# Functional Futures

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| Date | 18 November 2022 |
| Team ID | PNT2022TMID17220 |
| Project Name | Signs with Smart Connectivity for Better Road Safety |

# Functional Futures

## Introduction

Commodity derivatives are an emerging asset group for investors. Forwards, futures, swaps and options are among the most commonly used derivatives instruments. However, futures contracts are ruling the commodity derivatives market given their inherited benefits. Sendhil et al. (2013) describes futures as a commitment between a buyer and a seller to exercise the prearranged standardized contract entered on the day of agreement for delivery in the future. The main purposes with which commodity futures were introduced are to administer price risk and price discovery. Seth and Sidhu (2018) defines price discovery as a 'process of identifying the price of a commodity among different markets through interaction of buyers and sellers'. The price discovery process provides insight about the ruler of the derivatives market, that is, whether the spot market or futures market leads in discovering prices. Several researchers (Edward & Rao, 2013; Grunewald et al., 1993; Oellermann et al., 1989; Tse, 1999) believe that the futures market can incorporate new information more quickly than the spot market because of its ability to get an organized price about the underlying asset, low transaction costs and lack of short sale restrictions. When the futures market efficiently discovers prices, the producers of commodities, depending on the prices in the futures market, can formulate strategies regarding quantity of production, time of delivery, holding of inventory and setting of prices. As correctly expressed by Nargunam and Anuradha (2017), when price is instantaneously detected on an efficient market, the market directs the evaluation of risk and return. In this way, investors are able to minimize risk to a certain extent. Again, producers also have the opportunity to step into the futures market and hedge their produce by selling at a predetermined price. However, to provide the intended benefits to the market participants, the futures market must be efficient. Fama (1970) has defined market as 'one in which prices always fully reflect available information and where no traders in the market can make profit with monopolistically controlled information'. However, different researchers have focused on different time periods, different geographical boundaries and different commodities, and found different results. Dey and Maitra (2016) state that futures markets are moving away from their role of rationalizing growers' price expectations.

On the other hand, speculators and hedgers could use contango and normal backwardation to understand market behaviour and plan whether to buy or sell contracts and at which time. According to Rout and Rao (2017), in the normal backwardation market condition, the futures price is always lower than the expected spot price of the commodities, whereas the market condition is said to be in contango when the futures price is higher than the expected spot price. In contrast to backwardation, this situation arises when there is sufficient supply and the convenience yield is less than the cost of storage. Keynes attempted to explore the reason for normal backwardation. Backwardation is normally observed when a commodity is in short supply. It gives a lead about 'seasonal' and 'off-seasonal' products. If a producer is producing an off-seasonal product, they expect a better value for their products as demand for the commodity is higher than the supply, and hence, they will always seek the best price for the product. However, due to market uncertainties and price variations, producers will hedge sort, that is, make futures contract to sell their commodities in order to fix a certain price. Due to such hedging pressure, and the risk-averse nature of producers, they must set the futures price below the expected spot price.

Metal commodities and agricultural commodities are not similar in nature. First, metal commodities are durable and thus storable, while for most agricultural commodities, this is not the case. Second, the foundation of derivatives is accredited to hedgers who need to protect themselves against price fluctuations of their produce. The futures entered the metal segment after a long period. Third, during the first year of such trading in India (2004–2005), the share of agricultural commodities was the highest, at 68.3%, which has gradually declined to 15%–17% from 2013–2014 to 2014–2015 (Rout, 2018). Rout (2018) also stated that the share of non-agricultural commodities, especially metal commodities, progressively rose from 30% to 80% over the same period. Fourth, most agricultural commodities are prone to seasonal fluctuations, which is not the case for most metal commodities.

Commodity futures are financial assets for investors and a risk management tool for hedgers. Its contribution to economic stability motivated us to gain some insights about the Indian commodity futures market. This study specifically addresses whether the futures market in India has been successful in performing the function of price discovery and hedging effectively. Further, we also attempt to check the existence of contango and normal backwardation to understand market behaviour and simultaneously focus on optimum strategy by hedgers and speculators. Further, as the metal and agricultural commodities possess different features; combined study would not yield efficient results. Thus, this study compares both categories.

The remainder of the article is organized as follows. Existing literature is summarized in the second section. The third section explains the design of the study. The fourth section discusses the observations and the fifth section provides the conclusion.

## Literature Survey

The importance of commodity derivatives has created substantial research interest, leading to a plethora of literature in this regard. As the effectiveness of commodity derivatives largely depends on the price discovery mechanism, researchers have focused on finding whether the futures market is efficient in predicting prices in spot market, which ultimately helps in hedging and making investment decisions. At an early stage functioning of commodity derivatives, Garbade and Silber (1983), based on their equilibrium assumption for storable commodities, established that information first emerges in the futures market and is then transmitted to the spot market. Oellermann et al. (1989) and Koontz et al. (1990) also found a dominant behaviour of futures prices over spot prices in terms of new information. Grunewald et al. (1993) established that such behaviour of the futures market is due to new information generated by assets or markets. In recent times, other researchers have also found similar results. Ali and Gupta (2011), Edward and Rao (2013), and Sendhil et al. (2013) gauged the efficiency of the agricultural commodity futures market in India and observed that the futures market provides direction to the spot market. Sehgal et al. (2012) also tested the function of price discovery in the agricultural commodity markets in India and observed that price discovery exists in all commodities barring turmeric. This result is supported by Mukherjee and Goswami (2017) but in case of potato. Although a large number of researchers have opined that the futures market discovers spot prices, their results have been countered by other researchers who have found no evidence of the futures market predicting the spot price**.** Boudoukh et al. (2007), Srinivasan (2011), and Saranya (2015) have established that the spot market influences the futures price because fundamental information at the production level generates significant variation in future prices. David et al. (2011) examined the ability of futures prices to predict spot prices using 10 commodities traded in different international commodities exchanges for two years. They observed that futures prices were not contributing to forecasting spot prices. Moreover, some researchers have noticed bi-directional association between spot and futures prices. Bose (2008) supports a bi-directional lead–lag relationship for daily multi-commodity indices during 2005–2007. However, in case of agriculture indices, futures prices lead spot prices. Chhajed and Mehta (2013) have observed bi-directional causality between spot and future prices. However, the futures price is found to dominate the spot price. Similarly, regarding agricultural commodities, Shakeel and Purankar (2014) also observed bi-directional causality in spot and futures prices. Arora and Chandar (2017) too have found bi-directional causality in some commodities while evaluating the price discovery in Indian commodities derivatives market.

According to Goss (1981), futures prices of storable commodities are better predictors of spot prices compared to non-inventory and sporadic inventory. Forecast horizon and spell to maturity are also factors influencing the predictability of spot prices by the futures market (Garcia et al., 1988). Regarding short-run disequilibrium, Beja and Goldman (1980) stated that prices do not adjust quickly to information shocks because of inadequacies in institutions and agents. Grossman and Stiglitz (1980) further added that prices adjust slowly as the collection and evaluation of information is time-consuming and costly. Short-run inefficiencies are also attributed to superiority difference and trading volumes (Aulton et al., 1997).

The aim of introducing futures trading is to eradicate price fluctuation in the cash market. A futures contract hedges the volatility that persists in commodities trading. The extent of variance in returns that can be eliminated by hedging is called hedging effectiveness (Malhotra, 2015). Researchers have also attempted to understand the effectiveness and efficiency of hedging given the various roles played by commodity derivatives in an economy. Bose (2008) studied the Indian derivative market and established that hedging in the agricultural commodities is challenging, but it is also observed how effective hedging can be, when agricultural and non-agricultural commodities are compared. Kumar and Pandey (2011) observed this effectiveness and argued that agricultural commodities record higher hedging effectiveness compared to non-agricultural commodities. Increased hedging effectiveness indicates that Indian markets are effective for hedging. Chana futures are found to be an effective hedging tool, as observed by Singh and Singh (2015). By the same token, Malhotra (2015) evaluated the hedging efficiency in the oil and oilseeds market in India and established that CPO and refined soya oil show suitable hedging effectiveness, but mentha oil and mustard seeds show poor hedging effectiveness. She additionally stated that the poor effectiveness is because both commodities fall under narrow commodities, which are susceptible to price manipulation and cartel-like activities by speculators and hoarders. The work of Arora and Chandar (2017) too revealed a high degree of hedging effectiveness, as shown by the low variance in the hedged portfolio compared to the un-hedged portfolio. Interestingly, Gupta et al. (2017) stated that traders in the non-agricultural market use the futures for more speculation drives than hedging, as evidenced by the high speculation ratio and low speculation activity in agricultural commodities.

Thus, very few researchers have thrown light on market behaviour through contango and normal backwardation. Feldman and Till (2006) examined the role of backwardation in the performance of positive long positions in soybean, corn and wheat futures from 1950 to 2004. They found a high mediating role of backwardation and roll return in describing the performance of three commodity futures. Bose (2008) has explored the Indian commodity futures market from 2005 to 2007. The result based on multi commodity indices shown at higher exposure to material and energy product with clear and efficient price dissemination in national and international market. Fantacci et al. (2010) attempted to study speculation behaviour in commodities through Keynesian assumptions. They observed that normal backwardation applied only to well-specified circumstances. Varadi (2012) attempted to find the impact of speculators and investors in the Indian commodity futures market and found that speculation played an important role in price volatility, especially during the global crisis. He has pointed out how the theory of normal backwardation is helpful in this regard. Gorton et al. (2012) empirically verified how price-based signals are related to inventory levels and risk, and observed that an increase in hedging (decrease in long positions) by commercials is associated with higher futures returns. Commercials increase their short positions as prices rise, while non-commercial increase their long position in a rising market. Das and Chakroborty (2015) observed that a positive basis implies that the futures market is in backwardation, whereas a negative basis is termed as contango. Potato prices show a mixed pattern, with a greater incidence of contango and backwardation. Botterud et al. in 2016 studied the relationship between long and short-term prices in the Scandinavian electricity market. They established that on an average the futures price seems to overestimate the actual spot price and the average risk premium is negative.

The literature review has discovered the gaps in research in the commodity derivatives market in India. Although many researchers have studied the derivatives market, the sample period and commodities this study considers are unique. Further, this study focuses on the comparison of metal and agricultural commodities. Most importantly, the study attempts to assess the market situation—contango and normal backwardation—in both the metal and agricultural futures markets and relate it to price discovery and hedging effectiveness.

## Research Methodology

### *Data Crunching*

The Indian commodities market has witnessed more setbacks in commodity derivatives trading despite the increasing volume of trade; it captures 7% of world trade (Kapil & Kapil, 2010). This has been the motivation behind this study. We considered near-month daily data from January 2010 to December 2015 for select agricultural and base metal commodities: chana, chili, jeera, soybean and turmeric. We also considered commodities like aluminium, copper, lead, nickel and zinc in base metal commodities. The commodities are selected based on the continuity in their trading cycle. Scant research has been conducted in agricultural and metal commodities in India. Metal commodities and agricultural commodities differ in terms of durability and trade. Hence, a differential analysis would yield the relevant results. The prime sources of data are the National Commodity and Derivatives Exchange (NCDEX) and Multi Commodity Exchange (MCX). The select commodities are traded throughout the year, barring some agricultural commodities like jeera, chili and turmeric. These commodities have a cyclical break of one or two months every year due to sowing and harvesting activities on the yard. We considered a time span of six years to observe price discovery, lead–lag relationship and short-run disturbances.

### *Methodology*

The commodity futures market is a significant part of the financial market, and it has been the focus of research for several researchers. Researchers have used various methodologies ranging from intensive analysis through simple statistical tools, as applied by Muravyev et al. (2013) for analysing price discovery in equity options, to simple econometric tools like unit root test and autocorrelation test, as used by Nargunam and Anuradha (2017), price discovery metrics namely, Hasbrouck information share and Harris-McInish-Wood component share as proposed by Hasbrouck (1995) and Harris et al. (2002a, 2002b) respectively to highly complicated tools like cointegration, causality test, variance decomposition, impulse response function, GARCH models, and so on, by various new generation researchers. After an extensive literature review, this study uses the following tools:

*Unit root test*: The stock market or daily closing price data are basically non-stationary in nature, similar to macroeconomic time-series data (Nelson & Plosser, 1982). Non-stationary time-series data sometimes provide spurious regression results, amounting to serious bias (Tahir et al., 2010). The study employed the augmented Dickey–Fuller (ADF) test before proceeding with further analyses. Hence, the unit root test will be

$$\Delta M_t = k + \propto t + \wp M_i + \sum_{i=1}^{n} \varsigma_i \Delta M_{t-i} + \varepsilon_t \tag{1}$$

where $\Delta$ is the first difference operator, $t$ captures the time period of variable $M$ , $n$ stands for an optimum lag length, and $\varepsilon_t$ is the white noise term. Here, we have optimal lag length to ensure that error term is a white noise. Elements like $k$ , $\propto$ , $\wp$ and $\varsigma$ are the estimation parameters. The null hypothesis will be rejected when $\wp \neq 0$ and we will conclude that the series does not have a unit root, hence it is stationary.

*The Johansen's test for cointegration*: The Johansen's cointegration test is used in the study to examine the long-run association between the spot and futures market. This test is otherwise called the likelihood ratio test. The Johansen's test is of two types: the first part focuses on the maximum eigenvalue test and the second emphasizes the trace test. The Johansen's tests for both statistics are an initial null hypothesis of no cointegration between the variables. The maximum eigenvalue test examines whether the largest eigenvalue is zero compared to the next alternative eigenvalue (Dwyer, 2015). The $\lambda_{max} eq^n$ of maximum eigenvalue will be

$$\lambda_{max}(r, r+1) = \{-T \ln(1-\lambda_{r+1})\} \tag{2}$$

where $r$ be the rank of matrix $\psi$, $\lambda_{max}$ denotes the likelihood ratio statistics between $r$ versus $r + 1$. The first test shows the rank of the matrix $\mathcal{E}$ is zero. We can write the null hypothesis for rank $\psi = 0$ and the alternative hypothesis for rank $\psi = 1$. Furthermore, the null hypothesis for rank can be defined as $\psi = 1,2$ , and the alternative hypothesis as $\psi = 2,3$. If the rank of the matrix $\mathcal{E}$ amounts to be zero, the largest eigenvalue $\lambda_n$ is also found to be zero, and the conclusion would be that there is no cointegration test. Additionally, if the largest eigenvalue $\lambda_1$ is non-zero, the rank of the matrix is found to be at least one, and the conclusion would be that there are more cointegrating vectors. In the second aspect of the eigenvalue test, we have to consider the second largest eigenvalue $\lambda_2$. Now, let the second largest eigenvalue be zero, and here we can assume that there will be at least one cointegrating vector and vice versa. The test repeats for $r = 1, \ldots\ldots n$, until one misses the mark to reject the null hypothesis.

Similarly, in trace statistics, the rank of the matrix $\mathcal{E}$ is $r$ , and simultaneously, the null hypothesis is $\psi = 0$ with an alternative hypothesis that $r < \psi < n$ , where $n$ is the maximum number of possible cointegrating vectors. In another attempt, the null hypothesis will be $r + 1$ , and $r + 1 < \psi < n$ will be the alternative hypothesis. Then, the $\lambda_{trace}$ test $eq^n$ will be

$$\lambda_{trace}(r, n) = \left\{-T \sum_{i=r+1}^{n} \ln(1-\lambda_i)\right\} \tag{3}$$

where, $r$ is the number of cointegrating vector, $\lambda_{trace}(r, n)$ is the likelihood statistics for measuring $\psi = r$ versus $\psi < n$ . $\lambda_i$ is the examined value for the $i^{th}$ order eigenvalue from the $\mathcal{E}$ matrix.

*Causality test*: Granger (1961) defined a time-series data-based approach to measure causality. The Granger causality test is also used as a forecasting technique. Assuming we have an information set $Ҁ_t$ with the form ($x_t ,\ldots x_{t-j}$ , $y_t ,\ldots y_{t-i}$). Here, we can also presume that $x_t$ Granger causes for $y_t$ . In such an instance, the $Ҁ_t$ is probably the optimal linier predictor of $y_{t+h}$ . Again, the $Ҁ_t$ has a smaller variance than the optimal linear predictor $y_{t+h}$, where the lagged values of $y_t$ for any $h$. Thus, $x$ Granger causes $y$, only when if, $\sigma_a^2(y_t : y_{t-j}, x_{t-i}) < \sigma^2(y_t : y_{t-j})$ with $j,i = 1.2.3,\ldots n$ and $\sigma^2$ will be the variance of forecasting error. Now, according to Mahdavi and Sohrabian (1989), the Granger causality $eq^n$ between the spot price ( $s_t$ ) and the futures price ( $f_t$ ) for time $t$, will be

$$f_t = \sigma + \sum_{i=1}^{m} \beta_i f_{t-i} + \sum_{j=1}^{n} \kappa_j s_{t-j} + \varepsilon_t \tag{4}$$

$$s_t = \xi + \sum_{i=1}^{p} \beta_i s_{t-i} + \sum_{j=1}^{q} \xi_j f_{t-j} + \varepsilon_t \tag{5}$$

The unidirectional Granger causality from the spot to the futures price provides information about how the spot price influences the futures price, and in such a case, $\sum_{j=1}^{n} \kappa_j \neq 0$ and $\sum_{j=1}^{q} \xi_j = 0$. The causality test otherwise provides influential direction, whereby we can capture the influence of one variable on another and the direction of that movement. Second, when the direction of influence is from futures to spot, it reveals that the futures price influences the spot price, and in such a case, $\sum_{j=1}^{n} \kappa_j = 0$ and $\sum_{j=1}^{q} \xi_j \neq 0$. Third, in a bi-directional situation, either the spot price influences the futures price or the futures price influences the spot price, so in such a case, $\sum_{j=1}^{n} \kappa_j \neq 0$ and $\sum_{j=1}^{q} \xi_j \neq 0$.

*Error correction model*: The error correction model is used to determine the lead–lag relationship and the magnitude of error correction between spot and futures prices. The error correction model is associated with VAR (vector auto regression) family. Normally, we approach the ECM when our VAR is under restriction. After the cointegration verdict, the association between two variables like the spot and futures price further leads to vector error correction model (VECM), which is a restricted VAR, and the dissolution between the variables results in an unrestricted VAR. In the ECM approach, the speed of adjustment is captured for one variable over another variable to correct errors toward the long-run equilibrium. As per Sehgal et al. (2012), the more a market transmits information to another market, the more efficient the derivatives market will be**.** Information asymmetry also causes price movement, that is from spot to futures or from futures to spot. This is also called the lead–lag association of prices or markets in the derivative segment. VECM assumes that a portion of the disequilibrium in a given period will be corrected in the subsequent period (Shakeel & Purankar, 2014). The study has also focused on ‘short-run disturbances’ to arrest the short-run adjustment of errors. Short-run disturbances are typically based on strategic error correction dynamics in the VAR system. When we transform the VAR system, we could understand that

For and $n \times 1$ vector variables of $x_t$, at the time t, the Gaussian VAR for the $l^{th}$ order, the $eq^n$ will be

$$\Delta x_t = \tilde{n} x_{t-1} + \sum_{p=1}^{l-1} k_p \Delta x_{t-p} + \varepsilon_t \tag{6}$$

$t = 1, 2, \ldots, T$ and $\varepsilon_t \sim NI(0, \Sigma$

where $\varrho$ and $k_p$ are the $n \times n$ matrices of coefficients, $\Delta$ is the difference operator, and $\varepsilon_t$ is the normally distributed disturbances term. The rank of $\varrho$ is denoted as $r, 0 \leq r \leq n$ and it also represents the number of cointegrating errors in the system; hence, the $eq^n 6$ can be rewritten as

$$\Delta x_t = ø g x_{t-1} + \sum_{p=1}^{l-1} k_p \Delta x_{t-p} + \varepsilon_t \tag{7}$$

In an $n \times r$ matrix of r coordinating vectors ģ and the $n \times r$ weighting matrix ø. The $eq^n 7$ can be rewritten after partitioning the sub vectors of $w$ and $q$ variables as ( $\nu_t : c_t$ )

$$\Delta y_t = L_0' \Delta z_t + \text{ø}_{\varsigma}\, g x_{t-1} + \sum_{p=1}^{l-1} k'_{1,p} \Delta x_{t-p} + \acute{\upsilon}_t \tag{8}$$

$$\acute{\upsilon}_t \sim NI(0, \Sigma'_{\upsilon})$$

Again, for $z_t$, the equation will be

$$\Delta z_t = \text{ø}_2\, g x_{t-1} + \sum_{p=1}^{l-1} k'_{2,p} \Delta x_{t-p} + \varepsilon_{2,t} \tag{9}$$

where $L_0' = \Sigma_{1,2}\Sigma_{2,2}^{-1}$, $\text{ø}_{\varsigma} = \text{ø}_1 - L_0' \text{ø}_2$, $k'_{1,p} = k_{1,p} - L_0' k'_{2,p}$, $\acute{\upsilon}_t = \varepsilon_{1,t} - L_0' \varepsilon_{2,t}$, and last but not the least $\Sigma'_{\upsilon} = \Sigma_{1,1} - \Sigma_{1,2}\Sigma_{2,2}^{-1}\Sigma_{2,1}$ matrices are subcategorized with considering ($\nu_t : c_t$).

A continual leeway of fluctuations exists in the price of one market (spot/futures) when there is a change in another market (futures/spot), and hence, the equation of the futures and spot market can be written as

$$F_t = \sigma + \beta S_t + \varepsilon_t \tag{10}$$

We represent the Equation (1) as,

$$F_t - \sigma - \beta S_t = \hat{\varepsilon}_t \tag{11}$$

where $F_t$ and $S_t$ are the futures and spot prices of select commodities at time t. The coefficients (α, β) are the intercept and slope of the equation respectively, $\hat{\varepsilon}_t$ is the estimated white noise term. In the cointegrating equation, each market is represented by ECM. It also includes the last lag's equilibrium error with the intercept term and lagged values of first difference.

Therefore, it is very important to identify the statistical significance and the magnitude of the error correction coefficient and the coefficient of lagged variable.

$$\Delta S_t = \delta_s + \sum_{i=1}^{n} \sigma_{si} \Delta F_{t-1} + \sum_{i=1}^{n} \beta_{si} \Delta S_{t-1} + \gamma_s \Delta € _{t-1} + \varepsilon_{s,t} \tag{12}$$

$$\Delta F_t = \delta_f + \sum_{i=1}^{n} \sigma_{fi} \Delta S_{t-1} + \sum_{i=1}^{n} \beta_{fi} \Delta F_{t-1} + \gamma_f \Delta € _{t-1} + \varepsilon_{f,t} \tag{13}$$

$$€_{t-1} = S_{t-1} - \delta - \theta\, F_{t-1} \tag{14}$$

where $\delta_s$, $\delta_f$, are the intercepts, and $\varepsilon_{s,t}$, $\varepsilon_{f,t}$ are the white noise terms. The $\delta_s$, $\delta_f$, $\sigma_s$, $\sigma_f$, $\gamma_s$ and $\gamma_f$ are the parameters. $€_{t-1}$ is the error correction term (ECT) that measures how the dependable variable adjusts to the previous period's deviation from long-run equilibrium. The speed of adjustment is described by the intercept coefficient, $\sigma_f$ and $\sigma_s$. At least one coefficient must not be zero in ECM. θ is the cointegration vector and δ is the intercept.

*Contango and normal backwardation*: The study has also investigated the market situations regarding contango and normal backwardation in the derivatives segment. The situations are gauged depending on the basis, which is calculated by deducting the futures price from the spot price. In normal backwardation, the basis is positive, that is, $S_t > F_t$, which is caused due to a short supply of commodities. The backwardation is also called an abnormal market condition. In contrast, the contango is a negative basis, that is, $S_t < F_t$ and considered a normal market condition (Keynes, 1930).

*Hedging*: Price instability in the cash market drags the futures market into the discussion. Hedging provides a linear relationship between the spot and futures prices and explains the number of units of futures contract sold per unit of spot assets held. The study uses the conventional approach of ordinary least squares (OLS) in a linear regression to describe the change in spot prices or in futures price. The equation is depicted below:

$$R_s = \sigma_0 + \sigma_1 R_f + \varepsilon_t \tag{15}$$

The $R_s$ and $R_f$ is the return value of spot and futures price, $\sigma_1$ is the slope coefficient of ordinary least square regression, which is the estimate of the optimal hedge ratio, $\partial$, and is also known as the MV hedge ratio (Mayers & Thompson, 1989).

$$\text{Now, } \sigma_1 = \sigma_{s,f} / \sigma_f^2 \tag{16}$$

where $\sigma_{s,f}$ is the covariance between spot and futures prices, and $\sigma_f^2$ is the variance of futures returns. Although OLS is robust and dynamic in nature, we must still be careful. The disturbance term will be heteroskedastic if any violation occurs in the assumption. The spot and futures prices must follow the random walk hypothesis and $\varepsilon_s$ & $\varepsilon_f$ should be normally distributed. The OLS uses unconditional sample moments rather than conditional moments (Park & Switzer, 1995). The basis must decline in the futures contract and touch zero in the convergence month; it is normally observed in a direct hedge environment (Fama, 1970).

## Results and Discussion

*Unit root test*: The study has examined the prerequisite of Johansen's cointegration test, that is, stationarity of the time series. Table 1 shows the results of the ADF test, and the *p*-values indicate that the series stands stationary at first difference but non-stationary at level.

*Long-run association*: Table 2 shows the results of the cointegration test. The results justify that both agricultural and metal commodities are satisfying at least one cointegrating equation in the long run. Hence, it can be concluded that the spot and futures prices of select commodities share positive and negative fluctuation over the long run.

*Influential direction*: As already discussed, the Granger causality test provides an unambiguous implication of influential direction. The results as shown in Table 3 clearly help us understand that commodities such as chana, jeera and soybean have bi-directional causality between spot and futures and chili and turmeric have unidirectional causality in the agricultural segment. In bi-directional causality, both spot and futures Granger causes futures or spot. In chili and turmeric, unidirectional causality is observed. The spot price influences the futures price for Chili and the future price influences the spot price for turmeric. In the metal segment, aluminium, lead, nickel and zinc have bi-directional causality, where both futures influence spot and vice versa. The unidirectional connectedness is found only in copper, where the futures prices influences the spot price.

Table 1. ADF Unit Root Test.

| Agriculture Commodities | Spot Price | | | | Futures Price | | | |
|---|---|---|---|---|---|---|---|---|
| | Level | | First Difference | | Level | | First Difference | |
| | *t-stats* | *Prob** | *t-stats* | *Prob** | *t-stats* | *Prob** | *t-stats* | *Prob** |
| Chana | -0.871 | 0.798 | -36.095 | 0.000 | -0.885 | 0.793 | -37.750 | 0.000 |
| Chili | -0.125 | 0.945 | -23.326 | 0.000 | -0.705 | 0.843 | -28.295 | 0.000 |
| Jeera | -1.937 | 0.316 | -17.825 | 0.000 | -2.729 | 0.069 | -37.268 | 0.000 |
| Soyabean | -1.333 | 0.616 | -29.715 | 0.000 | -1.556 | 0.505 | -35.238 | 0.000 |
| Turmeric | -1.373 | 0.597 | -25.893 | 0.000 | -1.476 | 0.546 | -29.159 | 0.000 |
| Metal Commodities | Level | | First Difference | | Level | | First Difference | |
| | *t-stats* | *Prob** | *t-stats* | *Prob** | *t-stats* | *Prob** | *t-stats* | *Prob** |
| Aluminium | -3.521 | 0.008 | -43.906 | 0.000 | -3.321 | 0.014 | -43.927 | 0.000 |
| Cupper | -2.242 | 0.192 | -25.999 | 0.000 | -2.033 | 0.273 | -25.753 | 0.000 |
| Lead | -2.766 | 0.063 | -42.891 | 0.000 | -2.658 | 0.082 | -41.114 | 0.000 |
| Nickel | -1.710 | 0.426 | -41.050 | 0.000 | -1.527 | 0.520 | -39.016 | 0.000 |
| Zinc | -2.297 | 0.173 | -44.054 | 0.000 | -2.155 | 0.223 | -42.093 | 0.000 |

Source: The authors.

Table 2. Johansen's Test for Cointegration.

| Agricultural Commodities | No. of Cointegrating Equations | Max Eigen Statistic | Trace Statistic | 0.5 Critical Value | Prob.** |
|---|---|---|---|---|---|
| Chana | r = 0 | 58.943 | 59.663 | 15.495 | 0.000* |
| | r ≤ 0 | 0.720 | 0.720 | 3.841 | 0.396 |
| Chili | r = 0 | 22.011 | 22.061 | 15.495 | 0.000* |
| | r ≤ 0 | 0.050 | 0.050 | 3.841 | 0.824 |
| Jeera | r = 0 | 148.321 | 152.929 | 15.495 | 0.000* |
| | r ≤ 0 | 4.608 | 4.608 | 3.841 | 0.032 |
| Soyabean | r = 0 | 153.137 | 155.128 | 15.495 | 0.000* |
| | r ≤ 0 | 1.990 | 1.990 | 3.841 | 0.158 |
| Turmeric | r = 0 | 43.222 | 45.441 | 15.495 | 0.000* |
| | r ≤ 0 | 2.219 | 2.219 | 3.841 | 0.136 |
| Metal Commodities | | | | | |
| Aluminium | r = 0 | 291.693 | 302.353 | 15.495 | 0.000* |
| | r ≤ 0 | 10.661 | 10.661 | 3.841 | 0.131 |
| Copper | r = 0 | 207.412 | 212.461 | 15.495 | 0.000* |
| | r ≤ 0 | 5.049 | 5.049 | 3.841 | 0.025 |

*(Table 2 continued)*

*(Table 2 continued)*

| Agricultural Commodities | No. of Cointegrating Equations | Max Eigen Statistic | Trace Statistic | 0.5 Critical Value | Prob.** |
|---|---|---|---|---|---|
| Lead | r = 0 | 359.592 | 367.097 | 15.495 | 0.000* |
| | r ≤ 0 | 7.505 | 7.505 | 3.841 | 0.006 |
| Nickel | r = 0 | 412.390 | 414.833 | 15.495 | 0.000* |
| | r ≤ 0 | 2.443 | 2.443 | 3.841 | 0.118 |
| Zinc | r = 0 | 407.419 | 412.103 | 15.495 | 0.000* |
| | r ≤ 0 | 4.684 | 4.684 | 3.841 | 0.030 |

Source: The authors.

Notes: Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level. *denotes rejection of the hypothesis at the 0.05 level. **MacKinnon-Haug-Michelis (1999) *p*-values.

Table 3. Granger Test for Causality.

| Agricultural Commodities | Null Hypotheses | F-Statistic | Prob. | Decision |
|---|---|---|---|---|
| Chana | Ft price does not Granger-cause St price | 201.310 | 0.000 | Bi-directional |
| | St price does not Granger-cause Ft price | 13.649 | 0.000 | |
| Chili | Ft price does not Granger-cause St price | 2.885 | 0.056 | Unidirectional |
| | St price does not Granger-cause Ft price | 4.919 | 0.008 | |
| Jeera | Ft price does not Granger-cause St price | 135.433 | 0.000 | Bi-directional |
| | St price does not Granger-cause Ft price | 4.815 | 0.008 | |
| Soyabean | Ft price does not Granger-cause St price | 71.296 | 0.000 | Bi-directional |
| | St price does not Granger-cause Ft price | 12.277 | 0.000 | |
| Turmeric | Ft price does not Granger-cause St price | 21.192 | 0.000 | Unidirectional |
| | St price does not Granger-cause Ft price | 0.531 | 0.588 | |
| Metal Commodities | | | | |
| Aluminium | Ft price does not Granger-cause St price | 383.571 | 0.000 | Bi-directional |
| | St price does not Granger-cause Ft price | 9.243 | 0.000 | |
| Copper | Ft price does not Granger-cause St price | 306.764 | 0.000 | Unidirectional |
| | St price does not Granger-cause Ft price | 0.201 | 0.818 | |
| Lead | Ft price does not Granger-cause St price | 534.130 | 0.000 | Bi-directional |
| | St price does not Granger-cause Ft price | 3.302 | 0.037 | |
| Nickel | Ft price does not Granger-cause St price | 492.559 | 0.000 | Bi-directional |
| | St price does not Granger-cause Ft price | 4.741 | 0.009 | |
| Zinc | Ft price does not Granger-cause St price | 385.390 | 0.000 | Bi-directional |
| | St price does not Granger-cause Ft price | 4.934 | 0.007 | |

Source: The authors.

Note: Ft denotes Futures Price and St denotes Spot Price.

*.Lead–lag affiliation*: Table 4 shows that the ECT of the futures price for chana and chili was found to be negative and significant. It reveals that the futures rectify the anomalies in its price series toward equilibrium. On the other hand, the spot prices in turmeric self-correct toward equilibrium as the ETC is negative and significant. In contrast, for jeera and soybean, the ECT for both spot and futures are found to be significant and positive, revealing that both markets react differently in the opposite direction until equilibrium is reached when there is a shock in the market. However, considering the magnitude of adjustment, it can be concluded that the spot market dominates the futures market. Again, Table 5 shows metal commodities where the futures prices self-correct toward equilibrium in case of aluminium, lead, copper and zinc. But in the case of nickel, the spot prices correct deviations from the equilibrium.

*Short-run disturbance approach*: Through the help of ECT, we have assessed the long-run lead–lag relationship. The influence of the lagged spot and futures prices on the spot and futures prices in short run can be gauged from their coefficients and significance level, as provided in the VECM results in Table 4 and Table 5. In the case of chana, we see that the previous one-day futures and spot prices significantly impact the spot prices of the commodity. Likewise, in case of chili, the one-day lagged spot price influences the spot price itself. For soybean and turmeric, previous one-day futures prices significantly influence the spot prices. One-day lagged futures prices also influence futures prices in case of soybean. Again, a change in the spot prices of jeera is influenced by the previous one-day spot and futures price. The futures price is influenced by the lagged one and two-day spot prices. When the results are clubbed and the agricultural commodities are evaluated together, the futures market is found to be leading the spot prices in the short run, except in the case of chili. Likewise, for metal commodities too, the futures market is seen to be leading the spot prices, except in the case of copper.

*Price discovery process*: The price discovery process is the utmost motivation for research in the derivatives market. The efficiency of any emerging market is tilted toward information diffusion. At times, it is argued that the futures market assimilates information faster than the spot market does. Information asymmetry affords a different altitude of spot and futures prices. The benefit of price discovery in futures trading is predicted on the assumption that the futures price reflects the combined views of a large number of buyers and sellers, and thus, it is an expression of their perception of the future value of commodities (Fortenbery & Zapta, 1997). The process of price discovery is evaluated with the help of the Granger causality test and VECM. The direction of influence and the lead–lag relationship speak about the price discovery mechanism of the futures market. In this section, we have merely elaborated the inferences of those results. In our case, price discovery is found to be absent in the agricultural commodities, barring turmeric, as the spot market is found to be leading the futures market. However, in the short run, the result is opposite. This contradicts the findings of Bose (2008), Sehgal et al. (2012), Edward and Rao (2013), and Sendhil et al. (2013). However, the contradiction is justified as the researchers have examined different commodities and different time periods. Yet, the futures price is found to be leading in the metal segment, except in the case of nickel.

<Level B>*Contango and Normal Backwardation*

This study has investigated contango and normal backwardation to understand the market conditions for both agricultural and metal commodities. Table 6 shows that agricultural commodities provide considerably larger backwardation than contango over six years. The main factors behind such backwardation are short supply of agricultural commodities, food inflation, cartel risk and seasonality. Given the lack of similarity of the market and price variations, the producer will hedge short, whereas the speculator will net long. In this case, the producer sets the futures price below the spot price. The situation is different for contango (Rout & Rao, 2017). Producers are risk-averse as they have more fear than consumers because the commodities are in their possession, so in that specific instance, the convenience yield of the commodities will be higher than the cost of storage. This leads to an inherited

Table 4. Vector Error Correction Model (Agriculture).

| | Chana | | Chili | | Jeera | | Soyabean | | Turmeric | |
|---|---|---|---|---|---|---|---|---|---|---|
| | ΔS_t | ΔF_t | ΔS_t | ΔF_t | ΔS_t | ΔF_t | ΔS_t | ΔF_t | ΔS_t | ΔF_t |
| Ω | 1.217 | 1.361 | 5.962 | 7.405 | 0.328 | -0.123 | 0.770 | 0.738 | -1.735 | -1.592 |
| | [ 1.090] | [0.971] | [1.326] | [1.000] | [0.115] | [-0.019] | [0.718] | [0.478] | [-0.236] | [-0.171] |
| ΔS_t-1 | -0.189** | 0.036 | 0.166** | 0.123 | -0.101** | 0.145** | 0.038 | 0.129 | 0.029 | 0.037 |
| | [-5.458] | [0.842] | [3.955] | [1.777] | [-3.073] | [2.008] | [1.027] | [2.435] | [0.673] | [0.657] |
| ΔS_t-2 | -0.010 | 0.049 | 0.000 | -0.057 | 0.001 | 0.139** | 0.029 | -0.004 | 0.028 | 0.051 |
| | [-0.341] | [1.329] | [-0.008] | [-0.839] | [0.050] | [2.126] | [0.899] | [-0.103] | [0.647] | [0.952] |
| ΔF_t-1 | 0.467** | 0.064 | 0.035 | -0.001 | 0.196** | 0.033 | 0.189** | 0.059** | 0.125** | 0.035 |
| | [16.633] | [1.804] | [1.354] | [-0.032] | [12.471] | [0.963] | [6.649] | [1.456] | [3.404] | [0.759] |
| ΔF_t-2 | -0.057 | -0.052 | 0.036 | 0.036 | 0.010 | -0.066 | -0.028 | 0.004 | 0.016 | -0.065 |
| | [-1.924] | [-1.395] | [1.423] | [0.854] | [0.633] | [-1.861] | [-1.058] | [0.124] | [0.454] | [-1.431] |
| € | 0.020 | -0.089** | 0.012 | -0.037** | 0.056** | -0.069** | 0.109** | -0.110** | -0.069** | 0.013 |
| | [1.371] | [-4.740] | [1.553] | [-2.705] | [6.465] | [-3.671] | [5.696] | [-3.734] | [-4.335] | [0.661] |

Source: The authors.

Note: Ω = Constant, € = Error Correction Term, [] t = Stats, ** Significance at 5%.

Table 5. Vector Error Correction Model (Metal).

| | Aluminium | | Copper | | Lead | | Nickel | | Zinc | |
|---|---|---|---|---|---|---|---|---|---|---|
| | ΔS_t | ΔF_t | ΔS_t | ΔF_t | ΔS_t | ΔF_t | ΔS_t | ΔF_t | ΔS_t | ΔF_t |
| Ω | -0.001 | -0.002 | -0.017 | -0.003 | 0.002 | 0.001 | -0.153 | -0.166 | -0.007 | -0.006 |
| | [-0.061] | [-0.092] | [-0.086] | [-0.012] | [0.089] | [0.050] | [-0.492] | [-0.445] | [-0.233] | [-0.191] |
| ΔS_t-1 | -0.141** | 0.037 | -0.006 | -0.006** | -0.161 | -0.026 | -0.104** | -0.046 | -0.132** | -0.069 |
| | [-4.207] | [0.971] | [-0.093] | [-0.072] | [-4.692] | [-0.632] | [-2.552] | [-0.940] | [-3.347] | [-1.561] |
| ΔS_t-2 | -0.017 | 0.031 | -0.046 | -0.025 | -0.063** | -0.04 | -0.062** | -0.044 | -0.052 | -0.032 |
| | [-0.715] | [1.104] | [-1.131] | [-0.469] | [-2.631] | [-1.376] | [-2.234] | [-1.351] | [-1.873] | [-1.003] |
| ΔF_t-1 | 0.271** | -0.031 | 0.074 | 0.014 | 0.239** | 0.07 | 0.225** | 0.142** | 0.191** | 0.091 |
| | [7.490] | [-0.762] | [0.958] | [0.145] | [6.215] | [1.495] | [5.049] | [2.666] | [4.385] | [1.856] |
| ΔF_t-2 | 0.11** | -0.002 | 0.056 | 0.028 | 0.137** | 0.089** | 0.08 | 0.021** | 0.111** | 0.085** |
| | [3.559] | [-0.082] | [1.000] | [0.381] | [4.358] | [2.330] | [2.275] | [0.512] | [3.211] | [2.157] |
| € | 0.452** | -0.102** | -0.951** | -0.021 | 0.567** | -0.104** | 0.066** | -0.162** | 0.617** | -0.178** |
| | [12.89] | [-2.556] | [11.114] | [0.194] | [14.55] | [-2.189] | [13.565] | [-2.792] | [13.241] | [-3.381] |

Source: The authors.

Note: Ω = Constant, € = Error Correction Term, [] *t*-stats.

Table 6. Contango and Normal Backwardation.

| Agricultural Commodity | Market Situation | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2010-2015 |
|---|---|---|---|---|---|---|---|---|
| Chana | *Contango* | 50.34 | 57.53 | 37.63 | 25.00 | 48.70 | 27.56 | 41.94 |
| | *Backwardation* | 49.66 | 42.47 | 62.37 | 75.00 | 51.30 | 72.44 | 58.06 |
| Chili | *Contango* | 23.37 | 37.36 | 20.75 | 50.32 | 60.12 | 21.12 | 30.49 |
| | *Backwardation* | 76.63 | 62.64 | 79.25 | 49.68 | 39.88 | 78.88 | 69.51 |
| Jeera | *Contango* | 26.22 | 35.71 | 11.52 | 6.90 | 25.51 | 11.79 | 20.04 |
| | *Backwardation* | 73.78 | 64.29 | 88.48 | 93.10 | 74.49 | 88.21 | 79.96 |
| Soyabean | *Contango* | 94.85 | 81.42 | 51.15 | 20.99 | 28.44 | 38.77 | 57.29 |
| | *Backwardation* | 5.15 | 18.58 | 48.85 | 79.01 | 71.56 | 61.23 | 42.71 |
| Turmeric | *Contango* | 25.61 | 27.27 | 94.41 | 27.50 | 82.64 | 38.75 | 49.14 |
| | *Backwardation* | 74.39 | 72.73 | 5.59 | 72.50 | 17.36 | 61.25 | 50.86 |
| Metal Commodities | | | | | | | | |
| Aluminium | *Contango* | 75.58 | 78.95 | 79.87 | 85.22 | 81.50 | 73.44 | 79.14 |
| | *Backwardation* | 24.42 | 21.05 | 20.13 | 14.78 | 18.50 | 26.56 | 20.86 |
| Copper | *Contango* | 56.20 | 58.87 | 65.60 | 64.75 | 56.44 | 58.25 | 60.20 |
| | *Backwardation* | 43.80 | 41.13 | 34.40 | 35.25 | 43.56 | 41.75 | 39.80 |
| Lead | *Contango* | 72.43 | 59.87 | 71.05 | 69.76 | 68.77 | 74.51 | 69.26 |
| | *Backwardation* | 27.57 | 40.13 | 28.95 | 30.24 | 31.23 | 25.49 | 30.74 |
| Nickel | *Contango* | 67.44 | 67.03 | 73.03 | 74.22 | 71.15 | 69.80 | 70.46 |
| | *Backwardation* | 32.56 | 32.97 | 26.97 | 25.78 | 28.85 | 30.20 | 29.54 |
| Zinc | *Contango* | 73.09 | 81.25 | 74.01 | 77.32 | 63.78 | 71.37 | 73.79 |
| | *Backwardation* | 26.91 | 18.75 | 25.99 | 22.68 | 36.22 | 28.63 | 26.21 |
| | Contango | | Backwardation | | | | | |

Source: The authors.

Note: Contango, Backwardation.

weakness on the demand side of many commodities' future contracts (Feldman & Till, 2006). Simultaneously, base metal commodities manifest contango over six years as these commodities are more stable and freer from seasonality and inflationary drawbacks compared to agricultural commodities. These results are also consistent with the results of price discovery. When the market is in backwardation, the spot price is generally assumed to be leading, which is visible from the results of VECM.

## *Hedging Effectiveness*

The derivatives market is prone to price instability: a small fluctuation in prices leads to a large change in earnings. The extent of variance in returns that can be eliminated by hedging is called hedging effectiveness (Malhotra, 2015). The futures were introduced to resolve the instability of the commodity derivatives market. Table 7 shows the futures market approaches toward price volatility in the cash market. The $R^2$ of select commodities depicts the hedging efficiency of the futures market, and it measures the degree to which concurrent gains or losses in the spot market are balanced by respective losses or gains in the futures market. The $R^2$ of metal commodities is above 50%, confirming that the futures market is efficient in the case of metal commodities. In the case of agriculture commodities, barring chana, the $R^2$ is below 50%, revealing an inefficient futures market. This contradicts the findings of Malhotra (2015), and it is clearly visible why, as the sample commodities were different. Again, the constant hedge ratio, $\beta$, is lower in agricultural commodities than in metal commodities, amounting to an unenforceable futures market (Bose, 2008).

## Conclusion

This study has focused on the functioning of Indian commodity futures market, with special regard to the price discovery process and hedging effectiveness. It has gone further by comparing the agricultural and metal commodities. Considering five metal and five agricultural commodities during 2010–2015 and using the Granger causality test and VECM on the data set, we find that the spot price leads the futures price in discovering prices of agricultural commodities, barring turmeric. On the other hand, the futures market is found to be dominant in case of metal commodities, barring nickel. As per Chhajed and Mehta (2013), if changes in spot prices lead changes in futures prices, effective hedging strategies can be formulated. If changes in future prices lead changes in spot prices, effective speculative strategies can be formulated. Further, backwardation of market is constantly noticed in agricultural commodities. In this case, hedgers will hedge short and speculators will net long. In metal commodities, the prevalence of contango is largely observed. Thus, the hedgers will hedge long as an optimum strategy to gain premium until it reaches equilibrium. All the findings point toward an efficient futures market for metal commodities

Table 7. Hedging.

| Sl. No. | Agricultural Commodity | Hedge Ratio ($\beta$) | Hedging Efficiency ($R^2$) | Correlation between Spot & Futures ($r$) |
|---|---|---|---|---|
| 1 | Chana | 0.601 | 0.362 | 0.55 |
| 2 | Chili | 0.571 | 0.326 | 0.57 |
| 3 | Jeera | 0.591 | 0.351 | 0.48 |
| 4 | Soyabean | 0.672 | 0.452 | 0.67 |
| 5 | Turmeric | 0.672 | 0.452 | 0.58 |
| Metal Commodity | | | | |
| 1 | Aluminium | 0.621 | 0.542 | 0.52 |
| 2 | Copper | 0.532 | 0.423 | 0.43 |
| 3 | Lead | 0.688 | 0.592 | 0.62 |
| 4 | Nickel | 0.734 | 0.626 | 0.65 |
| 5 | Zinc | 0.721 | 0.601 | 0.61 |

Source: The authors.

and an inefficient futures market for agricultural commodities. De Boyrie et al. (2012) listed factors such as the trading platform, the nature and content of information flow, volatility, market size, trade volumes, transparency and technology used as the determinants of the direction of information flow. In the present case, the agricultural commodity futures market is less transparent, less traded due to the temporary bans and highly volatile, which might have led to its inefficiency.

Different stakeholders can benefit from the information provided in this study, be it an Indian investor or a foreign one. Although globalization has brought opportunities, it comes with limitations. Foreign traders are exposed to excessive risk. This study clearly demonstrated the nature of the agricultural and metal commodities derivatives markets, with special regard to its efficiency, lead–lag relationship in the short and long run, and backwardation or contango, thus providing a clear picture of the Indian commodities derivatives market. Therefore, Indian investors will be able to hold their position as hedgers or speculators in long or short run to earn maximum benefit. Hedgers can plan their produce, inventory, price and amount to be hedged at certain price and time. As it has been found that the spot market leads in the long run and lags in short run, investors can benefit from such information when making short or long-run investment decisions. In India, Securities and Exchange Board of India (SEBI) regulates commodity market. The SEBI has right to check the inherent quality of the products which are traded in the exchanges. On the basis of price fluctuations, price discovery mechanism and hedging effectiveness, the board has right to suspend or promote commodities in the trading platform. Therefore, through this study, market regulators would be able to devise an optimum strategy toward developing and penetrating the commodities market. By having access to such specific information of the Indian market, and similar information about various other geographical markets, international investors can also frame their strategies for price risk management as well as for portfolio diversification. Further, India is one of the fastest-growing economies in the world. Therefore, any innovation pertaining to the financial markets in India would also impact the other markets across the globe. Therefore, market regulators in other countries may take necessary action toward the market. Moreover, such studies would help regulators worldwide to collectively take necessary steps toward unifying and standardizing the commodities markets.

## Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

## Funding

The authors received no financial support for the research, authorship and/or publication of this article.