta & Singh, 2009 ; Sahadevan, 2007). As highlighted in literature, futures contracts help in performing two important management functions, that is, price discovery and price risk management for a specific commodity (Sahadevan, 2007). It is useful for producers as they get a fair idea about the prices likely to prevail at a future point of time and hence, can allocate their limited available resources among various competing commodities for optimizing their profits. It also provides food processors and consumers an idea about prices at which a specific commodity would be available at a future point of time. Although futures trading in a large number of agricultural commodities were re-introduced in India in the year 2003, the government is always skeptical about its efficiency and likely impact on the price movement of agricultural commodities.

There are very few studies that have explored the efficiency of the commodity futures markets in the Indian context in a detailed manner, especially at the individual commodity level. This paper analyzes the efficiency of agricultural commodity markets in India by assessing relationships between futures prices and spot market prices of major agricultural commodities to fill up the above gap. There are not many studies that have investigated the efficiency of commodity futures markets in the Indian setting in a point by point manner, particularly at the individual commodity level. This paper dissects the efficiency of the agrarian commodity markets in India by evaluating connections between futures prices and spot market prices of major agricultural commodities to fill up the above crevice.

Data and Methodology

(1) Data : In order to examine the relationship between the underlying spot and futures market of the agriculture commodity sector, the basic data used in this study consists of daily price histories for the near- month futures contract of the selected agricultural commodities and their respective spot prices.

The commodities considered in this paper are agricultural commodities from all major categories (spices, pulses, cereals, oil, and oil seeds) as specified by the commodity exchange. The commodities from all the categories were primarily selected based on their market share in the commodity futures market in India. The selected commodities are wheat (cereals) ; chilly, jeera, and pepper (spices) ; mustard seed and castor seed & soyabean (oil and oil seeds).The daily closing futures prices of these commodities were collected from NCDEX, which is a leading agri-commodity exchange with a market share of overall 75%. The daily closing prices of these commodities in the spot market were also collected from NCDEX website for the same period for those markets which are also the place of delivery under futures contract for respective commodities. The daily price information in spot and futures markets for a period of 9 years (2004- 2013) for seven major agricultural commodities taken from different categories of agri-products were incorporated into various econometric models to test the concerned objective (see Appendix 1).

The descriptive statistics such as mean, standard deviation, and coefficient of variation for spot and futures

Table 1.Descriptive Statistics for Daily Spot and Futures Prices

Commodities	Mean	Minimum	Maximum	*SD*	CV(%)	*F*-value	*p*-value
Wheat							
Spot Price	1313.0	1045.3	1692.1	48.3	11.7	24.66*	0.000
Future Price	1285.0	1047.2	1688.0	150.7	11.3		
Castor Seed							
Spot Price	2793.084	432.3	6145.7	1085.7	36.8	4.07*	0.000
Future Price	2855.680	1350.5	5962.5	1050.8	38.8		
Jeera							
Spot Price	11692.7	5722.0	16727.1	2874.9	25.6	15.84*	0.000
Future Price	11477.2	4877.4	17401.0	2943.4	24.5		
Pepper							
Spot Price	19958.3	6682.9	43128.9	10781.5	54.0	576.13*	0.000
Future Price	19929.6	6408.0	45605.0	10918.1	54.7		
Chilly							
Spot Price	5621.4	2802.8	9806.2	1369.0	28.2	15.84*	0.000
Future Price	5591.5	1880.0	22590.0	1580.7	24.3		
Mustard							
Spot Price	2630.1	1580.2	4643.2	757.5	28.8	169.67*	0.000
Future Price	2614.3	1594.0	4493.0	725.57	27.7		
Soybean							
Spot Price	2194.8	1129.65	4958.0	730.8	33.3	559.73*	0.000
Future Price	2193.9	1148.7	5064.5	702.3	32.0		

Note: Significant at the *0.05 level

prices for various commodities are presented in the Table 1. One-Way Analysis of Variance (ANOVA) was performed to test the equality of means of spot prices and futures prices for each commodity. The values of *F*-statistic along with the corresponding *p*-values are also included in the Table 1.

(2) Econometric Methods : The literature survey indicates the increasing use of cointegration tests for studying the efficiency of futures markets (McKenzie & Holt, 2002). Wang and Ke (2005) elaborated the use of cointegration for exploring the efficiency in futures market as it provides predictive signal on price convergence. The cointegration between the spot price and futures price is a necessary condition for market efficiency. It ensures that there exists a long-run equilibrium relationship between the two series. The absence of cointegration implies that futures prices provide little information about movement in cash price, indicating that a futures market is not very efficient. The same approach has been used in the current study. After exploring the existence of cointegration between futures and spot prices, it is imperative to test the causality to assess the direction of relationship. In the present study, Granger causality test has been used to assess the direction of relationship between futures and spot prices.

As precondition of cointegration and causality analysis, a unit root test was performed using an autoregressive model to check whether a time-series variable is non-stationary or not. A series is stationary if the mean and autocovariances of the series do not depend on time. Unit root tests based on the augmented Dickey-Fuller (ADF) test and non-parametric Phillips-Perron (PP) approaches were used in this study to examine the stationarity of all the futures and spot price series. The test of stationarity of futures and spot prices were carried out by estimating the following regression equation:

$$\Delta X_t = b_0 X_{t-1} + \Sigma^{T}_{i=1} b_i \Delta X_{t-i} + \in_t \qquad (1)$$

where,

X_t represents the base level or the first difference of the variables. The null hypothesis of non-stationarity is $b_0 = 0$. If the null hypothesis is accepted at the base level of the series, but rejected at the first difference of the series, then the series is taken as stationary at the first difference level, and it is denoted by $I(1)$. The above tests have been performed using a constant intercept and lag length has been determined though Schwarz information criterion.

The purpose of the cointegration test is to determine whether a group of non-stationary series are cointegrated or not, and explores the long-run equilibrium relationship among the variables. Under this study, Johansen's cointegration tests have been used to assess the long-run predictability among spot and futures prices, using maximum likelihood technique. The Johansen cointegration test, assuming a n - dimensional vector X_t with integration of on order $I(1)$, estimates a vector autoregressive model. Johansen and Juselius (1990) further improved the model by incorporating an error correction depicted as follows:

$$X_t = c + \Sigma^{k}_{i=1} \Pi_i X_{t-1} + \in_t \qquad (2)$$
$$\Delta X_t = \mu + \Sigma^{k}_{i=1} \Gamma_i \Delta X_{t-1} + \Pi i X_{t-1} + \in \qquad (3)$$

where,

X_t is a n x 1 vector of the $I(1)$ variables representing spot (S_t) and futures (F_{t-n}) prices, respectively ; μ is a deterministic component which may include a linear trend term, an intercept term, or both, Δ denotes the first difference operator, Πi is a n x r matrix of parameters indicating α and β, c is a vector of constants, k is lag length based on the Hannan-Quinn criterion, and $\in_t$ is a random error term, which indicates how many linear combinations of X_t are stationary. Under this study, it has been assumed that the cointegrating equation (3) follows liner deterministic trends with constant intercept to have a more precise idea about the order of integration. The cointegration model asserts that if the coefficient matrix Π has reduced rank $r < k$, then the cointegrating relationship can be determined by examining the rank of the coefficient matrix Π, based on the number of cointegrating vectors. If X_t is a vector of $I(1)$ variables, then ΠX_{t-k} has to be stationary for $\in_t$ to make the error term stationary. The null hypothesis of cointegration is formulated based on the rank of Π, indicating $r = 0, 1,. . .k$-1. Therefore, the cointegration test statistics is based on comparing the number of cointegrating vectors under the null and alternative hypotheses.

The residual vectors of the above model construct two likelihood ratio test statistics, that is, the trace test and the maximal eigenvalue test. The trace statistics test the null hypothesis of r cointegrating relations against the alternative of the k cointegrating relations. The maximum eigenvalue statistics test the null hypothesis of r cointegrating relations against the alternative of r + 1 cointegrating relations. There are varied views on the usefulness of the two tests for cointegration. While Johansen and Juselius (1990) argued that the trace test may lack power relative to the maximal eigenvalue test, Cheung and Lai (1993) viewed that the trace test shows more robustness than the maximal eigenvalue test. The Johansen likelihood ratio test statistic, λtrace, and the maximal eigenvalue, λmax for the null hypothesis that there are at most r cointegrating vectors are given by:

$$\lambda trace = -T \; \Sigma^{k}_{i=r+1} \text{In}\,(1-\lambda_i) \qquad (4)$$
$$\lambda max = -T \; \text{In}\,(1-\lambda_{r+1}) \qquad (5)$$

Finally, the Granger causality test was used to analyze the direction and causal relations between futures and spot prices of major agricultural commodities. The Granger (1969) approach predicts how much of the current value of one variable can be explained by past values of the other variable and then tries to see whether adding lagged values of prior variable can improve the explanation. For instance, Y is said to be Granger-caused by X if X helps in the prediction of Y, or equivalently if the coefficients on the lagged X is statistically significant.

Specifically, Y_t is causing X_t if some coefficient, *ai,* is non-zero in the following equation :

$$X_t = c_0 + \Sigma^p_{i=1} a_i Y_{t-1} + \Sigma^p_{j=1} b_j X_{t-1} + \varepsilon_t \quad (6)$$

A time series, Y_t causes another time series , X_t if the current value of X_t can be predicted better by using past values of Y_t than by not doing so:

$$Y_t = \gamma_o + \Sigma^p_{i=1} \alpha_i X_{t-1} + \Sigma^p_{j=1} \beta_j Y_{t-1} + \mu_t \quad (7)$$

where,
p is the number of lags used for the variable. The regression equations (6) and (7) test the existence of the short-term relationship between the variables X and Y. Moreover, if both futures and spot prices are cointegrated, then causality must exist in uni-directional or bi-directional. The test for causality is based on a F-statistics, which tests whether lagged information on a variable Y provides any statistically significant information about a variable X in the presence of lagged X. The F-statistic is given by:

$$F1 = \frac{(SSE_0 - SSE_1)/p)}{(SSE_1/(T-2p\ \text{-}1)} \quad (8)$$

where,

$SSE0$ and $SSE1$ are the sum of squares of residuals, p is the number of lags, and T is the number of observations. It is important to note that the statement "X Granger causes Y" does not imply that Y is the effect or the result of X. This implies that the Granger causality measures precedence and information content but does not by itself indicate causality in the true sense. The analysis of unit root, cointegration, and causality tests for different commodities were performed using econometric software Eviews Version 6.

Results and Discussion

(1) Agriculture Price Volatility : Price variability is a major component of market risk for both producers and consumers. The government plays an important role in administering agricultural prices in India through various market intervention mechanisms. The liberalization of agricultural market in recent decades has provided both opportunities and challenges to producers, traders, consumers, and participants in futures markets. The reduction in government intervention has increased the price and market risk exposure. It has been argued that as long as there is government intervention in agricultural commodities market in terms of minimum support prices and procurement guarantees, the forward and futures markets have limited role to play for hedging price risk in these commodities (Naik & Leuthold, 1988 ; Sahadevan, 2007).

An assessment of marketed surplus and share of the government procurement indicates that a major chunk of food grains, that is, more than 70% of marketed surplus is traded in open market arrangement. Apart from this, the government market intervention is limited to some food grains only and that too has reduced over time. In such situations, the role of futures market for agricultural commodities becomes important in price discovery and risk management.

As mentioned earlier, the Table 1 summarizes simple descriptive statistics and variability of spot and futures prices in terms of coefficient of variation for major agricultural commodities. While a large variability does exist in futures and spot prices across different commodities and also between futures and spot prices of the same commodity, variation is much more at the former level. Out of the seven commodities analyzed, coefficients of variation in spot and futures prices for one commodity (wheat) is less than 15%; it is between 20% and 30% for

Table 2. GDP, Volume, and Value of Agricultural Futures Markets

Year	GDP (₹ in crore)	Agricultural GDP (₹ in crore)	Agriculture futures turnover	
			Volume (lakh tonnes)	Value (₹ in crore)
2009-10	6,477,827	4,516,071	3991.21	1217949.04
2010-11	7,795,313	4,918,533	4168.35	1456389.62
2011-12	8,974,947	5,247,530	4942.09	2196149.50
2012-13	10,028,118	5,482,111	4398.11	2155700.42

three commodities (chilly, jeera, and mustard); between 30% and 40% for two commodities (castor and soybean) ; and it is more than 50% for one commodity (pepper). The ANOVA indicates that for all the commodities, there are significant differences between mean values of futures and spot prices.

(2) Performance of Agricultural Commodity Futures Market : The Indian commodity futures market was moderately prevalent till mid 70s. However, its development was fraught because of different limitations and regulations imposed by the Government of India. In 2003, these confinements were relaxed, prompting the unconstrained development of the commodity market in the nation. With huge approach changes and liberalization of world markets, the Indian commodity derivative business sector has achieved incredible development as far as volume of exchange, number of items on offer, and transparency are concerned.

The turnover of commodity futures market, especially in agricultural commodities, has significantly increased after establishment of national-level commodity exchanges after 2003. The commodity futures markets have experienced phenomenal growth in terms of number of products, participants, spatial distribution, and volume of trade. There are 95 notified commodities, more than 3,000 members registered with the exchanges, and above 20,000 terminals spread over more than 800 towns/cities in the country to facilitate commodity futures trading. During the year 2008-2009, the total volume of futures trades in agricultural commodities (in terms of number of transactions) was about 33.7% of the total volume of trade. However, the value of futures trades in agricultural commodities during the same year was only about 12% of the total value of trade as most of the other major commodities such as bullion, crude oil, energy and metal products traded on the commodity futures exchanges are comparatively higher in terms of value as compared to agricultural commodities.

Although agricultural commodities constituted the largest portion of the total value of trade in initial years, their share has declined over time, partly due to factors like stringent regulations, higher margins, and open interest limits imposed on agriculture commodities, and the dampening of sentiments of market participants due to frequent suspension of trade in certain agricultural commodities (Bose, 2008). Before the national-level commodity exchanges came into existence, regional commodity exchanges were trading in agricultural commodities. Among the national-level commodity exchanges, NCDEX leads in trading of agricultural commodities. The turnover of futures trading in agricultural commodities as percentage of agricultural gross domestic product (GDP) (as shown in the Table 2) of the country increased substantially during the last decade.

(3) Efficiency in Futures Markets : The turnover of the commodity futures market has grown exponentially in a short span of time. The case for building up the commodity futures market internationally has been made out in view of its potential commitment to price stability, poverty reduction, and financial advancement in a business sector based economy, through different channels, some of which are discussed here. A futures commodity exchange gives a concentrated commercial center where market clients can find the price of commodity futures delivery and where risk averse individuals can move commodity price risk to others, who are willing to bear it (Schap & Dan, 2003).

Before the subtle elements of the empirical examination are exhibited, I attempt to clarify here the inspiration behind looking at trends in the commodity and futures indices. As said, the most critical part of commodity futures markets is to give price stability through hedging. The advantages of hedging stream from the relationship between the prices of commodities and those of futures contracts. In as much as these two arrangements of prices move in close harmony and present a parallel (or firmly parallel) relationship, misfortunes in the physical market sector are counterbalanced, either completely or significantly, by the increases in the futures market. Hedging along these lines performs the financial capacity of serving to decrease essentially, if not dispense, the losses radiating from the price risk in commodities.

Futures contracts can be great hedging instruments just when they are effectively valued. An efficient market is one in which price dependably completely reflects accessible data and where no merchants in the business sector can make a benefit with monopolistically controlled data. For proficiency of the futures market, it is the key that the current futures prices contain all accessible data to anticipate the future spot cost. When all is said and done, there are three types of testing business sector effectiveness: strong form in which the present data set incorporates everything important; semi-strong tests in which the clearly openly accessible data is considered; and weak form tests in which the present data set contains the chronicled value arrangement only. The improvement of cointegration hypothesis by Engle and Granger (1987) gave another procedure for testing market effectiveness. The hypothesis of cointegration identifies with the proficiency's investigation of a future market in the accompanying way: Let, S_t be the spot price at time t and F_{t-i} be futures price taken at i periods before the agreement develops at time t, where i is the quantity of times of premium. In the event that the futures price give a prescient sign to the spot value i periods ahead, then some linear combination of S_t and F_{t-i} is required to be stationary. In the event that S_t and F_{t-i} are not cointegrated, they will float separated without bound so that the futures price gives little data about the spot price. Since cointegration is an essential condition for maket proficiency, inefficiency can be concluded if the futures price and the spot costs are not cointegrated.

Then again, cointegration as such does not demonstrate where the new information is prepared and which market changes with the other. The price discovery capacity of the futures market sector relies on whether new data in the business sector is reflected first in the progressions in futures price or changes in spot price. In the event that the futures price is an information effective marker without bounds spot price, there ought to be a level of information flow between the spot and futures markets, showed through lead-lack connections between the two arrangements of prices. For the futures prices to be an unprejudiced indicator of resulting spot prices, the futures price ought to lead the spot price and not the other way around. On the off chance that premise advancements estimate futures returns, then the spot sector can be said to lead the futures market. In actuality, if basis developments precisely gauge spot returns, then this would infer that the spot business sector is an unadulterated satellite of the futures market. In the event that every arrangement of price is seen to anticipate the other, it is taken as proof of bi-directional causality, that is, a reasonable instance of data spilling out of every market to the other and prices being balanced as needs be.

With enhancements in econometric methods, these tests have been reached out in a few directions. These expansions incorporate considering a more drawn out slack structure of reliance between the futures and the spot returns by utilizing a Granger causality system. The ADF and PP unit root tests are used to examine the stationarity of spot and futures prices. These two methods have been adopted to assess the unit root test using parametric and non-parametric approaches. The Table 3 presents the results of unit root tests for selected agricultural commodities by both the approaches. ADF tests suggest that the null of a unit autoregressive root, that is, integration of order $I(1)$ could not be rejected for all the commodities, that is, all the commodities have a unit root.

In the wake of testing the precondition of non-stationary time arrangement of value data, the cointegration test was conducted to focus on the presence of a long-run relationship between the spot and future prices. The Table 4 presents the cointegration results from the use of Johansen's technique for decreased rank regression utilizing the vector error correction model. The Johansen λtrace (trace statistics) and λmax (maximal eigenvalue) investigation In the open commodity market, any initiative on futures market will have its desired impact on cash market for commodities with cointegration and uni-directional relationship, where futures prices lead spot market prices.

Table 3. Unit Root Test on Spot and Futures Prices of Selected Agricultural Commodities

Commodities	Augmented Dickey-Fuller(ADF)		Phillips-Perron (PP)	
	Level	Ist Difference	Level	Ist Difference
Wheat				
Spot Price	-2.07(0.559)	-16.64(0.000)	-1.93(0.636)	-26.02(0.000)
Future Price	-1.93(0.633)	-34.69(0.000)	-1.95(0.627)	-34.69(0.000)
Castor Seed				
Spot Price	-3.19(0.854)	-48.39(0.000)	-3.30(0.065)	-48.39(0.000)
Future Price	-2.53(0.309)	-45.27(0.000)	-2.42(0.365)	-43.05(0.000)
Jeera				
Spot Price	-2.62(0.269)	-20.24(0.000)	-2.72(0.232)	-45.97(0.000)
Future Price	-3.20(0.830)	-47.48(0.000)	-3.43(0.475)	-47.48(0.000)
Pepper				
Spot Price	-1.75(0.724)	-16.22(0.000)	-1.77(0.718)	-43.87(0.000)
Future Price	-0.56(0.879)	-45.93(0.000)	-2.08(0.554)	-46.01(0.000)
Chilly				
Spot Price	-2.50(0.325)	-26.07(0.000)	-2.32(0.163)	-35.34(0.000)
Future Price	-2.52(0.109)	-29.07(0.000)	--3.26(0.016)	-12.47(0.000)
Mustard				
Spot Price	-2.26(0.454)	-29.09(0.000)	-2.29(0.435)	-37.70(0.000)
Future Price	-2.85(0.178)	-48.08(0.000)	-2.964(0.142)	-48.08(0.000)
Soybean				
Spot Price	-2.16(0.508)	-27.73(0.000)	-2.61(0.274)	-41.58(0.000)
Future Price	-2.21(0.523)	-44.49(0.000)	-2.31(0.426)	-44.57(0.000)

Notes: Significant at: *0.005 and **0.10 levels; values in parentheses indicate MacKinnon-Haug-Michelis (1999) *p*-values.

demonstrates that null hypothesis of non-cointegration ($r = 0$) is rejected at the 0.05 level of significance for all the commodities. The null hypothesis of reduced rank, $r \leq 1$ cannot be dismissed by both the λtrace and λmax statistics for all the commodities for which null of $r = 0$ is rejected.

The presence of cointegration between the spot and future price affirms the first essential condition for long−term market efficiency.

(4) Causality in Futures Markets : Since cointegration tests indicate only the existence of long-run relationship among futures and spot prices, Granger causality tests are used to analyze the direction of relationship among price series. Granger causality results (Table 5) show uni-directional causality, where futures market prices lead to spot prices for wheat, castor seed, and jeera. This implies that futures market discovers prices for these commodities and spot market prices are influenced by the futures market prices. The commodities such as chilly, pepper, mustard, and soybean show bi-directional relationship between spot and futures market prices. The empirical findings suggest that there is a long-term relationship between futures and spot prices for all the agricultural commodities (wheat, castor seed, chilly, jeera, pepper, mustard, and soybean) covered in this study. This implies that futures markets have enough ability to predict subsequent spot prices, that is, to discover prices in spot market for these commodities.

Hence, it can be inferred that futures markets have stronger ability to predict subsequent spot prices for wheat, castor seed, and jeera as compared to chilly, pepper, mustard, and soybean where bi-directional relationships exist in the short run. The results of this study are quite useful to various stakeholders of agricultural commodities such as producers, traders, commission agents, commodity exchange participants, regulators, and policy makers.

Table 4. Johansen's Cointegration Test Statistics for Selected Agricultural Commodities

Commodities	Trace Statistics		Max-eigen statistics	
	λtrace	*p*-value	λmax	*p*-value
Wheat				
H0: *r* = 0	42.616	0.000	40.725	0.000
H0: *r* ≤ 1	1.890	0.16	1.890	0.169
Castor Seed				
H0: *r* = 0	42.772	0.000	40.021	0.000
H0: *r* ≤ 1	2.751	0.097	2.751	0.097
Jeera				
H0: *r* = 0	136.930	0.000	134.088	0.000
H0: *r* ≤ 1	2.842	0.2429	2.842	0.091
Pepper				
H0: *r* = 0	65.27	0.000	65.12	0.000
H0: *r* ≤ 1	0.144	0.703	0.144	0.70
Chilly				
H0: *r* = 0	113.420	0.0001	107.27	0.000
H0: *r* ≤ 1	6.19	0.013	0.0032	0.013
Mustard				
H0: *r* = 0	84.198	0.000	84.226	0.000
H0: *r* ≤ 1	1.363	0.23	1.39	0.23
Soybean				
H0: *r* = 0	85.623	0.000	84.226	0.000
H0: *r* ≤ 1	1.396	0.23	1.39	0.70

Notes: Significant at: *0.005 and **0.10 levels; values in parentheses indicate MacKinnon-Haug-Michelis (1999) *p*-values.

Table 5. Granger Causality Test Statistics for Selected Agricultural Commodities

Commodity	Hypothesis	F-statistics	Probability	Direction	Relationship
Wheat	F does not cause S	41.35	0	Unidirectional	
	S does Not Cause F	0.92	0.396		F → S
Castor seed	F does not cause S	35.44	0	Unidirectional	
	S does Not Cause F	2.35	0.095		F → S
Chilly	F does not cause S	20.88	0	Bidirectional	
	S does Not Cause F	35.14	0		F → S
Jeera	F does not cause S	201.75	0	Unidirectional	
	S does Not Cause F	2.433	0.08		F → S
Pepper	F does not cause S	301.28	0	Bidirectional	
	S does Not Cause F	6.64	0.001		F → S
Mustard	F does not cause S	95.14	0	Bidirectional	
	S does Not Cause F	4.48	0.011		F → S
Soyabean	F does not cause S	233.33	0	Bidirectional	
	S does Not Cause F	9.89	0		F → S

Note: S spot price; F futures price ; → shows direction

Conclusion and Policy Implications

In the era of globalization and liberalization, Indian agriculture is also responding accordingly to reap the benefits. After a prolonged prohibition and stringent regulations, futures trading in the country in almost all agricultural commodities has been allowed by the government under close supervision of the FMC, Ministry of Consumer Affairs, and Food and Public Distribution as per rules and regulation of the Forward Contracts (Regulation) Act, 1952. Within a very short time span of about 12 years, futures trading in agricultural commodities has become an important platform for various stakeholders in the commodity markets. In case of agricultural commodity markets, the government has been playing an important role in stabilizing the market to protect producers as well as consumers through minimum support prices, market assurance schemes, and public distribution systems. However, with declining government intervention in agricultural commodities market, the role of the futures market in price discovery and price management has become quite important.

The sustainability of the agricultural commodity futures market depends on the transparency and efficiency of its functioning in terms of price discovery, price risk management, flexible contact specification, controlling unfair speculation, commodity delivery system and coverage, infrastructural support, and so forth. This study empirically examines the efficiency of futures markets for seven major agricultural commodities widely traded on the commodity exchanges using Johansen's cointegration approach. Empirical results suggest the existence of long-run equilibrium relationships between futures and spot prices for all agricultural commodities that were considered for the study.

The findings in this study have some important implications for market participants and policy makers. The direction of relationship between futures and spot prices shows that in general, the direction of causality is stronger for futures prices to spot prices in case of three commodities namely wheat, castor seed, and jeera, suggesting futures prices tend to affect spot prices in the short run. In case of wheat, castor seed, and jeera, futures price discovery can play an important role in market decision making for stakeholders in these commodities. The relationship is strong in both directions for chilly, pepper, mustard, and soybean. Based on the analysis, it can be concluded that although futures markets play a greater role in the price discovery process, the price discovery in spot markets still exists for some of the commodities in the short run. Although there are several limitations in using cointegration and causality in analyzing efficiency in commodity futures markets, these techniques provide a useful understanding of the futures trading system in India.

Limitations of the Study and Scope for Further Research

The major limitation in using cointegration and causality tests is much to do with the nature of time-series data and meeting the non-stationary requirements. It has also been criticized that Granger causality does not imply a cause and effect relationship in the strict sense. Kellard et al. (1999) argued that a limitation of existing tests is the rigid classification of markets as either efficient or inefficient with no scope to assess the degree to which efficiency is present.

The results of this paper show a few inquiries that merit further research. Some of these issues relate specifically to the futures market instability while others don't. Along these lines, a top to bottom investigation is required at the international level between the developed and developing markets. Finally, several directions for future research could be investigated to improve the informational efficiency behaviour of the Indian agriculture commodity sector. Some ideas are given below :

- Mispricing and its relationship between futures market is another area for future research.
- The cointegration among futures price series and open interest may provide some basic idea on the hedging efficiency of futures markets.

➭ The volatility of spot market is to be taken as the variable to predict the movement of the futures market, and it may provide more clarity on the relationship between the spot and futures markets.

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Appendix 1. Data Description Used for the Study

S. NO	Commodities	Duration	Number of observation(days)	Place(spot/deliverymarket)
1	**Wheat**	May 21,2009-May 20, 2013	1155	Delhi
2	**Castor Seed**	December 21,2004-May 20,2013	2376	Disa
3	**Chilly**	February 21 2006-May 28, 2013	1896	Guntur
4	**Jeera**	February 21 2005-March 20, 2013	2413	Unjha
5	**Pepper**	December 21,2005-April 18,2013	2182	Kochi
6	**Mustard**	December 20,2004-April 18, 2013	2476	Jaipur
7	**Soyabean**	December 21 2005-March 20,2013	2143	Indore