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Economics

INTRADAY LEAD/LEG RELATIONSHIPS BETWEEN THE FUTURES AND SPOT COMMODITY MARKET

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ABSTRACT

The aim of this paper is to investigate the lead-leg relationships between non- precious metals – nickel and zinc-on Multi Commodity Exchange (MCX) and agricultural commodities -pepper and soybean-on National Commodities & Derivatives Exchange (NCDEX) using Johansen's co-integration test, VECM and Granger causality test. The analysis used daily data on spot prices and near month futures prices of all the four commodities over the period from April 2011 to April 2013 which is obtained from MCX and NCDEX website. The study concludes that all the series of spot and futures prices are co-integrated of order one, and exhibit a stable long-run equilibrium relationship. The results of VECM show that there is a bi-directional causality in spot and futures market but the futures market is found to be more sound in terms of discounting new information than the spot market. The results of Granger causality suggest that bi-directional causality exists between spot returns and future returns of nickel in short run. Whenever zinc and pepper future returns, Granger causes spot returns but not the other way round. Moreover, whenever Soybean spot returns, Granger causes future returns in the short run.

Keywords: Co- integration Test, Commodity Market, Granger causality, Market Efficiency, Multi Commodity Exchange, VECM Futures Markets.

JEL Code Classification: C32, G14

INTRODUCTION

In India, future trading in commodities started in 1875 when a contract in cotton was introduced by Bombay Cotton Trade Association. Chicago Board of Trade with standardized contracts on various commodities was the first organized commodity exchange at international level. It was established in 1848. Indian commodity markets are regulated by the Forward Market Commission (FMC). At present there are 17 recognized commodity exchanges in India

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and of these, 6 commodity exchanges carry operations nationwide and trading in these national exchanges is carried on in different commodities whereas other 11 exchanges are regional exchanges and in these regional exchanges trading is carried on in limited commodities.[1] Multi Commodity Exchange of India Limited (MCX) started operations in November 2003. MCX is India's leading commodity futures exchange with a market share of about 82.82 per cent in terms of the value of commodity futures contracts traded in FY2014-15. It is the world's third largest commodity futures exchange in terms of the numbers of contracts traded in CY2012. MCX offers trading in varied commodity futures contracts across segments including bullion, ferrous and non-ferrous metals, energy and agricultural commodities.[2] National Commodity & Derivatives Exchange Limited (NCDEX) started operations in December 2003. As on March 30, 2013, the NCDEX offered 31 contracts for trading of following items: 23 agricultural commodities, 3 precious metals, 2 energy, 1 polymer and 2 other metals. The top 5 commodities, in terms of volume traded at the Exchange, were Soya oil, Soybean, RM seed, Chana and Castor Seed.[3] Out of these non-precious metals - nickel and zinc are selected from MCX and agricultural commodities -pepper and soybean are selected from NCDEX for the present study.

Nickel is a metal with a bright future as it is the main alloying metal needed in the production of certain types of stainless steel. While zinc is the fourth most common metal in use, after iron, aluminium and copper in terms of the metal's annual production. Zinc can be recycled indefinitely, without loss of its physical or chemical properties. It is present in a wide variety of foods, and found particularly in association with protein foods. Nickel and zinc prices in India are fixed on the basis of the rates that rule on the international spot market, and Indian Rupee and US Dollar exchange rates. The annual demand for nickel in India is around 40,000 MT and its market in India is totally dependent on imports. In India, the primary end use of zinc is in the galvanising and coating sectors, which currently account for an estimated 57% and 16% of the total production respectively.[4] Black pepper (*Piper nigrum*) is a flowering vine in the family Piperaceae. Hot and pungent black pepper is one of the most popular spices in the world. In India, harvesting starts from December and extends till March whereas the arrivals in the physical markets start from February. World pepper production is around 2.6 MT to 3.1 MT per year. Vietnam is the world's largest producer and exporter of pepper, producing almost one-third of the world's pepper crop. Other major producers include India (19%), Brazil (13%), Indonesia (9%), Malaysia (8%), Sri Lanka (6%), China (6%), and Thailand (4%). India produces about 50.000 MT of pepper every year with Kerala & Karnataka accounting for more than 95% of the domestic production. Indian pepper is traded at a premium in international markets owing to its superior quality.[5] Soybean (*Glycine max*) is called as Golden Bean. The plant is classed as an oilseed and is an important global crop. The processed soybean is the largest source of protein feed and second largest source of vegetable oil in the world.[6] USA, Brazil, Argentina, China and India are the largest soybean producing countries in the world. Soybean is largest grown oilseeds in the world and other major source of oilseeds are rapeseed (13%), cottonseed (10%), peanut(8%), sunflower (7%) seed and palm kernels. Among major oilseeds, higher percentage of meal is extracted from soybean (82%). The prices of soybean are determined by demand and supply of oil and meal.[7] Contract specifications of the selected commodities are presented in Table 1 & 2. It is clear from the Tables that futures contracts for the two commodities under the study have same specifications except trading unit, maximum order size, ticket size and delivery unit.

Table 1: Some specifications of contracts for nickel and zinc traded on MCX

	Nickel	**Zinc**
Symbol	NICKEL	ZINC
Contract start day	First day of contract launch month. If first day is a holiday then the following working day.	First day of contract launch month. If first day is a holiday then the following working day.
Last trading day	Last calendar day of the contract expiry month. If last calendar day is a holiday or Saturday then preceding working day.	Last calendar day of the contract expiry month. If last calendar day is a holiday or Saturday then preceding working day.
Trading period	Mondays through Friday	Mondays through Friday
Trading unit	250 Kg.	5 Tons
Quotation/base value (kg)	1 Kg.	1 Kg.
Maximum order size (MT)	24 MT	100 Tons
Tick size (minimum price movement, paise/kg)	10	5
Initial margin	Minimum 6 % or based on span whichever is higher	Minimum 5 % or based on span whichever is higher
Delivery unit	3 MT with tolerance limit of +/- 1%	10 Tons with tolerance limit of +/- 1% (100 Kg.)
(*Source*: www.mcxindia.com)		

Table 2: Some Specifications of Contracts for Pepper and Soybean Traded on NCDEX

	Pepper	**Soybean**
Symbol	PPRMLGKOC	SYBEANIDR
Opening of contracts	Trading in any contract month will open on the 10th of the month. If the 10th day happens to be a non-trading day, contracts would open on the next trading day.	Trading in any contract month will open on the 1st day of the month. If the 1st day happens to be a non-trading day, contracts would open on next trading day.

Due date/Expiry date	20th day of the delivery month. If 20th happens to be a holiday, a Saturday or a Sunday then the due date shall be the immediately preceding trading day of the Exchange, which is other than a Saturday.	20th day of the delivery month. If 20th happens to be a holiday, a Saturday or a Sunday then the due date shall be the immediately preceding trading day of the Exchange, which is other than a Saturday.
Trading period	Mondays through Friday	Mondays through Friday
Trading unit	1000 kgs (=1 MT)	10 MT
Quotation/base value (kg)	Rs. Per Quintal	Rs. Per Quintal
Maximum order size (MT)	50 MT	500 MT
Tick size (minimum price movement)	Rs. 5/-	Rs. 1
Initial margin	Minimum 5 %	Minimum 5 %
Delivery unit	1000 kgs (=1 MT)	10 MT
(*Source*: www.ncdex.com)		

Price discovery is the process through which markets attempt to reach equilibrium prices (Schreiber & Schwartz, 1986). In a static sense, price discovery implies the existence of equilibrium prices. In a dynamic sense, the price discovery process describes how information is produced and transmitted across the markets. It is often believed that futures markets potentially provide an important function of price discovery. If so, then futures prices or movements thereof should contain useful information about subsequent spot prices; beyond that already embedded in the current spot price (Wahab & Lashgari, 1993). The literature, as reviewed in the next section, focuses on whether futures rather than cash markets are the primary source for price discovery.

LITERATURE REVIEW

The lead–lag relation between price movements of stock index futures and the underlying cash market illustrates how fast one market reflects new information relative to the other, and how well the two markets are linked. In a perfectly frictionless world, price movements of the two markets are contemporaneously correlated and not cross-auto correlated. However, if one market reacts faster to information, and the other market is slow to react, a lead–lag relation is observed (Chan, 1992). In an efficient market, information processing should be expeditious and the most efficient market should lead the others. Hence, information transmission or price discovery is an indication of the relative market efficiencies of related assets. Therefore, it is important to determine the nature and location of price discovery (Bhatia, 2007). The most common explanation why a lead–lag relationship between the two markets is observed is that it is less costly for traders to exploit information in the futures market since transaction cost is lower and the degree of leverage attainable is higher. A lead in the futures prices implies that price is being discovered first in that market (Chaihetphon & Pavabutr, 2010).

Oellermann and Farris (1985) analysed daily closing prices of the nearby live cattle contract on Chicago Mercantile Exchange (CME) and average daily cash price of 1,100–1,300-lb. choice steers in Omaha from 1966 through 1982 by separating the time into three spans: 1966–1972, 1973–1977 and 1978–1982 and reached the conclusion that the futures market is the centre of price discovery. Oellermann *et al*. (1989) analysed the daily closing prices of the live cattle and feeder cattle futures contracts traded on CME for a period from 1979 through 1986 by applying Granger causality test and reached the conclusion that feeder cattle futures prices generally lead cash prices in incorporating new pricing information. Koontz *et al*. (1990) analyzed data on cash markets and the live cattle futures market over the three time periods between January, 1973 and December, 1984. By applying Granger causality test on weekly prices they reached the conclusion that the price discovery is dynamic and cash markets have decreased their reliance on the futures market as an overall price discovery mechanism but the futures market is relied upon to register information which emerges late in the week and is reflected in the cash markets the following week. Quan (1992) analyzed monthly data of crude oil spot and 1 month and 3 months futures prices from January, 1984 to July, 1989 by applying Garbade and Silber Approach and error correction model (ECM) and concluded that spot market dominates the futures market in incorporating new information. Chan (1992) studied lead–lag relationship between intraday futures and cash index prices for two sample periods—August, 1984–June, 1985 and January, 1987– September, 1987. Data on MMI and an index comprising of 20 actively traded stocks have been analyzed. Lead–lag relationship (a) under bad news and good news, (b) under different intensities of trading activity, and (c) under market wide movement has been examined and the conclusion reached is that there is an asymmetric lead–lag relationship between the two markets with the strong evidence that futures index leads the cash index and weak evidence that the cash index leads the futures.

Wahab and Lashgari (1993) analyzed daily closing values of stock index and stock index futures prices for both S&P 500 and FT-SE 100 indices from 1988 to 1992, by applying Vector ECM (VECM) and reached the conclusion that feedback relationship exists between cash and futures markets for both the indices but spot to futures lead appears to be more pronounced across days relative to the futures to spot lead. Raju and Karande (2003) studied price discovery between spot and futures markets by analyzing daily closing values of S&P CNX Nifty futures and spot prices from June, 2000 to October, 2002 by applying VECM and reached the conclusion that price discovery occurs in futures market. Figuerola-Ferretti and Gonzalo (2006), in their study on London Metals Exchange (LME) traded metals - aluminum, copper, nickel, lead and zinc by applying VECM and Permanent Transitory Decomposition on daily spot and 15-month futures prices from January, 1989 to mid-June, 2006 concluded that in case of aluminum, copper, nickel and zinc, price discovery occurs in futures market and in case of lead it occurs in spot market. Karande (2006), in his study on castor seed Futures market in India, analyzed the data for two periods from 1985 to 1993 and 1994 to 1999 for March, June, September and December contracts separately as well as for pooled data. By applying

VECM he reached the conclusion that there exists bi-directional causality in Mumbai and in Ahmedabad, Futures market dominates the Spot market.

Gupta and Singh (2007) analyzed daily closing values of Nifty Futures Index, stock futures (included in Nifty) and spot prices from 12 June 2000 to 30 June 2006 by applying Granger causality test and VECM and reached the conclusion that Futures market leads Spot market. Bhatia (2007) analyzed high frequency data (5 min data by filtering tick by tick data) for Nifty Spot Index and Nifty Futures Index from 1 April 2005 to 31 March 2006 by applying ECM and pair wise Granger causality test and reached the conclusion that there exists bidirectional causality in spot and futures index prices. Gupta and Singh (2009) analyzed high frequency (5 min interval) data for Nifty and most liquid fifty individual stocks on NSE from April 2003 to March 2007 by applying Granger causality test, VAR and VECM and reached the conclusion that price discovery takes place in both the markets; but Futures market has been found to be strongly causing the cash market. Karmakar (2009) analyzed daily price series of S&P CNX Nifty spot and the Nifty futures from 12 June 2000 to 29 March 2007 by applying VECM. The study concluded that bi-directional causality exists in futures and spot prices but futures market is found to be more information efficient than the underlying spot market. Chaihetphon and Pavabutr (2010), by applying VECM and information share on daily futures prices and spot prices from November 2003 to December 2007 for standard contract and mini contract of gold, traded on MCX, concluded that futures prices lead spot prices for both standard as well as mini- contracts. Kumar and Arora (2011) studied the price discovery role of Futures market in precious metals. By applying Johansen co-integration test and Granger causality test on daily closing values of spot and the nearby futures contract of gold, traded on MCX, from June 2005 to December 2009, they reached the conclusion that the series of spot and futures prices are co-integrated and the Futures market plays an important role in price discovery.

The research studies reviewed above are concentrated on stock market and in case of commodity markets these are concentrated on precious metals or agricultural commodities. Based on the above literature review; it is found that there is no study regarding non- precious metals like nickel and zinc traded on MCX and agricultural commodities like pepper and soybean traded on NCDEX. To the best of author's knowledge there is hardly any study that analyzed data of nickel and zinc on MCX and pepper and soybean on NCDEX. The present study is an attempt to fill this gap.

DATA & METHODOLOGY

The aim of this paper is to investigate the lead-leg relationships between non- precious metals – nickel and zinc on Multi-Commodity Exchange (MCX) and agricultural commodities - pepper and soybean on National Commodities & Derivatives Exchange (NCDEX). To accomplish the research objective, daily data on spot prices and near month futures prices ranging from April 2011 to April 2013 are obtained which comprises 444 data points for the analysis. The choice of study period is based on the availability of data series. Descriptions of variables and data sources are presented in Table 3.

Table 3: Description of Variables

Acronyms	Construction of Variable	Data Source
LNNICS	Natural logarithm of nickel spot price on Multi Commodity Exchange (MCX)	MCX Website
NICSR	Returns on nickel spot price on Multi Commodity Exchange (MCX)	MCX Website
LNNICF	Natural logarithm of nickel future price on Multi Commodity Exchange (MCX)	MCX Website
NICFR	Returns on nickel future price on Multi Commodity Exchange (MCX)	MCX Website
LNZINS	Natural logarithm of zinc spot price on Multi Commodity Exchange (MCX)	MCX Website
ZINSR	Returns on zinc spot price on Multi Commodity Exchange (MCX)	MCX Website
LNZINF	Natural logarithm of zinc future price on Multi Commodity Exchange (MCX)	MCX Website
ZINFR	Returns on zinc future price on Multi Commodity Exchange (MCX)	MCX Website
LNPEPS	Natural logarithm of pepper spot price on National Commodity & Derivatives Exchange (NCDEX)	NCDEX Website
PEPSR	Returns on pepper spot price on National Commodity & Derivatives Exchange (NCDEX)	NCDEX Website
LNPEPF	Natural logarithm of pepper future price on National Commodity & Derivatives Exchange (NCDEX)	NCDEX Website
PEPFR	Returns on pepper future price on National Commodity & Derivatives Exchange (NCDEX)	NCDEX Website
LNSOYS	Natural logarithm of soybean spot price on National Commodity & Derivatives Exchange (NCDEX)	NCDEX Website
SOYSR	Returns on soybean spot price on National Commodity & Derivatives Exchange (NCDEX)	NCDEX Website
LNSOYF	Natural logarithm of soybean future price on National Commodity & Derivatives Exchange (NCDEX)	NCDEX Website
SOYFR	Returns on soybean future price on National Commodity & Derivatives Exchange (NCDEX)	NCDEX Website

The present study employs the time series data analysis technique to study the relationship between the spot price and future prices of nickel and zinc on MCX and pepper and soybean on NCDEX. In a time series analysis, the results might generate a spurious data if the data series are non-stationary. Thus, the data- series must obey the time- series properties i.e. the time- series data should be stationary, meaning that, the mean and variance should be constant over time and the value of covariance between two time- periods depends only on the distance between the two time- period and not the actual time at which the covariance is computed. The most popular and widely used test for stationary is the unit root test. The presence of unit root indicates that the data series is non-stationary. The standard procedures of unit root test namely the Augmented Dickey Fuller (ADF) (1979) (1981) is performed to check the stationary nature of the series. Assuming that the series follows an AR (p) process the ADF test makes a parametric correction and controls for the higher order correlation by adding the lagged difference terms of the dependent variable to the right hand side of the regression equation. In the ADF test, null hypothesis is that data set being tested has unit root. This provides a robustness check for stationary data-series. The unit root tests also provide the order of integration of the time- series variables. In a multivariate context if the variable under consideration are found to be I (1) (i.e. they are non-stationary at level but stationary at first difference), but the linear combination of the integrated variables is I (0), then the variables are said to be co-integrated (Enders, 2004).The complete ADF model with deterministic terms such as intercepts and trends is shown in equation (1).

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + \cdots + \delta_{p-1} \Delta y_{t-p+1} + \varepsilon_t, \quad (1)$$

Where α is a constant, β the coefficient on a time trend and p the lag order of the autoregressive process. Lag length for VAR system is selected based on minimum sequential modified LR test statistic. The vector autoregression (VAR) is commonly used for forecasting systems of interrelated time series and for analyzing the dynamic impact of random disturbances on the system of variables. The VAR approach sidesteps the need for structural modelling by treating every endogenous variable in the system as a function of the lagged values of all of the endogenous variables in the system. The mathematical representation of a VAR is:

$$y_t = A_1 y_{t-1} + \cdots + A_p y_{t-p} + B x_t + \epsilon_t \quad (2)$$

where Yt is a k vector of endogenous variables, Xt is a d vector of exogenous variables, $A1$, ..., Ap and B are matrices of coefficients to be estimated, and $\epsilon\, t$ is a vector of innovations that may be contemporaneously correlated but are uncorrelated with their own lagged values and uncorrelated with all of the right-hand side variables.

Leg Length Criteria computes various criteria to select the lag order of an unrestricted VAR (Lütkepohl, 1991). The sequential modified Likelihood Ratio (LR) test is carried out as follows. Starting from the maximum lag, test the hypothesis that the coefficients on lag l are jointly zero using the χ^2 statistics:

$$LR = (T - m)\{\log|\Omega_{\ell-1}| - \log|\Omega_{\ell}|\} \sim \chi^2(k^2) \quad (3)$$

Where, m is the number of parameters per equation under the alternative, note that we employ Sims' (1980) small sample modification which uses [T-m] rather than T. We compare the modified LR statistics to the 5% critical values starting from the maximum lag, and decreasing the lag one at a time until we first get a rejection.

With the non-stationary series, co-integration analysis has been used to examine whether any long term relationship exists. However, a necessary condition for the use of co-integration technique is that the variable under consideration must be integrated in the same order and the linear combinations of the integrated variables are free from unit root. According to Engel and Granger (1987), if the variables are found to be co-integrated, they would not drift apart over time and the long run combination amongst the non-stationary variables can be established. To conduct the co-integration test, the Engel and Granger (1987) or the Johansen and Juselius (1990) or the Johansen (1991) approach can be used. The Engel-Granger's two step approaches can only deal with one linear combination of variables that is stationary. In a multivariate practice, however, more than one stable linear combination may exist. The Johansen's co-integration method is regarded as full information maximum likelihood method that allows for testing co-integration in a whole system of equations.

The Johansen methods of co-integration can be written as the following vector autoregressive framework of order p.

$$X_t = A_0 + \sum_{j=1}^{p} B_j X_{t-j} + e_t \qquad (4)$$

Where, Xt is an n×1 vector of non stationary I(1) variables, A_0 is an n×1 vector of constants, p is the maximum lag length, Bj is an n×n matrix of coefficient and e_t is a n×1 vector of white noise terms. The number of characteristic roots can be tested by considering the following trace statistic and the maximum eigenvalue test.

$$\lambda_{trace}(r) = -T \sum_{i=j+1}^{p} \ln(1 - \hat{\lambda}_j) \qquad (5)$$

$$\lambda_{max}(r, r+1) = -T \ln(1 - \hat{\lambda}_{r+1}) \qquad (6)$$

Where, r is the number of co-integrating vectors under the null hypothesis, T is the number of usable observations and $\hat{\lambda}_j$ is the estimated value for the j^{th} ordered characteristic roots or the eigenvalue from the Π matrix.

A significantly non-zero eigenvalue indicates a significant co-integrating vector. The trace statistics is a joint test where the null hypothesis is that the number of co-integration vectors is less than or equal to r against an unspecified general alternative that there are more than r. Whereas, the maximum eigenvalue statistics test the null hypothesis that the number of co-integrating vectors is less than or equal to r against the alternative of r +1 (Enders, 2004; Brooks, 2002)

A Vector Error Correction (VEC) model is a restricted VAR designed for use with non-stationary series that are known to be co-integrated. The VEC Model has co-integration relations built into the specification so that it restricts the behaviour of the endogenous variables to converge to their co-integrating relationships while allowing for short-run adjustment dynamics. The co-integration term is known as the error correction term since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments.

$$\Delta y_{1,\,t} = \alpha_1(y_{2,\,t-1} - \beta y_{1,\,t-1}) + \epsilon_{1,\,t} \tag{7}$$

$$\Delta y_{2,\,t} = \alpha_2(y_{2,\,t-1} - \beta y_{1,\,t-1}) + \epsilon_{2,\,t} \tag{8}$$

In this model, the only right-hand side variable is the error correction term. In long run equilibrium, this term is zero. However, if y_1 and y_2 deviate from the long run equilibrium, the error correction term will be non-zero and each variable adjusts to partially restore the equilibrium relation. The coefficient α_i measures the speed of adjustment of the i-th endogenous variable towards the equilibrium.

Further to examine dynamic relationship between variables, bi-variate Granger Causality test (Engel & Granger, 1987) is applied. The bi-variate regressions of Granger Causality Test are:

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \ldots + \alpha_l y_{t-l} + \beta_1 x_{t-1} + \ldots + \beta_l x_{-l} + \epsilon_t \tag{9}$$

$$x_t = \alpha_0 + \alpha_1 x_{t-1} + \ldots + \alpha_l x_{t-l} + \beta_1 y_{t-1} + \ldots + \beta_l y_{-l} + u_t \tag{10}$$

For all possible pairs of (*x, y*) series in the group, the reported *F*-statistics are the Wald statistics for the joint hypothesis:

$$\beta_1 = \beta_2 = \ldots = \beta_l = 0$$

For each equation, the null hypothesis is that *x* does not Granger-cause *y* in the first regression and *y* does not Granger-cause *x* in the second equation.

EMPIRICAL ANALYSIS

The descriptive statistics for all the variables under study are presented in Table 4 & 5. The value of skewness and kurtosis indicate the lack of symmetry in the distribution. Generally, if the value of skewness and kurtosis are 0 and 3 respectively, the observed distribution is said to be normally distributed. Furthermore, if the skewness coefficient is in excess of unity it is considered fairly extreme and the low (high) kurtosis value indicates extreme platykurtic (extreme leptokurtic). From the Tables 4 & 5, it is observed that the frequency distributions of underlying variables are not normal. The significant coefficient of Jarque-Bera statistics also indicates that the frequency distributions of considered series are not normal. The probability value of less than 0.05 of Jarque-Bera statistics indicates that the frequency distributions of considered series are not normally distributed except variables like LNZINS, ZINSR and LNZINF, which is the precondition for any market to be efficient in the weak form ((Fama E., 1965; Stevenson & Bear, 1970;Reddy, 1997).

Table 4: Descriptive Statistics of Nickel & Zinc

	LNNICS	NICSR	LNNICF	NICFR	LNZINS	ZINSR	LNZINF	ZINFR
Mean	6.859763	-0.059705	6.866768	-0.064818	4.633827	0.002686	4.640783	-0.001624
Median	6.847049	0.081946	6.855925	-0.078044	4.632785	0.050077	4.638923	-0.021577
Maximum	7.099945	5.204429	7.115212	4.925699	4.768988	3.927813	4.773660	3.630763
Minimum	6.708084	-6.768303	6.711979	-7.468998	4.465333	-4.641975	4.471133	-5.033097
Std. Dev.	0.070149	1.645662	0.069598	1.352065	0.051798	1.515758	0.050415	1.238862
Skewness	0.793717	-0.216790	0.853051	-0.283522	0.026154	-0.095377	0.059506	-0.294536
Kurtosis	3.848293	3.800933	4.041960	5.864662	3.189996	3.194864	3.279450	4.468115
Jarque-Bera	59.93164	15.34550	73.93452	157.76480	0.71844	1.37564	1.70673	46.29378
Probability	0.000000	0.000465	0.000000	0.000000	0.698220	0.502670	0.425978	0.000000
Observations	444	444	444	444	444	444	444	444
(*Source*: Author's Estimation)								

Table 5: Descriptive Statistics of Pepper & Soybean

	LNPEPS	PEPSR	LNPEPF	PEPFR	LNSOYS	SOYSR	LNSOYF	SOYFR
Mean	10.482200	0.094377	10.483640	0.093521	7.994379	0.168723	7.977497	0.404310
Median	10.521080	0.037876	10.484380	0.155240	8.049427	0.216702	8.006034	0.204499
Maximum	10.671950	7.087429	10.707280	8.170326	8.508758	47.707870	8.499131	80.381220
Minimum	10.108670	-6.090026	10.157120	-8.365681	7.631917	-30.008560	7.636511	-42.822970
Std. Dev.	0.141019	1.172780	0.138445	1.899408	0.234555	3.104854	0.216887	9.332122
Skewness	-0.676273	0.941544	-0.298150	-0.362234	0.291134	5.611586	0.304668	2.658743
Kurtosis	2.339071	11.836990	2.197182	6.352679	1.885138	146.811300	1.985706	31.830300
Jarque-Bera	41.92481	1510.3100	18.50168	217.65830	29.26613	384941.500	25.90156	15900.0500
Probability	0.000000	0.000000	0.000096	0.000000	0.000000	0.000000	0.000002	0.000000
Observations	444	444	444	444	444	444	444	444
(*Source*: Author's Estimation)								

To check the stationarity of the underlying data series, we follow the standard procedure of unit root testing by employing the Augmented Dickey Fuller (ADF) test. The results are presented in Table 6 & 7. On the basis of the ADF test, all the series are found to be non-stationary at level with intercept. However, after taking the first difference these series are found to be stationary at 1, 5 and 10 percent significance level. Thus the stationary test indicates that all series are individually integrated of the order I (1).

Table 6: Result of Augmented Dickey-Fuller Unit Root Test (Nickel & Zinc)

Variable	t-Statistic		Trend		Trend & Intercept		None	
			Prob.*	t-Statistic	Prob.*	t-Statistic	Prob.*	
D(LNNICS)	Augmented Dickey-Fuller test statistic		-23.0422	0.0000	-23.0160	0.0000	-23.0237	0.0000
	Test critical values:	1% level	-3.4449		-3.9790		-2.5702	
		5% level	-2.8679		-3.4200		-1.9415	
		10% level	-2.5702		-3.1327		-1.6162	
D(NICSR)	Augmented Dickey-Fuller test statistic		-13.9907	0.0000	-13.9743	0.0000	-14.0068	0.0000
	Test critical values:	1% level	-3.4452		-3.9793		-2.5703	
		5% level	-2.8680		-3.4202		-1.9416	
		10% level	-2.5703		-3.1328		-1.6162	
D(LNNICF)	Augmented Dickey-Fuller test statistic		-16.5980	0.0000	-16.5793	0.0000	-16.5804	0.0000
	Test critical values:	1% level	-3.4449		-3.9790		-2.5702	
		5% level	-2.8679		-3.4200		-1.9415	
		10% level	-2.5702		-3.1327		-1.6162	
D(NICFR)	Augmented Dickey-Fuller test statistic		-11.4642	0.0000	-11.4495	0.0000	-11.4761	0.0000
	Test critical values:	1% level	-3.4453		-3.9794		-2.5703	
		5% level	-2.8680		-3.4203		-1.9416	
		10% level	-2.5703		-3.1328		-1.6162	
D(LNZINS)	Augmented Dickey-Fuller test statistic		-23.3402	0.0000	-23.3133	0.0000	-23.3649	0.0000
	Test critical values:	1% level	-3.4449		-3.9790		-2.5702	
		5% level	-2.8679		-3.4200		-1.9415	
		10% level	-2.5702		-3.1327		-1.6162	
D(ZINSR)	Augmented Dickey-Fuller test statistic		-12.6497	0.0000	-12.6363	0.0000	-12.6634	0.0000
	Test critical values:	1% level	-3.4452		-3.9793		-2.5703	
		5% level	-2.8680		-3.4202		-1.9416	
		10% level	-2.5703		-3.1328		-1.6162	
D(LNZINF)	Augmented Dickey-Fuller test statistic		-18.3276	0.0000	-18.3067	0.0000	-18.3460	0.0000
	Test critical values:	1% level	-3.4449		-3.9790		-2.5702	
		5% level	-2.8679		-3.4200		-1.9415	
		10% level	-2.5702		-3.1327		-1.6162	

D(ZINFR)	Augmented Dickey-Fuller test statistic		-12.2321	0.0000	-12.2207	0.0000	-12.2454	0.0000
	Test critical values:	1% level	-3.4452		-3.9793		-2.5703	
		5% level	-2.8680		-3.4202		-1.9416	
		10% level	-2.5703		-3.1328		-1.6162	
*MacKinnon (1996) one-sided p-values.								
(*Source*: Author's Estimation)								

Table 7: Result of Augmented Dickey-Fuller Unit Root Test (Pepper & Soybean)

Variable	t-Statistic		**Trend**		**Trend & Intercept**		**None**	
			Prob.*	t-Statistic	Prob.*	t-Statistic	Prob.*	
D(LNPEPS)	Augmented Dickey-Fuller test statistic		-17.0980	0.0000	-17.3080	0.0000	-17.0428	0.0000
	Test critical values:	1% level	-3.4449		-3.9790		-2.5702	
		5% level	-2.8679		-3.4200		-1.9415	
		10% level	-2.5702		-3.1327		-1.6162	
D(PEPSR)	Augmented Dickey-Fuller test statistic		-15.1497	0.0000	-15.1310	0.0000	-15.1668	0.0000
	Test critical values:	1% level	-3.4451		-3.9792		-2.5703	
		5% level	-2.8679		-3.4201		-1.9416	
		10% level	-2.5702		-3.1327		-1.6162	
D(LNPEPF)	Augmented Dickey-Fuller test statistic		-19.6370	0.0000	-19.6940	0.0000	-19.6347	0.0000
	Test critical values:	1% level	-3.4449		-3.9790		-2.5702	
		5% level	-2.8679		-3.4200		-1.9415	
		10% level	-2.5702		-3.1327		-1.6162	
D(PEPFR)	Augmented Dickey-Fuller test statistic		-15.9824	0.0000	-15.9628	0.0000	-16.0015	0.0000
	Test critical values:	1% level	-3.4451		-3.9792		-2.5703	
		5% level	-2.8679		-3.4201		-1.9416	
		10% level	-2.5702		-3.1327		-1.6162	
D(LNSOYS)	Augmented Dickey-Fuller test statistic		-27.8673	0.0000	-27.8404	0.0000	-27.8345	0.0000
	Test critical values:	1% level	-3.4449		-3.9790		-2.5702	
		5% level	-2.8679		-3.4200		-1.9415	
		10% level	-2.5702		-3.1327		-1.6162	

D(SOYSR)	Augmented Dickey-Fuller test statistic		-12.8002	0.0000	-12.7852	0.0000	-12.8154	0.0000
	Test critical values:	1% level	-3.4452		-3.9793		-2.5703	
		5% level	-2.8680		-3.4202		-1.9416	
		10% level	-2.5703		-3.1328		-1.6162	
D(LNSOYF)	Augmented Dickey-Fuller test statistic		-16.7216	0.0000	-16.6940	0.0000	-16.7304	0.0000
	Test critical values:	1% level	-3.4450		-3.9791		-2.5702	
		5% level	-2.8679		-3.4201		-1.9415	
		10% level	-2.5702		-3.1327		-1.6162	
D(SOYFR)	Augmented Dickey-Fuller test statistic		-14.8606	0.0000	-14.8466	0.0000	-14.8780	0.0000
	Test critical values:	1% level	-3.4452		-3.9793		-2.5703	
		5% level	-2.8680		-3.4202		-1.9416	
		10% level	-2.5703		-3.1328		-1.6162	
*MacKinnon (1996) one-sided p-values.								
(*Source*: Author's Estimation)								

The presence and the number of co-integrating relationships among the underlying variables are tested through the Johansen procedure i.e., Johansen and Juselius (1990) and Johansen (1991). Specifically, trace statistic and the maximum eigenvalue are used to test for the number of co-integrating vectors. The result of VAR leg order selection criteria are presented in the Table 8,9,10 and 11. Leg order selected for nickel and zinc are based on FPE and AIC criterion. And Leg order for pepper and soybean are based on SC and HQ criterion. The results of both trace statistics and the maximum eigenvalue test statistics are presented in Table 12, 13, 14 & 15. The trace statistics for nickel, zinc and pepper indicate two co-integrating equations each. For soybean, one is co-integrating equation. While the maximum eigenvalue statistics for nickel, zinc and pepper also identify two co-integrating equations each. For soybean, it is one co-integrating equation. The results show that long-run equilibrium relationship exists between the spot and future price of nickel and zinc on MCX and pepper and soybean on NCDEX.

Table 8: VAR Lag Order Selection Criteria of Nickel

Lag	LogL	LR	FPE	AIC	SC	HQ
0	956.3921	NA	1.49E-07	-4.368771	-4.331361	-4.354007
1	5213.732	8417.035	5.29E-16	-23.82446	-23.63741*	-23.75064*
2	5236.783	45.14926	**5.12e-16***	**-23.85680***	-23.52011	-23.72393
3	5242.766	11.61021	5.36E-16	-23.81085	-23.32453	-23.61893
4	5256.331	26.07137	5.42E-16	-23.79968	-23.16372	-23.5487
5	5273.318	32.33776	5.40E-16	-23.80421	-23.01861	-23.49417
6	5285.908	23.73654	5.48E-16	-23.78857	-22.85333	-23.41948
7	5298.258	23.05646	5.58E-16	-23.77182	-22.68695	-23.34368
8	5314.221	29.51078*	5.58E-16	-23.77166	-22.53714	-23.28446

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion
(*Source*: Author's Estimation)

Table 9: VAR Lag Order Selection Criteria of Zinc

Lag	LogL	LR	FPE	AIC	SC	HQ
0	1133.341	NA	6.61E-08	-5.180465	-5.143055	-5.165701
1	5505.362	8643.766	1.39E-16	-25.16221	-24.97516*	-25.08839*
2	5526.369	41.14696	**1.36e-16***	**25.18518***	-24.84849	-25.05231
3	5534.447	15.67342	1.41E-16	-25.14884	-24.66251	-24.95691
4	5545.997	22.20067	1.44E-16	-25.12843	-24.49247	-24.87745
5	5553.438	14.16396	1.49E-16	-25.08916	-24.30356	-24.77913
6	5560.702	13.69581	1.55E-16	-25.04909	-24.11385	-24.68
7	5574.8	26.31932*	1.57E-16	-25.04036	-23.95549	-24.61222
8	5585.988	20.68394	1.60E-16	-25.0183	-23.78378	-24.5311

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion
(*Source*: Author's Estimation)

Table 10: VAR Lag Order Selection Criteria of Pepper

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-435.1206	NA	8.81E-05	2.014315	2.051724	2.029078
1	4526.867	9810.168	1.23E-14	-20.6737	**-20.48665***	**-20.59988***
2	4547.109	39.64819	1.21e-14*	-20.69316*	-20.35647	-20.56029
3	4559.191	23.44377	1.23E-14	-20.67519	-20.18886	-20.48326
4	4574.381	29.19505	1.24E-14	-20.67147	-20.03551	-20.42049
5	4593.046	35.53223	1.22E-14	-20.6837	-19.8981	-20.37366
6	4605.664	23.78917	1.24E-14	-20.66818	-19.73294	-20.29909
7	4619.328	25.50969	1.26E-14	-20.65747	-19.57259	-20.22932
8	4637.8	34.14903*	1.24E-14	-20.66881	-19.43429	-20.18161

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion
(*Source*: Author's Estimation)

Table 11: VAR Lag Order Selection Criteria of Soybean

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-2126.437	NA	2.06E-01	9.772648	9.810058	9.787412
1	405.838	5006.471	2.00E-06	-1.769899	-1.582851	-1.696081
2	566.697	315.0771	1.03E-06	-2.43439	-2.097704	-2.301518
3	623.0979	109.4384	8.56E-07	-2.619715	**-2.133391***	**-2.427788***
4	633.2682	19.54743	8.79E-07	-2.592973	-1.957011	-2.341992
5	652.6775	36.94891	8.66E-07	-2.608612	-1.823011	-2.298576
6	668.0149	28.91599	8.68E-07	-2.605573	-1.670334	-2.236483
7	688.7361	38.68595*	8.50e-07*	-2.627230*	-1.542353	-2.199085
8	701.2336	23.10323	8.64E-07	-2.611163	-1.376648	-2.123964

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion
(*Source*: Author's Estimation)

Table 12: Result of Johansen's Co-integration Test of Nickel

Hypothesized No. of CE(s)	Eigen-value e	Trace Statistic	0.05 Critical Value	Prob.**	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.177413	92.87492	15.49471	**0.0000**	86.12797	14.2646	**0.0000**
At most 1 *	0.015183	6.746952	3.841466	**0.0094**	6.746952	3.841466	**0.0094**
Trace test indicates 2 cointegrating eqn(s) at the 0.05 level							
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							
(*Source*: Author's Estimation)							

Table 13: Result of Johansen's Co-integration Test of Zinc

Hypothesized No. of CE(s)	Eigen-value e	Trace Statistic	0.05 Critical Value	Prob.**	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.179895	96.11325	15.49471	**0.0000**	87.4605	14.2646	**0.0000**
At most 1 *	0.01943	8.652754	3.841466	**0.0033**	8.652754	3.841466	**0.0033**
Trace test indicates 2 cointegrating eqn(s) at the 0.05 level							
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							
(*Source*: Author's Estimation)							

Table 14: Result of Johansen's Co-integration Test of Pepper

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.037114	22.75789	15.49471	**0.0034**	16.71661	14.2646	**0.0201**
At most 1 *	0.013575	6.04128	3.841466	**0.0140**	6.04128	3.841466	**0.0140**
Trace test indicates 2 cointegrating eqn(s) at the 0.05 level							
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							
(*Source*: Author's Estimation)							

Table 15: Result of Johansen's Co-integration Test of Soybean

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**	Max-Eigen Statistic	0.05Critical Value	Prob.**
None *	0.084367	39.4508	15.49471	**0.0000**	38.78165	14.2646	**0.0000**
At most 1	0.00152	0.669144	3.841466	0.4133	0.669144	3.841466	0.4133
Trace test indicates 1 cointegrating eqn(s) at the 0.05 level							
Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level							
* denotes rejection of the hypothesis at the 0.05 level							
**MacKinnon-Haug-Michelis (1999) p-values							
(*Source*: Author's Estimation)							

Assuming one co-integrating vector, the short run and long run interaction of the underlying variables the VECM has been estimated based on the Johansen co-integration methodology. The results are presented in Table 16, 17, 18 & 19. The results show that a long-run equilibrium relationship exists between the spot return and future return of nickel and zinc on MCX and pepper and soybean on NCDEX. The estimated co-integrating coefficients for the nickel, zinc, pepper and soybean spot return and future return are based on the first normalized eigenvector are as follows. These values represent long term elasticity measures. Thus the co-integration relationship can be re-expressed as:

NICSR = -0.005963 + (-0.984985)*NICFR
ZINSR = -0.006937 + (-1.003046)*ZINFR
PEPSR = -0.010750+ (-0.915559)*PEPFR
SOYSR = 0.175310 + (-0.915559)*SOYFR

Table 16: Results of Vector Error Correction Model of Nickel

Panel A: Normalized Co-integration Coefficients		
NICSR(-1)	NICFR(-1)	Constant
1.000000	-0.984985	-0.005963
	(-0.01726)	
	[-57.0636]	
Panel B: Coefficient of Error Correction term		
Error Correction:	D(NICSR)	D(NICFR)
CointEq1	-2.247653	0.063356
	(-0.28671)	(-0.25798)
	[-7.83941]	[0.24559]
F-statistic	96.19647	21.03130
Standard errors in ( ) & t-statistics in [ ]		
(*Source*: Author's Estimation)		

Table 17: Results of Vector Error Correction Model of Zinc

Panel A: Normalized Co-integration Coefficients		
ZINSR(-1)	ZINFR(-1)	Constant
1.000000	-1.003046	-0.006937
	(-0.019850)	
	[-50.5291]	
Panel B: Coefficient of Error Correction term		
Error Correction:	D(ZINSR)	D(ZINFR)
CointEq1	-1.964150	0.208297
	(-0.26638)	(-0.23538)
	[-7.37354]	[0.88493]
F-statistic	95.92745	35.95388
Standard errors in ( ) & t-statistics in [ ]		
(*Source*: Author's Estimation)		

Table 18: Results of Vector Error Correction Model of Pepper

Panel A: Normalized Co-integration Coefficients		
PEPSR(-1)	PEPFR(-1)	Constant
1.000000	-0.915559	-0.010750
	(-0.03116)	
	[-29.3853]	
Panel B: Coefficient of Error Correction term		
Error Correction:	D(PEPSR)	D(PEPFR)
CointEq1	-0.172583	1.361488
	(-0.07485)	(-0.1219)
	[-2.30578]	[11.1688]
F-statistic	51.46708	82.62256
Standard errors in ( ) & t-statistics in [ ]		
(*Source*: Author's Estimation)		

Table 19: Results of Vector Error Correction Model of Soybean

Panel A: Normalized Co-integration Coefficients		
SOYSR(-1)	SOYFR(-1)	Constant
1.000000	-0.698292	0.175310
	(-0.04496)	
	[-15.5326]	
Panel B: Coefficient of Error Correction term		
Error Correction:	D(SOYSR)	D(SOYFR)
CointEq1	-0.427181	2.764767
	(-0.08491)	(-0.22087)
	[-5.03083]	[12.5178]
F-statistic	76.95397	133.05930
Standard errors in ( ) & t-statistics in [ ]		
(*Source*: Author's Estimation)		

The t-statistics are given in [ ] brackets while the error term are given in ( ) brackets. The coefficients of nickel, zinc and pepper future returns are negative and statistically significant in Table 16, 17 and 18 respectively, while the coefficient of soybean is positive and statistically insignificant in Table 19. Results revels that the relationship between nickel, zinc, pepper and soybean future returns and spot returns are positive. The sign of the error correction coefficient in determination of nickel, zinc, pepper and soybean spot returns is negative: (-0.01726), (-0.019850), (-0.03116) and (-0.04496), respectively. The corresponding t-value is -57.0636, -50.5291, -29.3853 and -15.5326 for nickel, zinc, pepper and soybean, respectively. This indicates that nickel, zinc, pepper and soybean spot returns do respond significantly to re-establish the equilibrium relationship once deviation occurs.

The co-integration results indicate that causality exists between the co-integrated variables but it fails to show us the direction of the causal relationship. The pair-wise Granger causality test (1987) is performed between all possible pairs of variables to determine the direction of causality. The rejected hypotheses are reported in Table 20, 21, 22 & 23. The results show that bi-directional causality does exist between spot returns and future returns of nickel. While zinc and pepper future returns Granger causes spot returns but not the other way round. Soybean spot returns Granger causes future returns in short run.

Table 20: Result of Granger Causality Test of Nickel

Null Hypothesis:	Obs	F-Statistic	Prob.	Decision
NICFR does not Granger Cause NICSR	442	50.8036	**1.00E-20**	Reject
NICSR does not Granger Cause NICFR		5.49802	**0.0044**	Reject
(*Source*: Author's Estimation)				

Table 21: Result of Granger Causality Test of Zinc

Null Hypothesis:	Obs	F-Statistic	Prob.	Decision
ZINFR does not Granger Cause ZINSR	442	29.449	1.00E-12	Reject
ZINSR does not Granger Cause ZINFR		2.85153	5.88E-02	Accept
(*Source*: Author's Estimation)				

Table 22: Result of Granger Causality Test of Pepper

Null Hypothesis:	Obs	F-Statistic	Prob.	Decision
PEPFR does not Granger Cause PEPSR	443	47.3854	**2.00E-11**	Reject
PEPSR does not Granger Cause PEPFR		0.7063	0.4011	Accept
(*Source*: Author's Estimation)				

Table 23: Result of Granger Causality Test of Soybean

Null Hypothesis:	Obs	F-Statistic	Prob.	Decision
SOYFR does not Granger Cause SOYSR	441	1.63007	1.82E-01	Accept
SOYSR does not Granger Cause SOYFR		3.45937	**1.64E-02**	Reject
(*Source*: Author's Estimation)				

CONCLUSION

The aim of this paper was to investigate the lead-leg relationships between non- precious metals – nickel and zinc on Multi Commodity Exchange (MCX) and agricultural commodities - pepper and soybean on National Commodities & Derivatives Exchange (NCDEX) using Johansen's co-integration test, VECM and Granger causality test. The analysis used daily data on spot prices and near month futures prices of four selected commodities over the period from April 2011 to April 2013 which is obtained from MCX and NCDEX website.

To conclude, the Augmented Dickey Fuller test suggests that all the series are found to be non-stationary at level with intercept. However, after taking the first difference, these series are found to be stationary at 1, 5 and 10 percent level of significance. The Johansen's co-integration test suggests that in case of all the four commodities under the study, results are almost same. Series of spot and futures prices are found to be co-integrated of order one, indicating that there is a stable long-run equilibrium relationship in these series. The results of VECM suggest that there is bi-directional causality in case of all the four commodities in long run suggesting that both the markets are efficient in discounting the new information. Though there exists feedback relationship between spot and futures markets, futures market has been found to be more information efficient than the underlying spot market, i.e. more information flows from the futures market to spot market. The results of Granger causality suggest that bidirectional causality does exist between spot returns and future returns of nickel in the short run. While zinc and pepper future returns Granger causes spot returns but not the other way round. Soybean spot returns Granger causes future returns in the short run. At present, Indian commodity futures markets are in its incipient stage. More studies are required for the better implications of the results and strong evidences are required in favor of the results. The main implications of the results of the present study are for investors and policy makers. On the basis of the results, investors may decide about the market, futures or spot, in which they should invest and the policy makers may frame policies on the basis of market efficiency of these markets.

However, the limitations of the study should not be overlooked. The present study is limited to only four commodities. The same study can be extended for other commodities with a longer time period. A logical extension of the study can be done by including more commodities and finding the efficiency of Indian commodities market.

ENDNOTES

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