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ANALYSIS OF LONG-RUN COINTEGRATION RELATIONSHIP BETWEEN COPPER SPOT AND FUTURE MARKET IN INDIA

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ABSTRACT

The study investigates the long-run relationship between the spot and the future price of copper in the Indian commodity market. The data was collected for 10years from Multi Commodity Exchange. Factors contributing to determining the relationship between the spot and future price of copper are ADF Test, Cointegration test, and Granger Causality test. The result revealed that there is a causality relationship between Spot and the future price of copper. The relationship is bidirectional.

Keywords: Granger Causality Test, Copper, ADF Test, KPSS, Johansen and Juselius Cointegration.

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INTRODUCTION

One of the oldest metals, which was used 10,000years back for the manufacturing of Coins and Ornaments is Copper. It is an excellent conductor of electricity that is a ductile, corrosion-resistant, malleable, and metallic element. In addition to this, it is antimicrobial and extremely recyclable. Alloyed with other metals, it can exhibit additional characteristics like hardness, tensile strength and high corrosion resistance. The multi properties of this metal make it one of the world useful resources.

Copper finds its application in electrical and electronic products, building construction, industrial machinery and equipment, transportation equipment, consumer and general product. Copper's versatile property make it a material to use in high technology application. It is used in air conditioning system and as an anti-germ surface in hospitals because copper is biostatic.

The production of copper cathodes decreased compared to FY 2019-2020 to FY 2020-2021. Whereas the export of copper increased likewise the import of copper cathodes decreased (Gopinath & Poornapriya, 2020). China is the top exporter of copper cathode for India. Hindustan Copper Limited (HCL) in the public sector, Sterlite Industries (Vedantagroup) and Hindalco Industries in the private sector are the three major players who dominate the copper industry in India currently (Kavitha & Gopinath, 2020).

Table 1 Fundamental and Balance Sheet of Copper

Indian Scenario in MTs	2019-2020	2020-2021	2021-2022* (Till Apr 2021)
Production	4,08,398.00	3,63,638.00	33,934.00
Import	8,96,502.00	7,44,650.67	76,309.00
Export	1,41,033.86	2,09,444.21	19539
Consumption	11,63,866.00	8,98,845.46	90,704.00

Source: www.mcxindia.org

The major factor influencer of the copper market

- Like all other metals, copper price is affected by Spot market, freight rate, USD –INR rate and custom duties.
- Major economic reforms might affect the material flow.
- Company merging, restructuring, renovation and Shutdown related to commodity will affect the copper flow.
- Trade policies like the implementation of a new slab of taxes as they strictly restrict or encourage the material flow within or between the countries.

REVIEW OF LITERATURE

Tanushree Sharma (2015) attempts to investigate the relationship between the spot and future price of Channa, Soyabean, Soya oil, Guargam, Potato and Pepper of NCDEX in India.To examine the lead-lag relationship between the variables Vector error correction model and Johansen Cointegration model are employed. The result reveals that there is strong Cointegration between the selected commodities and there is no correlation between guar gum and potato spot and future price. Finally, the evidence shows that future leads to spot in case of soybean and soy oil, whereas Channa and pepper found to be bidirectional.

Kailash Chandra Pradhan, Sham Bhatt (2009) attempts to study price discovery, Causality and Forecasting in the Nifty future markets. To investigate the causal relationship between spot and futures prices Johansen, auto regressive integrated moving average, Vector autoregression and vector error correction model is employed. The result concludes that the spot market leads the future market and it is the primary source for price discovery.

Sanjay Sehgal, Namita Rajput, Florent -Delisting (2013) examines the price discovery and volatility spillover for Indian Commodity Markets. Twelve actively traded commodities from all sectors are selected for the study. A long-run relationship of 8 commodities is confirmed by the Johansen Cointegration procedure. The result of E Garch confirm the bivariate volatility spillover for Soybean, Zinc and Natural Gas with stronger spillover from spot to future

METHODOLOGY AND DATA

All the required information for the study has been retrieved from the Multicommodity exchange (MCX) website. The primary data for the analysis is the daily closing price of future and spot of copper. The dataset for the study is comprised of from 1st April 2011 to 31st March 2021.

Granger Causality test is employed to analyze the causal relationship between the spot and future prices. The following steps are followed to estimate the Granger Causality model.

Step 1: The closing price of copper is collected from mcxindia.org., then the spot and future price of copper price is computed.

Step 2: Then the stationarity of the collected data is tested by the Unit root test. The Augmented Dickey-Fuller test is one of the tools in the Unit root test. The equation for ADF test is p

$$\Delta y_t = \beta_0 + \beta y_{t-1} + \sum_{i=1} \phi_i \Delta y_{t-1} + e_t \qquad (1)$$

Where t is the time series in the time period, Δ is the first differential operator, p is the optimum number of lags and e is the white noise error.

Step 3: Once the variables are stationary, then they should be cointegrated. The Johansen and Juselius Cointegration test are used to study the long-run equilibrium relationship between the variables.

$$J_{trace} = -T \sum_{i=r+1}^{n} \ln(1 - \hat{\tau}_i) \qquad (2)$$

$$J_{max} = -T \ln (1 - \hat{\tau}_{r+1}) \qquad (3)$$

Step 4: After studying the long-run relationship, the Granger Causality test is employed to study the causal relationship between the variables (Pavithran et al., 2018). This states that, whether the spot price of variables significantly contributes to forecasting the future price, then the future price is said to granger cause spot price and vice versa.

$$y_t = \beta_0 + \sum_{i=1}^{i=p} \beta_i y_{t-1} + \sum_{i=1}^{i=p} \theta_i Z_{t-i} + e_t \qquad (4)$$

Where the null is $\sum_{\iota=1}^{p} \Theta_i$ and if that is rejected that implies Z_t granger causes y_t

OBJECTIVES OF THE STUDY

1. To examine the stationarity of spot and future price return of copper in the Indian commodity market
2. To determine the cointegration relationship between the spot and future price of copper.
3. To examine the cause-and-effect relationship between the spot and future price return of copper in the Indian Commodity market.

EMPIRICAL RESULTS AND DISCUSSIONS

The first step of the study is to test the stationarity of the spot and future price of copper by using the augmented dickey-fuller test.

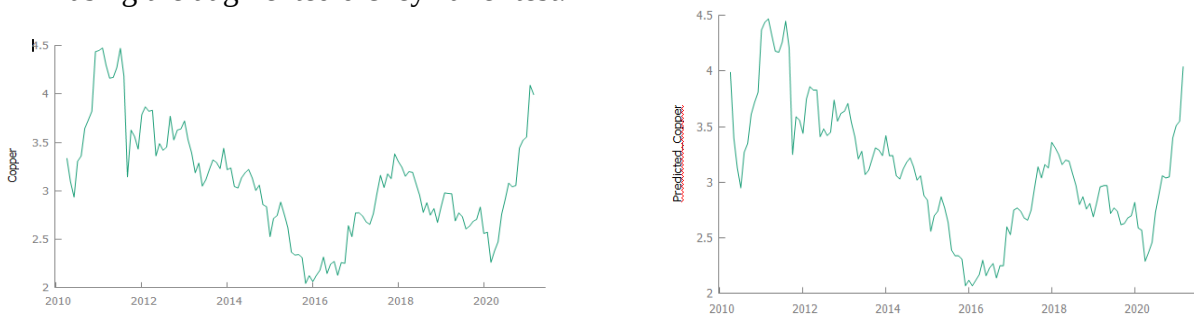

Figure 1 Non-Stationary Time Series Plot:

H_{01}: There is a unit root for the future and spot price of copper.

Table2 Result of ADF Test for copper future and spot price

					H_0	First Difference		H_0
		Level	T-Statistics	P-value		T Statistics	P-value	
ADF	Spot		-1.7227	0.4198	Accept	-12.7171	4.903e-28	Reject
	Future		-1.87177	0.346	Accept	-109994	1.926e-22	Reject

Source: Computed from SPSS, *** 1 % level

The above table2 reveals that the spot and future price of copper are not stationary since the test statistics (-1.7227 and -1.8718) are greater than critical values (-2.89). After taking the first difference, the test statistics (-12.717 & -10.9994) value are lesser than the critical value (-2.89). Therefore, the value of future and spot price of copper is found to be stationary, and the null hypothesis is rejected.

Table 3 Result of KPSS test of copper spot and future price

	T- Statistics	Level	Critical value	P-value	Conclusion
Spot	0.371927	1%	0.216	0.01	non- stationary
		5%	0.148	0.01	
		10%	0.12	0.01	
Future	0.370493	1%	0.216	0.01	
		5%	0.148	0.01	
		10%	0.12	0.01	
After First Difference					
	T- Statistics	**Level**	**Critical Value**	**P value**	
Spot	0.09045	1%	0.216	0.01	stationary
		5%	0.148	0.01	
		10%	0.12	0.01	
Future	0.060644	1%	0.216	0.01	
		5%	0.148	0.01	
		10%	0.12	0.01	

Source: Computed from SPSS

Table 3 reports the analysis of the unit root test of copper using the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test. It is another test to verify the stationarity of the series. Initially, the t-statistics (0.3719 and 0.370493) is not less than the critical value (1% - 0.216, 5% - 0.148, 10% - 0.12) for spot and future price of copper, hence the series is not stationary. But after taking the first difference, the t-statistic (0.09045 & 0.060644) is less than the p-value (1% - 0.216, 5% - 0.148, 10% - 0.12) of spot and future price of copper and the null hypothesis is accepted and the series is found stationary.

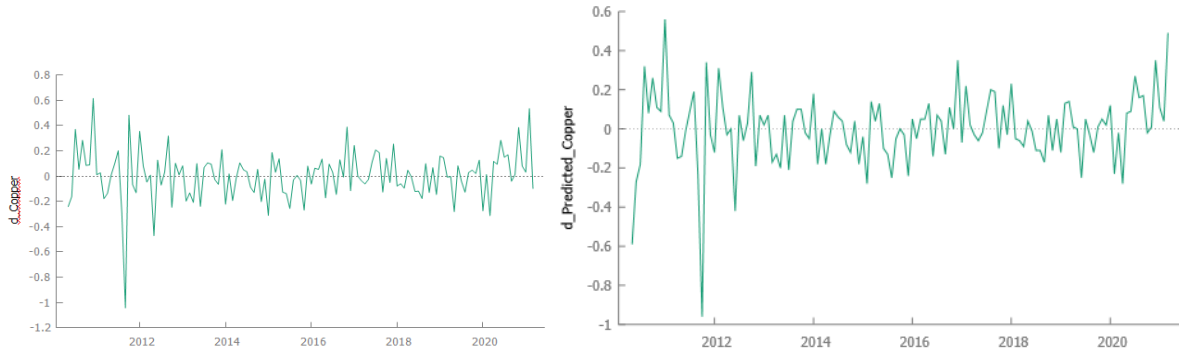

Figure 2 Stationary Time-series Plot

Johansen cointegration test for copper spot and future price

H_{03}: There is no cointegration between the future and spot price of MCX Copper.

Table 4 Result of Johansen Cointegration Analysis of Copper Spot and Future Prices

Hypothesized no. of CEs	Eigen Value	Trace Statistics	P-Value	L Max test	P-value
None	0.9998	1119.1	0.000	1116.5	0.0000
At most 1	0.019432	2.5706	0.1089	2.5706	0.1089

Source: Computed from SPSS

The cointegration between spot and future price of copper was tested with unrestricted Co-Integration trace Statistics and maximum eigen Value. The optimal lag length of two lags has been identified using the Schwartz information criterion. The result reveals that the trace value and maximum eigenvalue are greater than the critical value thus the null hypothesis is rejected. The alternative hypothesis of almost one cointegration equation has not been rejected since the trace statistics and Eigenvalue is less than the critical value (Gopinath et al., 2019). Thus, the null hypothesis is rejected, there exists a cointegration relationship between the spot and future price of copper.

Granger Causality test for Copper Spot and Future Price

H_{04}: There is no lead-lagrelationship between spot and future price of copper.

Table5 Result of Granger Causality test for Copper Spot and Future Price:

Null Hypothesis	F Statistic	P-Value	Direction
Copper Spot price does not granger cause Copper Future Price	-0.9515	0.3432	Bi-Directional
Copper Future price does not granger cause Copper Spot Price	0.6875	0.4930	

From the above table 5, since the probability value of the null hypothesis, "Copper Spot price does not granger cause Copper Future Price" and "Copper Future price does not granger cause Copper Spot Price" is greater than 0.005 we reject the null hypothesis. Thus, the result of the Granger causality test concludes that there is a bidirectional relationship between the spot and future price of copper (Jaya & Gopinath, 2020). As the coefficient of "Copper Future price does not granger cause Copper Spot Price" is greater than "Copper Spot price does not granger cause Copper Future Price" shows that the future market leads, and the spot market follows.

FINDINGS OF THE STUDY

1. The result of the ADF test shows that the time series variable of copperis stationary after the first difference.
2. Johansen and Juselius Cointegration test show that the spot and future price of copper are Cointegrated.
3. Granger Causality test proves that there is a bidirectional relationship between the spot and future price of copper, but due to the magnitude, it is evident that the Future price leads the Spot price (Kavitha & Gopinath, 2020b).

CONCLUSION

The commodity market in India is a new hub that is finding an optimum place in today's economy **(**Bhawiya Roopa& Gopinath, 2020; Saminathan et al., 2020b)). The paper attempts to study the stability of Spot and the future price of Copper in Multi Commodity Exchange. The result concluded that there is a long-run relationship between the future and spot price of copper (Saminthan et al., 2020a). Further, it is observed that there is a bidirectional relationship between the future and spot price. Though there is a bidirectional relationship, the future market has a greater impact on the spot market, indicating the information efficiency of Copper's future market is stronger than that of the future market (Kavitha & Gopinath, 2020a).

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