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Price Synergy in Spot and Future Market: A Study on Nickel Trade at MCX, India

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Futures, Cointegration, Nickel, Causality, Price discovery

JEL Classification

C01, D53, G13, G14.

Abstract: The paper is an attempt to identify the dynamic relationship between the spot and futures of nickel traded at MCX, India. The study is based on secondary data for a period ranging from 2013 to 2020. Augmented Dicky-fuller test and Phillip Perron test, Cointegration test, Granger causality test and variance decomposition are the empirical methods used in the study. The study confirms the existence of a long run relationship between the markets. In long run, the unidirectional causal effect is found between the cash and futures market of nickel whereas in the short run bidirectional causality is observed. In the long run futures market of nickel influences, the price discovery of the cash market whereas in the short run both markets influence each other for price discovery. The futures market of nickel traded at MCX, India reflects weak exogeneity in its cash market whereas the cash market of nickel reflects exogeneity in its futures market.

1. Introduction

After lifting restrictions on commodity trading the futures market has been consistently showing strong and steady growth. Producers, consumers, importers, exporters, speculators, and others are actively participating for the advantage of hedging, price discovery, price risk management etc. MCX (Multi Commodity Exchange) of India accounts for about 94 percent of the total market share. Besides hedging, price discovery, and price risk management speculators also participate for profit (Eswaran and Ramasundaram, 2008). Hence futures market reflects the expectations of all the market participants (Park and Lim, 2018). Among other commodities, base metals are considered the backbone of industrial production as it is used for manufacturing capital goods. Among other base metals nickel is the main alloying metal used for the production of stainless steel. It is also used in electro-plating, coins, chemicals,

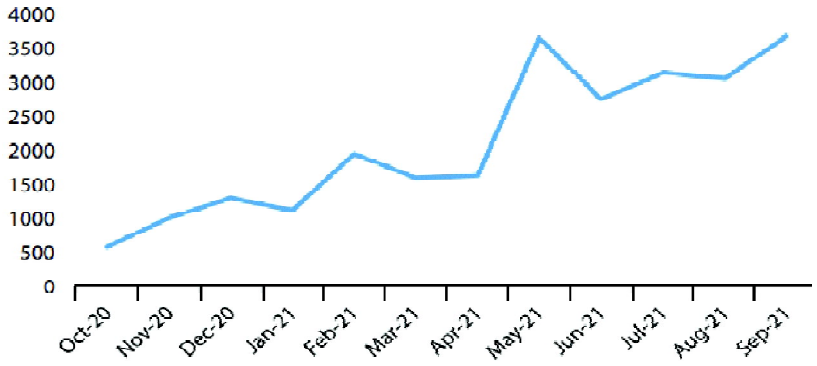

Figure 1: MCX METAL Futures Monthly Trade Value (Rs. Crore)

Source: CIYB 2021, MCX, India.

Figure 2: Average Daily Turnover in Base Metal Futures on MCX, India (Rs. Crore)

Source: CIYB 2021, MCX, India

aerospace industries, electronic gadgets etc. India is completely dependent on nickel imports and major import sources for India are Japan, Norway, China, USA, Netherlands etc.

The monthly trade value of the metal index traded at MCX, India has been showing a significant increase since its introduction. The nickel constitutes about 25.21 per cent share of the index. In the year 2022, the share of nickel ranks second after copper in the metal index. The average daily turnover in the base metal futures has been showing robust growth since the year 2006. In the year 2013 Government imposed Commodity Transaction Tax, therefore the growth declined sharply which is visible from the above figure. The average daily turnover in base metal futures traded on MCX has been constantly increasing since 2014.

Keeping the growth momentum of the metal futures into consideration, the present study empirically evaluates the dynamic relationship between cash and futures series of nickel for price discovery. In the present study, the unit root test (ADF and PP test) is used for checking the unit root properties of the price series and then the existence of the long-run relationship is verified. The

influential direction of price discovery between two markets of nickel is examined through causality checks. The variance decomposition test is employed to identify the endogeneity and exogeneity between the cash and futures market of nickel traded at MCX, India.

2. Review of Literature

Since the evolution of the commodity futures market extensive studies have been conducted to understand market efficiency, hedging, price risk management etc. By supporting Antoniou and Ergul (1997), Bakaert and Harvey (1997) found that emerging countries' commodity markets show poor information process capability as compared to developed economies. According to Sahadevan (2002), commodity cash and futures markets are not integrated. His study is based on six commodities that are traded in twelve regional commodity exchanges. This is further supported by Naik and Jain (2002). Unlike developed markets, the Indian futures market does not dominate the price discovery process (Kumar and Pandey 2011). Bose (2008) used the daily cash and futures indices from 2005 to 2007 and rejected the null of cointegration between the cash and futures market. By extending Bose's (2008) work Ali and Jabir (2011) employed the same methodology on selected twelve commodities and found the mixed directions of causality between the cash and futures market. By employing the vector error correction (VEC) model over a span of five years Srinivasan (2011) concluded that the cash market dominates futures for effective price discovery. His study was on futures indices. Panda and Dey (2022) in their study accepted the randomness of the futures market.

David and Shaun (2011) examined the price discovery process of futures by considering ten commodities as their sample and concluded that futures price doesn't contribute to the price discovery process of cash. Sehgal *et al.* (2012) found that except for turmeric futures other futures market effectively discovers the prices of their cash market. By supporting Sehgal *et al.*, (2012), Edward and Rao (2013) found causality from futures to cash markets. In contrast, Arora and Chandar (2017) supported the existence of bidirectional causality between the cash and futures markets. Clark (2021) supports the presence of the bidirectional causality between the cash and futures series of aluminium.

Raza *et al.* (2018) studies the different hedging strategies by considering the real estate and commodity index of the US and supported that the commodity index can be used for hedging real estate stocks. Olson *et al.* (2019) studied the energy market and concluded that the cross-hedging strategy is not effective for managing price risk. In contrast, Chen and Tongurai (2021) used a cross-hedging strategy and found that zinc and nickel contracts can be effectively used for managing the lead and tin cash exposure respectively. Their study is focused on the Chinese base metal market. Pani *et al.* (2022) reject the presence of a lead-lag relationship between cash and the futures market.

2.1. Research Gap

Indian commodity futures market has been growing exponentially (Pani *et al.*, 2022). By considering the growth momentum of the commodity futures segment of India, the present study is undertaken. Even though there has been extensive research conducted in commodities futures markets, their results are inconclusive and the studies relating to base metal futures of India are very less and the time horizons are also different. Moreover, research undertaken prior to 2013 completely ignored the growth

momentum of the Indian commodity market. There are divergent views regarding the price discovery mechanism between the two markets. In light of the above fact, the present study evaluates the influential direction of price discovery between the cash and futures market of nickel. For the said purpose, the study uses vector error correction methodology, causality checks and variance decomposition test.

3. Objectives of the study

The broad objectives of the study are as follows:

- To identify the influential direction of price discovery between the cash and futures market of nickel.
- To evaluate the hedging efficiency of the nickel futures market.

4. Research Methodology

Nickel cash and futures closing prices are downloaded from the official website of MCX, India for a period of seven years. Cash Price indicates cash price (₹ / Kg.) of nickel prevails in Mumbai, India while futures price refers to near month futures contracts (24 MT contract) of nickel traded at MCX, India. The historical daily price series are transposed first into their natural logarithm form and then econometric tools are used.

4.1. Unit Root Test

The unit root properties of cash and futures price series are checked through unit root tests. The present study uses ADF as well as the Phillip Perron unit root test to check the unit root properties of the cash and futures prices of nickel. The random walk-based regression equation with a drift can be stated as:

$$\Delta y_t = \varphi + \partial y_{t-1} + \Sigma\theta\Delta y_{t-j} + u_t \quad (1.1)$$

4.2. Co-integration Test

TheJohansen's cointegration test (Johansen, 1995) is used to identify the existence of a long-run relationship between the cash and futures price nickel. For the said purpose Johansen's cointegration (intercept in the cointegrating equation, no deterministic trend) can be stated as (Johansen, 1995):

$$H_1(r): P_{y_{t-1}} + Bx_t = \alpha(\beta' y_{t-1} + P_0) + \alpha_\perp \gamma_0 \quad (1.2)$$

The null hypothesis is tested against the existence of a cointegrating vector. The study considers both trace (λ_{trace}) as well as maximum eigenvalue (λ_{max}) test criteria.

4.3. Vector Error Correction Model (VECM)

The vector error correction model is designed for non-stationary series that are stationary at I(1). It restricts the long-run behaviour of the endogenous variable to converge to their co-integrating relationship while allowing for short-run adjustments. Vector error correction model can be specified as follows:

$$\Delta \ln S_t = a + \Sigma_{i=1}^{k-1} \beta_i \Delta \ln S_{t-i} + \Sigma_{j=1}^{k-1} \phi_J \Delta \ln f_{t-J} + \lambda_1 ECT_{t-1} + u_{1t} \quad (1.3)$$

$$\Delta \ln f_t = a + \Sigma_{i=1}^{k-1} \beta_i \Delta \ln S_{t-i} + \Sigma_{j=1}^{k-1} \phi_J \Delta \ln f_{t-J} + \lambda_2 ECT_{t-1} + u_{2t} \quad (1.4)$$

Where S_t represents cash price and F_t refers to the futures price. λ_i Represents the speed of adjustment and ECT_{t-1} stands for the error correction term. Akaike information criteria is used for selecting the lag length of the price series.

4.4. Minimum Variance Hedge Ratio

By following (Swain and Samal, 2017) to evaluate the hedging effectiveness of aluminium futures minimum variance hedge ratio technique is used. To identify the minimum variance hedge ratio, the following methodology has been used:

By considering Eq. (1.9) the minimum variance hedge ratio (h) can be written as

$$h = \rho\ (\sigma \Delta S)/(\sigma\ \Delta F) \quad (1.5)$$

Where *h* presents minimum variance hedge ratio. ΔS and ΔF refer to changes in the cash and futures prices during the life of the hedge respectively. The correlation coefficient between ΔS and ΔF is denoted with 'ρ'.

5. Data Analysis

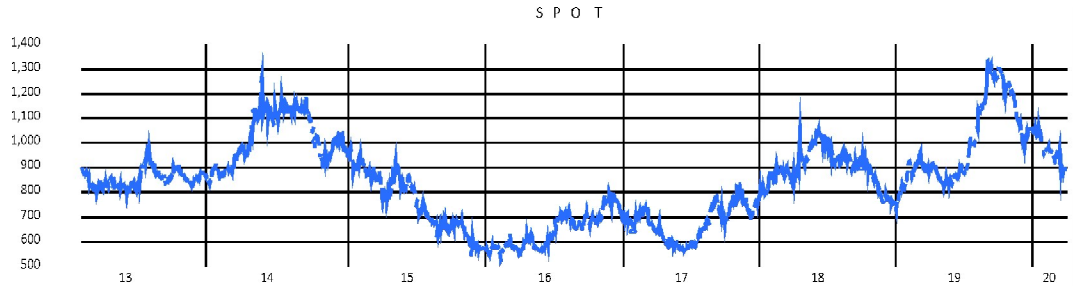

Figure 3: Trend of Spot Prices of Nickel

Source: Authors' Own Compilation

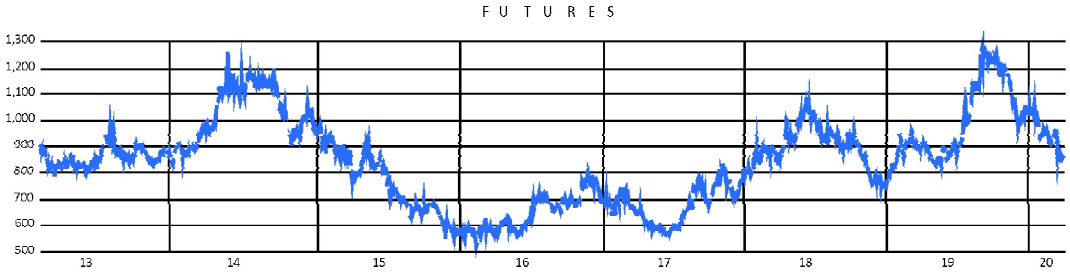

Figure 4: Trend of Futures Prices of Nickel

Source: Authors' Own Compilation

Table 1: Descriptive Statistics

Descriptive Stat	*Nickel*	
	Cash	*Futures*
Mean	841.25	842.78
Median	852.10	854.80
Maximum	1331.60	1284.80
Minimum	524.10	522.60
Std. Dev.	169.41	165.85
Skewness	0.34	0.25
Kurtosis	2.77	2.58
Jarque-Bera	40.63	33.77
Probability	0.00	0.00
Sum	1558005	1560841
Sum Sq. dev.	53125803	50914541
Observations	1852	1852

Source: Authors' Own Compilation

Both the cash and futures prices of nickel have shown a similar trend over the period chosen for the study. Nickel has been witnessing a bumpy ride from 2013 to 2020. There has been a sharp decline in the prices of nickel from 2013 to 2017. Indonesia and the Philippines account for about 30 per cent of global mined nickel production. In 2014 the ban imposed by Indonesia on the shipment of unprocessed nickel ore pressurised the nickel prices. On May 2017 Philippines parliament rejected the appointment of its environment minister thereby sending cheer to the mining arena. Because the decision by the minister affected about 10 per cent of the global nickel supply. These two events worsen the nickel prices.

Starting the financial year 2018 nickel prices move upward and touched all time high i.e. more than Rs. 1300 per kg in the mid of 2020 and thereafter starts consolidating by the end of the financial year 2020. After this sluggish run, there has been an upward movement in the prices of nickel at the onset of 2018 because of increasing steel prices and electric car demand. From the beginning of 2018 supply softness pushed the nickel prices upward and the further commitment of china to reduce its steel production capacity by 150 million tonnes from 2016 to 2020 pushed it further. Moreover declining stocks at the London Metal Exchange (LME) and Shanghai warehouses added fuel to it. Because of cyclone Ava, Sumitomo Corporation of Japan stopped its nickel mining at Ambatovy nickel mines further worsening the issue. The above table presents the summary statistics of the historical cash and futures closing prices of nickel traded at MCX, India. The mean and median prices of futures are marginally higher than the cash of nickel over the study period. The Jarque-Bera 'p' value rejects the presence of normality in both cash and futures pieces.

Table 2: Unit Root Test for Cash and Futures Prices of Nickel

Test	*Variable*	*Specifications*	*Test Statistics*	*Prob.*
Augmented Dickey-Fuller **(ADF)**	lncash	C	-1.792	0.384
		C and T	-1.831	0.689
		None	-0.066	0.660
	lnfutures	C	-1.822	0.370
		C and T	-1.847	0.681
		None	-0.131	0.638
	Δ lncash	C	-43.791	0.000**
	(First differenced)	C and T	-43.782	0.000**
		None	-43.803	0.000**
	Δ lnfutures	C	-43.977	0.000**
	(First differenced)	C and T	-43.967	0.000**
		None	-43.989	0.000**
Phillips-Perron **(PP)**	lncash	C	-1.730	0.416
		C and T	-1.769	0.719
		None	-0.064	0.661
	lnfutures	C	-1.762	0.399
		C and T	-1.787	0.710
		None	-0.132	0.638
	Δ lncash	C	-43.814	0.000**
	(First differenced)	C and T	-43.805	0.000**
		None	-43.826	0.000**
	Δ lnfutures	C	-44.007	0.000**
	(First differenced)	C and T	-43.991	0.000**
		None	-44.019	0.000**

Source: Authors' Own Compilation

**Indicates rejection of null hypothesis at 1 per cent significance level.

The raw data of cash and futures prices are transposed into their natural logarithm form. To evaluate the unit root properties of the cash and futures price series of nickel the study uses ADF as well as the PP unit root test. Both tests are carried out by using all three specifications viz. intercept, trend and intercept and none. The unit root test tabulated in the above table indicates the presence of unit root in both the price series of nickel at level but it is absent at I (1).

Table 3: Co-integration Test Results

Metal	*Test*	*Null Hypothesis*	*Test Statistic*	*Critical Value (0.05)*	*p-Value*
Nickel	Trace test	R=0	401.133	15.495	0.000**
		R=1	3.023	3.841	0.082
	Maximum	R=0	398.109	14.265	0.000**
	eigenvalue test	R=1	3.023	3.841	0.082

Source: Authors' Own Compilation

Note: 'R' refers to the number of cointegrating vectors under the null hypothesis.

*Indicates rejection of null hypothesis at 1per cent significance level.

Cash and futures price series are non-stationary at level but found stationary at the first difference, therefore it indicates the same order of integration. Long run relationship is identified by using the co-integration test (Johansen, 1988). Both λ_{trace}) and $\lambda_{max}$is considered for examining the null of no cointegrating relationship.

Table 3 presents the results of Johansen's cointegration between the cash and futures market of nickel where the null of no cointegration is rejected at a 1 per cent significant level.As there exists a long run relationship between the markets, therefore it is essential to examine the influential direction of price discovery between the two markets by using the vector error correction methodology. The study uses Akaike Information Criterion (AIC) for considering the lag length.

Table 4: Results of VECM

Commodity	*Null Hypothesis (H_0)*	*t-statistics*	*Prob.*	*Decision*
Nickel	Cash does not cause futures in long run	-1.931	0.053	Unidirectional
	Future does not cause cash in long run	-15.182	0.000*	

Source: Authors' Own Compilation

*indicates rejection of null hypothesis at a 5 per cent significant level

In the price discovery mechanism, the influential direction between the cash and futures market is an important phenomenon. Table 4 presents causality results between the cash and futures market of nickel. The null hypothesis of cash does not cause futures in long run is accepted as the adjustment coefficient is not significant at the 5 per cent level. Whereas the null hypothesis of futures does not cause cash in long run is rejected as t- statistics of the error correction term and its corresponding 'p' value is significant at a 1 per cent statistical level.

The study examines the short run influential direction of price discovery by using the Granger causality test. The results tabulated above evidence the existence of bidirectional causality between the cash and futures market in nickel. Unlike the long run, both markets of nickel influence each other for price discovery in the short run.

Table 5: Results of Granger Causality Test

Granger Causality between Futures Prices and Cash Prices				
Commodity	*Null Hypothesis (H_0)*	*F- Statistics*	*Prob.*	*Decision*
Nickel	Cash does not Granger cause futures	4.654	0.031*	Bidirectional
	Future does not Granger cause cash	794.610	0.000*	

Source: Authors' Own Compilation

* indicates rejection of null hypothesis at 5 per cent significant level

Table 6: Results of Variance Decomposition

Variance decomposition of lncash			*Variance decomposition of lnfutures*		
Period	*lncash*	*Lnfutures*	*Period*	*lncash*	*lnfutures*
1	100.000	0.000	1	38.894	61.105
2	79.846	25.154	2	40.776	59.223
3	74.326	25.674	3	42.076	57.924
4	69.514	30.486	4	43.051	56.949

Source: Authors' Own Compilation

At the initial period, a hundred per cent of the forecasted error variance in the cash market of nickel is explained by the variable itself in the short run. Unlike the cash market near about 39 of forecasted error variance in the futures market of nickel is explained by its cash market for the first period. The cash market of nickel reflects exogeneity in its futures market.

Table 7: Minimum Variance Hedge Ratio (Nickel)

Year	*Correlation Coefficient Between Δ Cash and Δ Futures Prices of Nickel*	*σ of Δ Cash Prices of Nickel*	*σ of Δ Futures Prices of Nickel*	*Ratio Between σ of Δ Cash and Δ Futures Prices of Nickel*	*Minimum Variance Hedge Ratio (h)*
2013-14	0.41	10.2	10.36	0.98	0.40
2014-15	0.68	19.37	18.66	1.04	0.71
2015-16	0.5	14.13	13.5	1.05	0.52
2016-17	0.39	11.91	12.09	0.99	0.39
2017-18	0.44	13.14	13.26	0.99	0.44
2018-19	0.44	15.4	14.14	1.09	0.48
2019-20	0.4	16.24	16.29	1.00	0.40
2013 to 2020	0.49	14.43	14.14	1.02	0.50

Source: Authors' Own Compilation

Results presented in table 7 show the minimum variance hedge ratio of nickel. It indicates that for the sample period 2013-14 0.4 units of futures position is required to hedge 1 unit of cash exposure of nickel. This has been increased to 0.71 for the sample period 2014-15 because the correlation between change in cash and futures has increased and secondly the ratio of variation between change in cash and futures prices of nickel is almost one. For the full sample period, the minimum variance hedge ratio stands at 0.5units.

6. Result and Discussion

Cash market witnesses a higher level of fluctuation than the futures market of nickel. Over the period chosen for the study, the cash market touched all time high i.e. Rs.1331.60 per Kg. whereas the futures market touched a maximum of Rs.1284.80 per Kg. there is not much difference in the minimum values of cash and futures prices of nickel. From the table, it is evident that both price series are positively skewed and platy kurtic.

The study considers both ADF and PP unit root tests. The results presented in table 2 indicate the presence of unit root at the level in all three specifications. But after the first difference i.e. at I (1) unit root is found to be absent in both the series. Both ADF and PP test rejects the null of the presence of unit root at I (1) for all specifications at a 1 per cent significance level. Cash and futures price series are non-stationary at level but found stationary at the first difference, therefore it indicates the same order of integration. Therefore, the Long run relationship is identified by using the co-integration test (Johansen, 1988). The study rejects null of no cointegration at a 1 per cent significant level by considering both λ_{trace} as well as λ_{max} criteria. It is evident that there might be short run disturbances but the cash and futures market is integrated in long rum.

The causality of price discovery is unidirectional between the markets in the long run. In long run, there is an influential direction from futures to the cash market of nickel for price discovery. Hence, the futures market of nickel influences the price discovery of the cash market whereas the cash market of nickel fails to influence the price discovery of the futures market in long run. There can be three possibilities of causality viz. unidirectional, bidirectional and independent. When there is 'unidirectional' indicates one way causality the other market conversely, in bidirectional causality both the market influences each other. Unlike the long run, both markets of nickel influence each other for price discovery in the short run.

For the first period futures market of nickel does not influence the cash. For the second period about 25.15 per cent of forecasted error variance in cash is explained by the futures market. For the fourth period, the cash market of nickel also implies endogeneity. Hence, the futures market of nickel reflects weak exogeneity in its cash market. Unlike the cash market near about 39 of forecasted error variance in the futures market of nickel is explained by its cash market for the first period. The influence of cash on futures increases gradually for the third and fourth periods. In the fourth period 43 per cent of forecasted error variance in the futures market of nickel is explained by its cash market. Therefore cash market of nickel reflects exogeneity in its futures market.

The hedge ratio of nickel is highest for the sample period 2014-15. After the financial year, 2014-15 decreasing trend has been found in the hedge ratio of nickel. The hedge ratio was lowest in the

sample period 2016-17 because of the lack of association between the movement of change in cash and futures prices of nickel. For the full sample period, the minimum variance hedge ratio stands at 0.5units. It is found that there is less hedging efficiency of nickel futures contact.

7. Conclusion

7.1. Research Outcome

Nickel is the main alloying metal used for the production of stainless steel and is also used in electro-plating, coins, chemicals, aerospace industries, electronic gadgets etc. Cash and futures series of nickel are stationary at I (1), hence there is the same order of integration. Johansen's cointegration result confirms the existence of a long run relationship between the markets. In long run, there is an influential direction from futures to the cash market of nickel for price discovery. Hence, the futures market of nickel influences the price discovery of the cash market whereas the cash market of nickel fails to influence the price discovery of the futures market in long run. There exist bidirectional causality between the cash and futures market of nickel. Unlike the long run, both markets of nickel influence each other for price discovery in the short run.

The futures market of nickel reflects weak exogeneity in its cash market whereas the cash market of nickel reflects exogeneity in its futures market. Moreover nickel futures market indicates a lack of hedging efficiency.

7.2. Implication, Limitation and Future Scope of Research

The study will help the hedgers to identify the number of futures positions they should take in order to manage their cash exposure. It will help the regulators to frame policies for increasing participation and liquidity in the market. The study will also provide information to the investors and speculators of the commodity futures market for designing hedging strategies. The present study has used only seven years of data which can be extended for further research. The study has considered only one base metal hence, the future study can include other base metals for analyzing cash and futures dynamics. Moreover, nonlinear causality, cross hedging strategies, cross country comparisons are the aspects left for future study.

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