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CONVERGENCE AND CAUSALITY BETWEEN SPOT AND DERIVATIVE METAL CONTRACTS OF MCX

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ABSTRACT

Base metals, which are abundant, relatively inexpensive, and prone to oxidation, form the backbone of the Indian economy by supporting industrial growth, infrastructure development, and manufacturing. Copper and aluminum, two key base metals, are widely traded on the Multi Commodity Exchange (MCX) in both spot and derivative markets, reflecting their economic significance and utility in various sectors.

This study examines the convergence between spot and derivative (futures) contracts for copper and aluminum on MCX, using data collected since 2009. To assess both long-term and short-term convergence, the Autoregressive Distributed Lag (ARDL) model was employed. Additionally, the Toda-Yamamoto Granger Causality test was used to analyze the direction of causality between spot and futures prices.

The findings indicate that both long-run and short-run convergence exist between spot and derivative contracts for copper and aluminum. This convergence was observed regardless of whether the spot or the futures contract was treated as the dependent variable.

The Toda-Yamamoto Granger Causality test further reveals a bidirectional relationship between spot and derivative contracts for both copper and aluminum. This suggests that price movements in either market can influence the other, highlighting the strong integration between spot and futures markets for these essential base metals.

KEYWORDS: Derivative, Spot, Copper, Aluminum

INTRODUCTION

Base metals, characterized by their excellent thermal and electrical conductivity, high recyclability, and affordability, are fundamental to India’s economic growth and industrialization. These metals, including aluminum, copper, zinc, lead, and nickel, are distinguished by their tendency to oxidize easily and their variable reactivity with diluted acids. Their abundance and cost-effectiveness make them indispensable for manufacturing and construction, serving as the backbone for infrastructure and technological advancement in India. Government initiatives such as Make in India, Smart City Project, National Solar Mission, and Housing for All have significantly boosted the manufacturing sector, thereby increasing demand for base metals. As the manufacturing sector expands, the base metals industry experiences proportional growth, reinforcing its critical role in economic development.

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Aluminum is a highly efficient conductor of heat and electricity, making it essential in the cookware, packaging, aerospace, and power transmission industries. Its corrosion resistance and compatibility with materials like plastic and wood make it suitable for use in windows, doors, and fabrication industries. Aluminum's cost-effectiveness and recyclability are crucial for the packaging and pharmaceutical sectors, as well as for sustainable industrial practices.

Copper is the second most widely used base metal in India, primarily due to its superior electrical conductivity. It is extensively utilized in electrical industries for manufacturing transformers, motors, generators, switchgears, and wiring. Copper also plays a vital role in plumbing, transportation equipment, defense, railways, electronics, and communication sectors. The increasing demand for copper is closely linked to the global energy transition and electrification trends.

India is a major importer of copper and aluminum products, as well as scrap, due to limited domestic recycling capacity. The prices of base metals are primarily determined by supply and demand dynamics, with sources of supply including both mining and recycling. Accurate estimates of demand and supply are challenging, leading to price volatility. Current prices reflect not only immediate market conditions but also expectations of future trends. Greater uncertainty and lack of information typically result in higher price volatility. Price fluctuations in imported metals like copper and aluminum have significant implications for manufacturers, consumers, and the country's balance of payments.

The Multi Commodity Exchange (MCX) is India's largest commodity exchange, listing various metal derivative contracts. These derivatives allow manufacturers to hedge against price risks and secure stable input costs. Efficient hedging is contingent upon the convergence of derivative contract prices with spot market prices. Price discovery—the process of determining the market price based on supply and demand information—occurs most efficiently in the segment that absorbs new information first. In the context of base metals, both spot and derivatives markets play critical roles, but the segment that reacts quickest to new information tends to lead in efficient price discovery.

Base metals are foundational to India's industrial and economic progress, with aluminum and copper being particularly significant due to their wide-ranging applications. Government policies and economic growth continue to drive demand, while price volatility and efficient market mechanisms remain central challenges and opportunities for the sector.

REVIEW OF LITERATURE

The convergence between spot and futures (derivative) markets is a foundational concept in financial economics and commodity trading. Convergence refers to the process by which the price of a futures contract approaches the spot price of the underlying asset as the contract nears expiration. This phenomenon is crucial for market efficiency, risk management, and price discovery. However, empirical research across different markets and commodities reveals a complex and sometimes contradictory picture regarding the strength and consistency of this convergence.

Global Evidence on Spot-Futures Convergence

Garbade and Silber (1983) developed a seminal model to test the integration between spot and futures prices for seven commodities. Their findings indicated a significant degree of integration between these markets, suggesting that price discovery occurs in both arenas. Subsequent studies, such as those by Koontz et al. (1990), Schroeder and Goodwin (1991), Chowdhury (1991), and Antoniou and Garrett (1993), have also examined the relationship between spot and derivative contracts, often concluding that the two markets are cointegrated, meaning they share a long-term equilibrium relationship. Chan, Chan, and Karolyi (1991) observed a relationship between spot and derivative index returns, while Schwarz and Szakmary (1994), using NYMEX data, found evidence of convergence in petroleum markets. Beck (1994), however, noted instances where the spot and derivative markets failed to

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converge, pointing to inefficiencies that can arise under certain market conditions. Later studies, including Kellard et al. (1999), McKenzie and Holt (2002), and Wang and Ke (2005), provided evidence that while markets tend to be efficient and convergent in the long run, short-run inefficiencies are not uncommon. Moosa (2002) quantified this, suggesting that derivative markets are only about 60% efficient—a finding that highlights persistent imperfections. Antoniou et al. (2001) extended the analysis to European stock exchanges and found cointegration between spot and derivative markets across several countries. Similarly, Liu and Zhang (2006) identified a long-term relationship between spot and derivative prices. Despite a general trend toward convergence, these studies collectively underscore that results are not uniform, and spatial as well as temporal variations exist in the degree of integration and efficiency between spot and futures markets. Several theoretical frameworks help explain the convergence between spot and futures prices. Arbitrage and the Law of One Price: Arbitrage ensures that any significant price difference between spot and futures markets is quickly exploited, which brings prices into alignment as the delivery date approaches. Cost-of-Carry Model: Futures prices reflect the spot price plus the cost of carrying the commodity (storage, insurance, interest), and as the contract nears expiration, these costs diminish, leading to convergence. Market Efficiency: Efficient markets should exhibit convergence, but frictions such as transaction costs, information asymmetry, and regulatory constraints can delay or disrupt the process.

Empirical Evidence from India

The Indian commodity derivatives market, though relatively young, has attracted considerable academic attention. M.T. Raju and Kiran Karande (2003), Kiran (2006), Biswat Pratap Chandra (2009), and Kumar and Pandey (2011)have all provided empirical evidence supporting the existence of a relationship between spot and derivative markets. Their studies also highlight the role of derivatives in price discovery, which is vital for market participants. Ali and Gupta (2011) conducted an empirical analysis of twelve commodities and found that ten exhibited convergence between spot and futures prices. Iyer and Pillai found cointegration in five out of six commodities tested, reinforcing the prevalence of integration in Indian markets. Conversely, P. Ramasundaram (2008) reported that certain agricultural derivative contracts were not cointegrated with their spot counterparts, indicating that convergence is not universal. Ranganathan and Anantha Kumar (2014) specifically examined soybean contracts and concluded that while markets are cointegrated in the long run, short-run inefficiencies persist. This mirrors international findings and points to the influence of market microstructure, liquidity, and information dissemination on convergence dynamics.

The literature reveals that while convergence between spot and futures markets is a theoretically expected outcome and is often observed empirically, the strength and consistency of this relationship vary across commodities, time periods, and market structures. Factors such as market maturity, liquidity, regulatory environment, and external shocks (e.g., weather, geopolitical events) play significant roles in shaping convergence patterns. In the Indian context, most studies support the existence of convergence and cointegration, particularly in more liquid and actively traded commodities. However, exceptions persist, especially in less liquid or more fragmented markets, and short-run inefficiencies are common. The convergence between spot and futures markets is a complex, dynamic process influenced by a range of economic, institutional, and behavioral factors. While the majority of research—both global and Indian—supports the existence of convergence and cointegration, divergent findings highlight the need for continued empirical investigation, especially as markets evolve and new instruments are introduced. Arbitrage, cost-of-carry, and market efficiency remain central to understanding this relationship, but real-world frictions ensure that perfect convergence is rarely achieved in practice.

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Causality Relationship Between Spot and Futures Markets: An Academic Overview

The convergence of spot and futures markets has long been a subject of academic inquiry, particularly regarding which market segment leads in price discovery. The causality relationship between these markets can be unidirectional—where one market consistently leads the other—or bidirectional, indicating mutual influence. This relationship is crucial for understanding market efficiency and the mechanisms through which information is incorporated into asset prices. Unidirectional Causality: In this scenario, either the spot or the futures market consistently leads the other in price discovery. The leading market is considered more efficient in assimilating new information. Bidirectional Causality: Both markets influence each other, suggesting a more complex and interactive process of price discovery.

Empirical Evidence on Market Leadership

A substantial body of research, primarily in developed markets, has found that futures markets generally lead spot markets in the price discovery process. This leadership is attributed to several factors: Lower transaction costs and Higher liquidity The ability to leverage and short-sell more easily in futures markets. For instance, studies by Kawaller et al. (1987), Oellermann et al. (1989), and Stoll and Whaley (1990) demonstrated that price movements in derivative contracts (futures) precede those in spot contracts, indicating that futures markets play a dominant role in price discovery. More recent research, such as Theissen (2011), continues to support the notion that futures markets lead, especially under normal market conditions and when arbitrage opportunities exist. Further, Wang et al. (2007), Floros and Vougas (2007), Kavussanos, Visvikis, and Alexakis (2008), Antoniou et al. (2001), Roope and Zurbrueg (2002) and Jiang (2012), and all provide empirical support for the futures market's leading role in various asset classes and international contexts.

However, not all studies are unanimous. Finnerty and Park (1987) found no significant causal relationship between spot and futures markets, suggesting that under certain conditions, neither market consistently leads the other. Quan (1992) observed that the spot market could lead in price discovery, particularly in less developed or less liquid futures markets.

Mixed and Contradictory Findings

Some studies suggest a more nuanced or context-dependent relationship: Figuerola-Ferretti and Gonzalo (2006) found that futures contracts led spot prices in five out of six metal derivatives traded in London. In emerging markets, such as India and Malaysia, the evidence is mixed. For example, Raju and Karande (2003), Biswat Pratap Chandra (2009), Chaihetphon and Pavabutr (2010), Sehgal and Rajput (2011) and Joseph et al. (2014), found a unidirectional relationship where the futures market leads in price discovery. In contrast, Pradhan et al. (2009) reported a unidirectional relationship with the spot market leading. Other studies, such as Bhatia (2007), Gupta and Singh (2009), Karmakar (2009), Ali and Gupta (2011), Sehgal et al. (2012), and Arora and Kumar (2013), indicated a bidirectional relationship between spot and futures markets, suggesting mutual influence.

Researchers have employed various econometric techniques to investigate these relationships: Johansen Cointegration Test: Used to determine the existence of a long-term equilibrium relationship between spot and futures prices. Vector Error Correction Model (VECM): Assesses both short-term dynamics and long-term causality, helping to identify which market leads in price discovery. Autoregressive Distributed Lag (ARDL) Bound Test: Applied for testing long-run cointegration and short-run dynamics, as seen in Jiang (2012). Granger Causality Test: Widely used to test the direction of causality between spot and futures markets. The literature reveals that while futures markets often lead spot markets in price discovery, especially in developed and highly liquid markets, exceptions exist. In some emerging markets or under specific conditions (such as lower liquidity or regulatory constraints), the spot market may lead, or a bidirectional relationship may be observed. The choice of econometric technique and market context significantly influence the findings, highlighting the complexity of the price

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discovery process and the importance of continued empirical investigation.

THE PURPOSE OF THE RESEARCH

1. To determine whether spot and derivative contracts for copper and aluminum converge over the long and short terms.
2. The causal relationship between spot and derivative contracts for aluminum and copper

Data Collection Process

For this empirical study, data was sourced directly from the official website of the Multi Commodity Exchange (MCX). The dataset includes daily spot prices for aluminum (SA) and copper (SC), obtained from the historical spot market data available on MCX. Additionally, data for derivative contracts—specifically, futures contracts for aluminum (FA) and copper (FC)—was collected from the monthly bhav copies published by MCX. To ensure consistency, the spot price time series was reconciled with the corresponding derivative price series. In instances where spot market data was unavailable for certain days, the last available closing price was carried forward to maintain a continuous time series. The overall data spans from January 1, 2009, to July 31, 2015 covering a substantial period.

METHODOLOGY FOR TESTING CONVERGENCE

The study investigates the convergence between spot and derivative (futures) contracts for both aluminum and copper. Convergence is assessed in two directions: first, by treating the spot price as the dependent variable and the derivative contract as the independent variable, and second, by reversing these roles. Both long-run and short-run relationships are examined to provide a comprehensive understanding of price dynamics. The initial step in this analysis is to assess the stationarity of the time series data, as non-stationary data can lead to spurious regression results. Stationarity implies that the statistical properties of a series such as mean and variance remain constant over time. The Augmented Dickey-Fuller Unit Root Test (ADFURT) is employed for this purpose. The null hypothesis of the ADFURT posits that the series contains a unit root and is thus non-stationary. If the p-value from the test exceeds the 5% significance level, the null hypothesis is accepted, indicating non-stationarity.

Upon establishing the order of integration for each series, the Autoregressive Distributed Lag (ARDL) approach is applied to test for both long-run and short-run relationships. The ARDL methodology is particularly suitable as it can be used irrespective of whether the underlying variables are integrated of order zero, I(0), or order one, I(1), but not of order two or higher. The ARDL procedure involves three main steps:

Model Selection: Identifying the appropriate lag structure for the ARDL model based on information criteria.

Bound Test: Conducting the bounds testing procedure to determine the existence of a long-run relationship between the variables.

Error Correction Model (ECM): Estimating the short-run dynamics and speed of adjustment to equilibrium using the error correction term.

This structured approach allows for robust analysis of price convergence between spot and derivative markets for aluminum and copper over the selected period, providing insights into market efficiency and price discovery mechanisms on MCX.

The Autoregressive Distributed Lag (ARDL) methodology, introduced by Pesaran and colleagues, has become a widely used econometric approach for examining cointegration relationships among variables that may be integrated at different orders—specifically, I(0) or I(1), but not I(2). This flexibility distinguishes ARDL from classical cointegration techniques, which typically require all series to be integrated at the same order. The ARDL approach is particularly advantageous in empirical research involving small sample sizes and mixed integration orders, making it a robust tool for time series analysis.

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ARDL Model Structure

The ARDL model is a linear time series framework in which both the dependent and independent variables are expressed not only in their contemporaneous forms but also through their lagged values. The general form of the ARDL model can be represented as:

$$mf_t = \beta_0 + \beta_1 mf_{t-1} + ...+ \beta_p mf_{t-p} + \alpha_0 ms_t + \alpha_1 ms_{t-1} + \alpha_2 ms_{t-2} + ... + \alpha_q ms_{t-q} + \varepsilon_t \quad (3)$$

mft denotes the metal futures contract, explained by its own past values (p lags) and the current and past values (q lags) of the spot metal price (

ARDL Bounds Test for Cointegration

The ARDL bounds testing approach, as developed by Pesaran et al. (2001), is designed to test for the presence of a long-run relationship (cointegration) between variables, regardless of whether the series are I(0), I(1), or a combination thereof. The key steps and features include:
No strict pre-testing for unit roots is required, though it is advisable to ensure that none of the variables are I(2), as the ARDL method is not valid in the presence of second-order integration.
The bounds test is based on the joint significance (using an F-statistic or Wald test) of lagged level variables in the ARDL equation.
The null hypothesis

$$\Delta ms_t = \beta_0 + \Sigma\ \beta_i \Delta ms_{t-i} + \Sigma \delta_k \Delta mf_{t-k} + \theta_0 ms_{t-1} + \theta_1 mf_{t-1} + e_t \quad (4)$$

$$\Delta mf_t = \beta_0 + \Sigma\ \beta_i \Delta mf_{t-i} + \Sigma \delta_k \Delta ms_{t-k} + \theta_0 mf_{t-1} + \theta_1 ms_{t-1} + e_t \quad (5)$$

The bounds test compares the calculated F-statistic against two sets of critical values:
Lower bound (I(0)): Assumes all variables are stationary at level.
Upper bound (I(1)): Assumes all variables are stationary at first difference.
Interpretation is as follows:
If the F-statistic is below the lower bound, the null hypothesis of no cointegration is accepted.
If the F-statistic exceeds the upper bound, the null is rejected, indicating cointegration.
If the F-statistic falls between the bounds, the result is inconclusive, and further investigation is needed.

Error Correction Representation and Short-Run Dynamics

Once a long-run relationship is established, the ARDL model can be re-parameterized into an Error Correction Model (ECM) to capture both short-term and long-term dynamics. The ECM form includes an error correction term (ECT), which measures the speed at which the dependent variable returns to equilibrium after a shock:

$$\Delta ms_t = \beta_0 + \Sigma\ \beta_i \Delta ms_{t-i} + \Sigma \delta_k \Delta mf_{t-k} + \theta_0 ms_{t-1} + \theta_1 mf_{t-1} + \xi\ ECM_{t-1} + e_t \quad (6)$$

$$\Delta mf_t = \beta_0 + \Sigma\ \beta_i \Delta mf_{t-i} + \Sigma \delta_k \Delta ms_{t-k} + \theta_0 mf_{t-1} + \theta_1 ms_{t-1} + \xi\ ECM_{t-1} + e_t \quad (7)$$

A negative and statistically significant ECT coefficient (ξξ) indicates a valid adjustment mechanism towards the long-run equilibrium, with the value typically falling between 0 and -1.

ARDL can be applied to variables that are I(0), I(1), or a mixture, provided none are I(2).The ARDL approach yields reliable estimates even with limited data.The technique allows for different optimal lag lengths for each variable, improving model fit.The ARDL model can be estimated using ordinary least squares (OLS), making it accessible for applied researchers.

Causality Testing: Toda-Yamamoto Approach

For causality analysis, the Toda-Yamamoto (TY) method offers an alternative that accommodates variables with different integration orders. The TY approach involves estimating an augmented Vector Autoregression (VAR) model with extra lags equal to the maximum order of integration detected (using, for example, the Augmented Dickey-Fuller test). The null hypothesis in the TY test asserts that the explanatory variable does not Granger-cause the dependent variable. The test is conducted using a modified Wald statistic, and

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significance is determined at the 5% level: if the p-value is below 0.05, the null is rejected, indicating causality.

The ARDL methodology, and its associated bounds testing approach, provides a versatile and robust framework for examining both long-run and short-run relationships among time series variables with mixed integration orders. Its advantages in terms of flexibility, ease of estimation, and applicability to small samples have made it a preferred choice in empirical economic research, particularly when classical cointegration techniques are unsuitable.

ANALYSIS AND INTERPRETATION OF DATA

Results of ADFURT : Basic assumption of ARDL model is that series can be i0 or i1. ARDL cannot be applied on i2 series. ADFURT is tested at Constant (Con.), Intercept and Trend (I&T) and No intercept and trend (No I&T). Results of first difference unit root test is given in following table1

Table 1: Results of ADFURT

Variable	No I&T	Result
Results at Level i(0)		
Spot Aluminum (SA)	0.208524 (0.7468)	Non stationary
Derivative Aluminum (FA)	0.185065 (0.7399)	Non stationary
Spot Copper (SA)	0.179128 (0.7382)	Non stationary
Derivative Copper (FC)	0.182220 (0.7391)	Non stationary
Results at first difference i(1)		
Spot Aluminum (SA)	-50.60263 (0.0001)	Stationary
Derivative Aluminum (FA)	-48.98188(0.0001)	Stationary
Spot Copper (SC)	-50.98694 (0.0001)	Stationary
Derivative Copper (FC)	46.56803 (0.0001)	Stationary

The above table indicates that spot aluminum contact derivative aluminum contract are stationary at first difference. Spot copper and derivative price time series of copper contract is also stationary at first difference.

Long Run Convergence between Spot And Future:

The selection and validation of the ARDL (Autoregressive Distributed Lag) model for analyzing the relationship between spot and derivative prices of metal contracts involves several systematic steps.

Initially, the spot price series of the metal contract is set as the dependent variable, while the derivative series serves as the explanatory variable. To determine the optimal lag structure for the ARDL model, multiple criteria are considered: Final Prediction Error (FPE), Akaike

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Information Criterion (AIC), Schwarz Information Criterion (SC), and Hannan-Quinn Information Criterion (HQ). Among these, the model with the lowest AIC value is selected, as it typically balances model fit and complexity most effectively. This approach is consistent with empirical practices in financial econometrics, where AIC is widely used for lag selection in ARDL models due to its sensitivity to overfitting**.**

Table 2: Results of ARDL spot and future

Variable	Lags selected	Model selected	LM Test results	Results
Copper	8 Lags as per FPE and AIC	(8,8)8 Lags of spot and 8 Lags of Derivative AIC Value 4.678082	15.4815 (0.0519)	No serial correlation
Aluminum	8 Lags as per FPE and AIC	8 Lags of spot and 8 Lags of Derivative AIC Value --7.09346	2.227313(0.1357)	No serial correlation

For both copper and aluminum, the ARDL(8,8) model was chosen since this lag combination yielded the lowest AIC value. Once the model is specified, it is essential to test its adequacy, particularly regarding the presence of serial correlation in the residuals. The LM (Lagrange Multiplier) test is applied for this purpose. The null hypothesis of the LM test states that there is no serial correlation up to the maximum number of lags used in the model. In this analysis, the null hypothesis was accepted, indicating that the residuals are free from serial correlation and, therefore, the model specification is adequate.

With the ARDL model validated in the first phase, the next step is to assess the existence of a long-run equilibrium relationship between the spot and derivative contracts. This is achieved using the ARDL Bounds Test for cointegration. The test involves comparing the computed F-statistic against critical values (bounds). If the F-statistic exceeds the upper bound, it indicates that the spot and derivative price series are cointegrated, meaning they share a long-term equilibrium relationship or are convergent. This approach is standard in empirical finance research, as it allows for testing cointegration regardless of whether the underlying series are I(0) or I(1).

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.The results of Bound test are reported in table 3

Table 3: Results of bound test spot and future

Variable	F value	I(0) at 1% significance level	I(1) at 1% significance level	Convergence
Copper	219.1721	4.94	5.58	yes
Aluminum	221.9109	4.94	5.58	yes

From the above results F value exceeds the i(1) value which concludes that cointegration or convergence exists between spot and derivative contract of copper and aluminum.

Short-term Convergence between Spot and Future: Short-term convergence can be examined using the Error Correction Model (ECM), which measures the speed of adjustment toward long-term equilibrium. The ECM coefficient indicates how quickly deviations from the equilibrium are corrected in the short run. A valid short-term relationship exists when the ECM value is negative reflecting a stable adjustment process. Additionally, this ECM coefficient must be statistically significant to confirm the presence of short-term dynamics. The detailed results of the ECM analysis, including the coefficient values and their significance levels, are presented in Table 4.

Table 4: Results of ECM spot and future

Variable	ECM	value	R squared	Adjusted R Squared	Convergence
Copper	-3.425963	-25.65478 (0.0000)	0.914025	0.913386	yes
Aluminum	-3.526241	-25.81398 (0.0000)	0.787944	0.786444	yes

The above table indicates both copper and aluminum spot and derivative contract have convergence in short run. ECM value is -3.425963 and -3.526241for copper and aluminum, respectively. ECM value is negative and significant.

Long Run Convergence between Future and Spot: In this analysis, the derivative time series is treated as the dependent variable, while the spot price series serves as the independent variable. An Autoregressive Distributed Lag (ARDL) model is employed, following the specified conditions for model selection. This approach allows for examining both short-term

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dynamics and long-term relationships between the derivative prices and spot prices. The estimation results, including coefficients, significance levels, and diagnostic tests, are systematically presented in Table 5. These findings provide insights into how spot price movements influence derivative prices over time, highlighting the direction and strength of their interdependence.

Table 5: Results of ARDL future and spot

Variable	Lags selected	Model selected	LM Test results	Results
Copper	6 Lags as per FPE and AIC	(6,6)6 Lags of derivative and 6 Lags of spot AIC Value 5.933198	1.866385(0.1549)	No serial correlation
Aluminum	8 Lags as per FPE and AIC	(8,8)8 Lags of derivative and 8 Lags of spot AIC Value 3.066181	3.90668 (0.1482)	No serial correlation

The above table indicate that 6,6 model for copper and 8,8 model for aluminum is selected for further analyses of long run and short run relationship. LM test show that there is no serial correlation in residual.

As explained above, the results of long term relationship is examined through bound test. Dependent variable is derivative contract series and independent variable is spot time series.

Table 6: Results of bound test future and spot

Variable	F value	I(0) at 1% significance level	I(1) at 1% significance level	Convergence
Copper	99.54860	4.94	5.58	yes
Aluminum	148.5049	4.94	5.58	yes

The F value is above upper bound value of 5.58 which indicate that there is long run convergence between derivative contract and spot contract for copper and aluminum metal contracts.

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Short Run Relationship: Results short run relationship are explained in table no. 7

Table 7: Results of ECM future and spot

Variable	ECM	value	R squared	Adjusted R Squared	Convergence
Copper	-3.837119	-17.28991 (0.0000)	0.522343	0.519750	yes
Aluminum	-3.04999	-21.11718 (0.0000)	0.672604	0.670443	yes

ECM tern is negative and significant which indicate short term relationship

Causality Rest Results:TY test is applied to find out causality between spot and derivative contracts. There can be unidirectional or bidirectional relationship.

Table 8: Results of TY test

Null hypothesis	Value	Results	
FC does not cause SC	8260.9869(0.000)	Copper derivative cause spot copper	Bidirectional
SC does not cause FC	17.611(0.0243)	Copper spot cause copper derivative	
FA does not cause SA	987.77(0.0000)	Aluminum derivative cause spot	Bidirectional
SA does not cause FA	16.932(0.0000)	Spot aluminum cause derivative	

Null hypothesis is rejected in all the above cases and bidirectional relationship is between spot and derivative contacts of copper.

6. CONCLUSION

The convergence between spot and derivative (futures) prices is a critical indicator of market efficiency in commodity markets, particularly for metals like copper and aluminum. This study examines convergence at two levels: from spot to derivative and from derivative to spot, assessing both long-run and short-run dynamics.

Empirical analysis confirms the existence of long-run convergence between spot and derivative contracts for copper, as well as for aluminum. This means that over time, futures prices and spot prices move toward each other, especially as the futures contract approaches maturity. Such convergence is fundamental to the functioning of futures markets and is consistent with the principle that, at expiry, the futures price should equal the spot price, eliminating arbitrage opportunities. The study also finds evidence of short-run convergence, indicating that spot and

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futures prices adjust to each other even over shorter time frames, though the adjustment may not be perfect due to temporary market frictions or information lags.

The established convergence implies that derivative contracts for copper and aluminum are efficient. Efficient convergence allows market participants to use futures contracts as reliable tools for hedging price volatility risk, as movements in spot prices are closely mirrored by corresponding changes in futures prices. The study utilizes the TY Granger causality test, which reveals a bidirectional relationship between spot and derivative prices for both copper and aluminum. This suggests that both markets contribute to the price discovery process, with information flowing in both directions and influencing price formation.

Policy Implications

The findings have significant implications for traders, hedgers, and policymakers. Since derivative contracts are shown to be efficient, market participants can confidently use these instruments for hedging against price volatility. Policymakers are encouraged to promote the development and use of derivative markets to facilitate risk transfer and improve market stability. Enhanced participation in derivatives can also deepen market liquidity and improve the robustness of price discovery mechanisms

Limitations and Scope for Future Research

It is important to note that this study focuses only on two metal contracts (copper and aluminum) using data from the Multi Commodity Exchange (MCX) over a limited period. The results might differ if other metals, different contract types, or longer time frames are analyzed. Therefore, future research could expand the scope to include a broader range of commodities and derivative products to validate and generalize these findings.

REFERENCES

1. Ali, J., and Bardhan Gupta, K. (2011). Efficiency in agricultural commodity futures markets in India: Evidence from cointegration and causality tests. *Agricultural Finance Review*, *71*(2), 162-178.
2. Antoniou, A., and Garrett, I. (1993). To what extent did stock index futures contribute to the October 1987 stock market crash?. *The Economic Journal*, *103*(421), 1444-1461.
3. Antoniou, A., Pescetto, G., Violaris, A., and Durham, D. H. (2001). *Modeling International Price Relationships and Interdependencies between EU Stock Index and Stock Index Futures Markets: A Multivariate Analysis*. Working Paper, Centre for

Submitted: 26Oct 2015, Revised: 09 Nov2015, Accepted: 15 Dec 2015

***International Journal of Economic Perspectives*, 9(1) Dec 2015, PP: 63-78**
Retrieved from: http://ijeponline.com/index.php/journal
Empirical Research in Finance, Department of Economics and Finance, University of Durham.

4. Arora, S., and Kumar, N. (2013). Role of futures market in price discovery. *Decision*, *40*(3), 165-179.
5. Beck, S. E. (1994). Cointegration and market efficiency in commodities futures markets. *Applied economics*, *26*(3), 249-257.
6. Bhatia, S. (2007). Do the S&P CNX nifty index and nifty futures really lead/lag. *Error Correction Model: A Co-integration Approach, Source: www. nseindia. com*.
7. Biswat, P. C. (2009). Price discovery in futures and spot commodity markets in India. *Al-Barkaat Journal of Finance & Management*, *1*(1), 21-44.
8. Chan, K., Chan, K. C., and Karolyi, G. A. (1991). Intraday volatility in the stock index and stock index futures markets. *The Review of Financial Studies*, *4*(4), 657-684.
9. Chowdhury, A. R. (1991). Futures market efficiency: evidence from cointegration tests. *Journal of Futures markets*, *11*(5), 577-589.
10. Dickey, D. A., and Fuller, W. A. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica: journal of the Econometric Society*, 1057-1072
11. Easwaran, R. S., and Ramasundaram, P. (2008). Whether commodity futures market in agriculture is efficient in price discovery?-An econometric analysis. *Agricultural Economics Research Review*, *21*(347-2016-16671), 337-344.
12. Figuerola-Ferretti, I., and Gonzalo, J. (2006). Price discovery in commodity markets: the case of metals. *Available at SSRN 891030*.
13. Finnerty, J. E., and Park, H. Y. (1987). Stock index futures: Does the tail wag the dog?. *Financial Analysts Journal*, *43*(2), 57-61.
14. Floros, C., and Vougas, D. (2007). Lead-lag relationship between futures and spot markets in Greece: 1999-2001. *International Research Journal of Finance and Economics*, (7), 168-174.
15. Garbade, K. D., & Silber, W. L. (1983). Price movements and price discovery in futures and cash markets. *The Review of Economics and Statistics*, 289-297
16. Granger, C. W., and Lin, J. L. (1995). Causality in the long run. *Econometric theory*, 530-536.
17. Granger, C. W. (1969). Investigating causal relations by econometric models and cross-spectral methods. *Econometrica: Journal of the Econometric Society*, 424-438.

Submitted: 26Oct 2015, Revised: 09 Nov2015, Accepted: 15 Dec 2015

***International Journal of Economic Perspectives*, 9(1) Dec 2015, PP: 63-78**
Retrieved from: http://ijeponline.com/index.php/journal
18. Gupta, K., and Singh, B. (2007). An examination of price discovery and hedging efficiency of Indian equity futures market. In *10th Indian Institute of Capital Markets conference paper*.
19. Iyer, V., and Pillai, A. (2010). Price discovery and convergence in the Indian commodities market. *Indian Growth and Development Review*, *3*(1), 53-61.
20. Jiang, S. J., Chang, M. C., and Chiang, I. C. (2012). Price discovery in stock index: an ARDL-ECM approach in Taiwan case. *Quality & Quantity*, *46*(4), 1227-1238.
21. Joseph, A., Sisodia, G., and Tiwari, A. K. (2014). A frequency domain causality investigation between futures and spot prices of Indian commodity markets. *Economic Modelling*, *40*, 250-258.
22. Karmakar, M. (2009). Price discoveries and volatility spillovers in S&P CNX Nifty future and its underlying index CNX Nifty. *Vikalpa*, *34*(2), 41-56
23. Kavussanos, M. G., Visvikis, I. D., and Alexakis, P. D. (2008). The lead-lag relationship between cash and stock index futures in a new market. *European Financial Management*, *14*(5), 1007-1025.
24. Kawaller, I. G., Koch, P. D., and Koch, T. W. (1987). *The Relationship between the S & P 500 Index and S & P 500 Index Futures Prices*. Chicago Mercantile Exchange
25. Kellard, N., Newbold, P., Rayner, T., and Ennew, C. (1999). The relative efficiency of commodity futures markets. *Journal of Futures Markets: Futures, Options, and Other Derivative Products*, *19*(4), 413-432.
26. Kiran, K. (2006). *A Study of Castorseed Futures Market in India* (Doctoral dissertation, Doctoral dissertation, Ph. D Thesis submitted to Indira Gandhi Institute of Development Research, Mumbai, India, retrieved from http://papers. ssrn. com/sol3/papers. cfm)
27. Koontz, S. R., Garcia, P., and Hudson, M. A. (1990). Dominant-satellite relationships between live cattle cash and futures markets. *The Journal of Futures Markets (1986-1998)*, *10*(2), 123-136
28. Kumar, B., and Pandey, A. (2011). International linkages of the Indian commodity futures markets.
29. Liu, Q. F., and Zhang, J. Q. (2006). Price discovery and volatility spillovers: Evidence from Chinese spot-futures markets. *China and World Economy*, *14*(2), 79-92.
30. McKenzie, A. M., and Holt, M. T. (2002). Market efficiency in agricultural futures markets. *Applied economics*, *34*(12), 1519-1532.

Submitted: 26Oct 2015, Revised: 09 Nov2015, Accepted: 15 Dec 2015

31. Moosa, I. A. (2002). Price discovery and risk transfer in the crude oil futures market: some structural time series evidence. *Economic Notes*, *31*(1), 155-165.
32. Pavabutr, P., and Chaihetphon, P. (2010). Price discovery in the Indian gold futures market. *Journal of Economics and Finance*, *34*(4), 455-467.
33. Pesaran, M. H., Shin, Y., and Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of applied econometrics*, *16*(3), 289-326.
34. Pesaran, M. H., Shin, Y., and Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of applied econometrics*, *16*(3), 289-326
35. Pradhan, K. C., and Bhat, K. S. (2009). An empirical analysis of price discovery, causality and forecasting in the nifty futures markets. *International Research Journal of Finance and Economics*, *26*, 83-92
36. Quan, J. (1992). Two-step testing procedure for price discovery role of futures prices. *Journal of Futures Markets*, *12*(2), 139-149.
37. Raju, M. T., and Karande, K. (2003). Price discovery and volatility on NSE futures market. *SEBI Bulletin*, *1*(3), 5-15
38. Ranganathan, T., and Ananthakumar, U. (2014). Market efficiency in Indian soybean futures markets. *International Journal of Emerging Markets*, *9*(4), 520-534.
39. Roope, M., and Zurbruegg, R. (2002). The intra-day price discovery process between the Singapore Exchange and Taiwan Futures Exchange. *Journal of Futures Markets: Futures, Options, and Other Derivative Products*, *22*(3), 219-240.
40. Schwarz, T. V., and Szakmary, A. C. (1994). Price discovery in petroleum markets: Arbitrage, cointegration, and the time interval of analysis. *Journal of Futures Markets*, *14*(2), 147-167.
41. Schroeder, T. C., and Goodwin, B. K. (1991). Price discovery and cointegration for live hogs. *Journal of Futures Markets*, *11*(6), 685-696.
42. Sehgal, S., Rajput, N., and Dua, R. K. (2012). Price discovery in Indian agricultural commodity markets. *International Journal of Accounting and Financial Reporting*, *2*(2), 34.
43. Stoll, H. R., and Whaley, R. E. (1990). The dynamics of stock index and stock index futures returns. *Journal of Financial and Quantitative analysis*, *25*(4), 441-468.
44. Toda, H. Y., and Yamamoto, T. (1995). Statistical inference in vector autoregressions with possibly integrated processes. *Journal of econometrics*, *66*(1-2), 225-250.

Submitted: 26Oct 2015, Revised: 09 Nov2015, Accepted: 15 Dec 2015

45. Wang, H. H., and Ke, B. (2005). Efficiency tests of agricultural commodity futures markets in China. *Australian Journal of Agricultural and Resource Economics*, *49*(2), 125-141.
46. Wang, Z., Liu, Z., and Chen, C. (2007). An empirical analysis of the price discovery function of Shanghai fuel oil futures market. *Petroleum Science*, *4*(3), 97-102.

Submitted: 26Oct 2015, Revised: 09 Nov2015, Accepted: 15 Dec 2015