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Price Discovery between Spot and Contemporaneous Future Cotton Contract in India

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***Abstract**: Cotton crop in India is so important that it is often termed as white Gold. India is the largest producer of cotton in the world accounting for about 26% of the world cotton production. As step towards better management practices the cotton is traded in future at two major stock exchanges NCDEX and MCX to help better price discovery. The spot prices of cotton since 2013 had witnessed high fluctuations. The increase in prices will impact small textile players the most, since cotton is the key raw material and it will also lower their inventory holding capacity. So it is very important to understand nature of relationship between the spot and future contracts of cotton. It is also to be found out which segment plays lead role in price discovery. Market efficiency implies cointegration because the same factors that determine the spot price are reflected in the current futures price, so the two should not drift apart. Johnson Cointegration Test is applied to examine the long run relationship between spot and future contract of cotton traded at MCX. Granger Causality Test is implied to empirically test the lead lag relationship of contemporaneous future contract .Augmented Dickey-Fuller test is conducted to find out stationary characteristic of time series data. Akaike Information Criterion (AIC) test is used in to find out optimum lag length. Through Vector Error Correction Method (VECM) price discovery process is analysed. The data of spot price and derivative price of cotton contract of MCX from January 2013 to May 2017 is tested for this paper. The Study concludes that there is long run association between spot prices and future contracts of cotton. Since both the markets are integrated any policy impact on any of segment of market will impact other segment of market also in long run. Empirical study through the Granger causality Test is found that contemporaneous future contract of cotton cause the spot price of cotton. There is lead lag relationship between future contract and spot cotton contract where future contract leads in price discovery. The study offers room for conducting further research as in present study only one commodity is empirically tested with limited period data of MCX.*

***Keywords**: Price Discovery, Market Efficiency, Commodity Derivative, Cointegration,*

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I. Introduction

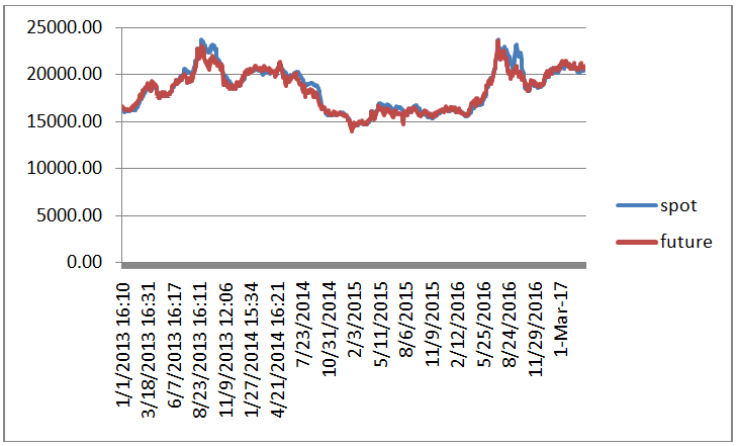
Cotton crop in India is so important that it is often termed as white Gold. It provides basic raw material for textile industry. Cotton seeds are used in produce edible oil and also used as fodder for milch cattle for increasing production of milk. India is the largest producer of cotton in the world accounting for about 26% of the world cotton production. It has the distinction of having the largest area under cotton cultivation in the world ranging between 10.9 million hectares to 12.8 million hectares and constituting about 38% to 41% of the world area under cotton cultivation. The yield per hectare (i.e.504 kgs to 566 kgs per hectare) is however still lower against the world average of about 701 Kgs to 766 kgs per hectare(Source: Cotton corporation of India). Cotton provides employment to 60 million people engaged in direct or indirect ways like farming, industry and trade related to cotton and cotton by products. Textile exports accounts for 30 % of India's total exports. Cotton textiles alone make up 20% of the exports.

Cotton is a kharif crop (Crop that are harvested in Rainy season) and 6-8 months are required to mature the crop. Its time of sowing and harvesting differs in different parts of the country depending upon the climatic conditions. In India, cotton is cultivated can be divided into three ecological zones, viz., Northern (Punjab, Haryana and Rajasthan), Central (Gujarat, Maharashtra and Madhya Pradesh) and Southern zone (Andhra Pradesh, Tamil Nadu and Karnataka).

Since independence the area under cotton has increased from 44.24 hectares to 128 hectare and production increased from 33.36 lakh Bales (170 kgs) to 386 lakh bales. So the area under cultivation increased to 3 fold and production increased to almost 12 times. But still the per hectare production is very low. Government has taken various steps to increase the production. Since launch of "Technology Mission on

Cotton" by Government of India in February 2000 significant achievements have been made in increasing yield and production through development of high yielding varieties, appropriate transfer of technology, better farm management practices, increased area under cultivation of Bt cotton hybrids etc. All these developments have resulted into a turnaround in cotton production in the country since last 6-7 years (Cotton corporation of india).

Trading in cotton is allowed in Derivative at two major stock exchanges National Commodity and Derivative Exchange Limited(NCDEX) and Multi commodity Exchange of India Limited (MCX) to help better price discovery. The spot and future prices of cotton since 2013 had witnessed high variation in prices.



Source: Spot price data of cotton MCX

The increase in prices will impact small textile players the most, since cotton is the key raw material and it will also lower their inventory holding capacity. Ginners and spinners are most likely to be affected. With the rise in prices export will impact. With the derivative the farmers and industry can shift the risk of price change to the speculators. So it was necessary to understand nature of relationship between the spot and future contracts of cotton.

This paper studies the relationship between spot and future price of cotton.. The whether the future market is efficient in price discovery of spot prices of commodity or not. Granger Causality test is implied to empirically test hypothesis. The result explains that Future prices causes the spot prices.

II. Review Of Literature

In last decade lot of study on Indian commodity market is done by the various researchers. .

Sahi (2006) studied Wheat futures market at NCDEX and efficiency has been estimated through Johansen's Cointegration approach for different futures forecasting horizons ranging from one week to three months. The commodity futures market is not efficient even in the short run.

Sahi and Raizada (2007) applied Granger causality tests and results show that an unexpected increase in futures trading volume unidirectionally causes an increase in cash price volatility for wheat, turmeric, sugar, raw jute and soybean oil. Likewise, there is a causal effect from unexpected increase in open interest to cash price volatility for wheat, turmeric, raw jute and soybean oil.

Research conducted by Lokare (2007) explains that although there is less liquidity in few commodities in India but still there is evidence of co-integration of spot and future prices in almost all the commodities. He further examined that volatility in few commodities are more in future when it is compared to spot market volatility.

Roy (2008) did the study of the wheat contract in commodity spot and future market and concluded that there is efficiency in Indian commodity future market and long run cointegration between spot and future wheat contract exist except few month contract.

Sahoo and Kumar (2008) did analysis of six commodities traded on commodity exchange and found that future market for these commodities are not efficient and there is no long term equilibrium relationship between future and spot market

Biswat pratap Chandra (2009) found that future and spot market are co integrated in longrun and causality follows from future market to spot market.

Nath and Lingareddy (2012) conducted study in Indian commodity market and finds that in India future trading in the selected commodities had apparently led to increase in prices of commodities like Urad. It also increased the volatilities in the spot market.

Kushankur D and Debasish M (2012) observed pepper contract in spot and future market and found the unidirectional causality from future to spot and adjustment of shock in future is more in future when compared with cash market.

Srinivasan P (2012) inferred that there is flow of information from spot commodity market to future market and bidirectional volatility spill over is there.

Malhotra and Sharma (2016) observed that there is an efficient transmission of information between spot and futures markets but it is the spot market which leads to the flow of information to futures. The spot market has a greater impact on the volatility of futures market, indicating that informational efficiency of oilseeds spot market is stronger than that of the futures market.

Problem Formation

The cotton is important cash crop and also termed as white gold in India. Its utility as raw material for textile industry is well understood. The prices of cotton had increased more than 35% since 2015. The increase in price of raw material will increase the cost of textiles for Indian consumers. The export potential will also reduce due to surge in prices of textile. So it is very important to understand the nature of relationship between the spot and future contracts of cotton. It is also to be found out which segment plays lead role in price discovery. Market efficiency implies cointegration because the same factors that determine the future spot price are reflected in the current futures price, so the two should not drift apart (Beck S 1994). If cointegration exist in spot and future then it can be said that market is efficient. The relationship between the

Objective of the Study

To examine the long run relationship between spot and futures contract of Cotton and Price discovery processTo study the causality relationship between the spot and future contract of Cotton and understand the lead lag relationship between spot and future contracts.

To Analyse the Price discovery process in cotton contract

III. Data And Methodology

This empirical study is conducted on the secondary data collected from the official website of MCX for spot and near month future price of cotton contract from January 2013 to May 2017. The data analysis is carried out through appropriate statistical and econometric techniques. The long run relationship between the futures and spot prices of cotton contract is examined through the Johansen Cointegration Test. In order to make the time series data stationary, the Augmented Dickey Fuller test is used. To find out Lead lag relationship between the spot and future prices Granger Causality test is conducted. To analyse the price discovery process Vector Error Correction method is used.

Johansen Cointegration Test

Johansen (1991,1995) developed VAR based cointegration Test. The null hypothesis in this test is the series does not have cointegration and alternate hypothesis is the series have cointegration. The spot prices of cotton and future is taken at level to conduct test of coinegration. The series is said to be coninterated if the probability value is less than 5%. The Johansen cointegration test is tested by trace statistics and max- Eigen statistics. Trace test and Max-Eigen value statistics indicate the presence of one co-integrating at five per cent level. The series is said to be coninterated if the probability value is less than 5%. Johansen test allows more than one cointegration relationship.

Augmented Dickey-Fuller Test

Augmented Dickey fuller Test can be used to determine whether the time series is stationary of not. Testing procedure for Augmented Dickey Fuller test

$\Delta X_t=\alpha+\beta t+\Upsilon X_{t-1}+\delta\Delta X_{t-1}+\ldots\ldots\ldots\ldots..+\delta_{p-1}\Delta X_{t-p+1}+\varepsilon_t$

Where α is constant and β is trend and p is lag order. The dickey fuller test is done on trend, intercept and no trend and no intercept.

For Lag length selection Akaike Information Criterion (AIC) test is used in to find out optimum lag length.

Granger Causality Test

The Granger (1969) developed Granger Causality Test to answer the question of whether spot (S) causes Future (F) or not. In this paper we examine whether cash cotton prices causes future cotton prices or future cotton prices causes cash cotton prices. In First step is to see how much of the current S is explained by past values of S itself and in next step to see whether adding lagged values of F can improve the model and vice versa for whether F causes S.

$S_t=\alpha_0+\alpha_1S_{t-1}+\ldots\ldots.+\alpha_lc_{t-l}+\beta_1F_{t-1}+\ldots\ldots\ldots+\beta_tF_{t-l}+\varepsilon_t$

$F_t=\alpha_0+\alpha_1F_{t-1}+\ldots\ldots.+\alpha_lF_{t-l}+\beta_1S_{t-1}+\ldots\ldots\ldots+\beta_tS_{t-l}+\mu_t$

Vector Error Correction Model (VECM)

Vector error correction method can be used to understand the price discovery process. VECM is extention of Vector Autoregression Method. The vector autoregression (VAR) models are the natural extensions of the univariate Auto regressive moving average ARMA models. Mathematic representation of VAR is

$S_t = c_1+\alpha_1 S_{t-1+} \alpha_2 S_{t-2+\ldots\ldots\ldots+} \alpha_l c_{t-l+} \beta_t F_{t-l+} \beta_2 F_{t-l+\ldots\ldots\ldots+} \beta_t F_{t-l+} \varepsilon_t$

$F_{t=} c_{2+} \alpha_1 F_{t-1+} \alpha_2 F_{t-2+} \ldots\ldots\ldots+ \alpha_l F_{t-l} + \beta_1 S_{t-1+} + \beta_2 S_{2-1+\ldots\ldots\ldots+} \beta_t F_{t-l+} \varepsilon_t$

Corresponding VEC Model will be as follows:

$\Delta S_{1,t}=\alpha_1(F_{t-1}-\beta S_{t-1})+\varepsilon_{1,t}$ (A)

$\Delta F_{1,t=} \alpha_2(S_{t-1}-\beta F_{t-1})+\epsilon_{2,t}$ (B)

Where $\Delta S = S_t-S_{t-1}$ and $\Delta F = F_t-F_{t-1}$

In the above A and B equation right-hand side variable is the error correction term. In long run equilibrium, this term is zero. If spot and Future deviate from the long run equilibrium,the error correction term will be nonzero and each variable adjusts to partially restore. The coefficient α_1 and α_2 measures the speed of adjustment of the *i*-th endogenous variable towards the equilibrium.

IV. Finding And Analysis

Cointegration of Spot and Future prices of Cotton

The data of Cotton contract from MCX is studied from 1st January 2013 to May 31st 2017 for Spot and Future. The Result of Johansen Cointegration

Table-1

Sample (adjusted): 6 1133
Included observations: 1128 after adjustments
Trend assumption: Linear deterministic trend
Series: FUTURE SPOT
Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.029649	37.56905	15.49471	0.0000
At most 1	0.003203	3.619041	3.841466	0.0571

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

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.029649	33.95001	14.26460	0.0000
At most 1	0.003203	3.619041	3.841466	0.0571

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

on Test is displayed in following table

First Null hypothesis is that there is no cointegration between the spot and future. P Value is 0.00 as per trace test and 0.000 as per Max Eigen Statistic. In Both the case value is less than 5% so Null hypothesis is rejected. Second case the Null hypothesis is that there is at most 1 cointegrated equation between spot and future. P value is 0.0571 as per both Trace test and Max Eigen Statistic. So P value is more than 5% and null hypothesis is accepted. The empirical test shows that there is long run integration between spot contract of cotton and future contract of cotton. The cointegration exists between spot and future contracts of cotton implies the market is efficient

Augmented Dickey-Fuller Test

The Difference log is taken for spot and future for testing the stationarity of the series. The series is stationary when there is no unit root in the series. The Null hypothesis is there is unit root in the series. The statistic below in Table 2 shows the rejection of Null hypothesis as p value in all the cases is 0.0000. So the series at first difference log is stationary and does not have unit root.

Table -2

T Statistics (P Value)	Intercept	Trend	No
Future	-24.90315(0.00)	-34.80394 (0.00)	-34.82544 (0.00)
Spot	-24.90712 (0.00)	-24.89625 (0.00)	-24.90429 (0.00)

Granger Causality Test

The following table displays the result of Granger Causality test. There are two null hypothesis : first, Future prices of cotton does not cause spot price of cotton alternate is future prices causes spot price. The P value is less that 5% so null hypothesis is rejected and alternate hypothesis is accepted. Second null hypothesis is spot prices of the cotton does not causes the future price of cotton contract and alternate is spot cause future prices of cotton contract. P value is more than 5% so null is accepted and alternate hypothesis is rejected.. So there is unilateral relationship in cotton contract of MCX. Future contract leads and spot contract lags in this study.

Table-3

Pairwise Granger Causality Tests
Sample: 1 1133
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
D(FUTURE) does not Granger Cause D(SPOT)	1130	57.4614	2.E-24
D(SPOT) does not Granger Cause D(FUTURE)		2.26207	0.1046

VECM Model

After testing the cointegration between the two series spot and future, Vector Error Correction Model can be applied. The appropriate lag length for testing VECM Is required Table 4 Shows the appropriate lag length through various methods like Akaike information criterion(AIC) Schwarz information criterion(SC) and Hannan-Quinn information criterion (HQ). The star is marked on appropriate lag length. As per AIC optimum lag length is 4 lag length.

Table-4 Lag Selection

Endogenous variables: FUTURE SPOT
Exogenous variables: C

Sample: 1 1133
Included observations: 1123

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-18873.09	NA	1.36e+12	33.61547	33.62442	33.61885
1	-14638.37	8446.807	7.27e+08	26.08080	26.10764	26.09095
2	-14551.84	172.2993	6.28e+08	25.93381	25.97855*	25.95072*
3	-14546.00	11.59163*	6.26e+08	25.93055	25.99318	25.95422
4	-14541.75	8.433956	6.26e+08*	25.93010*	26.01063	25.96053
5	-14538.76	5.917554	6.27e+08	25.93190	26.03032	25.96910
6	-14538.50	0.526011	6.31e+08	25.93855	26.05487	25.98251
7	-14536.46	4.017598	6.33e+08	25.94205	26.07626	25.99277
8	-14534.11	4.625091	6.35e+08	25.94499	26.09709	26.00248
9	-14531.55	5.047780	6.37e+08	25.94755	26.11754	26.01179
10	-14530.58	1.892088	6.40e+08	25.95295	26.14084	26.02396

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error

AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

The empirical test of the VECM is displayed in Table-5

Table -5

Vector Error Correction Estimates
Sample (adjusted): 5 1133
Included observations: 1129 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1	
FUTURE(-1)	1.000000	
SPOT(-1)	-0.928726	
	(0.03320)	
	[-27.9761]	
C	-1181.871	
Error Correction:	D(FUTURE)	D(SPOT)
CointEq1	-0.002719	0.044089
	(0.01399)	(0.00807)
	[-0.19430]	[5.46350]
D(FUTURE(-1))	-0.056805	0.174456
	(0.03474)	(0.02003)
	[-1.63537]	[8.70947]
D(FUTURE(-2))	-0.040215	0.023857
	(0.03607)	(0.02080)
	[-1.11479]	[1.14680]
D(FUTURE(-3))	-0.017565	0.021859
	(0.03482)	(0.02008)
	[-0.50445]	[1.08859]
D(SPOT(-1))	0.072560	0.117682
	(0.05594)	(0.03226)
	[1.29717]	[3.64825]
D(SPOT(-2))	0.066099	0.046337
	(0.05590)	(0.03223)
	[1.18252]	[1.43753]
D(SPOT(-3))	0.048996	0.060457
	(0.05087)	(0.02933)
	[0.96316]	[2.06093]
C	3.309048	2.140543
	(6.47771)	(3.73547)
	[0.51084]	[0.57303]
R-squared	0.006360	0.204576
Adj. R-squared	0.000155	0.199609
Sum sq. resids	53008275	17627483
S.E. equation	217.4548	125.3985
F-statistic	1.024960	41.18734
Log likelihood	-7674.235	-7052.727

Akaike AIC	13.60892	12.50793
Schwarz SC	13.64456	12.54357
Mean dependent	3.578388	3.844110
S.D. dependent	217.4717	140.1655

Determinant resid covariance (dof adj.)	6.10E+08
Determinant resid covariance	6.02E+08
Log likelihood	-14615.48
Akaike information criterion	25.92290
Schwarz criterion	26.00308

The following is the model of VECM to find out the relationship between the Spot and Future cotton Contract.
D(FUTURE) = C(1)*(FUTURE(-1) - 0.928726328799*SPOT(-1) - 1181.87067628) + C(2)*D(FUTURE(-1)) + C(3)*D(FUTURE(-2)) + C(4)*D(FUTURE(-3)) + C(5)*D(SPOT(-1)) + C(6)*D(SPOT(-2)) + C(7)*D(SPOT(-3)) + C(8)

D(SPOT) = C(9)*(FUTURE(-1) - 0.928726328799*SPOT(-1) - 1181.87067628) + C(10)*D(FUTURE(-1)) + C(11)*D(FUTURE(-2)) + C(12)*D(FUTURE(-3)) + C(13)*D(SPOT(-1)) + C(14)*D(SPOT(-2)) + C(15)*D(SPOT(-3)) + C(16)

The table Six gives the analysis of first relationship mentioned above.

Table- 6

Dependent Variable: D(FUTURE)
Method: Least Squares

Sample (adjusted): 5 1133
Included observations: 1129 after adjustments
D(FUTURE) = C(1)*(FUTURE(-1) - 0.928726328799*SPOT(-1) - 1181.87067628) + C(2)*D(FUTURE(-1)) + C(3)*D(FUTURE(-2)) + C(4)*D(FUTURE(-3)) + C(5)*D(SPOT(-1)) + C(6)*D(SPOT(-2)) + C(7)*D(SPOT(-3)) + C(8)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.002719	0.013994	-0.194298	0.8460
C(2)	-0.056805	0.034735	-1.635372	0.1023
C(3)	-0.040215	0.036075	-1.114786	0.2652
C(4)	-0.017565	0.034820	-0.504449	0.6140
C(5)	0.072560	0.055937	1.297167	0.1948
C(6)	0.066099	0.055897	1.182515	0.2373
C(7)	0.048996	0.050870	0.963162	0.3357
C(8)	3.309048	6.477713	0.510836	0.6096

R-squared	0.006360	Mean dependent var	3.578388
Adjusted R-squared	0.000155	S.D. dependent var	217.4717
S.E. of regression	217.4548	Akaike info criterion	13.60892
Sum squared resid	53008275	Schwarz criterion	13.64456
Log likelihood	-7674.235	Hannan-Quinn criter.	13.62238
F-statistic	1.024960	Durbin-Watson stat	1.999225
Prob(F-statistic)	0.411621		

The table -7 shows the results of the relationship of the model mentioned above

Table-7

Dependent Variable: D(SPOT)
Method: Least Squares
Sample (adjusted): 5 1133
Included observations: 1129 after adjustments
D(SPOT) = C(9)*(FUTURE(-1) - 0.928726328799*SPOT(-1) - 1181.87067628) + C(10)*D(FUTURE(-1)) + C(11)*D(FUTURE(-2)) +

C(12)*D(FUTURE(-3)) + C(13)*D(SPOT(-1)) + C(14)*D(SPOT(-2)) + C(15)*D(SPOT(-3)) + C(16)

	Coefficient	Std. Error	t-Statistic	Prob.
C(9)	0.044089	0.008070	5.463500	0.0000
C(10)	0.174456	0.020031	8.709465	0.0000
C(11)	0.023857	0.020803	1.146799	0.2517
C(12)	0.021859	0.020080	1.088591	0.2766
C(13)	0.117682	0.032257	3.648249	0.0003
C(14)	0.046337	0.032234	1.437531	0.1508
C(15)	0.060457	0.029335	2.060934	0.0395
C(16)	2.140543	3.735468	0.573032	0.5667

R-squared	0.204576	Mean dependent var	3.844110
Adjusted R-squared	0.199609	S.D. dependent var	140.1655
S.E. of regression	125.3985	Akaike info criterion	12.50793
Sum squared resid	17627483	Schwarz criterion	12.54357
Log likelihood	-7052.727	Hannan-Quinn criter.	12.52140
F-statistic	41.18734	Durbin-Watson stat	2.007621
Prob(F-statistic)	0.000000		

The table 6 & 7 shows that C9,C10, C13,and C15 are significant at 5% level and rest are insignificant at 5% level. This implies that if any disequilibrium arises between spot and futures prices, futures price would respond to this disequilibrium rapidly. The spot prices are affected by the future prices. So there is lead lag relationship between future and spot where as future leads and spot price lags in price discovery.

V. Conclusion

The study empirically examines the process of price discovery by future market, If future market are not to help in price discovery then amendment in polices are required . The analysis concludes that there is long run association between spot prices and future prices of contracts of cotton.. Since both the markets are integrated any policy impact on any of segment of market will impact other segment of market also in long run. Empirical study through the Granger causality Test it is found that contemporaneous Future contract of cotton cause the spot price of cotton. VECM test shows that future prices helps in price discovery process and both the markets have long run relationship..Derivative cotton contract works as instrument for spot price discovery of cotton and price risk management. There is lead lag relationship between Future contract and spot cotton contract where future contract leads in price discovery. The finding has significance for portfolio managers and investor who can make effective trading strategies using the result. The policy maker can use the results of finding to increase the market stability The study offers room for conducting further research as in present study only one commodity is empirically tested with limited period data of MCX.

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