



Study of Causality Between Intercontinental Exchange (ICE) and Indian Cotton Futures Prices

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/CJAST/2022/v41i931685

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/86485>

Short Research Article

Received 14 February 2022

Accepted 21 April 2022

Published 22 April 2022

ABSTRACT

Cotton is the major fibre crop which is traded globally. India is one of the major producer, consumer and exporter of cotton whereas US is one of the major producer and exporter of Cotton. Cotton 2.0 Futures in Intercontinental Exchange (ICE) has been the benchmark price for cotton across the world alongside Cotlook A index. In India, Multi Commodity Exchange (MCX) cotton futures provides a platform for price discovery and price risk management for agriculturists, traders and processors. This study is carried on to identify the causality of price movements between ICE cotton futures and MCX cotton futures. It is identified that there exists a bidirectional causal relationship between Intercontinental Exchange and Multi-Commodity Exchange of India (MCX) cotton futures prices. Johansen Co-integration analysis and Vector Error Correction Model indicates the existence of long run and short run equilibrium relationship between ICE and MCX cotton futures price series.

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The study is helpful in establishing that ICE futures prices are also to be considered when making any price estimates by the spinning and other cotton related industry when making purchase and stocking decisions related to cotton.

Keywords: Causality; cotton futures price; India; US.

1. INTRODUCTION

Cotton is one of the globally traded commodities where in more than 33% of the total cotton produced is traded across borders before being utilized. Main cotton producers in the world are China (26.30%), India (24.96%) and United States (13.02%). These three countries account for over 64.28% of the global cotton production. Amidst being the major producers, India and China are the major consumers too. China consumes about 42% of the global cotton production and India consumes about 20% of the global cotton production. Much of the cotton produced in India and China are consumed domestically, whereas about over 70% of the total supply of US cotton in a year is being exported to other countries from US which accounts for 34% of the total global cotton exports. As per, USDA estimates for marketing year 2020-21, the global export scenario is dominated by US with about 34% share, followed by Brazil with 22.75% share and India with 12.79% share of global cotton exports [1].

India and United States are top producers and exporters of cotton globally. Both the countries have a major role in the global cotton production as well as cotton exports indicating a key role along with China. Both the countries US and India have commodity futures exchanges which are essentially set up for the purpose of price discovery and price risk management based on the supply and demand situation.

Commodity futures derivatives products are a way to efficient price discovery mechanism and risk management. Globally ICE Cotton futures act as a platform to minimize risk for traders and processors across the globe while in India, tool of price risk management is offered by cotton futures traded in one of the agricultural commodity exchanges - Multi Commodity Exchange of India Limited (MCX).

This study has been carried out to identify whether global benchmark ICE Cotton futures prices influence the price of Indian Cotton Futures and to assess the relationship between the cotton futures prices of ICE and MCX. Same

way, Letife Ozdemir et. al (2019) established that there exists uni-directional causality between USA's Dow Jones Industrial Average (DOW) Spot and futures and Turkey's Borsa Istanbul (BIST) markets [2].

2. LITERATURE REVIEW

There are various studies carried out in agricultural commodities to assess dynamic relationship between various markets. Ulas Unlu & Ersan Ersoy (2012) used Engle- Granger (1987) methodology to study the causal relationship between foreign currency futures and spot market in Turkey [3]. In this study they used ADF (Augmented Dickey-Fuller) test to find the stationarity of the two series followed by long run equilibrium test using OLS regression method and Vector Error Correction Model was employed to know the direction of causality. Dr. Muruganathi et al (2013) used Granger Causality for identifying the direction of price relationship and have employed Augmented Dickey-Fuller (ADF) test to check stationarity of the time series, Granger Causality test to identify the direction of relationship, Cointegration analysis to determine the long run relationship and Vector Error Correction Model to assess the short run relationship between the two price series [4]. Kailash Chandra Pradhan & Dr.K.Sham Bhat in their study, Price Discovery and Causality in the NSE Futures Market employed Augmented Dickey-Fuller test to check stationarity and employed Johansen's Co-integration test to investigate the long run relationship and Vector Error Correction Model to investigate the causal relationship between the spot and futures prices of NSE traded securities [5]. Babu Jose and Daniel Lazer (2015) has employed VAR Granger Causality method to assess the causality between Indian futures and cash markets [6]. Amrinder Singh and Tarun Kumar Soni (2021) employed co-integration tests to examine the long term relationships among Indian, Chinese and US cotton futures prices [7]. R. Sendhil et. al. employed Johansen's Cointegration analysis to examine the relationship between spot and futures markets of chickpea, wheat, maize and barley [8]. Vaishali Jain, Rahul Dahigude and Dr. Rajiv Divekar used

Auto Regressive Distributed Lag model (ARDL Model) to assess the causative association between spot, futures and options market and found that there existed long run relationship between them [9]. Jabir Ali and Kriti Bardhan Gupta (2011) examined the efficiency of agricultural commodity futures markets in India using Johansen's Cointegration analysis and Granger Causality tests [10].

3. METHODOLOGY

Daily closing prices of Intercontinental Exchange (ICE) cotton 2.0 futures and Mult-Commodity Exchange of India (MCX) Cotton futures prices are used in this study. In both ICE and MCX, there will be more than one contract running parallel at any point of time. Average of the closing prices of all the running contracts available on a particular day is calculated and used as closing price for that day. This has been done for both ICE & MCX cotton futures prices. Once the daily closing prices are arrived at, dates for which closing prices are available for both ICE and MCX futures are segregated and aligned and used in this study. Aligned data pertains to the time period from Oct 2011 to Dec 2020 with 2246 data points. The aligned data set of daily closing prices of ICE and MCX Cotton futures are subjected to the following analysis to find whether there exist causal relationship between ICE cotton futures and MCX cotton futures in the long and short run and the direction of the causal relationship.

3.1 Augmented Dickey Fuller Test

For robust results, the price series used should be stationary. Augmented Dickey Fuller (ADF) test with following equation was used to assess whether the two price series are integrated of first order.

$$\Delta X_t = \rho_0 + \rho_{X_{t-1}} + \delta_i \Delta X_{t-i} + \varepsilon_t$$

Where,

X_{M_t} = the price at selected markets (ICE & MCX)

ρ_0 = a constant

$\rho = (\alpha - 1)$

Δ = the first difference operator

ε_t = white noise error term and

$\Delta X_{t-1} = (X_t - 1 - X_{t-2}), \Delta X_{t-2} = (\Delta X_{t-2} - \Delta X_{t-3}), \text{etc.},$

$i=1$ to n is number of lagged difference terms

The null hypothesis was to test that $\rho = 0$. The condition $\rho = 0$ indicate the presence of unit root which in turn indicate that the time series analysed is non stationary. For a stationary condition, ρ must be negative. In this study, stationarity of price series of ICE Cotton futures and MCX cotton futures are tested using Augmented Dickey Fuller test.

3.2 Granger Causality

Granger (1969) gave methodology to investigate whether changes in one series X cause changes in another series Y. If one could predict value of Y based on the past values of X and also the past values of Y considering other relevant information then one can say that X causes Y. Similarly, if values of X could be predicted using past values of Y including past values of X along with considering other relevant information, then one can say that Y causes X. The above concept is explained by the two OLS regression equations mentioned below which is used in Granger Causality test:

$$Y_t = \alpha_0 + \sum \alpha_i Y_{t-i} + \sum \beta_j X_{t-j} + U_t$$

$$X_t = \alpha_0 + \sum \alpha_i X_{t-i} + \sum \beta_j Y_{t-j} + U_t$$

where,

"i" = 1 to m and t indicates time t.

Y_t = Price at time t in market 1

X_t = Price at time t market 2

Y_{t-i} = lagged price at market 1;

X_{t-i} = lagged price at 2;

The number of lags to be used in this study is decided based on the Akaike Information Criteria (AIC) and Schwartz Bayesian Criteria (SBC). In this study, the dynamic relationship and direction of information flow between ICE cotton futures and MCX Cotton futures has been worked out using Granger Causality test.

3.3 Johansen Co-Integration Test

Johansen Multiple co-integration test was used to test the long run relationship between the price series which are integrated of the same order. The concept of co-integration has been introduced by Granger (1981). Engle and Granger (1987) proposed a procedure to test co-integration hypothesis. A level regression was

performed to generate residuals which may be thought of as equilibrium pricing errors. Residuals were then tested for co-integration. With the cotton price series of ICE futures and MCX futures, the co-integration equation is

$$X_t = \eta_0 + \eta_t Y_t + \varepsilon_t$$

Where,

X_t —Price at time t

η_0 – constant

η_t is the regression coefficient measures the influence of one market on the other and ε_t is the residuals or error terms.

The two price series will be co-integrated if and only if ε_t is stationary.

3.4 Vector Error Correction Mechanism (Ecm)

Error Correction Model (ECM) assess the long run co-integrating relationship between the level variables and short run relationship between their first differences. Engel and Granger (1987) demonstrated that for the co-integrated variables, there would be a corresponding error correction representation which implied that changes in the dependent variable are a function of the level of disequilibrium in the co-integrating relationship. Level of disequilibrium in the co-integrating relationship is captured by error correction term as well as changes in other variables.

Even if one demonstrates market integration through co integration, there could be disequilibrium in the short run, i.e., price adjustment across markets may not happen instantaneously. It may take some time for the spatial price adjustments. ECM can incorporate such short run and long run changes in the price movements. The long-term causal relationship between the market was implied through the significance of 't' tests of the lagged error correction term as it contains the long-term information because it has been derived from the long-term relationship. The coefficient of the lagged error correction term is a short-term adjustment coefficient and represented the proportion by which the price adjusted in response to the long run disequilibrium.

$$\Delta X_t = a_x Z_{t-1} + \sum_{i=1}^p b_{xi} \Delta X_{t-i} + \sum_{i=1}^p c_{xi} \Delta Y_{t-i} + \varepsilon_{x,t}$$

$$\Delta Y_t = a_y Z_{t-1} + \sum_{i=1}^p b_{yi} \Delta X_{t-i} + \sum_{i=1}^p c_{yi} \Delta Y_{t-i} + \varepsilon_{F,t}$$

Where,

ΔX_t is the differenced price series from market 1
 ΔY_t is the differenced price series of market 2,
 b_{xi} , c_{xi} , b_{yi} , and c_{yi} are the short-run coefficients,
 z_{t-1} is the error correction term (ECT),
 and $\varepsilon_{S,t}$ and $\varepsilon_{F,t}$ are residuals.

The magnitude of the coefficients a_x and a_y will determine the speed of adjustment back to the long-run equilibrium following a market shock. When these coefficients are large, adjustment is quick. When two markets are co-integrated prices, the ECM will capture dynamic correlations and causalities between their prices. If the coefficients on the lagged price in the equation are found to be significant, then turning points in one market will lead turning points in other, that is, one Granger causes the other.

4. RESULTS AND DISCUSSION

4.1 Augmented Dickey Fuller Test

The results of the unit root tests based on Augmented Dickey-Fuller (ADF) test to examine the stationarity of ICE & MCX Futures prices are presented in Tables 1.1 and Table 1.2.

Based on Schwarz information criteria, the optimal lag length chosen for ADF test was 4. All the price series were non stationary at levels at 1% level of significance and they became stationary after taking first difference. All the series have to be stationary at same order which is a pre requisite to test the co-integration. All the price series were non stationary at levels at 1% level of significance and they became stationary after taking first difference.

Table 1.1. ADF test results of ICE daily futures price series at level

Market	Level	T Statistic
1%	-3.433069	
5%	-2.862627	-2.303972
10%	-2.567395	

In the above tables, it is seen that at Level, T statistic is greater than ADF critical values and hence we need to accept the null hypothesis i.e., ICE prices have unit root. That means the data is

non-stationary at level. But at first difference, T statistic value is very much lesser than ADF critical values and hence null hypothesis can be rejected. That is ICE prices does not have unit root and hence they are stationary at first difference.

Table 1.2. ADF test results of ICE daily futures price series at first difference

Market	First difference	T Statistic
1%	-3.433070	
5%	-2.862628	-21.20780
10%	-2.567395	

Note: If T Statistic is less than ADF Critical values, then we will be rejecting the null hypothesis

Table 1.3. ADF test Results of MCX daily futures price series at level

Market	Level	T Statistic
1%	-3.433069	
5%	-2.862627	-2.896171
10%	-2.567395	

Table 1.4. ADF test results of MCX daily futures price series at first difference

Market	First difference	T Statistic
1%	-3.433070	
5%	-2.862628	-28.77566
10%	-2.567395	

In the above tables, it is seen that at Level, T statistic is not significantly lower than ADF critical values and hence we need to accept the null hypothesis i.e., MCX prices have unit root. That means the data is non-stationary at level. But at first difference, T statistic value is very much lesser than ADF critical values and hence null

hypothesis can be rejected. That is MCX prices does not have unit root and hence they are stationary at first difference.

4.2 Granger Causality Test Result

The result of the Granger causality test between ICE Futures and MCX Futures is given below.

Based on the probability and F values we can conclude that there is bidirectional causality between ICE and MCX cotton futures. This implies that both the markets are integrated and any change in one futures impact the other.

4.3 Johansen Co-Integration Test Result

After testing the price series for non-stationarity, the ICE and MCX Cotton futures are tested for long term equilibrium using Johansen's Co-integration analysis.

The null hypothesis of no-integration is rejected at one percent level of significance in both the trace test and maximum eigenvalue statistics indicating the presence of two co-integrating equations among ICE and MCX cotton futures price. This implies the existence of long run equilibrium among the two price series.

4.4 Vector Error Correction Model Test Result

The short run equilibrium test is carried out using Vector Error Correction model. The speed of adjustment is hinted by the adjustment coefficient. The results of vector error correction model is presented in Table 4.1 and 4.2.

Table 2. Result of granger causality test

S.No	Null Hypothesis	F-Statistic	Prob	Direction of Relationship
1	MCX does not Granger Cause ICE	5.42188	0.0045	
	ICE does not Granger Cause MCX	13.3754	2.E-06	Bidirectional

Table 3. Result of Johansen Co-integration Test

Hypothesized no of co integration equation	Eigen value	Trace statistics	Critical value	Prob**
None *	0.008758	27.46322	15.49471	0.0005
At most 1 *	0.003442	7.732691	3.841465	0.0054

Trace test indicates 2 co integrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Table 4.1. Equation 1: d_MCX

	Coefficient	Std. Error	t-ratio	p-value	
const	1.68148	0.258587	6.5026	<0.00001	***
d_MCX_1	-0.428635	0.0191183	-22.4202	<0.00001	***
d_ICE_1	0.0994841	0.0756914	1.3143	0.18887	
EC1	-0.0567031	0.00816317	-6.9462	<0.00001	***
<i>Mean dependant Var</i>	<i>0.005343</i>	<i>S.D.dependent var</i>	<i>5.012015</i>		
<i>Sum squared resid</i>	<i>43813.52</i>	<i>S.E. of regression</i>	<i>4.420651</i>		
<i>R-squared</i>	<i>0.223097</i>	<i>Adjusted R-squared</i>	<i>0.222057</i>		
<i>rho</i>	<i>-0.110354</i>	<i>Durbin-Watson</i>	<i>2.220616</i>		

Table 4.2. Equation 2: d_ICE

	Coefficient	Std. Error	t-ratio	p-value	
const	0.132466	0.072631	1.8238	0.06831	*
d_MCX_1	0.0157307	0.00536987	2.9294	0.00343	***
d_ICE_1	0.00982294	0.0212599	0.4620	0.64410	
EC1	-0.00425573	0.00229284	-1.8561	0.06357	*
<i>Mean dependent var</i>	<i>0.006879</i>	<i>S.D. dependent var</i>	<i>1.243868</i>		
<i>Sum squared resid</i>	<i>3456.519</i>	<i>S.E. of regression</i>	<i>1.241657</i>		
<i>R-squared</i>	<i>0.004883</i>	<i>Adjusted R-squared</i>	<i>0.003552</i>		
<i>rho</i>	<i>-0.000253</i>	<i>Durbin-Watson</i>	<i>2.000374</i>		

In the above table showing the result of the study to find out the impact of price changes of ICE futures with 1 lag over the MCX futures prices, EC 1 value is significant at 10% level and hence both MCX futures and ICE futures are in short run equilibrium.

From the Tables 4.1 & 4.2, it can be inferred that impact of MCX futures prices on ICE futures is more than the impact of ICE futures price over MCX futures prices at 2 lag.

5. CONCLUSION

The ICE and MCX cotton futures are non-stationary at level and are stationary at first difference and there exists a bi-directional causality between them. There exists both long run and short run equilibrium relationships between the two price series. Therefore in any major price shock in one of the markets tend to get reflected in the other. Therefor having a close monitoring on the international updates related to cotton production, trade and the ICE price movements would lend a helping hand to take better purchase and stocking decision for cotton spinning mills and other consuming category segments of cotton.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:

The peer review history for this paper can be accessed here:
<https://www.sdiarticle5.com/review-history/86485>