Testing the Co-Integration in Indian Commodity Markets : A Study with Reference to Multi Commodity Exchange India Ltd.

** M. Babu*
*** S. Srinivasan*

Abstract

This paper aims to analyze the relationship between spot and futures prices in the Indian commodity markets. There are various studies relating to testing the efficiency and cointegration of capital markets at the national and global level. An attempt has been made in this paper to test the cointegration of commodities in Multi Commodity Exchange India Ltd. using Johansen's cointegration test. The study period was from January - December 2012. A sample of 10 commodities based on their total turnover during the study period were selected. Johansen's cointegration test results reveal that the spot prices of the selected sample commodities had no influence on their futures prices.

Keywords: **efficiency, Johansen co-integration test, commodities, futures market**

JEL Classification: C58, G10,G14

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A commodity market is where raw or primary products are exchanged. Commodity exchanges are the place where the raw commodities are traded on standardized contracts. The Indian commodity market can be subdivided into the following two categories : The wholesale market and the retail market. In India, the commodity markets are governed by the Forward Markets Commission (FMC), which has been set up by a Special Act in the Indian Parliament.

Multi Commodity Exchange of India Ltd. (MCX) is an independent and demutualized nationwide electronic multi commodity futures exchange set up by Financial Technologies with permanent recognition from the Government of India for facilitating online trading, clearing, and settlement operations for futures markets across the country. There are 14 key shareholders of MCX, which include SBI and its subsidiaries and Financial Technologies (India) Ltd. Its headquarters are in the financial capital of India, Mumbai. The exchange started operations in November 2003. As on December 31, 2011, MCX offered futures trading in more than 100 commodities defined in terms of the type of contracts offered, from various market segments including bullion, energy, ferrous and non-ferrous metals, and so forth. The exchange strives to be at the forefront of development in the commodities futures industry, and has forged ten strategic alliances with many international commodity exchanges (Multi Commodity Exchange of India Ltd. (MCXa), n.d.). In finance, the efficient market hypothesis suggests that the markets are "Informationally Efficient". There are three major classifications of the efficient market hypothesis, which include :

1) Weak Form Efficiency which suggests that past prices cannot be used as an indicator to predict future prices. History is 'history'. Historical data has no significance in analyzing future prices.

2) Semi Strong Form Efficiency asserts that share prices react very quickly, and in an unbiased fashion, to publicly available new information.

3) Strong Form Efficiency holds that prices reflect all information, public and private, which may include market rumors, price manipulation, and so forth (Chandra, 2006).

* *Assistant Professor - Commerce and Financial Studies,* Bharathidasan University, Tiruchirapalli, Tamil Nadu.
E-mail : babuphd@gmail.com
** *Ph.D Scholar,* Department of Commerce and Financial Studies, Bharathidasan University, Tiruchirapalli, Tamil Nadu.
E-mail : ssrinivasantirupathi@gmail.com

Review of Literature

Dixit and Pandey (2011) examined the relationship between SME variables such as SMEs' output, exports, employment, number of SMEs with their investments, India's GDP, total exports, and employment (public and private) for a period from 1973-74 to 2006-07.The results of the study gave evidence that there was positive causality between SME output and India's GDP, and that the independent variables had a positive effect on the dependent variables.

Joshi (2013) examined the relationship and co-integration of stock market prices of BRIC countries. The daily closing prices were considered for the period from April 2002 to March 2007 and from April 2007 to March 2012. The study analyzed the relationship between stock markets during the pre and post crisis period. The tools used for analysis included correlation analysis and Engle-Granger's co-integration test. The findings of the study revealed that the Indian stock market had a strong positive correlation with Brazil, Russia, and China. Saxena and Bhadauriya (2013) made an attempt to highlight the determinants of inflation in India during April 2001 to March 2011. The relationship between selected economic determinants and inflation was estimated using Johansen's cointegration test and vector error correction. The results of the study gave evidence that there was positive relationship between gross domestic product (GDP) and the consumer price index (CPI). Money supply and crude oil prices were highly interdependent on inflation in India during the study period.

Inoue and Hamori (2012) examined the weak form of efficiency analysis using Johansen's methodology. The sample period selected was from January 2, 2006 to March 31, 2011. Daily spot and future prices were collected from MCXCOMDEX. The unit root test was examined using Augmented Dickey Fuller test. The study concluded by stating that there was co-integrating relationship between spot and future prices of MCXCOMDEX and the commodity futures market was efficient during July 2009. Tariq (2013) examined the relationship between Pakistan equity market and the markets of selected developed and developing countries. The sample countries chosen included Australia, Canada, France, Germany, Japan, Norway, Netherlands, UK, USA, China, India, Korea, Kuwait, Singapore, Saudi Arabia, UAE, Qatar, and Hong Kong. Monthly data from July 2003 to June 2012 were used for the study. Cointegration and causality was examined using Johansen's test and the Granger causality test. The results of the study found that there is a long term relationship between developed countries, developing countries, and Pakistan's stock markets.

Soni (2013) analyzed the market efficiency of guar seed futures contract traded at the National Commodities and Derivative Exchange Ltd. (NCDEX) using co-integration analysis and the error correction model. The data for the study comprised of daily closing spot and futures prices from April 2004 till March 2012 collected from the NCDEX website. The results of the study indicated that the futures market for guar seed was inefficient in both short and long term. Natanelov, McKenzie, Alam, and Huylenbroeck (2011) focused on analyzing the price movements between crude oil futures and a series of agricultural commodities and gold futures. Johansen's statistic, vector error correction, and threshold co-integration methods were used for analysis. The data used for analysis comprised of monthly futures prices of crude oil, cocoa, coffee, corn, soybeans, soybean oil, wheat, rice, sugar, and gold starting from July 1989 until February 2010. The major findings of the study indicated that there existed co-movement between crude oil and other well established commodity futures markets.

Design of the Study

↳ **Statement of the Problem :** The commodity market is very popular in India because of hedging and speculation by all types of industries. Every market has fluctuations due to some factors like demand, supply, global political conditions, international market structure, inflation, weather conditions, and so forth, which have their effect on commodity prices. The volatility in the prices of commodities affects not only the investors, but has its impact on the common man. Climatic variations these days has brought a serious effect on agricultural products. Can there be stable movements in the commodity prices? This question calls for analysis of cointegration between spot and future prices. Proper planning of investments in commodity markets can help the investors in gaining better returns. This requires a careful investigation of spot and future price movements of the commodities. Against this background, this study focuses on analyzing the spot and futures prices in the Indian commodity market.

↳ **Need for the Study :** The present study gains importance as it can help the investors to better perceive the movements of the markets for deciding the timing of the investments. The peculiar characteristics of any market are unlimited loss and unlimited profit, and therefore, the investors should know the market conditions in order to earn more returns. The common layman investors prefer to invest their money only in bank deposits, post office savings deposit, and so forth. Despite the risks, there are several advantages of commodities investment, which have attractive features such as diversification, weather derivatives, and hedging against price fluctuations, which can help in managing the investments. Hence, there is a need to test the co-movement in commodity prices in India. Studies related with testing the cointegration of national level commodity exchanges are limited in number. Hence, the present study is an attempt to analyze the co-integration of spot and future prices with the help of Johansen's cointegration test.

Objectives of the Study

1) To examine whether the spot and futures prices returns of the Indian commodity market are stationary or not.
2) To determine the relationship between spot and futures prices returns of the commodity market.

Hypotheses of the Study

1) H_{01} **:** The spot and futures prices returns of the Indian commodity market are not stationary.
2) H_{02} **:** There is no cointegration in the spot and futures price returns of the selected sample commodities.

Methodology of the Study

↳ **Sample Selection :** The Multi Commodity Exchange (MCX) is a more active trade exchange among the four major commodity exchanges in India. For the purpose of the present study, the spot and futures prices of the commodities were selected on the basis of their total turnover during the study period. Before selecting the commodity, availability of the spot and futures prices data in MCX was also considered. The selected sample commodities considered for the present study are given in the Table 1.

Table 1. Details of Sample Commodities Selected and their Turnover During the Study Period

S. No	COMMODITY	TURNOVER (2012) (₹ in Lakhs)
1	Gold	3,026,298,9650.50
2	Silver	2,947,722,7700.09
3	Crude Oil	2,861,269,7439.10
4	Copper	1,371,427,8385.25
5	Natural Gas	5,375,444,424.39
6	Nickel	3,575,924,750.39
7	Mentha oil	1,231,036,105
8	Aluminium	4,72,165,518
9	Cardamom	2,84,80,82,91
10	Cotton	1,72,23,73,80

Source : Multi Commodity Exchange of India Ltd. (MCXb) (n.d.). Historical data for volume. Retrieved from http://www.mcxindia.com/SitePages/HistoricalDataForVolume.aspx

↳ **Period of the Study :** For the purpose of this study, the study period covered is one year - from January to December 2012.

Sources of Data : The spot and futures prices of commodities which are traded in MCX were collected from MCX website (www.mcxindia.com). The other relevant details for this study were collected from MCX publications, websites, journals, and books.

Tools Used for Analysis

1) Descriptive statistics,
2) Augmented Dickey Fuller test,
3) Johansen cointegration test.

(1) Descriptive Statistics

Daily Return : The daily returns on each commodity in the sample were calculated using the daily adjusted prices collected from the MCX Website.

$$R_{it} = \left(\frac{P_t - P_{t-1}}{P_{t-1}}\right) * 100$$

Where,
$R_{i,t}$ = Returns on commodity i on time t,
P_t = Price of the commodity at time t,
P_{t-1} = Price at time $t-1$.

Mean is the average of the distribution and it is calculated by using the following formula :

$$\bar{x} = \frac{1}{n} \cdot \sum_{i=1}^{n} x_i$$

Standard Deviation : In financial parlance, standard deviation is a measure of volatility. A lower standard deviation indicates that the data values are closer to the mean; whereas, a higher standard deviation is an indication that the data values are spread over larger variations. It can be calculated as follows :

$$\sigma = \sqrt{\frac{1}{N} \sum_{i=1}^{N} (x_i - \mu)^2}$$

Skewness : It is a measure of symmetry or asymmetry. If the data is at the left and the right tail is longer, we say that the distribution is skewed right or positively skewed; if the peak is toward this right and the left tail is longer, we say that the distribution is skewed left or negatively skewed.

$$SKEW(X) = \frac{E[(X - \mu)]^3}{\sigma^3}$$

Kurtosis : Measure of kurtosis indicates the degree to which a curve of a frequency distribution is peaked or flat-topped. Kurtosis measures the peakedness of a normal curve. A normal curve, which is symmetrical and bell-shaped is designed as mesokurtic, because it is kurtosis in the centre. If a curve is relatively narrower and peaked at the top, it is designated as leptokurtic. If the frequency curve is more flat than the normal curve, it is platykurtic.

$$\text{Kurtosis} = \frac{E[(X - \mu)]^4}{N\sigma^4}$$

(2) Augmented Dickey-Fuller test (ADF) : An Augmented Dickey-Fuller test (ADF) is a test for a unit root in a time series sample. The ADF statistic, used in the test, is a negative number. The more negative it is, the stronger the

rejections of the hypothesis that there is a unit root at some level of confidence. The testing procedure for the ADF Test is the same as for the Dickey-Fuller test, but it is applied to the model in the following way :

$$\Delta y_t = \quad + \beta t + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + ... + \delta_p \Delta y_{t-p} + \varepsilon_t ,$$

Where,
α is a constant,
β is the coefficient on a time trend,
p is the lag order of the autoregressive process.

Imposing the constraints $\alpha = 0$ and $\beta = 0$ corresponds to modeling a random walk ; using the constraint $\beta = 0$ corresponds to modeling a random walk with a drift. By including lags of the order *p,* the ADF formulation allows for higher-order autoregressive processes. This means that the lag length *p* has to be determined when applying the test.

(3) Johansen - Juselius Co-Integration Test (JJ) : Johansen test is a test to analyze the co integration between spot and future price of time series. This test does not require all variables to be in the same order of integration, and hence, this test is much more convenient than the Engle-Granger test for unit root, which is based on the Dickey-Fuller (or augmented) test. The Johansen trace and maximum Eigen value statistics both have the same null. (Rank $(P_i) = r$) but different alternatives. The alternative for the trace test is Rank $(P_i) > r$. The alternative for the maximum Eigen value test is rank $(P_i) = r + 1$. It is defined as :

$$X_t = \pi_1 X_{t-1} + ... + \pi_k \quad X_{t-k} + \ + t$$

Limitations of the study

1) The study period is restricted to one year only and hence, the results cannot be generalized.
2) The results of the study are based on the data that was collected from the MCX website.
3) The results of the study may vary when different time periods are taken into account.
4) All the limitations of tools used for the analysis apply to this study as well.

Results and Discussion

The Table 2 explains the summary of descriptive statistics for the select sample commodities' spot and future price returns during the study period from January 1, 2012 to December 31, 2012. It can be observed that crude oil, nickel, and cotton observed negative returns, implying that the investors earned losses in these sample commodities. Silver recorded the highest returns followed by gold, which gave a favorable position to the investors. The standard deviation was positive for all sample commodities. Volatility was high for gold, silver, and crude oil. Skewness was negative for gold, crude oil, mentha oil, and cotton. The value of kurtosis is greater than 3 for all sample commodities, indicating that the distribution is leptokurtic.

A summary of the Augmented Dickey Fuller test is presented in the Table 3. The Augmented Dickey Fuller test is used to examine the stationary in spot and future price returns of sample commodities. It is evident from the table that the ADF *t* -statistic values of spot and future prices returns of all sample commodities were lower than the critical values at 1%, 5%, and 10% significance level. Hence, the H_{01} is rejected. This is a clear indication that all the sample commodities attained stationary at the level difference itself, and hence, it is not necessary to go for first difference (Brooks, 2008 ; Kozhan, 2010). The results of Johansen's cointegration test, which was conducted to check the long-run equilibrium relationship between spot and future price returns of the selected sample commodities is summarized in the Table 4. The cointegration between spot and future price returns was tested with unrestricted cointegration trace statistic and max Eigen value. It becomes clear from the Table that the trace value and max-Eigen values are greater than the critical values at 5% level of significance for all the select sample commodities. Hence, it is a clear indication to accept the null hypothesis H_{02}. The results clearly denote that there is no long term relationship between spot and

Table 2. Analysis of Normality for the Selected Sample Commodities from 01.01.2012 to 31.12.2012

Commodity		Minimum	Maximum	Mean	Std. Dev	Skewness	Kurtosis
Gold	Spot	-0.033	0.026	0.0004	0.006	-0.162	7.053
	Future	-0.032	0.043	0.0003	0.006	0.497	12.25
Silver	Spot	-0.048	0.04	0.0004	0.0109	0.160	5.44
	Future	-0.05	0.0812	0.0006	0.0121	1.211	12.68
Crude Oil	Spot	-0.055	0.078	-4.93	0.015	0.270	6.467
	Future	-0.78	7.25	-0.0001	0.0118	-0.078	7.25
Copper	Spot	-0.0349	0.0373	0.0003	0.0122	0.068	3.3319
	Future	-0.029	0.047	0.0003	0.008	0.3005	5.87
Natural Gas	Spot	-0.077	0.131	0.008	0.029	0.4113	4.870
	Future	0.179	-0.075	0.0004	0.028	1.435	10.9
Nickel	Spot	-0.037	0.047	-0.0001	0.0128	0.0180	3.540
	Future	0.067	-0.033	0.0002	0.0107	0.723	8.446
Mentha Oil	Spot	-0.102	0.117	0.0002	0.024	-0.209	7.367
	Future	-0.389	0.142	0.0007	0.033	-5.075	65.10
Aluminium	Spot	-0.035	0.032	0.0002	0.011	0.026	3.84
	Future	-0.020	0.03	0.00015	0.007	0.624	4.86
Cardamom	Spot	-0.111	0.114	0.0017	0.019	0.355	10.23
	Future	-0.109	0.265	0.0015	0.029	2.19	23.61
Cotton	Spot	-0.034	0.65	0.0001	0.008	-0.1718	5.65
	Future	-0.04	0.110	-0.0001	0.013	1.77	18.88

Source : Collected from mcxindia.com and computed using E-Views 5.0

Table 3. Summary of Results of Augmented Dickey Fuller Test for the Sample Commodities From 01.01.2012 to 31.12.2012

S.No	Commodity	ADF *t* - Statistic		Significance Level		
		Spot	Futures	1%	5%	10%
1	Gold	-17.675	-16.569	-3.452	-2.871	-2.571
2	Silver	-19.812	-18.241	-3.452	-2.871	-2.571
3	Crude Oil	-21.069	-17.814	-3.452	-2.871	-2.571
4	Copper	-21.735	-19.259	-3.452	-2.871	-2.571
5	Natural Gas	-18.067	-16.498	-3.452	-2.871	-2.571
6	Nickel	-17.869	-15.983	-3.452	-2.871	-2.571
7	Mentha Oil	-11.950	-17.007	-3.452	-2.871	-2.571
8	Aluminium	-17.410	-16.714	-3.452	-2.871	-2.571
9	Cardamom	-14.823	-16.396	-3.452	-2.871	-2.571
10	Cotton	-14.345	-17.816	-3.452	-2.871	-2.571

Source Collected from mcxindia.com and computed from E-Views 5.0

future price returns of the select sample commodities (Brooks, 2008 ; Kozhan, 2010).

Findings of the Study

1) Amongst the sample commodities, gold, silver, copper, natural gas, mentha oil, aluminum, and cardamom recorded positive returns.

Table 4. Results of Johansen Trace Statistic and Max-Eigen Values for the Sample Commodities

Commodity	Criteria	Trace Statistic	0.05 Critical Value	Max-Eigen Statistic	0.05 Critical Value
Gold	None	131.05	15.494	81.976	14.264
	Atmost 1	49.07	3.84	49.078	3.841
Silver	None	114.22	15.494	71.40	14.264
	Atmost 1	42.75	3.84	42.75	3.841
Crude Oil	None	170.31	15.494	123.32	14.264
	Atmost 1	46.98	3.84	46.984	3.841
Copper	None	175.92	15.494	121.75	14.264
	Atmost 1	54.16	3.84	54.169	3.841
Natural Gas	None	130.58	15.494	81.968	14.264
	Atmost 1	48.61	3.84	48.615	3.841
Nickel	None	157.60	15.494	101.78	14.264
	Atmost 1	55.82	3.84	55.82	3.841
Mentha Oil	None	130.343	15.494	92.699	14.264
	Atmost 1	37.64	3.84	37.643	3.841
Aluminium	None	163.84	15.494	114.38	14.264
	Atmost 1	49.460	3.84	49.46	3.841
Cardamom	None	95.413	15.494	64.260	14.264
	Atmost 1	31.153	3.84	31.153	3.841
Cotton	None	159.38	15.494	115.94	14.264
	Atmost 1	43.44	3.84	43.44	3.841

Source : Collected from mcxindia.com and computed from E-Views 5.0

2) The standard deviation, which is a measure of volatility, was positive for all sample commodities.

3) The prices of silver showed a higher volatility among the select sample commodities.

4) There is negative skewness for gold, crude oil, mentha oil, and cotton.

5) Mentha oil futures price returns recorded a higher kurtosis (65.10), indicating that the distribution is leptokurtic and copper spot prices showed a lower kurtosis (3.33).

6) The results of the Augmented Dickey Fuller test imply that all the selected sample commodities attained stationary at the level difference itself.

7) Johansen's co-integration test results reveal that the spot prices of the selected sample commodities had no influence on their futures prices.

Suggestions

1) A basic knowledge of the factors affecting the commodities markets can help the investors to better perceive the movements of the markets in a better manner.

2) Publicly available information plays a vital role in determining the market trends, which in turn has its effects on the returns earned by the investors.

3) MCX website provides the option of measuring the Value at risk (VaR). The investors can measure the degree of risk involved in the investments before investing in commodities.

4) A close monitoring of spot prices of commodities will be helpful in planning the investments, as in some commodities, the spot prices have their reflection in the future.

Conclusion and Research Implications

The difference in spot and future prices of commodities helps the investors to earn profits. Hedging, a tool of risk reduction, requires careful monitoring of spot price movements of the commodities. A systematic evaluation of co-movement between spot and future price movements can help the investing community in better earnings. Multi commodity exchange has been publishing various reports and data on market movements. The middlemen involved in the markets can help the investing people by using the reports which can facilitate better market prediction. The awareness programmes conducted by MCX India for various categories of market participants will help the investing public to safeguard their hard-earned money. The major results of the study indicate that there is no co-movement between spot and future price returns of the selected sample commodities during the study period. This may give a different view as against the previous work. Though the findings give a negative view of spot and future price movements, the results are applicable for short term investment planning. Therefore, it becomes essential that the market movements need to be studied at frequent intervals, which can help in better market prediction so as to earn better returns.

Scope for Further Research

1) The same title and area of study can be used for studies in the Indian as well as international stock markets, forex markets, and commodity markets with the help of advanced tools.

2) The sample commodities and the sample period chosen can also be extended to ascertain the results in the long run.

3) A comparative study of Indian commodity markets with any of the international commodity markets can also be made.

4) A similar study with the help of primary data can also be undertaken in order to ascertain the reaction of the investors towards market price movements.

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