# Market Efficiency in Indian Turmeric Futures Trading Markets

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**Abstract**

Tremendous fluctuations have been seen in the prices of agricultural commodities, including turmeric in recent years. Turmeric is branded as curcuma longa in the family Zingiberaceae. India leads in turmeric production as it produces approximately eighty to eighty-five percent of the total world production. The data for the study has been analyzed from the year 2004 to 2020, which are collected from the website NCDEX. An attempt has been made in this paper to examine the finding of price regarding turmeric in the futures market. Econometrics models, viz., Granger Causality, Johansen's Co-Integration, and Vector Error Correction Model (VECM) are applied to analyze. The result shows that there is cointegration between turmeric predictions and spot prices. The co-integration result reveals a long-term connection between the current spot price of turmeric and its future price. Moreover, the flow of information from the futures market to the spot market is unidirectional. Error correction terms for both future & spot price series are significant in the long term. Hedgers can definitely use this information for managing risk associated with price in predicting price and managing their risk.

**Keywords:** agriculture commodity, Co-Integration test, Granger causality, spot price, future price, turmeric

## 1. Introduction

In India, the commodity futures market has been in presence to meet price risk management, improve market productivity, cutting-edge technology, a wide variety of contracts, increase user awareness and participation, and a tight regulatory framework toward the commodity market by traders have created a compelling need to transform commodity futures markets into highly sophisticated markets. Price risk management and Price discovery are the twin operations that are used to assess the effectiveness of the futures market. Price discovery is a method that provides aid in determining the accurate price of an item in a market when there is a big

number of buyers and sellers engaging with one another. Hedgers and speculators offer the futures market with the much-needed liquidity and information value, which makes it easier for prices to be found in the futures market.

According to the NCDEX study, the scientific name for turmeric is curcuma longa. This plant, which is a member of the zingiberaceae family and prefers red soil, can be grown in temperatures ranging from 20 to 30 degrees. Besides its medicinal and culinary use, turmeric is also widely utilized in cosmetics. India is responsible for the production of the majority of the nation's, and it provides anywhere from eighty to eighty-five percent of the population of the globe. The country's yearly production of scales between 6.0 lakh MT to 7.0 lakh MT. India is also recognized as the world's greatest exporter. Pakistan, China, Haiti, Peru, Taiwan, and Thailand are other big producers. The majority of the turmeric that is produced in Asia is consumed inside the continent itself. Indian turmeric is regarded to be of good quality and is increasingly being recognized for its medical and aesthetic uses because of its high curcumin concentration. Tamil Nadu, Andhra Pradesh, Orissa, Karnataka, Maharashtra & West Bengal are leading turmeric-producing states in India. Figure 1 depict the turmeric export year of year as shown in below.

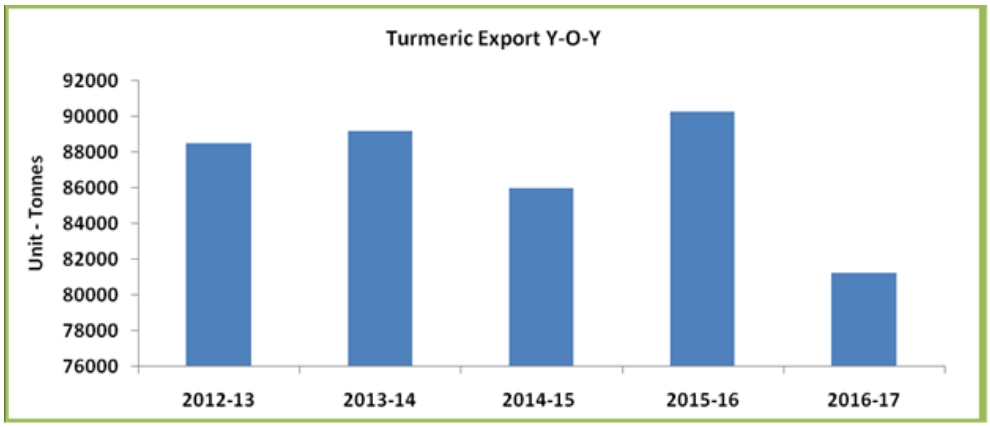


**Figure1. Turmeric Export Y-O-Y. Source (www.agriwatch.com)**

Figure 1 shows turmeric export quantity year on year basis. Export demand reported well 2015-16 compared to the previous year 2014 -15 due to good quality supply. Turmeric export in the current year, April to November is higher by 21059 MT than in the corresponding period last year as a result of hybrid quality demand (Agriwatch report, 2014).

Turmeric is commonly used as a culinary additive in dried, powdered form, providing taste and colour to foods. In certain regions of India, turmeric leaves are also used to wrap and prepare food. Turmeric futures trading contract was established on NCDEX in April 2004 and has since attracted a large number of supply chain players. Producers can reduce their price risk by using a futures platform. Exporters can protect themselves against price danger by increasing the score of export demand. Turmeric stocks that are in high demand provide attractive arbitrage possibilities for many market participants. Contract speculators may readily join and exit the market since it is very liquid. As a consequence of this, the

turmeric contract accommodates all possible categories of investment.

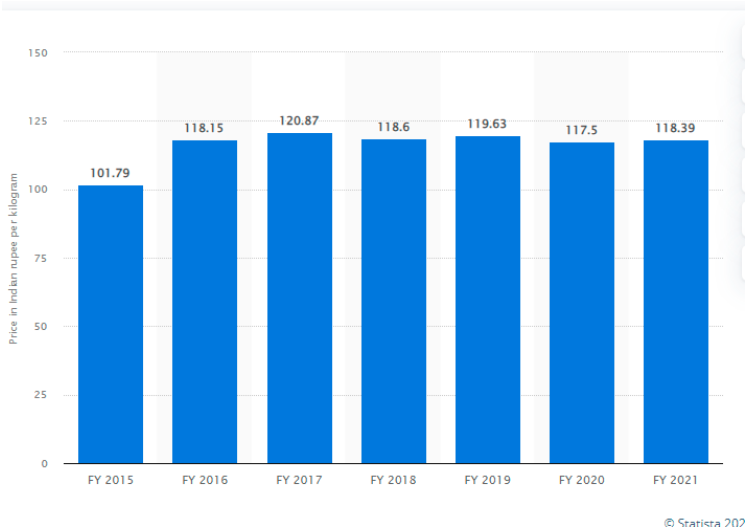


**Figure2. Turmeric Prices Seasonal Trend (Nizamabad Mandi) Turmeric Average price/Chennai, India FY 2015 to 2021 (Rs. Per KG). Source: Statista Research department**

As per Figure 2, in 2016-17 December months, Turmeric prices reported slightly up in the major indicative market. However, compared to prices in 2018, prices reported a downtrend. The present paper attempts to study the (i) long-term relationship between turmeric future and spot prices; and (ii) price discovery and causality in spot and futures markets to identify the leading market in terms of information transmission.

## 2. Literature Review

In the Nifty futures markets, Pradhan and Bhat (2009) investigated, information, along with forecasting and discovery of price. The VECM of Johansen (1988) is used to explore the causal relationship between future and spot prices. In his study, the analysis is done based on three useful forecasting techniques, viz. VAR, VECM & (Auto-Regressive Integrated Moving Average) ARIMA models, to anticipate futures prices on spot prices. The findings of Johansen's VECM indicate that the spot market outperforms the future market. On a post-sample basis, the VECM findings outperform VAR in the univariate ARIMA model. The outcomes demonstrate the significance of the study.

Chandra and Pradhan (2009) analyzed the lead-lag relationship as well as the price discovery mechanism between the NSE, Standard & Poor's Nifty spot index, and its futures index as an underlying asset. Nifty is an index that measures prices of equities traded on the National Stock Exchange. In order to study the short-term and long-term factors that are at work in costs between spot markets and futures markets, it employs the VECM, the Johansen-Julius cointegration test, variance decomposition, and impulse response functions. The outcomes suggest that spot prices and futures prices have a long-term link. VECM demonstrates that, in the near term, there is unidirectional causation from futures to spot markets. The investigation also found

evidence of unidirectional Granger causality between the spot market and the futures market.

Srinivasan and Deo (2009) used the VECM and Johansen's Cointegration test to investigate the long-term equilibrium between the mini gold spot markets and futures markets, where they used closing data daily for both indexes. In the long run, cointegration and casual relationships were found between both markets. According to the results, in the long run, unidirectional causation goes from spot markets to futures markets, and the results also show that the spot market plays the most important role in terms of price formation.

Antonios (2009) conducted research in Spain utilising the VECM to examine the possible causal link between the growth of the stock market and the credit market. In order to investigate the nature of the long-term connection that exists between these variables, the Johansen cointegration method will be used in this study. The trend in Spain was found to be from productivity to stock market development. So, we can conclude that the stock market development dose has an impact on credit market development and productivity.

Mallikarjunappa and Afsal (2010) found that the top twelve individual stocks did not have any significant peak or lagging influence in either the futures or spot markets. This was the case for both types of market. Despite the belief that with its cost and benefits regarding hedging the futures market normally lead the spot market, in the case of the Indian futures market scenario, it could not furnish initial information to the spot market.

Maran and Kok (2009) attempted to re-examine the dynamic interface between Malaysia and Asian Tigers. VECM with a five-variable, Johansen multivariate cointegration test, and the Granger causality test is utilized to fix correlation and lead-lag. According to the data, there is a connection between the five markets that exists over a longer period of time, with Hong Kong and Taiwan looking to be the most significant in the region.

Wang (2011) looked at Hong Kong Exchange & SGX FT Stock Exchange Xinhua China A50 index futures markets for empirical data on futures pricing. He wanted to see if any link between the underlying stock indexes and index futures prices could be explained by the cost of carry model. According to the findings, using stock market volatility in pricing models appears to be useful in projecting prices for these two index futures.

Li (2011) conducted research to determine the connection between the price of crude oil, unleaded petrol, and heating oil futures and the exchange rate for the United States on the New York Mercantile Exchange (MEX) as well as the trade-weighted rate of exchange for the United States. His findings were published in the journal Energy Economics. In addition, the causal linkages between the prices of energy futures are investigated. There is no relationship between the US dollar and energy prices, as shown by Granger causality tests and impulse response functions.

Dogru (2012) investigates the relationship between US Dollar (USD) futures contract closing prices and trading volume on the Turkish Derivatives Exchange (TURKDEX). While there is no short-run relationship between prices and volume, the findings show that there is a long-term relationship between volume and pricing. As a result, according to

the efficient market theory, the Turkish futures market is inefficient.

Khan(2014) examined the degree and the direction of flow in copper. They emphasized necessity to conduct research on a specific commodity and whether the relationship between the spot and future prices of a commodity like Silver, which is used both industrially and domestically, and Copper (an industry metal), which is used only for industrial purposes, are similar in the same Indian commodity market, such as MCX.

Pandey (2014) researched the spot, futures, and options markets with the purpose of determining the price discovery and volatility spillover of the Indian NIFTY 50 index. The volatility spillover was investigated using a bivariate EGARCH model. It was his observation that the spot market was preeminent in the process of price discovery, while the options market, the spot market, and the futures market were preeminent in the transmission of information through volatility spillover.

According to Singh (2015) examined that the introduction of commodity futures contracts has led to a substantial rise in the price of commodities, especially agricultural commodities. The futures contract has a destabilising impact; however, this effect is intermittent in character and has a tendency to vary over an extended period of time. The empirical data shows that the futures market is superior than others in disseminating information.

Kawamoto (2011) analyzed that cointegration analysis is employed to examine the efficiency and fairness of the market for WTI futures contracts of varying maturities, while the error correction model and the GARCH-M-ECM are used to examine the efficiency of the market across shorter time frames. WTI futures are continuously efficient and impartial between an 8-month maturity and steadily effective and impartial within a 2-month maturity, as per the findings.

A Granger causality test (a), a VECM (b), a cointegration test (d), and an Error Correction model with TGARCH faults (e) were the four empirical methods used by Floros(2011) in their analysis of price discovery in South Africa's spot and futures markets between 2002 and 2006. The JSE/ FTSE top forty stock index spot and futures markets are cointegrated, as per the empirical findings. Furthermore, the results of Granger causality, VECM, and ECM-TGARCH(1,1) imply that futures and spot prices have bidirectional causation.

For stakeholders, like farmers and traders, Singh and Singh (2015) found that for hedging mechanism chana futures are of use. Malhotra (2015) used the minimum variance hedge ratio, Vector Error Correction and Ordinary least squares to evaluate the hedging efficiency of the oilseed markets & Indian oil and, it was found that refined palm oil and crude palm oil along with soya oil are effective for hedging., while on the other hand poor hedging effectiveness was found in Mentha oil and mustard seeds. When a comparision is made between a hedged portfolio and the unhedged portfolio Chander and Arora (2017) state that strong hedging efficacy is observed in a hedged portfolio comparatively because of reduced variation of the same. Gupta, Choudhury, and Agarwal (2017) found that traders in the futures markets utilised futures contracts for speculation more frequently than for hedging, as shown by the speculating ratio. The greater

hedging efficacy might be explained by a decreased number of speculative actions in agricultural commodities futures. When metal commodities are compared to futures, in spite of minimal speculation, a reduction in the efficiency of hedging is observed in castor seeds. The responsible factor could be the Essential Commodities Act. The study also found that near-month contracts outperform next-to-near-month contracts for agricultural commodities futures in terms of hedging efficacy, albeit in the case of non-agriculture commodity future.

## 3. Methodology

For turmeric, the daily closing futures price and the spot price for the period from 2004 to 2020 were collected from NCDEX. Time series data were exposed to the following analysis to have the efficiency of the futures market in turmeric and the prevailing relationship among the variables. A total of 1920 observations have been examined and analysis is done with the help of daily closing prices of future and spot series. An Efficient market hypothesis is created on the presumption of continuous and voluminous trading; therefore, in comparison to the contracts for the intermediate and far-off months, the values of the near-month futures contract are analyzed since they have a substantial amount of liquidity. Time-series data is non-stationary with time-varying mean and variance. When the analysis is done on such data, it yields false results. We can neither generalize the data nor can we use it for forecasting purposes. The first step in making the data series stationary is to determine the difference between the future log returns series and the spot log returns series. The first differences in price returns are tested for stationarity through Phillips Perron test and the Augmented Dickey-Fuller Test.

Cointegration is defined as the relationship between spot prices and futures prices which is follow as:

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

Where $F_t$ and $S_t$ refer to the futures and spot prices at time t. $\beta$ is the coefficient of cointegration and $U_t$ indicates the deviation in equilibrium.

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

The VAR model for the variables can be expressed as:

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

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

The above VAR model must be rearranged into the following VECM to apply the Johansen test for cointegration.

$$\Delta x_t = \Pi x_{t-1} + \Pi_1 x_{t-1} + \Pi_2 x_{t-2} + .. \Pi_0 D_t + \varepsilon_t \quad (3)$$

With the help of equation (3) the following possibilities emerge from the rank of the $\pi$ vector.

When Rank $\Pi = 0$, then no cointegration is found among variables.

When Rank $\Pi = 2$, it indicates spot and future prices are stationary.

When Rank $\Pi = 1$, one cointegrating relation is found between the two series.

## 4. Results and Analysis

The descriptive statistics, i.e., skewness, kurtosis Jarque Bera mean, standard deviation, are reported in Table 1 to explain the statistical features of the return series. The average daily returns of both spots and futures are positive and similar. The percentage standard deviation is higher for spot returns than futures return, showing relatively lower volatility in the future markets. Future and spot return series are not highly skewed. The kurtosis which measures peak is higher than the normal value of 3 for both series, but the spot return series has higher kurtosis of 40.4, indicating that the deviations are larger in the spot market.

**Table1. Statistical Features of the return series.**

| Series Name | Mean | Standard Deviation | Skewness | Kurtosis |
|---|---|---|---|---|
| Spot | 0 .0006 | 0 .022 | 2 .25 | 40 .42 |
| Future | 0 .0005 | 0 .036 | -0 .31 | 18 .14 |

Unit root test is conducted to examine the long-term relationship between future and spot prices, (Tables 2 and 3). The results denoted that stationarity is present at first differences, but at levels, both series are non-stationary.

**Table 2. Unit Root Test Results-Augmented Dickey Fuller (ADF) test**

| S.No. | Market | Tests | | p-value | |
|---|---|---|---|---|---|
| | | ADF | 1ST Difference | level | 1st difference |
| 1. | Spot | -0.7241 | -11.89326 | 0.3435 | 0.0000* |
| 2. | Future | 0.60952 | -36.48947 | 0.4538 | 0.0000* |

**Table3. Unit Root Test Results-Phillips Perron (PP)**

| S.No. | Market | Tests | | p-value | |
|---|---|---|---|---|---|
| | | ADF | 1st difference | Level | 1st difference |
| 1. | Spot | -1.710099 | -31.72157 | 0.4250 | 0.0000 |
| 2. | Future | -1.818148 | -36.54848 | 0.3715 | 0.0000 |

As per table3, the result is same when the test was run with intercept and trend. A cointegration test is conducted for testing the long-run relation between future and spot

prices. The result reflects non-stationarity at levels, but stationarity is found at first difference.

Figure 3 shows that the data is not stationary for the given time period. So, it has changed into stationary by using the unit root test. The graph depicts that data are not stationary at level, but after the first difference, it became stationary.

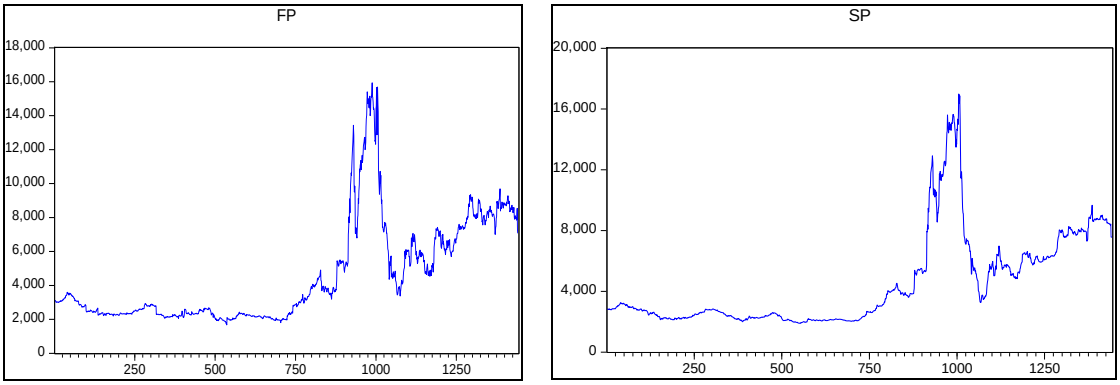


**Figure 3: Spot and future prices of turmeric before applying the unit root test**

Figure 4 represents the stationarity of future and spot and spot price. The series are stationary and can be used to run econometric models.

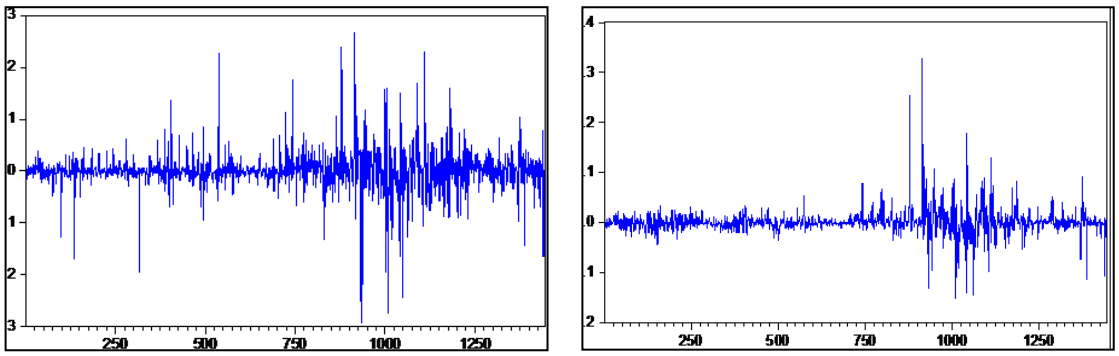


**Figure 4: Spot and future prices of turmeric after applying the unit root test**

### 4.1 Cointegration Test

Johansen cointegration test is established on the maximum estimation with a VAR model. The Cointegration model is used to i.e., future and spot prices of turmeric to check whether there is a long-run relationship among the variables. There are 1438 observations having lag 5. The outcomes of the cointegration test depict that there are two integrated equations, so we can run the VECM model. Table 4 indicate the results of Johnsen's test for cointegration trace statistics as shown below.

**Table4. Results of Johansen's Test for Cointegration Trace Statistics**

| No. of co-integrating equation | Eigen Value | Trace Statistics | Critical Value | Probability** |
|---|---|---|---|---|
| None * | 0.040199 | 53.95547 | 15.49471 | 0 |
| At most 1 | 0.002656 | 3.284832 | 3.841466 | 0.0699 |

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

In Table 4, the cointegration results are denoted on trace statistics and eigen values to maximum are denoted. The outcomes of the cointegration test are placed on trace statistics and the maximum eigen values test. We conducted the Cointegration test to determine if any cointegration is present among variables. For this lag 5 as per Akaike Information Criterion (AIC) criteria. Here the null hypothesis is rejected as the critical value is less than the t-stats value. Hence, it proved that there is at least one cointegrating vector among series. The VECM model can be applied when variables are cointegrated.

### 4.2 Long and short- run Dynamics – VECM and Granger Causality

The VECM Model is used in order to look into the deviations in the long run-in order to determine whether or not there are deviations in both the long run and the short run. We also use the WALD test to evaluate causality in the near term. In order to examine the effects of the variables, the VECM model is required. The lag selection is completed before the VECM Model is executed. We have selected lag 5 to run the VECM for this analysis.

**Table 5. Selection criteria VAR Lag order**

| Lag | Log L | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | 6335.803 | NA | 5.13e-07 | -8.50 | -8.80* | -8.80 |
| 1 | 6378.85 | 85.95 | 4.83e-07 | -8.83 | -8.83 | -8.83 |
| 2 | 6384.033 | 10.34 | 4.83e-07 | -8.85 | -8.83 | -8.83 |
| 3 | 6398.635 | 29.74 | 4.75e-07 | -8.84 | -8.83 | -8.85 |
| 4 | 6412.05 | 26.74 | 4.74e-07 | -8.83 | -8.86 | -8.85* |
| 5 | 6418.35 | 12".35* | 4.65e-07* | -8.82* | -8.85 | -8.86 |

* Indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

HQ: Hannan-Quinn information criterion

AIC: Akaike information criterion

SC: Schwarz information criterion

The test result of cointegration can be obtained with the help of trace statistics and maximum eigen values. We have to find whether cointegration among variables exists or not. For this, lag 5 is selected based on the results described in Table 5. The model is better at the lower value. Therefore, the maximum number of times lag 5 is recommended, which means three criteria are asking for lag 5. So, lag 5 is taken to run the model. This lag is used to run the Johansen cointegration test and VECM.

In the long term, error correction terms are significant for both, and futures price series as mentioned in Table 6. Bidirectional causality, in the long run, is found among future and spot price. This implies that in the case of turmeric, both spot and futures market respond to restore the equilibrium whenever there is some inconsistency.

**Table 6. Vector Error Correction Results**

| Commodity | | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|---|
| **Turmeric** | C:1 | - 0.110154 | 0 .047684 | - 2.309615 | 0 .0211 |
| | C:2 | - 0.518695 | 0 .045475 | - 11.40705 | 0 .0000 |
| | C:3 | - 0.322245 | 0 .036504 | - 8.828225 | 0 .0000 |
| | C:4 | - 0.039817 | 0 .039866 | - 0.998775 | 0 .3181 |
| | C:5 | - 0.009922 | 0 .026997 | - 0.367500 | 0 .7133 |
| | C:6 | 1.34E-06 | 0 .000828 | 0 .001618 | 0 .9988 |

As can be seen from Table 6, Error correction term is negative and significant in future and spot price series for turmeric. The coefficient values are negative, and the probability values are less than 5%, indicating that the error correction is significant and includes long-run causality running among the spot and future price series for turmeric. It was discovered that there was a connection between future pricing and spot prices over the long period.

We have used the wald test to measure whether there is short-run causality or not. From Table 7, it is clear that spot and future prices of turmeric have a short-run relationship and the future price is leading.

**Table 7. Wald Test Result**

| Commodity | Dependent variable | T-stats | Value | Probability | Causality |
|---|---|---|---|---|---|
| Turmeric | Spot | F-stats | 0.645 | 0.5253 | No Causality in short run flowing from spot to future |
| | | Chi-square | 1.288 | 0.5298 | |
| | Future | F-stats | 46.106 | 0.0000 | Causality in the short run flowing from future to spot |
| | | Chi-square | 92.213 | 0.0000 | |

It is necessary to do the Granger Causality test in order to get an understanding of the connection that exists between future trading actions and the volatility of current prices. The Granger Causality test is used to investigate the dynamic connection that exists between the spot price volatility and the amount of trading activity in the futures market. When we take a look at Table 8, we are certain that the spot price and the future price of turmeric have a causal impact on each other and, as a result, have bidirectional causality. This is because the pricing of both goods is influenced by the other. At a level of significance equal to or greater than 5%, the null hypothesis is shown to be incorrect. Hence, we found that spot price and future prices doesn't granger cause each other.

**Table 8. Granger Causality Test Result**

| Null hypothesis | F-statistics | Prob** |
|---|---|---|
| DSP does not Granger DFP | 5.52076 | 0.0044 |
| DFP does not granger DSP | 3.88923 | 0.0205 |
| * Indicates rejection of the null hypothesis of no causality at a 5% significance level | | |

## 5. Conclusions

Turmeric future contracts were introduced on NCDEX in April 2004, which helps producers to minimize their price risk. The future platforms fulfill the needs of traders, farmers, and exporters and have witnessed ample participation from different supply chain participants. The speculators have the liberty to enter and exit the market at their convenience because of the high liquid nature of contracts. In the present study, an attempt has been made to empirically assess the turmeric futures markets with respect to their price discovery and efficiency. The models used in the study are some econometrics models, viz., Johansen's Cointegration, Granger Causality, VECM. The result shows that turmeric futures and spot prices are cointegrated. The outcome of the cointegration analysis reveals the long-term association between the current price of turmeric and its future price. In the short term, a one-way flow of information from futures markets to spot markets has been seen. This flow of information occurs in the short run. Error correction terms for both spot and future price series are significant in the long term. This information can be utilized by hedgers for managing price risk in predicting price and managing their risk.

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