I J A B E R, Vol. 14, No. 6, (2016): 3841-3857

INTERNATIONAL LINKAGES OF THE INDIAN AGRICULTURE COMMODITY FUTURES MARKETS

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Abstract: *The present paper attempts to examine the international linkage between the Indian and world futures markets with reference to five agriculture commodities, viz. Cotton, Crude Palm Oil, Refined Soya Oil, Soya Bean and Sugar, using Johansen Cointegration test and Vector Error Correction Model. The cointegration result confirms that there is a long-run relationship between the Indian futures and World futures prices of each commodity that belongs to Agricultural sector. Besides, the empirical evidence suggests that the World futures market prices leads to the Indian futures market prices for the case of Agriculture commodities such as Cotton, Crude Palm Oil, Refined Soya Oil, Soya Bean and Sugar, both in the long-run and short-run. It can be therefore, the present study concludes that the World agriculture futures markets plays a dominant role in influencing the price movement of Indian agriculture futures market prices of Cotton, Crude Palm Oil, Refined Soya Oil, Soya Bean and Sugar.*

JEL Codes: *C32, G12, G13*

Keywords: *Cross Market Linkages, Agriculture Commodity, Cointegration, VECM*

1. INTRODUCTION

The futures markets mechanism was introduced in India started by Bombay cotton trade association in 1875. Primarily the market functions were materialized and the most of trading process were done by the manual works. In 1994, the Kapra committee had been recommended to Forward Market Commission (FMC) to create the electronic trading platform in India based on that online commodity trading operations has been begins on 2002-03 in India. The main legal framework governing Commodity Derivatives Market in India is the Forward Contracts Regulation Act 1952 (FCRA). The exchanges are regulated by the Forward Market Commission. The commodity market has been segmented into two types as forwards, and futures. Options contracts are not enforced in agricultural commodities in the market. The exchanges are offering online trading system to the investors. The online systems provide the transparency process of market

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participants. Then agricultural commodities trading have also been included in the existing market system.

The commodity futures market in India has achieved substantial development in term of transparency, technology and trading activities. The futures markets evince huge interest to traders, market participants and exchange stakeholders in India and abroad. The market microstructure of commodity futures market has undergone metamorphosis in the last decade. Commodity Derivatives Market witnessed huge increase in volumes after reforms in trading, clearing and settlement processes and risk management.

Futures market development has been the focus of many studies in recent years since it provides important functions related to price discovery and risk management through hedging. Price discovery is the process of revealing information about future spot prices through the futures market prices. The essence of the price discovery function hinges on whether new information is reflected first in changes of futures prices or changes of spot prices. Another interesting prospective on understanding market linkages has its origin in the efficient market hypothesis which says that all markets incorporate any new information simultaneously and there does not exist any lead-lag relationship across these markets. However, frictions in markets, in terms of transaction costs and information asymmetry, may direct to lead-lag relationship between markets. As a consequence, understanding the influence of one market on the other or examining the cross market linkages have become increasingly important research issue among academicians, regulators and practitioners alike as it provides an idea about the market efficiency, volatility, hedging effectiveness and arbitrage opportunities, if any. Moreover, understanding information flow across markets is also important for hedge funds, portfolio managers and hedgers for hedging and devising cross-market investment strategies.

The present paper attempts to examine the international linkage between the Indian and world futures markets with reference to five agriculture commodities, viz. Cotton, Crude Palm Oil, Refined Soya Oil, Soya Bean and Sugar. The remainder of the article is organised as follows: Section 2 provides the review of literature. Section 3 describes the methodology and data used for empirical analysis. Section 4 offers empirical results and discussion of the study. Conclusions are presented in section 5.

2. REVIEW OF LITERATURE

Hua and Chen (2007) studied the relationship between the Chinese and World futures markets of copper, aluminum, soybean and wheat, using Johansen's cointegration test, error correction model, the Granger causality test and impulse response analyses. They found that the futures prices in the Shanghai Futures

Exchange are cointegrated with the futures prices on the London Metal Exchange (LME) for copper and aluminum. They also found that a cointegration relationship exists for Dalian Commodity Exchange and Chicago Board of Trade (CBOT) soybean futures prices, but no such relationship for Zhengzhou Commodity Exchange and CBOT wheat futures prices. They further found that while LME has a bigger impact on Shanghai copper and aluminum futures and CBOT a bigger impact on Dalian soybean futures, the Chinese futures markets also have a feedback impact on LME and CBOT futures.

Kumar and Pandey (2011) investigated the cross market linkages of Indian commodity futures for nine commodities with futures markets outside India. They analyzed the cross market linkages in terms of return and volatility spillovers for the nine commodities, viz. two agricultural commodities: Soybean, and Corn, three metals: Aluminum, Copper and Zinc, two precious metals: Gold and Silver, and two energy commodities: Crude oil and Natural gas. Return spillover is investigated through Johansen's cointegration test, error correction model, Granger causality test and variance decomposition techniques. They applied Bivariate GARCH model (BEKK) to investigate volatility spillover between India and other World markets. they found that futures prices of agricultural commodities traded at National Commodity Derivatives Exchange, India (NCDEX) and Chicago Board of Trade (CBOT), prices of precious metals traded at Multi Commodity Exchange, India (MCX) and NYMEX, prices of industrial metals traded at MCX and the London Metal Exchange (LME) and prices of energy commodities traded at MCX and NYMEX are cointegrated. In the case of commodities, they found that world markets have bigger (unidirectional) impact on Indian markets. In bivariate model, they found bi-directional return spillover between MCX and LME markets. However, effect of LME on MCX is stronger than the effect of MCX on LME.

Berlia and Sehgal (2013) examined the process of information transmission in futures prices of bullion (gold and silver) and metals (aluminum, copper, and zinc) between India, represented by MCX, and its global counterparts trading platforms, such as COMEX, LME, and SHFE for the period of 2005 to 2012. The price discovery results confirmed that there is a long-term equilibrium relationship among the futures prices of examined trading platforms in each commodity series, with the exception of aluminum. The MGARCH results of volatility spillovers indicated that, in the case of bullion, MCX seems to be more dominant than COMEX, implying that it is no longer a satellite market, while in case of metals; LME seems to play the dominant role followed by MCX and SHFE.

Sinha and Mathur (2013) focused on the linkages in agri-processed (soy oil and crude palm oil) and energy commodities (natural gas and crude oil) traded on commodity exchanges of India (NCDEX; MCX) and their corresponding international commodity exchanges (Chicago Board of Trade; Bursa Malaysia Derivative Exchange; New York Mercantile Exchange). They examined the linkages in futures price, return and volatility of a commodity across commodity exchanges using Cointegration, Error Correction Model, Modified GARCH model and ARMA-GARCH in mean model. The study indicated that there are strong linkages in price, return and volatility of futures contracts traded across commodity exchanges of India and their corresponding international commodity exchanges.

Pani and Jadhav (2015) analyzed the inter-linkage of international crude oil futures markets with Indian markets as Indian crude oil futures price acts as a price signal for the various market participants in the Crude oil industry. They explored the international linkage (short run and long-run relationship) of Indian crude oil market using various time series techniques such as Vector Error Correction Model (VECM) and Granger Causality test. Commodity future price daily data from Multi-Commodity Exchange (MCX) and New York Mercantile Exchange (NYMEX) is used in the study to explore the linkage. The VECM results suggested both short run and long-run linkage of International Commodity futures market with Indian commodity futures markets. However, Granger Causality test showed unidirectional causality from International markets to Indian markets.

It can be seen from the existing literatures that studies on international linkages of commodity futures markets are meager. Considerable volume of research has been conducted on the price discovery mechanism among the futures and spot prices of emerging commodity markets. Besides, only a few notable studies have made an attempt on cross market linkages of Indian futures commodity market with international futures market. Though the Indian Commodity futures markets have grown in importance, they are yet to be intensively researched, especially on individual commodity futures contracts pertaining to agricultural sector.

Our study attempts to investigate the international linkage between the Indian and world futures markets with reference to five agriculture commodities, viz. Cotton, Crude Palm Oil, Refined Soya Oil, Soya Bean and Sugar.

3. METHODOLOGY

Johansen's (1988) cointegration approach and Vector Error Correction Model (VECM) have been employed to investigate the cross market linkages of Indian commodity futures for ten commodities with futures markets outside India. Before doing cointegration analysis, it is necessary to test the stationary of the series. The Augmented Dickey-Fuller (1979) test was employed to infer the stationary of the series. If the series are non-stationary in levels and stationary in differences, then there is a chance of cointegration relationship between them which reveals the long-run relationship between the series. Johansen's cointegration test has been employed to investigate the long-run relationship between two variables. Besides, the causal relationship between Indian commodity futures and International futures prices investigated by estimating the following Vector Error Correction Model (VECM) (Johansen, 1988):

$$\Delta X_t = \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-i} + \Pi X_{t-1} + \varepsilon_t;\ \varepsilon_t \mid \Omega_{t-1} \sim \text{distr}(0, H_t) \qquad (1)$$

where X_t is the 2x1 vector $(I_t, W_t)'$ of log-Indian Futures market price and log-International (World) Futures market price, respectively, Δ denotes the first difference operator, ε_t is a 2x1 vector of residuals $(\varepsilon_{I,t}, \varepsilon_{W,t})'$ that follow an as-yet-unspecified conditional distribution with mean zero and time-varying covariance matrix, H_t. The VECM specification contains information on both the short- and long-run adjustment to changes in X_t, via the estimated parameters Γ_i and Π, respectively.

There are two likelihood ratio tests that can be employed to identify the co-integration between the two series. The variables are cointegrated if and only if a single cointegrating equation exists. The first statistic λ_{trace} tests the number of cointegrating vectors is zero or one, and the other λ_{max} tests whether a single cointegrating equation is sufficient or if two are required. In general, if r cointegrating vector is correct. The following test statistics can be constructed as:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{n} 1n\left(1 - \hat{\lambda}_i\right) \qquad (2)$$

$$\lambda_{max}(r, r+1) = -T 1n\left(1 - \hat{\lambda}_{r+i}\right) \qquad (3)$$

where $\hat{\lambda}_i$ are the eigen values obtained from the estimate of the Ð matrix and T is the number of usable observations. The λ_{trace} tests the null that there are at most r cointegrating vectors, against the alternative that the number of cointe-grating vectors is greater than r and the λ_{max} tests the null that the number of cointegrating vectors is r, against the alternative of r + 1. Critical values for the λ_{trace} and λ_{max} statistics are provided by Osterwald-Lenum (1992).

Johansen and Juselius (1990) showed that the coefficient matrix Ð contains the essential information about the relationship between I_t and W_t. Specifically, if rank(Π) = 0, then Π is 2x2 zero matrix implying that there is no cointegration relationship between I_t and $W_{t,t-n}$. In this case the VECM reduces to a VAR model in first differences. If Π has a full rank, that is rank(Π) = 2, then all variables in X_t are I(0) and the appropriate modelling strategy is to estimate a VAR model in levels. If Π has a reduced rank, that is rank(Π) = 1, then there is a single cointegrating relationship between I_t and W_t, which is given by any row of matrix Π and the expression ΠX_{t-1} is the error correction term. In this case, Π can be factored into two separate matrices α and β, both of dimensions 2x1, where 1 represents the rank of Π, such as Π = αβ′, where β′ represents the vector of cointegrating parameters and á is the vector of error-correction coefficients measuring the speed of convergence to the long-run steady state.

If Indian futures and International futures prices are cointegrated then causality must exist in at least one direction (Granger, 1988). Granger causality can identify whether two variables move one after the other or contemporaneously. When they move contemporaneously, one provides no information for characterising the other. If "X causes Y", then changes in X should precede changes in Y. Consider the VECM specification of Equation (1), which can be written as follows:

$$\Delta I_t = \sum_{i-1}^{p-1} a_{Ii} \Delta I_{t-i} + \sum_{i-1}^{p-1} b_{I_i} \, \Delta W_{t-i} + a_I z_{t-1} + \varepsilon_{I,t} \quad (4)$$

$$\varepsilon_{i,t} \mid \Omega_{t-1} \sim \text{distr}(0, H_t)$$

$$\Delta W_t = \sum_{i-1}^{p-1} aw_i \, \Delta I_{t-i} + \sum_{i-1}^{p-1} b_{w,i} \, \Delta W_{t-i} + a_w z_{t-1} + \varepsilon_{w,t} \quad (5)$$

where $a_{I,i}$, $b_{I,i}$, $a_{W,i}$, $b_{W,i}$ are the short-run coefficients, $z_{t-1} = \beta' X_{t-1}$ is the error- correction term which measures how the dependent variable adjusts to the previous period's deviation from long-run equilibrium from equation (1), and $\varepsilon_{I,t}$ and $\varepsilon_{W,t}$ are residuals.

In the above equations of Vector Error Correction Model, the unidirectional causality from International Futures-to-Indian price (W_t Granger causes I_t) requires: (i) that some of the $b_{I,i}$ coefficients, i = 1, 2, …, p-1, are non zero and/or (ii) a_I, the error-correction coefficient in Equation (4), is significant at conventional levels. Similarly, unidirectional causality from Indian Futures-to-International Futures price (I_t Granger causes W_t) requires: (i) that some of the $a_{W,i}$ coefficients, i = 1, 2, …, p-1, are non zero and/or (ii) a_W is significant at conventional levels. If both variables Granger cause each other, then it is said that there is a two-way feedback relationship between I_t and W_t (Granger, 1988). These hypotheses can be tested by applying Wald tests on the joint significance of the lagged estimated coefficients of $ÄI_{t-i}$ and $ÄW_{t-i}$. When the residuals of the error-correction equations exhibit heteroskedasticity, the t-statistics are adjusted by White (1980) heteroskedasticity correction.

The sample data for the daily futures prices of Multi-Commodity Exchange (MCX), New York Mercantile Exchange (NYMEX), Chicago Board of Trade (CBOT) and National Commodity & Derivatives Exchange (NCDEX) for five agriculture commodities, viz. Cotton, Crude Palm Oil, Refined Soya Oil, Soya Bean and Sugar. These are the leading exchanges for the respective commodity futures contracts in terms of volume traded. All the necessary information is retrieved from the Bloomberg database. Based on the availability of the data, the sample period of

Table 1
Data Description

S. No	*Name of the Agriculture Commodity*	*Indian Agriculture Commodity Futures Markets*	*International Agriculture Commodity Futures Markets*	*Time Period*
1.	COTTON	Multi-Commodity Exchange (MCX)	New York Mercantile Exchange (NYMEX)	4th October 2011 to 31st December 2014
2.	CRUDE PALM OIL	Multi-Commodity Exchange (MCX)	Chicago Board of Trade (CBOT)	5th January 2005 to 31st December 2014
3.	R S OIL	Multi-Commodity Exchange (MCX)	Chicago Board of Trade (CBOT)	3rd January 2005 to 31st December 2014
4.	SOYA BEAN	Multi-Commodity Exchange (MCX)	Chicago Board of Trade (CBOT)	3rd January 2005 to 31st December 2014
5.	SUGAR	National Commodity & Derivatives Exchange (NCDEX)	New York Mercantile Exchange (NYMEX)	3rd January 2005 to 31st December 2014

Table 2
Descriptive Statistics of Agriculture Futures Commodity Markets

Statistics	*COTTON*		*CRUDE PALM OIL*		*R S OIL*		*SOYA BEAN*		*SUGAR*	
	MCX Returns	*NYMEX Returns*	*MCX Returns*	*CBOT Returns*	*NCDEX Returns*	*CBOT Returns*	*NCDEX Returns*	*CBOT Returns*	*NCDEX Returns*	*CBOT Returns*
Mean	-0.00022	-0.00073	0.00013	0.00031	0.00021	0.00022	0.00057	0.00058	0.00012	0.00023
Maximum	0.09660	0.17446	1.10471	0.92606	0.05758	0.08038	0.24484	0.07771	0.09294	0.40353
Minimum	-0.07571	-0.13392	-0.61430	-0.11039	-0.27519	-0.74467	-0.24033	-0.20763	-0.14415	-0.11327
Std. Dev.	0.01431	0.01815	0.03400	0.02864	0.01253	0.02156	0.01896	0.01910	0.01433	0.02294
Observations	702	702	1674	1674	2246	2246	1674	1674	2201	2201

each agriculture commodity is given in Table 1. We construct the continuous futures price series using daily closing futures prices of near month futures contracts for all commodities. For consistency, we converted all data into US Dollars. For estimation purpose, all price series are further converted into natural logarithms.

4. EMPRICAL RESULTS AND DISCUSSION

The descriptive statistics of daily return series of the Indian and World futures markets of Agriculture (Cotton, Crude Palm Oil, Refined Soya Oil, Soya Bean and Sugar) was depicted in Table 2. The table indicates that the average daily returns of Cotton in both Indian and World futures markets are negative and other commodities, viz. Crude Palm Oil, Refined Soya Oil, Soya Bean and Sugar, in both the markets yielded positive returns during the study period. The maximum return lies within the range of 0.0575 to 1.1047 in Indian futures markets and of 0.0777 to 0.9260 in World futures markets. On an average, the returns in the World agriculture futures markets are relatively higher than that of Indian agriculture futures markets.

The unit root property of the data series is crucial for the cointegration and causality analyses. The standard Augmented Dickey–Fuller (ADF) was employed to examine stationary property of the Indian and World futures markets price series of Agriculture commodities, viz. Cotton, Crude Palm Oil, Refined Soya Oil, Soya Bean and Sugar. Table 3 depicts the results of Augmented Dickey-Fuller test for the selected data series. Based on Akaike Information Criteria (AIC), the optimal lag length chosen for ADF test and the ADF test statistics indicate that the log price series of Indian and World futures markets of respective commodities that belongs to Agriculture sector contains unit root, implying the fact that both the log futures prices series of respective commodity are non stationary. More to the point, the ADF test statistics reject the hypothesis of a unit root at 1% level of significance in return series, implying the fact that the return series of Indian and the World futures markets of respective commodities that belongs to Agriculture sector are stationary.

Before we proceed to examine the presence of long-run relationship between Indian and the World futures markets price series of respective commodity that belongs to Agriculture sector viz. Cotton, Crude Palm Oil, Refined Soya Oil, Soya Bean and Sugar, Johansen Cointegration test is more sensitive to the lag length employed. Besides, inappropriate lag length may give rise to problems of either over-parameterization or under-parameterization. The necessary lag length of Indian and the World futures markets price series for the respective commodity is determined by the Akaike Information Criterion (AIC) and the results are depicted in Table 4. The table results indicate 2 for the Cotton, Soya Bean and Sugar, 6 for Crude Palm Oil and 7 for Refined Soya Oil.

The Johansen Cointegration results for the Agriculture Indian futures and the World futures commodity markets are reported in Table 5. The Maximal Eigen

Table 3
Results of Augmented Dickey-Fuller Test for Unit Root

Name of the Agriculture Commodity	*Market*	*Levels*	*First Difference*	*Inference on Integration*
COTTON	MCX	-1.5016	-29.566*	I(1)
	NYMEX	-1.8097	-23.541*	
CRUDE PALM OIL	MCX	-2.4659	-40.028*	I(1)
	CBOT	-2.3075	-40.290*	
R S OIL	NCDEX	-1.4731	-45.304*	I(1)
	CBOT	-2.2724	-46.972*	
SOYA BEAN	NCDEX	-0.8682	-40.881*	I(1)
	CBOT	-1.3755	-39.425*	
SUGAR	NCDEX	-1.0240	-49.944*	I(1)
	NYMEX	-1.9056	-47.324*	

Notes: * – indicates significance at one per cent level. Optimal lag length is determined by the Akaike Information Criterion (AIC) for the Augmented Dickey-Fuller Test.

Table 4
Results of VAR Lag Length Selection for Indian Agriculture Futures and International Agriculture Futures Commodity Markets

COTTON

Lag	*LogL*	*LR*	*FPE*	*AIC*	*SC*	*HQ*
0	1155.18	–	0.0001	-3.2901	-3.2771	-3.2850
1	3831.75	5330.23	6.23e-08	-10.915	-10.876	-10.900
2	3851.89	39.9911	5.95e-08*	-10.961*	-10.896*	-10.936*
3	3852.66	1.5223	6.01e-08	-10.951	-10.861	-10.916
4	3854.07	2.7912	6.05e-08	-10.944	-10.827	-10.899
5	3857.29	6.3389	6.07e-08	-10.942	-10.799	-10.887
6	3863.12	11.440*	6.03e-08	-10.947	-10.778	-10.882
7	3865.30	4.2626	6.07e-08	-10.942	-10.747	-10.867
8	3866.98	3.2798	6.11e-08	-10.935	-10.714	-10.850
9	3868.57	3.0900	6.15e-08	-10.928	-10.682	-10.833
10	3871.54	5.7727	6.17e-08	-10.925	-10.653	-10.820

CRUDE PALM OIL

Lag	*LogL*	*LR*	*FPE*	*AIC*	*SC*	*HQ*
0	765.22	–	0.0013	-0.9178	-0.9113	-0.9154
1	7586.16	13617.26	3.77e-07	-9.1162	-9.0967*	-9.1090*
2	7590.43	8.5251	3.77e-07	-9.1165	-9.0840	-9.1045
3	7591.16	1.4433	3.78e-07	-9.1126	-9.0670	-9.0957
4	7596.09	9.8157	3.78e-07	-9.1137	-9.0551	-9.0920
5	7601.88	11.492	3.77e-07	-9.1159	-9.0442	-9.0893
6	7608.73	13.600*	3.75e-07*	-9.1193*	-9.0346	-9.0879
7	7611.85	6.1694	3.76e-07	-9.1182	-9.0205	-9.0820

contd. table

8	7613.62	3.5203	3.77e-07	-9.1156	-9.0048	-9.0745
9	7615.68	4.0754	3.78e-07	-9.1132	-8.9895	-9.0674
10	7616.47	1.5429	3.79e-07	-9.1094	-8.9726	-9.0587

R S OIL

Lag	*LogL*	*LR*	*FPE*	*AIC*	*SC*	*HQ*
0	858.58	–	0.0015	-0.7665	-0.7614	-0.7646
1	12030.12	22313.09	7.28e-08	-10.759	-10.744	-10.754
2	12036.07	11.873	7.27e-08	-10.761	-10.736	-10.752
3	12349.62	625.13	5.51e-08	-11.038	-11.002	-11.025
4	12367.16	34.938	5.44e-08	-11.050	-11.004*	-11.033*
5	12371.13	7.8852	5.44e-08	-11.050	-10.994	-11.030
6	12373.86	5.4391	5.45e-08	-11.049	-10.983	-11.025
7	12380.54	13.264*	5.44e-08*	-11.051*	-10.975	-11.023
8	12384.00	6.8705	5.44e-08	-11.051	-10.964	-11.019
9	12384.77	1.5336	5.45e-08	-11.048	-10.951	-11.013
10	12387.38	5.16126	5.46e-08	-11.047	-10.939	-11.008

SOYA BEAN

Lag	*LogL*	*LR*	*FPE*	*AIC*	*SC*	*HQ*
0	-413.34	–	0.0056	0.4995	0.5060	0.5019
1	8467.72	17730.09	1.30e-07	-10.176	-10.156*	-10.169*
2	8475.13	14.770*	1.30e-07*	-10.180*	-10.147	-10.168
3	8475.77	1.2830	1.30e-07	-10.176	-10.130	-10.159
4	8477.91	4.2584	1.31e-07	-10.174	-10.115	-10.152
5	8478.72	1.6041	1.31e-07	-10.170	-10.098	-10.143
6	8481.80	6.1141	1.31e-07	-10.169	-10.084	-10.137
7	8485.01	6.3572	1.32e-07	-10.168	-10.070	-10.132
8	8485.15	0.2767	1.32e-07	-10.163	-10.053	-10.122
9	8488.77	7.1610	1.32e-07	-10.163	-10.039	-10.117
10	8489.58	1.5876	1.33e-07	-10.159	-10.022	-10.108

SUGAR

Lag	*LogL*	*LR*	*FPE*	*AIC*	*SC*	*HQ*
0	-191.05	–	0.0040	0.1763	0.1815	0.1782
1	11352.43	23055.34	1.08e-07	-10.362	-10.346*	-10.356*
2	11359.69	14.486	1.08e-07*	-10.365*	-10.339	-10.355
3	11362.72	6.0380	1.08e-07	-10.364	-10.327	-10.350
4	11366.09	6.7259	1.08e-07	-10.363	-10.316	-10.346
5	11367.58	2.9569	1.08e-07	-10.361	-10.304	-10.340
6	11371.30	7.4013	1.08e-07	-10.361	-10.293	-10.336
7	11373.46	4.2930	1.09e-07	-10.359	-10.281	-10.330
8	11378.34	9.6880*	1.09e-07	-10.360	-10.271	-10.327
9	11382.62	8.4697	1.09e-07	-10.360	-10.261	-10.324
10	11383.87	2.4807	1.09e-07	-10.357	-10.248	-10.317

Notes: * 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 SIC: Schwarz information criterion HQ: Hannan-Quinn information criterion.

Table 5
Results of Johansen's Cointegration Test for Indian Agriculture Futures and International Agriculture Futures Commodity Markets

Name of the Agriculture Commodity	*vector (r)*	*Trace test Statistics* (λ_{trace})	*Maximal Eigen value* (λ_{max})	*5% Critical value for Trace Statistics*	*5% Critical value for Max-Eigen Statistics*	*Remarks*
COTTON	H_0: r = 0	17.689**	15.787**	15.494	14.264	*Cointegrated*
	$H_{1:}$ r ≥ 1	2.9023	2.9023	3.8414	3.8414	
CRUDE PALM OIL	H_0: r = 0	19.793**	16.958	15.494	14.264	*Cointegrated*
	$H_{1:}$ r ≥ 1	2.834	2.834	3.8414	3.8414	
R S OIL	H_0: r = 0	19.279**	15.740**	15.494	14.264	*Cointegrated*
	$H_{1:}$ r ≥ 1	3.538	3.5385	3.8414	3.8414	
SOYA BEAN	H_0: r = 0	18.014**	17.242**	15.494	14.264	*Cointegrated*
	$H_{1:}$ r ≥ 1	3.7717	3.7717	3.8414	3.8414	
SUGAR	H_0: r = 0	17.031**	15.6744**	15.494	14.264	*Cointegrated*
	$H_{1:}$ r ≥ 1	2.3571	2.3571	3.8414	3.8414	

Notes: ** – indicates significance at five per cent level. The significant of the statistics is based on 5 per cent critical values obtained from Johansen and Juselius (1990). r is the number of cointegrating vectors. H_0 represents the null hypothesis of presence of no cointegrating vector and H_1 represents the alternative hypothesis of presence of cointegrating vector.

value and Trace test statistics indicates that the null hypothesis is rejected in the case of each commodity that belongs to Agriculture sector (Cotton, Crude Palm Oil, Refined Soya Oil, Cotton and Sugar) which reveals that one cointegration relationship exists between the Indian futures and the World futures prices. Thus, the Indian futures and World futures prices of respective commodity of Agriculture market shares common long-run information. The cointegration result confirms that there is a long-run relationship between the Indian futures and World futures prices of each commodity that belongs to Agricultural sector.

Once existence of single cointegration among the Indian futures and the World futures commodity prices of respective commodity that belongs to Agriculture sector (Cotton, Crude Palm Oil, Refined Soya Oil, Soya Bean and Sugar) are confirmed, one should search for proper Vector Error Correction Model (VECM). By using the definition of Cointegration, the Granger Representation Theorem (Granger, 1983) which states that if a set of variables are cointegrated, then there exists valid error correction representation of the data. For this purpose the VECM are estimated for the respective commodity that belongs to Agriculture and it is presented in Table 6. The dynamic VECM representation provides us with a framework to test for the causal dynamics in the Granger sense among the price series through both short-run and error-correction channels (ECTs) of causation. Short-run market causality test will determine whether Indian futures price of respective commodity markets respond instantaneously to changes in its corresponding World futures prices. The coefficient of the lagged error correction term (ECT) shows the portion by which the long-run disequilibrium in the dependant variable is being corrected in each short period to have stable long-run relationship. If both short-run causality coefficient and ECTs are insignificant, the market can be treated as exogenous to the system (Masih and Masih 1997). The application of Akaike Information Criterion (AIC) is used to find the optimal lag for the vector error correction model.

The VECM estimates for the Agriculture Indian futures and the World futures commodity markets are presented in Table 6. The coefficients of the Error Correction terms (ECTs) in the Indian futures equations of Cotton, Crude Palm Oil, Sugar and Soya Bean are statistically significant, while the coefficients of the ECTs in the futures equations of these commodities are not statistically significant, suggesting a unidirectional causation runs from World futures market prices to Indian futures market prices in the long-run. For the Refined Soya Oil, the coefficients of ECT in the Indian futures equation and World futures equation are statistically significant, suggesting a bidirectional relationship the Indian futures and World futures market prices in the long-run. However, the size of the coefficient of ECT in Indian futures equation for Refined Soya Oil is relatively greater than the ECT of World futures equation, implying that the World futures market leads the Indian futures markets for Refined Soya Oil in the long-run.

Table 6
Results of Vector Error Correction Model for Indian Agriculture Futures and International Agriculture Futures Commodity Markets

Variables	*COTTON*		*CRUDE PALM OIL*		*R S OIL*		*SOYA BEAN*		*SUGAR*	
	ΔIF_t	ΔWF_t	ΔIF_t	ΔWF_t	ΔIF_t	ΔWF_t	ΔIF_t	ΔWF_t	ΔIF_t	ΔWF_t
ECT	-0.0060*** (0.003) [-1.716]	0.0068 (0.005) [1.338]	0.0002 (0.0006) [0.422]	0.0018* (0.0005) [3.503]	-0.0005 (0.0004) [-1.318]	0.0016** (0.0008) [1.971]	-0.0013 (0.001) [-0.723]	0.0047* (0.001) [2.499]	-0.0030** (0.001) [-2.239]	0.0049** (0.002) [2.222]
ΔIF_{t-1}	-0.1716* (0.039) [-4.364]	-0.0704 (0.050) [-1.386]	-0.0076 (0.039) [-0.193]	0.0400 (0.032) [1.219]	-0.0573* (0.021) [-2.697]	0.0137 (0.042) [0.323]	-0.0079 (0.024) [-0.322]	0.0450*** (0.024) [1.814]	-0.0635* (0.021) [-2.983]	0.0278 (0.034) [0.814]
ΔIF_{t-2}	-0.0420 (0.039) [-1.076]	-0.0114 (0.050) [-0.226]	-0.0147 (0.039) [-0.375]	-0.0234 (0.032) [-0.713]	-0.0451** (0.021) [-2.126]	-0.0649 (0.042) [-1.527]	0.0127 (0.024) [0.518]	-0.0130 (0.024) [-0.524]	-0.0400*** (0.021) [-1.880]	-0.0148 (0.034) [-0.434]
ΔIF_{t-3}	---	---	0.0055 (0.039) [0.142]	0.0591*** (0.032) [1.806]	-0.0079 (0.021) [-0.374]	0.0453 (0.042) [1.065]	---	---	---	---
ΔIF_{t-4}	---	---	0.0121 (0.039) [0.309]	-0.0496 (0.032) [-1.514]	0.0003 (0.021) [0.015]	-0.0165 (0.042) [-0.388]	---	---	---	---
ΔIF_{t-5}	---	---	-0.0643 (0.039) [-1.641]	0.0281 (0.032) [0.856]	-0.0200 (0.021) [-0.942]	-0.0505 (0.042) [-1.190]	---	---	---	---
ΔIF_{t-6}	---	---	0.0505 (0.039) [1.285]	0.0739** (0.032) [2.247]	0.0287 (0.018) [1.564]	0.0126 (0.036) [0.343]	---	---	---	---
ΔIF_{t-7}	---	---	---	---	0.0224 (0.018) [1.224]	-0.0448 (0.036) [-1.219]	---	---	---	---
ΔWF_{t-1}	0.1607* (0.030) [5.260]	0.1399* (0.039) [3.543]	0.0463 (0.046) [0.994]	-0.0152 (0.039) [-0.391]	0.0224 (0.018) [1.224]	-0.0448 (0.036) [-1.219]	0.0775* (0.024) [3.171]	0.0353 (0.024) [1.435]	0.0298** (0.013) [2.248]	-0.0060 (0.021) [-0.282]
ΔWF_{t-2}	-0.0046 (0.031) [-0.150]	0.0154 (0.040) [0.383]	0.0370 (0.046) [0.796]	0.0249 (0.038) [0.641]	0.2918* (0.010) [27.45]	-0.0286 (0.021) [-1.345]	0.0059 (0.024) [0.243]	-0.0162 (0.024) [-0.658]	-0.0071 (0.013) [-0.534]	-0.0290 (0.021) [-1.358]
ΔWF_{t-3}	---	---	0.0082 (0.046) [0.176]	-0.0641 (0.038) [-1.652]	0.0721* (0.012) [5.868]	-0.0463*** (0.024) [-1.886]	---	---	---	---

contd. table 6

ΔWF_{t-4}	---	---	-0.0013 (0.046) [-0.028]	0.0743*** (0.038) [1.915]	0.0307** (0.012) [2.483]	-0.0076 (0.024) [-0.308]	---	---	---	---
ΔWF_{t-5}	---	---	0.0738 (0.046) [1.591]	-0.0090 (0.038) [-0.232]	-0.0069 (0.012) [-0.561]	-0.0130 (0.024) [-0.526]	---	---	---	---
ΔWF_{t-6}	---	---	-0.0505 (0.046) [-1.086]	-0.0674*** (0.038) [-1.733]	0.0337* (0.012) [2.728]	0.0489** (0.024) [1.976]	---	---	---	---
ΔWF_{t-7}	---	---	---	---	0.0186 (0.012) [1.508]	-0.0297 (0.024) [-1.202]	---	---	---	---
C	-0.0001 (0.0005) [-0.303]	-0.0006 (0.0006) [-0.958]	0.0001 (0.0008) [0.135]	0.0003 (0.0007) [0.484]	0.0001 (0.0002) [0.563]	0.0002 (0.0004) [0.551]	0.0005 (0.0004) [1.151]	0.0005 (0.0004) [1.190]	0.0001 (0.0003) [0.511]	0.0002 (0.0004) [0.487]

Notes: Optimal lag length is determined by the Akaike Information Criterion (AIC), IF_t and WF_t are the Indian Futures and World Futures market prices respectively, *, ** and *** denote the significance at the one, five and ten per cent level, respectively. [ ] - Parenthesis shows t-statistics, and ( ) - Parenthesis shows standard error.

More to the point, the empirical findings reveal that the lagged coefficients of changes in World futures prices of Cotton, Crude Palm Oil, Refined Soya Oil, Soya Bean and Sugar in their respective Indian futures prices equation are found to be statistically significant, implying that World futures markets of these commodities plays a dominant role and serve effective price discovery vehicle. The study evidence for both long-run and short-run suggests that the World futures market prices leads to the Indian futures market prices for the case of Agriculture commodities such as Cotton, Crude Palm Oil, Refined Soya Oil, Soya Bean and Sugar.

5. CONCLUSION

In its history of commodity derivatives, commodity futures market has witnessed several developments since 2003. There has been tremendous growth in commodity futures market in terms of volume of trade, number of products on offer participants and technology. Commodity futures are diversified asset class they do not boost resources for firms to invest, rather they allow producers to gain insurance for the future value of their outputs. Commodity futures perform two fundamental functions of the economy i.e. price discovery and risk management. Futures markets provide liquidity and facilitates to hedge against future price risk. It helps buyers and sellers of agricultural products to quickly manage their trade at a fair price. Commodity trading also offers a chance for financial leverage to hedgers, speculators and other traders. The present paper attempts to examine the international linkage between the Indian and world futures markets with reference to five agriculture commodities, viz. Cotton, Crude Palm Oil, Refined Soya Oil, Soya Bean and Sugar, using Johansen Cointegration test and Vector Error Correction Model. The cointegration result confirms that there is a long-run relationship between the Indian futures and World futures prices of each commodity that belongs to Agricultural sector. Besides, the empirical evidence suggests that the World futures market prices leads to the Indian futures market prices for the case of Agriculture commodities such as Cotton, Crude Palm Oil, Refined Soya Oil, Soya Bean and Sugar, both in the long-run and short-run. It can be therefore, the present study concludes that the World agriculture futures markets plays a dominant role and serve as effective price discovery vehicle. To the market makers and speculators in Indian agriculture futures markets, news from the World agriculture futures markets should be taken seriously, as the world agriculture futures prices increasingly become an important factor in influencing the price movement of Indian agriculture futures market prices of Cotton, Crude Palm Oil, Refined Soya Oil, Soya Bean and Sugar.

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