Price Discovery and Co-Integration Analysis Between Spot and Futures Prices of Refined Soy Oil in NCDEX

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***Abstract*—Price discovery is one of the important economic functions of Commodity futures market as it provides competitive future price from which spot market can be derived. The study attempts to examine the evidence of price discovery and co-integration analysis in refined soyoil futures and spot market. The tests were conducted by using econometric tools like Augmented Dickey Fuller (ADF) test and Phillips-Perron(PP)test, Co-integration test and Trend analysis. The ADF test and PP test shows that there is a unit root or Stationarity at first order difference not at level. The Johansen co – integration test shows that soyoil futures and spot prices are co-integrated and there exists 1 co – integration equation between the soyoil futures and spot price series. We can conclude that, soyoil futures price movement can be used as price discovery vehicle for spot market transactions. This study can be further validated by comparing the results of Indian future soyoil prices with international futures soyoil prices.**

***Index Terms*—Futures market, Spot market, Price Discovery, Co-integration**

I. INTRODUCTION

A problem of agricultural markets in NCDEX has been price instability which has a negative impact on economic growth, income distribution, and on the poverty. The uncertainty of commodity prices leaves a farmer open to the risk of receiving a price lower than the expected price for his farm produce. Globally, futures contracts have occupied a very important place to cope this price risk. Futures contracts are originally developed as new financial instrument for price discovery and risk transfer. Changing economic environment, increasing commodity uses through value addition at different stages, increasing number of market participants, changing demand and supply position of agricultural commodities and growing international competition requires wider roles for futures markets in the agricultural economy.

Futures trading perform two important functions of price discovery and risk management with reference to the given commodity. It is useful to all segments of the economy. It is useful to producer because he can get an idea of the price likely to prevail at a future point of time and therefore can decide between various competing commodities, the best suits him. Farmers can derive benefit from futures markets by participating directly/indirectly in the market to hedge their price risks and to take benefit of prices exchanges by taking rational and well-informed cropping/marketing decisions physical markets for price risk management. It also for the various market functionaries. Hence, providing a vital tool to the policymakers and planners in designing their pricing policies and investment plans for efficient allocation of infrastructure.

II. NATIONAL COMMODITY AND DERIVATIVES EXCHANGE (NCDEX)

National Commodity & Derivatives Exchange Limited (NCDEX) is an Indian online commodity and derivative exchange based in India. It has an independent board of directors and provides a commodity exchange platform for market participants to trade in commodity derivatives. It is an online technology-driven trading exchange. It is a private limited company, its original shareholders were National Stock Exchange of India (NSE), National Bank for Agriculture and Rural Development (NABARD), CRISIL (now known as S&P India), Life Insurance Corporation (LIC) ICICI Bank. Current shareholders include IFFCO, Jaypee Capital Services, Punjab National Bank, Canara Bank, Build India Capital Advisors, Shree Renuka sugars and Star Agri

warehousing.
NCDEX was incorporated on 23 April 2003 under the Companies Act, 1956 and obtained its Certificate for Commencement of Business on 9 May 2003. It commenced operations on 15 December 2003. The exchange transition is deemed recognized stock exchange under the Security Contracts (Regulation) Act, 1956, on September 28, 2015, regulated by SEBI. As of 31 July 2013, NCDEX has 848 registered members, a client base of about 20 Lakhs, and offers trading on more than 49,000 terminals across 1,000 centersin India. It facilitates deliveries of commodities through a network of over 594 accredited warehouses through eight warehouse service providers, with holding capacity of around 1.5 million tonnes and average deliveries of1 lakh MT at every contract expiry. NCDEX has offices in Mumbai, Delhi, Ahmedabad, Indore, Hyderabad, Jaipur, and Kolkata.

III. REVIEW OF LITERATURE

1. Shekhawat (2018) “Price Discovery and Co-Integration Analysis between Spot and Futures Prices of Refined Soy Oil in India”.

In this article, the author examined the co-integration between spot and futures prices of agricultural commodities, specifically refined soy oil, the data obtained from National Commodity and Derivative Exchange (NCDEX). The methods used in this paper includes, Augmented Dickey-Fuller (ADF) unit root test, Johansen‘s co-integration test and Vector Error Correction Mechanism (VECM) model. The limitation in the research manuscript is focused only on NCDEX.

2. Shakeel.M and Purankar S (2014) “Price discovery mechanism of spot and futures market in India: A case of selected agri-commodities”

The work in this paper focusing on price discovery relationship for 3 of thetop traded agricultural commodities on NCDEX specifically Soya bean,Castor Seed and Channa. The techniques used for analysis are Augmented Dickey Fuller test, Johansen co-integration test and Vector Error Correction Mechanism (VECM). Here the author has suggested that both the spot and future markets of the selected respective agricultural commodity plays the leading role through price discovery process in India and said to be informationally efficient and reacts more quickly to each other.

3. Mohit Garg, Shelly Singhal, Kiran Sood, Ramona Rupeika-Apoga, R and SimonGrima(2023)“Pricediscoverymechanism andvolatilityspillover between national agriculture market and national commodity and derivatives exchange:”

In this article, the author studied on investigates the price discovery mechanism, lead-lag relationship, and volatility spillover between spot prices on the National Agriculture Market (E-NAM) and futures and spot prices on the National Commodity and Derivative Exchange (NCDEX) in the Indian agricultural commodity market.The methods are the Johansen Cointegration, Vector Error Correction (VEC), Granger causality tests, and bivariate GARCH models were applied. The author discovered the long-run relationship using the Johansen Cointegration test and concluded that the NCDEX spot and futures market is dominant in the price discovery mechanism, and the NCDEX futures and spot markets lead the E-NAM spot prices having a unidirectional or bidirectional relationship. Furthermore, the bivariate GARCH model suggested a volatility spillover from E-NAM spot prices to NCDEX futures and spot markets for most commodities, except for bajra, barley, and jeera, which have no volatility spillover.

4. Ravi,Sunitha,andPKGupta(2012)“Impact of commodity futures on spot prices using selected agricultural commodities in India”

The author study attempted to examine the interrelationship between spot and future prices in Indian Commodity Market using selected agricultural commodities namely_ chana‘ ,_gaurseed‘ and refined soyoil. The results indicates that agricultural prices in India have gone up after the introduction of futures trading. The study examines the daily price and co-integration relationships and price discover between spot and future markets. The data is obtained from the NCDEX. The author not used any models for analysis.

5. Irani Sarveshwar Kumar(2018)“Price discovery and efficiency of Indian agricultural commodity futures market: an empirical investigation”

The author examined the price discovery process and relative efficiency often most liquid agricultural commodities‘ futures contracts, traded on the largest agricultural commodity exchange of India (National Commodity and Derivative Exchange Limited).He used the methodologies like the component share method (Gonzalo and Granger in J Bus Econ Stat 13:27–35, 1995), information share method (Hasbrouck in J Financ 50:1175–1199, 1995), and modified information share method (Lien and Shrestha in J Futures Mark 29:377–395, 2009)—have been employed to determine the extent of price discovery contribution by spot and futures markets. The price discovery results show that the futures market leads the spot market in case of six commodities, i.e., castor seed, coriander, cottonseed oilcake, soy oil, sugar and turmeric. The author concluded that spot and futures prices are integrated and co-integrated for all commodities.

6. Siddavatam, Ravi Prakash and S. Appa Rao (2022) "Price risk management of turmeric commodity futures (NCDEX) and spot Market" The author has been analyze the price risk management of spot and futures market of agricultural commodity, specifically the Turmeric commodity. The objective of the paper is, The Price discovery and price risk management.

Here, the author has been analyze the 6years of spot and futures prices by using techniques like Unit Root test, Johansen Co-integration test, Granger Causality test, VECM, Wald test, Variance Decomposition test and Impulse Response Graphs by using Eviews software version 10. The author has concluded that both market prices are well integrated and have relation in short and long terms.

IV. NEED FOR THE STUDY

The refined soy oil market in India is a dynamic and significant segment of the agricultural commodity landscape, impacting various stakeholders from farmers and processors to consumers and investors. The National Commodity & Derivatives Exchange (NCDEX) serves as a vital platform for futures trading in this commodity, offering mechanisms for price risk management and potential price discovery. A thorough investigation into the relationship between spot and futures prices of refined soy oil on NCDEX is not merely an academic exercise but addresses several pressing needs like Enhancing Market Efficiency and Transparency, Improving Risk Management and Hedging Strategies, Informing Investment Decisions and Speculative Activities etc.

V. OBJECTIVES OF THE STUDY

The objective of the study, as indicated to analyze the price discovery and co- integration between spot and futures prices of refined soy oil on NCDEX.

Main objective of the study:

1. To identify the unit root test between refined soyoil spot price and future price.
2. To identify the co-integration between refined soyoil spot price and future price.

METHODOLOGY:

The study is based on secondary data. Secondary Data comprises of monthly average Soyoil futures prices from January 2022 to March 2022 and monthly closing spot prices of Soyoil fromJanuary2022 to March 2022. These time series data are obtained from National Commodity and Derivatives Exchange (Commodity Insight Year Book). The study uses econometric tools like Augmented Dickey Fuller (ADF) test and Phillips-Perron (PP) test to check stationary of data, Co- integration test to examine the long run relationship between futures and spot prices of Soyoil by using EViews software. Trend analysis is used to find the positive trend and negative trend of futures prices and spot prices of soyoil, which helps to take a decision whether we have to enter futures contracts or not.

SCOPE OF THE STUDY:

Thestudyfocusesspecificallyonrefinedsoyoil.Itwouldnotincludeotheredible oils or agricultural commodities unless explicitly stated as comparative elements.

1. Markets Covered: The research will analyze prices in two specific markets:
   - Spot market: This refers to the physical market where refined soyoil is bought and sold for immediate delivery.
   - Futures market: This specifically refers to the futures contracts for refined soyoil traded on the National Commodity & Derivatives Exchange (NCDEX) in India.
2. Geographical Focus: The study is confined to the Indian market, given the specific mention of NCDEX.

3. Time Period: The scope will define the specific duration for which historical data on spot and futures prices of refined soyoil will be collected and analyzed. This could be, for example, "daily data from January 2010 to December 2024," or a similar defined period, which is crucial for time-series analysis like cointegration.

4. Key Concepts/Variables Examined:

➢ Price Discovery: This involves investigating which market (spot or futures) leads in incorporating new information into prices. The study will aim to determine if futures prices influence spot prices or vice-versa, or if there's a bidirectional relationship.

➢ Co-integration: This refers to the long-run equilibrium relationship between the spot and futures prices. The study will assess whether these two price series move together in the long run, even if they deviate in the short run.

➢ Other related concepts might include:
- Causality
- Volatility spillover
- Market efficiency

5. Methodology: The study will likely employ specific econometric techniques suitable for time-series analysis and price discovery/cointegration.

6. Data Type: The study will primarily use secondary data, specifically spot and futures price data for refined soyoil.

In essence, the scope clarifies what the study will cover, setting clear boundaries to ensure a focused and achievable research objective. It helps to avoid ambiguity and ensures the research remains within manageable limits.

LIMITATIONOFTHE STUDY:

a) Limited to Refined Soy Oil: The findings might not be generalizable to other commodities traded on NCDEX or other exchanges, as each commodity has unique supply-demand dynamics, storage costs, and market participants.
b) NCDEX Specific: The results are confined to the National Commodity & Derivatives Exchange (NCDEX), an Indian commodity exchange. The market structure, regulatory environment, and participant behavior on NCDEX might differ significantly from other international or even domestic exchanges, limiting the external validity.
c) Time Period: The study would be based on a specific historical time period. Market dynamics (e.g., liquidity, volatility, regulatory changes) evolve, so conclusions drawn from past data might not hold true for future periods. Unusual events during the study period (e.g., policy changes, extreme weather, global economic crises) could skew the results.
d) Data Frequency: The frequency of the data (e.g., daily, weekly, monthly) used in the analysis can impact the results. Higher frequency data might reveal short-term dynamics not captured by lower frequency data, and vice-versa

VI. DATA ANALYSIS AND INTERPRITATION

Data analysis is described as the process of bringing order, structure, and meaning‖ to the collected data. The data analysis aims to unearth patterns or regularities by observing, exploring, organizing, transforming, and modeling the collected data.

It is a systematic approach to applying statistical techniques for describing, exhibiting, and evaluating the data. It helps drive meaningful insights, form conclusions, and support the decision-making process. This process of converting data, ordering, and summarizing it also gets answers to questions to test if the hypothesis holds. Exploratory data analysis is a huge part of data analysis. It is to understand and discover the relationships between the variables in the data.

Data interpretation is the process of assigning meaning to the processed and analyzed data. It enables us to make informed and meaningful conclusions, implications, infer the significance between the relationships of variables and explain the patterns in the data.

Explaining numerical data points and categorical data points would require different methods; hence, the different nature of data demands different data interpretation techniques.

YEAR	MONTH	SPOT PRICE	FUTURES PRICE
2022	JANUARY	1203.9	1210.51
2022	FEBRUARY	1263.9	1270.29
2022	MARCH	1553.22	1557.77

BASICSTATISTICAL ANALYSIS

STATIONARITY TEST:

Augmented Dickey Fuller Test (ADF) is a test for a unit root in a time series sample. It is an augmented version of the Dickey Fuller Test for a larger and more complicated set of time series models. The augmented Dickey–Fuller (ADF) statistic, used in the test, is a negative number. The more negative it is, the stronger the rejection of the hypothesis that there is a unit root at some level of confidence.

The test consists the following regression equation:

m

ΔRt=β1+β2t+ρRt-1ΣαiΔRt-1 1

i=1

Where ΔR is the first differenceof Rt,β1 is the intercept, β2,ρ arethe coefficients, t is the time or trend variable, m is the number of lagged terms chosen to ensure that t is white noise i.e. t contains no autocorrelation and is the pure white noise error term, and m

ΣαiΔRt-1isthesumofthelaggedvalues

ofthedependentvariableΔR

i=1

Phillips-Perron (PP) test is a unit root test. It is used in time series analysisto test the null hypothesis that is time series is integrated of order 1. It builds on the Dickey Fuller test of the null hypothesis ρ=0

Δyt=Yt-1+ut

WhereΔisthefirstdifferenceoperator,Yt-1isendogenousvariable,ytisa higher order of auto correlation.

JOHANSEN CO-INTEGRATION:

If two or more series are individually integrated(in the time series sense) but some linear combination of them has a lower order of integration then the series are said to be co integrated. Co integration of two price series is a necessary condition for market efficiency, since the Efficient Market Hypothesis implies that the future price is an unbiased predictor of the future spot price. If the two series are co integrated, St and Ft-1 move together and will not trend to drift apart over time. If this is the case, then the futures price is an unbiased predictor of the spot price.

VII. RESULTS AND DISCUSSIONS

STATIONARITYTEST

H0:“Soyoil price series are not stationary”

H1: “Soyoil price series are stationary”

Table.1 Results of Augmented Dickey Fuller Test and Philip– Perron Tests
Spot Price at Level

	Spot At Level	
Unit Root Test	ADF Test Statistics	PP Test Statistics
CalculatedValue	-2.876048	-2.821265
5% value	-2.909206	-2.909206
P Value	0.8134	0.7698
Conclusion	Non– Stationary	

The above table shows the results of Augmented Dickey Fuller (ADF) test and Phillips-Perron (PP) tests. They are done to check the Stationarity of the data series. This test is basic to use the financial models like Co-integration test in the above we have identified that the calculated value of the ADF and PP test statistic is more than the critical values at 5% level and also the p value is more than 0.05 at level. Therefore the data series can be taken to be non-stationary. The time series data is non- stationary at level. From the result is found that soyoil spot prices are integrated of order I (1) series. So the research hypothesis is rejected and the necessary condition for testing co- integration is not satisfied.

TABLE :2
Results of augmented dickey fuller test and Philip - Perron Tests
Spot price at 1st difference

	Spot at 1stDifferences	
UnitRootTest	ADF Test Statistics	PP Test Statistics
CalculatedValue	-2.821265	-2.071256
5% value	-2.910019	-2.910019
P Value	0.0000*	0.0000*
Conclusion	Stationary	

The above table shows the results of Augmented Dickey Fuller (ADF) test and Phillips-Perron (PP) tests. They are done to check the Stationarity of the data series. This test is basic to use the financial models like Co-integration test. In the above we have identified that the calculated value of the ADF and PP test statistic is more than the critical value at 5% level and also the p value is less than 0.05 in 1st differencing. Therefore the data series can be taken to be stationary. The time series data is stationary at first difference and notat level. From the result is found that Soy oil spot prices are integrated of order I(1) series. So the research hypothesis is accepted and the necessary condition for testing co- integration is satisfied.

Table :3 Results of augmented dickey fuller test and Philip- Perron Tests
Futures Price at Level

	Futures At Level	
UnitRootTest	ADFTest Statistics	PPTestStatistics
CalculatedValue	-2.881398	-2.881398
5% value	-2.909206	-2.909206
P value	0.8129	0.7708
Conclusion	Non – Stationary	

The above table shows the results of Augmented Dickey Fuller (ADF) test and Phillips-Perron (PP) tests. They are done to check the Stationarity of the data series. This test is basic to use the financial models like Co-integration test. In the above we have identified that the calculated value of the ADF and PP test statistic is more than the critical value at 5% level and also the p value is more than 0.05in at level. Therefore the data series can be taken to be non-stationary. The time series data is non- stationary at level. From the result is found that soyoil futures prices are integrated of order I (1) series. So the research hypothesis is rejected and the necessary condition for testing co- integration is not- satisfied.

Table :4 Results of Augmented Dickey Fuller Test and Philip- Perron Tests
Futuresprice 1st Difference

UnitRootTest	ADF TestStatistics	PPTestStatistics
CalculatedValue	-2.832597	-2.832597
5% value	-2.910019	-2.910019
P value	0.0000*	0.0000*
Conclusion	Stationary	

The above table shows the results of Augmented Dickey Fuller (ADF) test and Phillips-Perron (PP) tests. They are done to check the Stationarity of the data series. This test is basic to use the financial models like Co-integration test. In the above we have identified that the calculated value of the ADF and PP test statistic is more than the critical value at 5% level and also the p value is less than 0.05 in 1st differencing. Therefore, the data series can be taken to be stationary. The time series data is stationary at first difference and not at level. From the result is found that soy oil futures prices are integrated of order I (1) series. So the research hypothesis is accepted and the necessary condition for testing co- integration is satisfied.

VIII. CO-INTEGRATIONTEST

H_0: "There is no co-integration between soy oil futures prices and soy oil spot prices"

H_1:"There is co-integration between soy oil futures prices and Soyoil spot prices"

TABLE:5
RESULTSOFJOHANSENCO –INTEGRATION TEST

Hypothesized No. Of CEs	Eigen Value	Trace Statistic	Critical Value 5% level	Ma Eige n Statistic	Critical Value 5% level	Pvalue**
None*	0.31891	24,284	15.494	28.04	14.264	0.0016
Atmost1	0.01964	1.1902	3.8414	1.19	3.8414	0.2758

Note: Trace test indicates 1 cointegrating eqn(s) at the 0.05 level, Max-eigenvaluetestindicates1cointegratingeqn(s)atthe0.05level,

*denotesrejectionofthehypothesisatthe0.05 level,
**MacKinnon-Haug-Michelis(1999)p-values

In order to test for co- integration between spot and futures, the Johansen (1988) co-integration method is followed. In the above table, by using trace statistic and maximum Eigen value statistic, we have identified that there exists one co – integration equation between the futures and spot Soyoil price. The result of trace Test as shown in table 2 revealed that trace statistic value of 24.28 was greater than 15.49, the critical value at 5 percent level. The maximum Eigen statistic value of 28.04, which is greater than the critical value of 14.26 at 5 percent level of significance and P value is 0.0016 which is less than 5% level of significance, indicating rejection of the hypothesis and signifying at least one co integrating equation at 5% level of significance. So research hypothesis is accepted.

IX. FINDINGS, SUGGESTIONS AND CONCLUSION

FINDINGS

MAJOR FINDINGS

1. By using econometric model like unit root test we got to know there is a stationarity between spot and future prices based on P value (i.e., less than 0.05).
2. The Johnsen co-integration test concluded that there is relationship between spot and future prices based on the P value.

GENERAL FINDINGS

1. PRESENCEOFCO-INTEGRATION

The study finds that spot and futures prices of refined soyoil in NCDEX are co-integrated. This means that despite short-term fluctuations, the two price series move together in the long run and maintain a stable, equilibrium relationship. This is a fundamental finding, indicating that the markets are integrated and arbitrage opportunities are limited in the long run.

2. PRICE DISCOVERY

A very common finding in commodity markets, including refined soy oil on NCDEX, is that the futures market plays a dominant role in price discovery. This implies that new information relevant to the supply and demand of refined soy oil is often reflected first in the futures prices, which then transmit to the spot market. While futures markets often lead, some studies might find evidence of bidirectional causality between spot and futures prices. This suggests that both markets contribute to price discovery, with information flowing in both directions, though one direction might be stronger

3. SPOT MARKET IN FLUENCE

It's less common for the spot market to consistently dominate price discovery in these analyses, though it can still play a role, especially for commodities with strong physical market influences or specific contract maturities (e.g., near expiry).

4. RELATIVE SPEED OF ADUSTENT

The coefficient of the error correction term indicates the speed at which each market adjusts to correct disequilibrium. Often, the market found to be dominant in price discovery (e.g., futures) will also show a faster adjustment to correct deviations.

5. MARKET EFFICIENCY AND UNBIASEDNESS

Many papers conclude that the refined soy oil futures market on NCDEX is efficient in the long run and that futures prices are unbiased predictorsof future spot prices (after accounting for a risk premium, if any). This means that, over a longer horizon, futures prices accurately reflect available information and don't systematically over or under-predict spot prices.

6. VOLATILITY SPILLOVER

Some research also examines volatility spillover, finding that volatility in one market (e.g., futures) can influence the volatility in the other (spot), and vice versa. This further highlights the interconnectedness of the two markets.

SUGGESTIONS

1. Enhancing methodology and data analysis
2. Need to improve the government policies and regulations in the context of export and import
3. Need to encourage the researchers to do study on spot and futures markets
4. Evaluate the market efficiency test
5. Need to investigate volatility spillover.

X. CONCLUSION

The study attempts to examine the evidence of price discovery and co-integration analysis in refined soyoil futures and spot market. The tests were conducted by using econometric tools like Augmented Dickey Fuller (ADF) test and Phillips- Perron(PP)test,Co-integrationtestandTrendanalysis.TheADFtestandPPtest shows that there is a unit root or Stationarity at first order difference not at level. The Johansen co – integration test shows that soyoil futures and spot prices are co-integrated and there exists 1 co – integration equation between the soyoil futures and spot price series. The Trend analysis explains the positive trend and negative trend of Soyoil futures prices and spot prices. In case of positive trend the farmers can get more profits in futures market by retaining their commodity until the expiry of the futures contracts. In case of negative trend they can sell their commodity in the spot market to get more profit than futures market. Overall we can conclude that, soyoil futures price movement can be used as price discovery vehicle for spot market transactions. This study can be further validated by comparing the results of Indian future soyoil prices with international futures soyoil prices.