Price Discovery and Market Efficiency of Commodities Futures Market in India – a Cointegration and Causality Analysis

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Abstract

The paper studies the Indian commodity futures market in order to determine the price discovery, long run market efficiency and short run dynamics in futures market using by time series analysis tools. To test the market efficiency and long run equilibrium, tools like Engle and Granger cointegration test (1987) and Johansen cointegration test (1988) have been applied. The Granger Causality (1969) test is used test the market efficiency to infer cause and affect relationship between spot and futures market in India. To examine efficiency of commodity futures and spot market the MCX's[1] four spot and futures commodity indices data are used. The paper observes that the role of commodity futures is very significant in price discovery, and improving efficiency of the market.

Keywords: Commodity Market, Cointegration, Causality, Price Discovery, Indices, Futures, market Efficiency

Introduction

Economic theories are often proving that a relationship exists in a series economic variable, thus the series of economic variable follows a short dynamics in price movements due to other economic forces influence on price movements, but over a due course of time, the series of economic variable possess the long run equilibrium (M-M Approach on Arbitrage). The certain pair of economic variable possesses the long run equilibrium relationship as they are cointegrated, even though two variables may drift away from equilibrium for a moment, economic forces perform on them to refurbish equilibrium. In commodity market too, there is a likelihood of markets integration and price transmission between futures and spot market as markets are efficient, in a pair of economic variables as one economic variable cause another variable and vice versa, it explains strength of the relationship exists between them as to reach perfect equilibrium, price discovery and effective risk management will possible in the market mechanism.

The commodity prices in an organized derivatives market reflect the perception of market participants about the future and lead the prices of underlying to the perceived future level. The prices of futures converge with the prices of the underlying at the expiration of the futures contract. Thus Commodity Derivatives[2] help in discovery of future as well as current prices. The hedgers (producers and consumers) and traders (speculators and arbitrageurs) who provide liquidity in the market in the course of seeking profits, while price discovery is happen when there is convergence of the futures and spot prices which is an indication that available information are incorporated into the futures price. The futures market

1 As Multi Commodity Exchange (MCX) capture more than 80 percent market in commodity derivatives trading in India, since 2003 to 2014 MCX is found as leader among commodity exchanges, hence the MCX consider as proxy to assess the performance of commodity derivatives market in India.

2 Commodity Derivatives are conceptually gaining the advantage due to price fluctuations of the commodities or securities. Derivatives' trading is mitigating the price fluctuation by creating the contracts at predetermined price with a predetermined date of settlement of physical commodities or price differentiation between spot and settlement price or exercise price of the commodity.

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is said to be inefficient if is unable to perform Price risk management and price discovery in the futures market.

The trading on Commodity derivatives (Futures) markets have been in existence for centuries and attained a degree of formalization in ancient Greece and Rome. Whereas India commodities markets was started contemporarily with organised trading in 1875. But due to some regulatory issues it was ban in 1952, aftermath the second generation reforms in India started with three national commodity exchanges (MCX, NMCE & NCDEX) in 2003 and at present six national commodity futures exchanges and fifteen regional exchanges by showing the significant growth in value and volume of the market and under the control of regulatory body Forward Market Commission (FMC).

Review of Literature

Silvapulle and Moosa (1999) examined the relationship between the spot and futures prices of WTI crude oil using a sample of daily data. Linear causality testing revealed that futures prices lead spot prices, but nonlinear causality testing revealed a bi-directional effect. This result suggests that both spot and futures markets react simultaneously to new information.

Zapata (2005) the study found that unidirectional Granger causality from futures prices for world sugar on the New York Exchange and world cash prices for sugar. The futures market for sugar leads the cash market in price discovery and a shock in the futures price innovation generates a quick (one month) and positive response in futures and cash prices; but not vice versa.

Liu and Zhang (2006) have studied the price discovery of spot and future prices in Chinese copper, aluminum, rubber, soybean and wheat markets. However, the lad lags relationship between spot and future markets in Indian Commodity Derivatives are quite limited.

Abhijit Sen (2007) examine the presence and extent of contribution of futures trading on the unexpected rise in the prices of agricultural commodities. The committee revealed that even if the agricultural price inflation is accelerated during the post futures period, the same cannot be attributed only to the trading of futures contract in essential agricultural commodities. A part of the price acceleration of agricultural commodities in the post futures period may be due to recovery of the past trend of relatively low agricultural prices observed during the pre-futures era.

Raizada and Sahi (2006) in their study have shown that the wheat futures market is even weak-form inefficient and fails to play the role of spot price discovery. Spot market has found to capture the market information faster and therefore expected to play the leading role. This inefficiency of the futures market may be attributed to the lack of necessary data to truly capture the actual lead-lag relationship between the spot and futures market.

Jatinder Bir Singh (2007) Futures Markets and Price Stabilization - Evidence from Indian Hessian Market, the study was found that futures market has reduced the price volatility in the hessian market. It was concluded that it is important that hessian futures market was efficient and market efficiency entails price discovery, price insurance and other things on liquidity of market.

IIM Bangalore (2008) FMC had commissioned to study the impact of Futures Trading in some important agricultural commodities are gram, sugar, guar seed, wheat, Urad and Tur. The first conclusion of this study is that all these crops, except sugar, witnessed higher price increase in the Post Exchange period compared to the Pre Exchange period and spot price volatility increased after introduction of futures. It also found that many contracts traded on Indian Commodity Exchanges do not satisfy a fairly minimal condition for these to be attractive for hedging by those holding physical commodities.

Sushismita Bose (2008) Commodity Futures Market in India – a Study of Trends in the Notional Multi-Commodity Indices, the findings of the study based on the movements of the existing commodity spot and futures indices indicate an important informational role of the futures market. Price formation in the spot and futures market does not take place in isolation but is closely related. The futures indices provide more or less accurate indications of the future spot price at least a month ahead. The indices considered here are significant barometers of the performance of the Indian commodities market.

Golaka C Nath and T. Lingareddy (2008) “Commodity derivatives contributing for rise or fall in risk”, the study found the Futures trading in the selected commodities has apparently led to increase volatilities particularly in case

of urad. Although gram prices too have posted a moderate rise in the post-futures trading period, the impact was not found statistically significant.

Ranajit and Asima (2010) studied the efficiency of Indian commodity market in terms of price formation of agricultural commodities traded on commodity exchanges. They emphasized that with the information of any one index hedging can be done on other commodity indices. New information was found as an important factor to predict the future value of commodities.

Brajesh Kumar, Ajay Pandey (2010) Role of Indian Commodity Derivatives Market in Hedging Price Risk: Estimation of Constant and Dynamic Hedge Ratio, and Hedging Effectiveness, The findings point out the great differences between agricultural and non-agricultural commodities with regard to the hedging performance of futures contracts traded in India. We also find that the hedging role of Indian commodity futures markets has increased in the recent period with increased activity in the market.

Subhasis Biswas and Prabina Rajib (2010) Testing Price Volume Relationship for Indian Commodity Futures with Linear Causality Test, it has a strong implication on the market efficiency as the past value of daily volume may be used to predict the daily return.

Vishwanathan and Archana (2010) examined the role of futures markets in terms of price discovery process and rate of convergence of information, Result supported the existence of price discovery process in Indian commodity exchanges. Further, a high rate of convergence of information in case of metals and slow convergence of information in case of agricultural commodities has been found between the different markets.

Kedarnath Mukherjee (2012) Impact of Futures Trading on Indian Agricultural Commodity Market, The empirical findings significantly shows that comparative advantage of futures market in disseminating information, leading to a significant price discovery and risk management, can help to successfully develop the underlying commodity market in India.

Brajesh and Pandey (2013) they investigated the short run and long run market efficiency of Indian commodity futures market. The result confirmed the long run efficiency of commodity futures prices and inefficiency of futures prices in short run.

Tarun Soni (2013) Nonlinearity in the Indian commodity markets: evidence from a battery of tests. the presence of nonlinearity in returns is considered as evidence against the efficiency of Indian commodity markets theory which characterizes data as random walk or more strictly a martingale

Objective of the Study

The objective of the present study is to examine role of commodity futures in price discovery, and persuading efficiency of Indian commodity futures market. To analyse the in new journey of markets are achieving the objective of price risk, price discovery and long-term market efficiency in Indian Commodity Futures market or not?

Data and Methodology

The study in explorative, empirical and analytical in nature data collected through secondary source from the MCX official website from April, 2006 to March, 2014 of all spot and futures indices. The MCX maintains composite index of two major segments of spot indices and corresponding futures indices, namely MCX COMDEX SPOT, MCX COMDEX FUTURES, and this main indices comprises with three spot and futures sub indices they are: MCX AGRI SPOT INDEX, AGRI FUTURES INDEX, ENERGY SPOT INDEX, ENERGY FUTURES INDEX, METAL SPOT INDEX AND METAL FUTURES INDEX of all Agricultural indices, Energy indices and Metal indices. This composition consists of highly liquid contracts, high trade volumes and value weights hence, they are considered as samples in the index, which are considered as yardstick to assess the performance of respective commodities futures market. In order to examine the role of commodity derivatives role in price discovery and efficiency of market, various econometric tools namely, Granger Causality, for price discovery, Engel Granger, Johanson Co-integration test, for price risk and short term dynamics towards equilibrium as well the efficiency of the market are employed.

Augmented Dickey Fuller (ADF) Test

This test is conducted on the variables in original price series (ADF regression including the intercept and trend) and first differences (ADF regression with only

intercept as trend will be removed while differencing). The variables that are integrated of the same order may be cointegrated, while the unit root test finds out which variables are integrated of same order, for example; if integrated by order one then it is denoted as I(1). The following ADF regression equation is used for testing the stationarity,

$$\Delta Yt = \beta 1 + \beta 2t + \delta Yt - 1 + \alpha i \sum_{i=1}^{m} \Delta Yt - 1 + ut$$

Where Yt is a vector to be tested for cointegration, t time or trend value, ΔYt is the first order difference, ut is pure white noise term, The null hypothesis that, δ = 0; signifying unit root, states that the time series is non-stationary while, the alternative hypothesis, δ < 0 signifies that the time series is stationary, thereby rejecting the null hypothesis.

The Engle and Granger Cointegration Approach

Generally one would find most of the economic variables to be non-stationary I(1) variables. Hence, any equilibrium theories that involve these variables require the existence of a combination of the variables to be stationary.

The components of a (kx1) vector, Yt, are said to be cointegrated of order i,j, denoted, Yt~CI (i,j), if (i) all the components of the vector yt are I(i), that is, they need d differences to induce stationarity, and (ii) there exists a vector β (≠0) so that Zt = β^1 Yt ~I (i-j) The vector β is called the Cointegrating vector. Usually we consider the case with i=j=1. This is an important result as any arbitrary linear combination of I(1) series will be I(1) (unless the series are cointegrated).

Cointegrating combinations are "equilibrium". So it is important to be able to discover and model these relationships. An alternative approach to the analysis of "long-run" (equilibrium) relationship would be to analyse the relationships between the differences of the series, i.e. among I(0) series. However, this approach is only concerned with short-run movements, while it throws useful long-run information.

If a set of variables are cointegrated, then there exists a valid error correction representation of the data, and vice versa.

If y and x are both I(1) and have a long run relationship, there must be some force which pulls the equilibrium error back to zero.

As they recommend a two-step procedure for cointegration analysis.

(i) Estimate the long-run (equilibrium) equation:

$$Yt = \delta 0 + \delta Xt + \varepsilon t$$

The OLS residuals measure of disequilibrium:

$$\hat{\varepsilon t} = Yt - \delta \hat{o} - \delta 1\, Xt +$$

A test of cointegration is a test of whether $\hat{\varepsilon t}$ is stationary. This is determined by ADF tests on the residuals, with the MacKinnon (1991) critical values adjusted for the number of variables (which MacKinnon denotes as n).

If cointegration holds, ordinary Least square the estimator is said to super be consistent be Implications: as $T_{n \to \infty}$ (i) there is no need to include I (0) variables in the cointegration equation.

(ii) Second step: estimate the Error Correction Model

$$\Delta Yt = \phi o + \sum_{j=1} \phi j\, \Delta Yt - j + \sum_{h=0} \psi h\, \Delta Xt - h + \alpha \hat{u} 1 - 1\, \varepsilon t$$

by OLS as this equation has only I(0) variables, standard hypothesis testing using t ratios and diagnostic testing of the error term is appropriate. The adjustment coefficient α must be negative.

Special case:

$$\Delta Yt = \phi o + \phi j\, \Delta Yt - 1 + \phi 1\, \Delta Xt - 1 + \alpha\, (Yt - 1 - \delta \hat{o} - \delta 1\, Xt - 1) + \varepsilon t$$

ECM describes how *y* and *x* behave in the short run consistent with a long run cointegration relationship.

Johansen Cointegration Test

Johansen's cointegration test has been employed to investigate the long-run relationship between two variables. The price linkage between futures market and spot market is examined using cointegration analysis that has reveals the extent to which two markets has moved together towards long run equilibrium.

$$Yt = \mu + A1Yt - 1 + ApYt - p + \varepsilon t$$

Where Yt is a vector (n x 1) integrated of first order denoted by 1(I), εt is an error term (vector (nx1) of innovations)

and A1 …. Ap are variables. The test comprises of two methods: the Maximum Eigen Value test and the Trace test which have been put to use.

Granger Causality Test

Granger (1969) was developed a time series model in order to determine the causality between two economic time series variables, he intellect that one economic variable cause of another economic variable, if X can be usable in predicted value of accuracy of y with its past values.

Clarification of the model : the information set Ω_t with the form $(a_t,….a_{t-j}, b_t…b_{t-k})$ it may conclude that a_t is granger causal for b_t, w rt, Ω_t if the variance of the optimal linear predictor of b_{t+k} based on Ω_t has small variance than the optimal predictor of b_{t+k} based on logged value of b_t for any h, thus a granger cause b if and only if $\sigma_1^2(b_t: b_{t-k,} a_{t-j}) < \sigma_1^2(b_t: b_{t-k})$ with j and k = 1,2,3…n and σ^2 representing the variance of forecast error. Granger Causality is based on the simple logic that effect cannot precede cause.

It is important to note that the statement "*x* Granger causes *y*" does not imply that *y* is the effect or the result of *x*. Granger causality measures precedence and information content but does not by itself indicate causality in the more common use of the term. Granger causality is a necessary condition for causality, but not a sufficient condition. The test itself is just an F test of the joint significance of the other variable(s) in a regression that includes lags of the dependent variable.

The different types of situation in which causality test may applied, in a simple granger-causality test there are two variable and their lags, in multi causality more than two variables and final causality also tested in a VAR frame work in this multivariate model extended.

$$St = \alpha o + \sum_{i=1}^{m} \beta i(S)t - 1 + \sum_{j=1}^{n} \gamma j(F)t - i + \varepsilon t$$

$$Ft = \phi o + \sum_{i=1}^{m} \psi i(F)t - 1 + \sum_{j=1}^{n} \varphi j(S)t - i + et$$

Where St and Ft are two variable at time 't", I and j the number of lags, β_0 is deterministic, ε_i is error term, γ and β are coefficients on lagged St and Ft value respectively.

Where St and Ft are two variable at time 't", I and j the number of lags, ϕ is deterministic, e_i is error term, γ and are coefficients on lagged St and Ft value respectively.

Null hypothesis is $\gamma i=0$ for all I's and j's and $\psi j=0$ for all j's versus the alternative hypothesis that $\gamma i \neq 0$ and $\psi j \neq 0$ for at least some I's and j's. if the coefficients γi are statistically significant but ψj's are not, then Ft causes St, but if both γi and ψj are significant, than causality bidirectional.

Analysis, Discussions and Findings

Descriptive Analysis

The table 1 exhibits the market performance through select indices of MCX, viz, COMDEX SPOT (COMDEX S), COMDEX FUTURES (COMDEX F), AGRI INDEX SPOT (AGRIINDEX S) AGRIINDEX FUTURES (AGRI

Table 1: Descriptive Analysis of MCX Spot and Futures Indices

	N	*Minimum*	*Maximum*	*Mean*		*Std. Deviation*	*Skewness*		*Kurtosis*	
		Statistic	*Statistic*	*Statistic*	*Std. Error*	*Statistic*	*Statistic*	*Std. Error*	*Statistic*	*Std. Error*
COMDEX S	96	1602	4562	2991.45	78.126	765.478	.163	.246	-1.393	.488
COMDEX F	96	1819	4509	2992.74	73.250	717.699	.147	.246	-1.413	.488
AGRIINDEX S	96	1415	3851	2399.16	75.919	743.850	.267	.246	-1.407	.488
AGRIINDEX F	96	1392	3613	2177.76	54.452	533.517	.513	.246	-.389	.488
ENRGYINDEX S	96	1494	4906	2991.33	74.595	730.878	.427	.246	-.338	.488
ENRGYINDEX F	96	1707	4946	3032.62	73.184	717.056	.492	.246	-.296	.488
METALINDEX S	96	1978	5364	3626.25	108.248	1060.609	.206	.246	-1.611	.488
METALINDEX F	96	2162	5489	3663.58	108.809	1066.108	.223	.246	-1.614	.488

Source: Calculated by Researcher, MCX

INDEX F) ENRGY INDEX SPOT (ENERGY INDEX S), ENERGY INDEX FUTURES (ENERGY F), METAL INDEX SPOT (METAL INDEX S) and METAL INDEX FUTURES (METAL INDEX F) with the help of Mean, Standard Deviation, Skewness and Kurtosis.

Results, Discussion and Findings

The analysis shows that the mean values of spot and futures Comdex were 2991.45 and 2992.74 respectively. But maximum spot comdex value was higher than futures comdex value and with a spot and futures standard deviation of 756 and 717 respectively. It implies that futures comdex value is more consistence than spot comdex. By comparing the symmetry of distribution of both spot and futures comdex, it is found that there is a positive skewness that infers the mean value is greater than most frequently occurring comdex value, whereas, the coefficient of kurtosis, both spot and futures comdex value less than three implied a platykurtic curve, a curve more flat than normal. The spot and futures Agri index mean values were found at 2399 and 2177, but maximum spot agri index value is higher than futures agri index with standard deviation of 743 and 535, it implies that futures Agri Index value is more consistence than spot Agri Index, comparing symmetry of distribution for both spot and futures Agri Index, it infers that mean value is greater than most frequently occurring indices value.

Energy spot and futures index mean values were found at 2991 and 3032 with standard deviation of 730 and 717 respectively, whereas maximum value of spot index is lower than futures index, it can be concluded that spot index value is more consistent than futures index value, the symmetric distribution of spot and futures index have positive skewness that infers as mean value is greater than most frequently occurring index values. On the other hand Metal spot and futures mean values are found at 3626 and 3663 with standard deviation of 1060 and 1066, it can be analysed that the spot index value is more consistent than futures index value, whereas symmetric distribution of spot and futures index value have positive skewness, which states that mean value is greater than most frequently occurring index values. As the kurtosis of all spot and futures indices have fewer values than a platykurtic curve values, which is a curve more flat than normal. it can be asserted that the mean value and volatility moved in the above cited segments in a passive manner accordingly the change in volume, more specifically.

Correlation Analysis is to Test the Association Between MCX Spot and Futures Commodity Indices

Pearson coefficient of correlation is applied for the analysis of select MCX spot and futures indices.

Results, Discussion and Findings

Ho: There is no correlation between spot and Futures indices of MCX (Spot Index of MCX ≠ Futures Index of MCX)

Table 2: Correlations Analysis of MCX Commodity Indices

Indices	*COMDEXS*	*COMDEXF*	*AGRIINDEXS*	*AGRIINDEXF*	*ENRGYINDEXS*	*ENRGYINDEXF*	*METALINDEXS*	*METALINDEXF*
COMDEXS	1	.996**	.911**	.763**	.852**	.862**	.972**	.968**
COMDEXF		1	.908**	.791**	.844**	.857**	.972**	.970**
AGRIINDEXS			1	.887**	.579**	.595**	.959**	.961**
AGRIINDEXF				1	.415**	.430**	.834**	.838**
ENRGYINDEXS					1	.996**	.711**	.701**
ENRGYINDEXF						1	.726**	.718**
METALINDEXS							1	.999**
METALINDEXF								1

**. Correlation is significant at the 0.01 level (2-tailed).
Source: Calculated by Researcher, MCX

Ha: There is a correlation between spot and futures indices of MCX (Spot Index of MCX = Futures Index of MCX)

Table 2 presents the analysis of correlation between the Spot Indices and Futures Indices of MCX. The analysis clearly depicts that Comdex S is possessing a high positive correlation with all other spot as well as futures indices. The Agri index S and F possesses low degree of positive correlation coefficient with Energy index S and F, whereas correlation coefficient between Metal indices S and F and Energy indices S and F is positive, but it is lower than other indices comparatively, hence it can be concluded from the analysis that all the select indices are moving in same direction and having reciprocal impact on each and every opponent indices.

Analysis on Test of Stationarity

In order to determine the order of integration of each indices value or price series, in analysis first tested whether MCX spot and futures indices are stationarity or not. The Augmented Dickey Fuller (ADF) test had performed on level form of each index value series.

Results, Discussion and Findings

Ho: The existence of unit root in MCX spot and Futures indices

It is very clear from table 3 that all MCX spot and futures indices value series were non stationary at 5% level, but attains stationarity at 5% significance at first difference I (1) of indices. The stationarity tests conducted for the spot and futures indices series sets of time series shows that attain the stability at first difference and now amenable for cointegration analysis. It makes possible to investigate the existences of long run relation between series.

Analysis of Cointegration test to Test the Long Run Market Efficiency (Engle-Granger Cointegration test)

To investigate the long run relationship between spot and futures indices, the cointegration implies that two series spot and futures indices are non stationary but a linear combination of two series is stationary so that both are cointegrated.

Results, Discussion and Findings

Ho: There is no cointegration between MCX spot indices and MCX futures indices value in long run.

Ha: There is cointegration between MCX spot indices and MCX futures indices value in long run.

The Engle-granger test results presents through the table 4 and table 5, that the test statistics of MCX spot and futures comdex, MCX spot and futures Agri index, MCX spot and futures Energy index and MCX spot and futures Metal indices presents through value compare with p value and the coefficient value of all indices were more than zero. It can be concludes that the reject the null hypothesis that there is no cointegration between MCX spot and futures indices and accept the alternate hypothesis as there is cointegration between MCX spot and futures indices. Hence, it can conclude that Indian commodity futures market in long run equilibrium and reaches towards market efficiency.

Table 3: Analysis of Stationarity through ADF of MCX Commodity Indices

MCX INDICES SERIES	*estimated value of (a - 1)*	*ADF (t stats)*	*Critical values 5%*	*Lag Order*
COMDEX S	-0.931478	-8.92781	-3.03	2
COMDEX F	-0.954603	-9.16723	-3.03	2
AGRIINDEX S	-1.41522	-15.0022	-3.03	2
AGRIINDEX F	-1.03459	-9.97984	-3.03	2
ENERGYINDEX S	-0.786044	-7.74618	-3.03	2
ENERGYINDEX F	-0.748929	-7.43406	-3.03	2
METALINDEX S	-0.89164	-4.28573	-3.03	2
METALINDEX F	-0.709684	-4.0448	-3.03	2

The test of stationarity at 5% significance level

Table 4: Engle- Granger Cointegration Analysis of MCX Commodity Indices

MCX INDICES Cointegrating equation	*coefficient*	*std. error*	*t-ratio*	*p-value*	*Lags*
const	-189.399	28.6454	-6.612	2.28e-09 ***	12
COMDEXSPOT	1.06284	0.00931162	114.1	1.28e-102 ***	12
const	837.243	97.8015	8.561	2.10e-013 ***	12
SAGRIINDEX,	0.553938	0.0383946	14.43	1.44e-025 ***	12
const	103.468	27.9862	3.697	0.0004 ***	12
SENERGYINDEX,	0.978936	0.00909104	107.7	2.93e-100 ***	12
const	136.978	56.4877	2.425	0.0172 **	12
SMETALINDEX,	0.968181	0.0148640	65.14	5.12e-080 ***	12

(OLS, using observations 2006:04-2014:03 (T = 96))
Source: Calculated by Researcher, MCX

Whereas table 5 exhibits the lag length criterion based on Akaike Information criterion (AIK), Schwarz (SIC) and Maximum Likelihood criterion and Durban-Watson test statistics. It shows the values higher than zero, which means the non stationarity of the series at individual level and the linearity between the series is cointegrated.

Analysis of Johansen's Cointegration test between and among MCX Commodity Indices

The Johansen cointegration test carried out to determine the existence of long run relationship between the MCX spot and futures indices of the pair of series.

Results, Discussion and Findings

The Johansen cointegration test analysis is examined by establishing the hypothesis that Ho: there is no cointegration (r=0) between MCX spot and futures indices.

Table 6 exhibits that four pairs of spot and futures indices of MCX were tested with trace and Maximal Eigen value test statistics and compared with the t-statistics.

Table 5: Engle- Granger Cointegration Coefficients of MCX Commodity Indices

	COMDEXSPOT& COMDEFUTURES	*SAGRIINDEX& FAGRIINDEX*	*SENERGYINDEX& FENERGYINDEX*	*SMETALINDEX& FMETALINDEX*
Mean dependent var	2990.979	2177.760	3031.781	3663.646
S.D. dependent var	765.4720	533.4744	718.4514	1066.141
Sum squared resid	398748.3	8411100	394328.9	2340574
S.E. of regression	65.13067	299.1317	64.76873	157.7965
R-squared	0.992837	0.688899	0.991958	0.978324
Adjusted R-squared	0.992760	0.685589	0.991873	0.978094
Log-likelihood	-536.1415	-682.4924	-535.6065	-621.0929
Akaike criterion	1076.283	1368.985	1075.213	1246.186
Schwarz criterion	1081.412	1374.113	1080.342	1251.315
Hannan-Quinn	1078.356	1371.058	1077.286	1248.259
Rho	0.472862	0.737995	0.067314	0.493412
Durbin-Watson	1.024635	0.523628	1.850308	1.009237

(OLS, using observations 2006:04-2014:03 (T = 96))

Table 6: Johansen's Cointegration Test Analysis Between MCX Commodity Spot and Futures Indices

commodity	*Cointegration equation*	*Eigen Value*	*Trace test*			*Max. Eigen value*		
			Statistics	*Critical value 0.05*	*Prob.***	*statistics*	*Critical value*	*Prob.***
COMDEX S & F	None*	0.143395	16.16407	15.49471	0.0396	14.39438	14.26460	0.0477
	Almost 1	0.018849	1.769693	3.841466	0.1834	1.769693	3.841466	0.1834
AGRIINDEX S & F	None*	0.165817	18.84907	15.49471	0.0150	16.86108	14.26460	0.0190
	Almost 1	0.021149	1.987987	3.841466	0.1586	1.987987	3.841466	0.1586
ENERGYINDEX S & F	None*	0.201642	24.85864	15.49471	0.0015	20.94344	14.26460	0.0038
	Almost 1	0.041225	3.915204	3.841466	0.0478	3.915204	3.841466	0.0478
METALINDEX S & F	None*	0.247122	27.19374	15.49471	0.0006	26.39824	14.26460	0.0004
	Almost 1	0.008517	0.795502	3.841466	0.3724	0.795502	3.841466	0.3724

Source: Calculated by Researcher, MCX

Note: 1. *Null hypothesis tested is for the number of cointegrating equations present between the MCX spot and futures indices

2. All the tests were done at 5% of significance.

Lags interval (in first differences): 1 to 2

Lags are selected based on Schwarz Information Criterion (SIC)

Trace 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

Test statistics were higher than t-statistics, hence the null hypothesis rejected which means that there exists more than one cointegrating equation between spot and futures market. Thus, spot and futures market in long run reaches equilibrium and share the information. This analysis further interpret the result as there is a price discovery process in spot and futures market that states how market such as spot and futures commodity reveals pricing information through price difference between respective markets. Therefore, consequently the price change in futures market generates price change in spot market vice-versa in the direction to bring long run equilibrium.

Analysis on Ganger Causality between MCX Spot and Futures Commodity Indices

The analyse causality between MCX spot and futures indices and direction of causality are tested through using Granger causality.

Results, Discussion and Findings

H1: MCX spot indices Comdex S, Agri Index S, Energy index S and Metal index S series do not granger cause Futures indices Comdex F, Agri Index F, Energy index F and Metal index F series.

H2: MCX Futures indices Comdex F, Agri Index F, Energy index F and Metal index F series does not granger cause spot indices Comdex S, Agri Index S, Energy index S and Metal index S series.

The table 7 presents result of causality analysis tests, it clearly illustrates that hypothesis selected as MCX spot indices do not granger cause futures indices and MCX futures indices do not granger cause spot indices, the null hypothesis was rejected and it is inferred that spot prices granger cause vis-a-vis futures prices. There are four MCX commodities spot and futures indices selected and tested the causality and direction of lead indices values. The result shows the unidirectional causality (at lag 1) as spot comdex granger cause is found with futures comdex, precisely the information flow from spot market to futures market, thereby price discovery occur in spot market. Agri indices depict that the unidirectional causality (at lag 1 to 5) as futures have the granger cause on spot index, which infers that information flow from futures to spot as the cause for price discovery happens in futures market. The energy indices shows that there is a unidirectional causality (at lag 1 to 3) as spot index granger cause futures index, it can be concluded that the information flow happens from spot to futures market, hence, we can states that price discover happens at spot market, on the other hand, metal indices shows the result that unidirectional causality (at

Table 7: Ganger causality test analysis

Null hypothesis: commodity wise	S does not Granger Cause F			F does not Granger Cause S		
	lags	F-Statistics	P value	F-Statistics	P value	Direction of causality
COMDEX	1	3.14760	0.0793	0.00505	0.9435	Unidirectional causality. Spot granger causes futures.
	2	1.69248	0.1899	0.80949	0.4483	
	3	1.94413	0.1285	0.82254	0.4850	
	4	1.48995	0.2127	0.64148	0.6344	
	5	1.35119	0.2517	0.75181	0.5872	
AGRIINDEX	1	0.00099	0.9749	5.19879	0.0249	Unidirectional causality. Futures granger causes spot.
	2	0.00868	0.9914	3.42604	0.0369	
	3	0.05693	0.9820	2.63386	0.0550	
	4	1.13395	0.3463	2.92152	0.0259	
	5	0.86814	0.5063	2.55612	0.0338	
ENERGYINDEX	1	6.11172	0.0153	0.06555	0.7985	Unidirectional causality. Spot granger causes futures
	2	2.89425	0.0606	1.27442	0.2846	
	3	2.84227	0.0425	1.18946	0.3186	
	4	1.95614	0.1088	0.91955	0.4566	
	5	1.59760	0.1703	0.84812	0.5198	
METALINDEX	1	0.38725	0.5353	3.68092	0.0581	Unidirectional causality. Futures granger causes spot.
	2	0.05407	0.9474	2.32490	0.1037	
	3	0.11039	0.9538	1.05201	0.3739	
	4	0.07042	0.9908	0.93291	0.4490	
	5	0.32185	0.8985	0.93707	0.4617	

lag 1) futures energy index having granger cause on spot index, it is due to deduce of information flow from futures to spot market. It infers that price discovery is happened in futures market. Further it can be declared that in MCX spot and futures indices shown unidirectional causality of spot to futures indices, in case of comdex and energy indices and futures as well agricultural and metal indices also the same effect has been identified, hence, it can be concluded that there is a market efficiency which has been found through commodity futures in Indian commodity derivatives market.

Findings and Conclusion of the Study

It is asserted that the mean value and volatility of spot and futures indices moved in a slow manner accordingly the change in volume, hence it can be concluded from the analysis that all the select indices are moving in same direction and having reciprocal impact on each and every opponent indices.

It is found that stationarity tests conducted for the spot and futures indices series sets of time series shows that attain the stability at first difference and it makes possible to investigate the existences of long run relation between series.

The Engle-granger analysis proved that MCX spot and futures comdex, MCX spot and futures Agri index, MCX spot and futures Energy index and MCX spot and futures Metal indices are cointegrated. Further, it found that there is non stationarity at individual series Viz; Spot, future indices, but linearity is established between the series. Hence, it can be concluded that Indian commodity futures market is efficient.

The Johansen's cointegration analysis demonstrated that the select indices of MCX reveals that more than one cointegrating equation between spot and futures market is found. This enables the price discovery in spot and futures market The connotation of cointegration is that the commodity prices in two different markets react disproportionately to the pricing information in short run but the convergence will happen in long run.

The Granger causality analysis reveals the comdex indices and energy indices are showing unidirectional causality that spot market granger causes futures market, which infers that information flow form spot market to futures market and leads to price discovery in spot market. In case of agri indices and metal indices there is unidirectional causality where futures market granger causes spot market, which infers that information flowing from futures to spot, leads to price discovery in futures market.

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