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A Study of Market Efficiency and Volatility of Jeera Future Trading

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Abstract

In 2004, the Jeera futures contract was launched on the National Commodity & Derivatives Exchange Limited (NCDEX) platform. Since Jeera was launched on the NCDEX it has witnessed volatility, and in the last 10 years, the Jeera rates have doubled on the spot markets. This was due to a fall in production – especially in Gujarat. To examine the performance of the Jeera futures market and its efficiency, econometric models, specifically Johansen's Co-integration, the Vector Error Correction Model, the Impulse Response and the Variance Decomposition, are used on data from 2005 to 2019 from the NCDEX. The analysis revealed a long-term correlation between spot and futures prices, demonstrating that futures contracts are a viable hedging tool. Information flows unidirectionally from spot markets to future markets. Both markets undergo error correction to restore market equilibrium. The Granger causality test is utilised to assess the causal connection between future and spot prices. The augmented GARCH model was utilised to examine the contemporaneous relationship between spot volatility and unexpected futures trading activity, and the Granger Causality test was utilised to determine causality. The finding supports regulators', real hedgers', and other traders' concerns.

Keywords: Future trading; Market efficiency; Agri -commodities; Jeera;

Jel: G12; G14

1. Introduction

Since India is a commodity-based country, the amount of trading in this market, like other financial markets, has been gradually increasing. India holds a 7% geographical share of the global commodity derivatives market. On the other hand, price volatility is the primary issue that has piqued the interest of commercial traders/hedgers in participating in this market (Kapil & Kapil, 2021).

Price discovery and volatility spillover linked with spot and futures markets have been relevant since the beginning of the futures market. The process through which the market seeks to find an equilibrium price is known as price discovery. Price discovery entails the existence of an equilibrium price in a static sense. In a dynamic sense, the price

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discovery process defines how information is produced and communicated across the market. A key function of the commodities futures market is price discovery. Price discovery information is critical since these marketplaces are widely used by enterprises involved in the manufacturing, selling, and processing of commodities. Price discovery in the commodities futures market is typically thought to be more efficient than in the spot market.

Jeera, also known as Cuminum Cyminum, is a flowering plant in the Apiaceae family that grows to 15-50 cm tall. Jeera can be used in various ways, including perfumes and flavouring compounds in various cuisines. It is primarily harvested in February and seeded between October and November. Jeera has a maturation period of 110-115 days. Unjha in Gujarat, India, is the main commercial centre for Jeera. Rajasthan and Gujarat are the two states that produce Jeera most. India's top export destinations are the United States, the United Kingdom, Brazil, and Japan.

Jeera futures were listed on the NCDEX in February 2004 and have since experienced high volatility. Many factors influence the price of Jeera as a commodity in the market, such as the demand for Jeera seed from processors of spices in India and exporting countries. International prices often affect the price of Jeera along with carryover stock, government policies for import and export and weather conditions in Jeera-producing areas.

The above figure describes the production of Jeera based in different countries. India is considered the largest Jeera producer, followed by Syria and Iran. India produces 70% of the world's cumin and is the major exporter (30-35% of total production), cumin prices are soaring high. Hence the study of this commodity is important not only for India but for other importing countries too.

Figure 2 displays the price change of Jeera in the Unjha market. There was a sharp hike in Jeera prices from 2020 onwards. Jeera supply has been reported to expect high prices in the coming days. On the NCDEX, cumin January futures were trading above Rs 27,200. Cumin prices have reached all-time highs. Cumin's price jumped by 10% in a month. Cumin prices have risen by more than 50% this year. The current study investigates whether a contemporaneous and causative relationship exists between spot price volatility and unexpected futures trading activity in

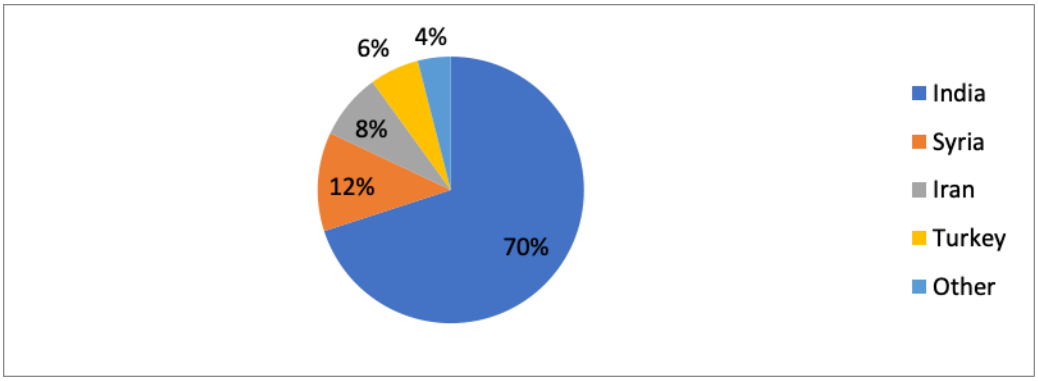

Figure 1. Percentages of Jeera production in the world
Source: adapted by Authors from www.agriwatch.com

Figure 2. adapted by Authors from Jeera future Historical data (2007-22)(Source: Investing.com)

the jeera market. If the contemporaneous relationship is positive and there is a causal impact from UTV to spot price volatility, it will show that excessive trading activity in the futures market can lead to increased spot price volatility in the jeera physical market. Unexpected futures trading activity refers to unusual levels of trading activity connected with potentially unstable speculative holdings.

2. Literature Review

In their paper, Sendhil et al. (2013) applied the GARCH model to measure the extent of volatility in spot prices due to futures trading. He selected a few commodities for the study, such as cumin, cotton seeds etc. They concluded that the futures market helps reduce price volatility, which is not required in all commodities. Soni (2013) aimed to study the market efficiency of the guar seed with the help of the GARCH M and error correction models. His study found that the futures market is inefficient and biased in both the long and short run in the case of the guar seed for all maturity periods, which may be caused by over-speculation. Vasantha and Mallikarjunappa (2015) examined the price discovery and lead-lag relationship among pepper's spot and futures markets. The models used in the study are co-integration, VECM and GARCH(1,1). The findings show that the spot market is more efficient than the futures market in price discovery.

Sharma (2016)] studied the impact of future trading on volatility for pepper and used the GARCH (1,1) Model to examine the relationship between spot volatility and unexpected traded volume. Biswas [6] studied the correlation between volume and price change in a few cases. He showed that Granger causality was present and supported SIH (Sequential information arrival hypothesis). Kumar (2015) examined the co-integration relationship between spot and futures prices of pepper. His Granger causality test confirmed the VECM on unidirectional causality flow from spot to futures prices of pepper. The Impulse response results indicated that spot returns have a greater response to shock in futures prices. Variance decomposition reflects the variations between spot and futures prices. Futures prices are much larger than spot prices.

Naik and Kumar (2001) examined the major commodity futures market with the help of the co-integration theory. He concluded that

the poor performance of the Indian futures market is due to the inadequate participation of hedgers in the futures market. Sharma and Malhotra (2015) examined the impact of future trading activity on the volatility of the guar seed spot market prices with the help of the GARCH model and causality test. The study found a positive and significant relationship between the futures trading volume, the spot returns volatility, and the causality from UTV to spot volatility. Ali and Gupta (2011) investigated the futures market efficiency in 12 agricultural commodities. He used the co-integration and causality tests to find the relationship between futures and spot prices for the selected commodities. Jain and Arora (2014) examined the volatility in commodity prices. The focus of their study, was on finding the relationship between futures and spot prices of pepper.

Chakraborty and Das's (2013) study indicated that unexpected trading volume causes volatility in the spot prices for a few commodities. They used the Granger Causality and GARCH (1,1) Models for the volatility of spot prices. Ahmad and Sehgal (2015) investigated the destabilization effect on the agricultural commodity market from January 2009 to May 2013. Ahuja (2006) found that the Indian commodity market had risen since 2003 with several commodity exchanges and future trading activities. Sayee (2014) investigated the proper functioning of the agricultural commodities futures market by using the Granger Causality and Error Correction Model.

Rout et al. (2021a) assessed the Indian agricultural commodity futures market in terms of price discovery, hedging efficiency, and volatility. They used the co-integration test, the Granger causation test, the vector error correction (VEC) model, ordinary least squares (OLS) regression, the exponential generalized autoregressive conditional heteroskedasticity (EGARCH) model, and the value-at-risk (VaR) model and found that the spot market is seen as leading the futures market and variations in the lead-lag connection exist between different commodities. Furthermore, they noted that both markets are subject to downside risk, and volatility is passed from the spot market to the futures market. They noted that the agricultural product futures market is inefficient at hedging risks. In another paper, Rout et al. (2021b) found that the spot market is leading the futures market, and variations in the lead-lag connection exist between different commodities.Bohmann(2019) suggested that rising speculation in commodity derivatives, rather than hedging action, is a primary factor of price discovery in the options markets. Mohanty(2020) revealed that Indian agricultural commodities futures markets remain inefficient in the short term, both before and after the merger Forward Market Commission (FMC) and Securities Exchange Board of India (SEBI). Manogna(2021) highlights the value of spot price forecasting for farmers and dealers by providing the best price movement predictions. and open the door to the development of pricing models that can aid in the fair regulation of agricultural commodity prices. Kaur(2021) confirms the absence of a causal relationship between NCDEX agricultural commodities and NSE FMCG index except barley, cottonseed, jeera, mustard seed and wheat.

Furthermore, both markets are subject to downside risk, and volatility is passed from the spot market to the futures market. It is discovered that the agricultural product futures market is inefficient at hedging risks.

Over time, the Indian agricultural commodity market became more efficient. To

acquire new insights from recent data, it is vital to revisit the price discovery process and previous related studies due to contradicting findings on the direction of causality. Most agricultural commodity studies in India have focused on price discovery and volatility. Very few studies have employed the combination of the aforementioned two Price discovery and volatility spillover approaches to analyse the relationship between futures and spot prices across NCDEX-traded oil seeds, key spices, and cereals.

The purpose of this research is to investigate (i) the long-term relationship between jeera spot and futures prices; and (ii) price discovery and causation in spot and futures markets in order to determine the leading market in terms of information transmission.. We checked the co-integration between spot and future price. VECM is applied for price discovery. Open interest GARCH(1,1) is applied to check if there is speculating activity. We have focussed on the volatility and the downside potential of select commodities in the agricultural commodity derivatives market. The expected and unexpected components of the futures trading activity series, namely futures trading volume and open interest, are dissected. The motivation for decomposition was derived from significant works in this sector by Bessembinder and Seguin (1992), Darrat and Rahman (2002), and Yang et al. (2005). The explanatory variables are the four series that come from decomposition: ETV, UTV, EOI, and unexpected open interest (UOI). Because volatility varies over time, spot returns volatility is modelled as a GARCH (1, 1) process. The remaining part of the paper is organised as follows. In the following section, we will review the substantial literature on commodities derivatives and other derivatives markets. Then we discuss the gap in existing research, followed by the research design and methodology used. We offer the study's findings, followed by a debate, and close with policy recommendations.

3. Research Methodology

The data employed for the study includes daily closing spot and futures prices of the Jeera from 2005 to 2019. The above data are collected from the NCDEX, which is a leading commodity exchange in India. A total of 2,541 observations have been examined for the study. The log of the daily closing spot and futures prices were used for the analysis. The first differences between spot and futures log prices are calculated to calculate price returns.

The series is non-stationary, with a mean and variance that change with time. Since time series data is non-stationary, these results cannot be precise. Consequently, the data is transformed into stationery. This was accomplished by calculating the difference between the spot and futures log return series.

The Augmented Dickey-Fuller (ADF) test has been used in the paper for changing data into stationary. The combination of two non-stationary series is stationary. Then they are said to be co-integrated.

Co-integration between spot and futures prices is given by:

$$F_t = \alpha + \beta S_t + u_t \quad (1)$$

Where F_t and S_t are the futures and spot prices at time t, β is the coefficient of co-integration, u_t is the equilibrium deviation.

If unit root tests confirm non-stationary of F_t and S_t, co-integration is tested on the two series at levels using Johansen and Juselius's (1990) method.

VAR (Vector Auto regression) model for the variables can be expressed as:

$$x_t = A_1 x_{t-1} + A_2 X_{t-2} + \cdots + + A_P X_{t-p} + AD_t + \varepsilon_t \quad (2)$$

Where D_t are deterministic elements like intercept, trend and seasonal dummy.

The above VAR model should be rearranged into the following VECM to apply the Johansen test for co-integration.

$$\Delta x_t = \prod x_{t-1} + \Gamma_1 \Delta x_{t-1} + + \Gamma_2 \Delta x_{t-2} + .. \Gamma_0 D_t + \varepsilon_t \quad (3)$$

With the help of the above equation(2), the following possibilities can emerge from the rank of $\prod$ vector

When Rank $\prod$=0, then no co-integration is found among variables.

When Rank $\prod$=2, it indicates that spot and futures prices are stationary.

When Rank $\prod$= 1, one co-integrating relation is found between the two series.

4. Results and Discussion

The figures below reflect the graphical display of daily spot and futures price trends. Figure 4 shows the graph for the spot and future prices when they are non-stationary. For further generalization and forecasting, the data should be stationary. So, we have to change the data into stationary by using the unit root test

Figure 3 shows that Jeera's data on future price and spot price is not stationary for the respective time period. So, we have to change the data to stationary by using the unit root test. The graph shows that data are not stationary.

The statistical features of the Jeera spot and futures return series are presented with the following statistics. For the mean, standard deviation, skewness, kurtosis and JarqueBera (J-B) are shown in Table 1. The average daily spot and futures prices are positive. The standard deviation is high for the future as compared to the spot. The spot and future series are not highly skewed. The kurtosis, which measures peaked, is higher than the normal value of 3 for both series, but the spot return series has higher kurtosis of 2.66, implying that the deviations are larger in the spot market. J-B test statistic used to test the normality has a probability of zero at a 5% significance level in both series, indicating that future and spot return series are not normally distributed.

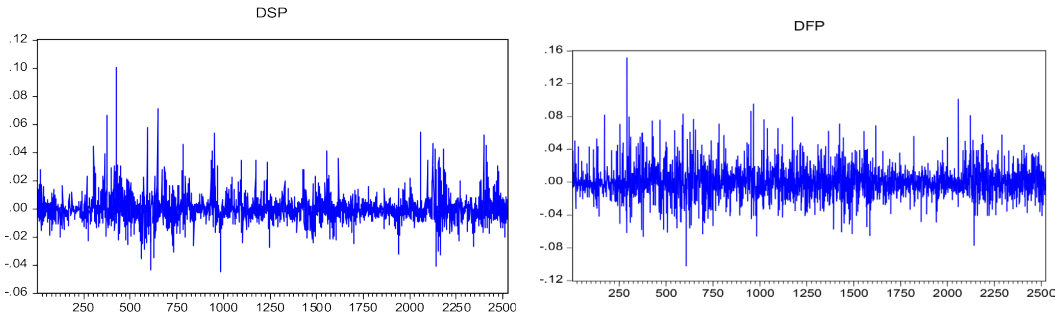

Figure 3. Spot and future prices after applying unit root test
Source: Authors' Compilation

Table 1. Descriptive Statistics for Jeera – Spot and Futures Daily Return Series

Series Name	Mean	SD	skewness	kurtosis	J-B
Spot	12656.29	3162.50	-0.38	2.59	79.60(0.00)
Future	12380.5	3129.85	-0.39	2.66	79.72(0.00)

Note: Figures in parentheses are the p-values at a 5% significance level

Source: Authors' Compilation

Table 2. Unit Root Test Results

S.no.	market	Tests		p-value	
		ADF	*1ST Difference*	*level*	*1st Difference*
1.	Spot	0.804	-23.49	0.886	0.0000
2.	future	0.373	-50.247	0.792	0.0000

Note: Null hypothesis of ADF is that the spot/futures return series has a unit root.

Source: Authors' Compilation * denotes significance at a 5% level.

Table 3. Results of Johansen's Test for Co-integration (Jeera Futures and Spot Price Series at Levels)

Lag Length Selected	Co-integration Test Using Trace at Levels				
	No. of Co-integrating Equations(CE)	Eigenvalue	Trace Statistics	Critical value at 5%	Prob.**
1-4 (in the first Difference of two series)	H0:r<0	0.229	971.3	ss	0.0001
	H1:r>0	0.114	303.39	3.84	0.087

Note: Trace test indicates 1 co-integrating equation at a 5% significance level.
The max-eigen test indicates one co-integrating equation at a 5% significance level.
*indicates rejection of the null hypothesis at a 5% significance level.

Source: Authors' Compilation

Before examining the long-term relationship between spot and futures prices, a unit root test is conducted (Table 2). The results indicate that both series are not stationary at levels, but their first differences are stationary.

The results are the same if the test is run with both intercept and trend. The condition for the co-integration test is satisfied, which sets the stage for testing the long-run relation between spot and futures prices.

Co-integration Test

In Johansen's procedure for a long-run testing relationship, the eigenvalues are arranged in descending order, and the rank of the co-integration matrix is analysed using trace and max, which are maximum-likelihood ratio-based statistics. The results have been reported in Table 3 and are based on the third Model used when there is a stochastic trend in the series. This implies that the Jeera spot and future prices have a stable long-run relationship, and convergence often occurs

on the contract's expiry. For futures markets to serve the purpose of hedging price risk, long-run co-movement is an important input.

The co-integration model is used to check whether there is a long-run relationship among the variables, i.e. spot and future prices of Jeera. There are 2523 observations having lag 4. The co-integration test results show that there are two integrated equations. Therefore, we can run the VECM Model.

The co-integration test findings are based on trace statistics, and table 3 displays the maximum eigenvalues test. The co-integration test is used to determine the long-term relationship between variables. For this latency, the number 4 is selected as having been completed sooner. We must determine whether or not there is a co-integration between variables. Here, the value of the t-statistics in all cases exceeds the crucial value; hence the null hypothesis is rejected.

In addition, at least one co-integrating equation must exist. Thus, it was demonstrated that the variables have a long-term association. Trace statistics indicate that all variables are co-integrated and identical to the case of the highest eigenvalue. Therefore, when variables are co-integrated, the VECM Model can be implemented.

Short-Run Dynamics – VECM and Granger Causality

We use the co-integration test to determine whether long- and short-run deviations exist. In the short run, there may be deviations, so adjusting those deviations is necessary. For these adjustments of deviations, the VECM Model is required. The VECM Model helps to analyze such temporary deviations. This also helps to find the long-run relationship between the two series. The VECM Model is necessary to analyze the responses of the variables. Lag selection is done before running the VECM Model. The number of future lags and spot prices required to run the Model are selected. For this study, lag 4 is selected to run the error correction model.

The lower the value, the better the Model. Therefore, the maximum number of times lag 4 is recommended. As per the three criteria, we should select lag 4, and we shall use this lag 4 to run the Johansen co-integration test and VECM Model.

Table 4. VAR Lag Order Selection Criteria

Lag	Log L	LR	FPE	AIC	SC	HQ
0	15053.31	NA	2.9E-08	-11.87	-11.87	-11.8731
1	15272.91	438.68	2.01 E-08	-12.04	-12.03	-12.399
2	15312.28	78.57	1.96 E-08	-12.07	-12.04	-12.0645
3	15340.9	57.09	1.92 E-08	-12.09	-12.0598*	-12.0805
4	1535.93	19.97	1.91 E-08*	-12.096*	-12.0555	-12.081948*

* 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

Source: Authors' Compilation

Table 5. Estimates of Vector Error Correction Model

CointEq1	D(DSP)	D(DFP)
S1	-0.050711	0.17764
	-0.02573	-0.01201
	[-1.97067]	[14.7964]
S2	-0.113975	0.013933
	-0.02768	-0.01291
	[-4.11774]	[1.07899]
S3	-0.041938	0.035894
	-0.02745	-0.01281
	[-1.52784]	[2.80288]
S4	-0.035049	0.001746
	-0.02648	-0.01235
	[-1.32369]	[0.14136]
F1	0.19538	-0.061839
	-0.05515	-0.02573
	[3.54285]	[-2.40351]
F2	0.kumar5722	0.069557
	-0.05499	-0.02566
	[3.01346]	[2.71104]
F3	0.099859	0.055537
	-0.0543	-0.02534
	[1.83890]	[2.19208]
F4	-0.022534	0.03738
	-0.04994	-0.0233
	[-0.45122]	[1.60433]

*standard error () and t-stats []

Source: Authors' Compilation

After identifying a co-integrated equation between spot and future prices, a VECM model is estimated. Table 5 above indicates that the error correction is significant, which shows that the Model is in an equilibrium state. The coefficient of error correction terms is negative, and the series moves downward to the equilibrium. This since the error correction term in the future equation is greater than the spot equation. It shows that

Table 6. Wald test results

Test stats	value	probability
F-stats	0.371	0.6897
Chi-square	0.743	0.6896

Source: Authors' Compilation

Table 7. Granger Causality Test Result.

Null hypothesis	F-statistics	Prob**
Spot ⟶ Future	5.63	0.0002
Future ⟶ Spot	58.13	0.0008

* indicates rejection of the null hypothesis of no causality at a 5% significance level

Source: Authors' Compilation

the spot price reacts rapidly, leads to price discovery, and implies a unidirectional causal relationship between the spot and futures market. Therefore, spot prices lead to future prices. Manogna (2020) also found spot leads the future prices in Jeera.

Whether future prices cause spot prices or not, the Wald test is examined, and the results are shown in Table 6. We know that if the p-value is less than 0.05%, we accept the null hypothesis. The probability value in Jeera spot is 68.96, which is more than 5%, confirming short-run causality between Jeera's future and spot price.

In comparison, Rout (2021a) and Rout (2021b) found bidirectional causality.

Impulse Response

To investigate the coefficients of the VECM Model, the impulse response function and variance decomposition are utilised to demonstrate the influence of changes in the value of one variable on another. These methods are utilised to determine the impact of the shock on variables. Spot returns suggest a stronger reaction to future shocks that lasts a few days before settling down. Thus, the response of futures to a shock in spot returns is small.

Variance Decomposition

The Jeera spot and futures returns using the Variance Decomposition Model were used to determine how much variation in both spot and futures returns exists and to determine whether spot returns vary due to their shock against futures returns or vice versa. Table 8 shows the percentage variation in Jeera futures returns. In spot returns, this is shown as 0.84% to 0.85% of the variations. On the other hand, spot returns are explained by the futures returns, and the variation is 40.67% to 47.02%. We can say that the spot price leads Jeera's futures trading.

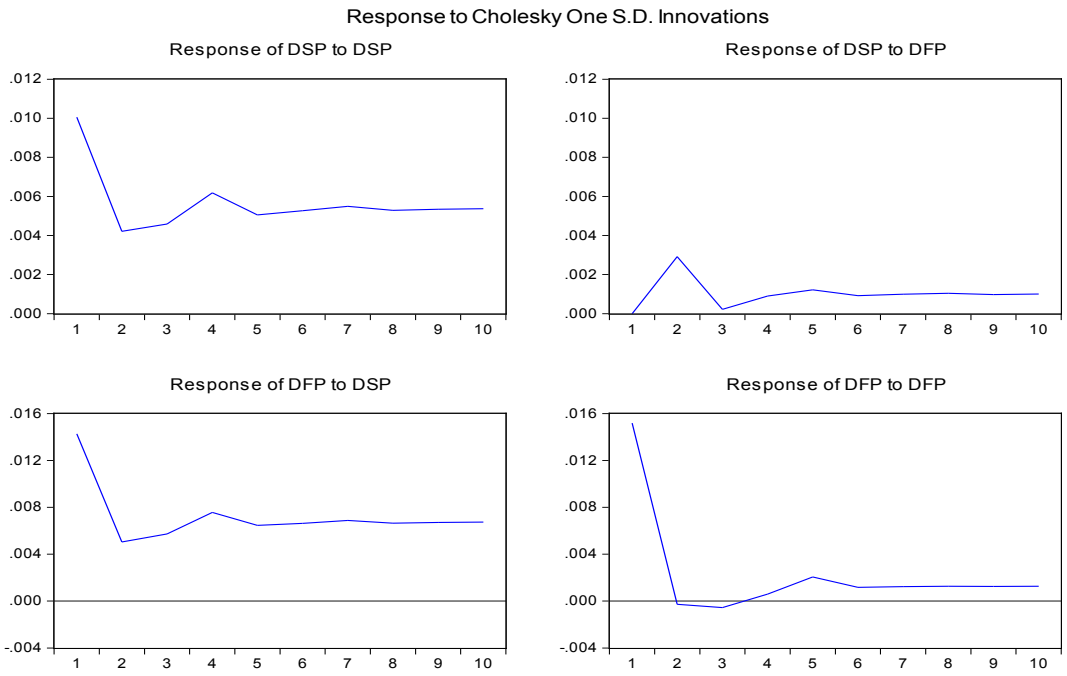

Figure 8. Impulse response function of Jeera
Source: Authors' Compilation

Table 8. Variance Decomposition of Jeera spot and futures return series

Period	Future return explained by	
	Spot returns (%)	Futures returns (%)
1	100	0
2	98.15602	1.843982
3	96.37828	3.621717
4	94.79635	5.20365
5	93.45377	6.546228
6	91.15516	8.844841
7	90.565	9.435
8	89.64119	10.35881
9	88.67646	11.32354
10	87.7523	12.2477
Period	Spot return explained by	
	Spot returns (%)	Futures returns (%)
1	44.58689	55.41311
2	53.35085	46.64915

Period	Future return explained by	
	Spot returns (%)	Futures returns (%)
3	53.10613	46.89387
4	54.28575	45.71425
5	54.20663	45.79337
6	53.97357	46.02643
7	55.13406	44.86594
8	55.5776	44.4224
9	55.95328	44.04672
10	56.24712	43.75288

Table 9. GARCH Estimation Results

	ARCH term	GARCH term	ETV	UTV	OI	UOI
Jeera	0.130815 (0.00)	0.9027 (0.00)	0.0004 (0.0272)	0.000864 (0.000)	0.000267 (0.48)	0.0010 (0.083)

Source: Authors' Compilation

Table 9 shows the detailed analysis in ARCH and GARCH terms, ETV (Expected Traded Volume), UTV (Unexpected Traded Volume), OI (Open Interest) and UOI (Unexpected Open Interest) for Jeera. The ARCH term, Garch term, ETV, and UTV are significant in the case of Jeera. The probability values are less than 0.05, reflecting that it is negative and significant in explaining the spot price volatility. A positive relationship has been found in spot returns volatility and unexpected Traded volume for Jeera. However, open Interest and unexpected Open Interest are not significant in explaining the spot price of the Jeera. The impact of trading volume in terms of expected and unexpected components shows that an unexpected or abrupt increase in futures trading volume increases spot volatility, making traders' spot and futures market positions undesirable and bringing instability. Uninformed speculators may introduce noise into the market, which is communicated to the spot market via arbitrage and generates heightened price volatility. Kumar (2015) and Ahmad et al. (2015) conducted studies on Indian commodity futures markets and found similar results.

However, similar to the results of the GARCH model, where UOI is not significant in explaining spot volatility, UOI has no causal impact on cash price volatility. Kumar (2015) found that UOI had little effect on spot price volatility for the castor seed, the guar seed, zinc, and natural gas futures.

5. Conclusions

The Jeera futures contract was introduced on the NCDEX in February 2004. This helps farmers, exporters, and merchants meet their hedging requirements. In addition, this enables them to assist spot market participants with pricing decisions. As export demand grows, exporters purchase insurance against price fluctuations. Due to the contract's extremely liquid character, speculators can easily enter or exit the market. Using econometric models like Johansen's Co-integration, Granger

Causality, VECM, Impulse Response, and Variance Decomposition, the current study examines the efficiency and price discovery of the Jeera futures market. Beginning with the introduction of Jeera futures trading contracts in 2006 and extending through 2019, the timeframe covered by the study extends through 2019. The study observed long-term co-movement between the spot and futures prices using the aforementioned methods.In the short run spot price is leading in jeera. The hedgers can use this information to manage their risk. A two-way flow of information has been seen between the futures and spot markets in the long run.

Both markets undergo error correction to restore market equilibrium. A Granger causality result suggests that the variables have a causal link. Long-term causation is discovered between the spot price and the future price. In the long run, the spot price is dominant. The contemporaneous relationship between futures trading volume and spot return volatility is positive and substantial, as well as causative from UTV to spot volatility. Indicative of speculative activity. A fast increase in the volume of futures trading increases the volatility of physical market prices and is destabilising. However, as reflected by open interest, hedger activity has a little direct effect on the volatility of current prices. The findings validate the participants in the Jeera value chain's apprehension that they are unable to maximise the risk management benefits of futures contracts. The policy makers need to make policy to curb speculation and price rigging in jeera future market.

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