Information Flow and Causality Relationship between Spot and Futures Market: Evidence from Cotton

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Abstract: *India plays a predominant role in production, consumption, and export of cotton in the world. In 2016, India alone contributes 25 percent of world cotton production and second largest exporter followed by the United States. The cotton prices is collected from the MCX official website from 2011 to 2017. We employed econometric tools like Johansen's cointegration test, VECM, Breusch-Godfrey, CUSUM and Granger Causality Test to identify the information flow and causality relationship. The empirical analysis shows that futures market play a vital role in information flow and also futures market is more efficient than the spot market.*

Keywords: *Cotton Market, Long Run, Short Run, VECM and Granger Causality Test*

I. INTRODUCTION

India's first organized Futures trading was started after a two-decade of Chicago Board of Trade (CBOT) in 1875 for cotton. Soon after, Futures trading in oilseeds was initiated by Gujarati Vyapari Mandali in 1900 with castor seeds, groundnut, and cotton as a commodity. Then, Futures trading is started in various commodities like raw jute (1919), Bullion (1920) and jute goods (1927). But, Derivatives trading was completely prohibited in India under the Defence Act.

Commodity Future market and the Stock market have come into Union list after Independence. Afterward, Regulation of Futures market is controlled by the Central Government. The expert committee was constituted by Union Government to study the feasibility of Derivative market under the guidance of Prof. A. D Shroff. This committee submitted his final version of Forward Contract (Regulation) Act in December 1952 after two successive Parliament discussion. In September 1953, Forward Markets Commission (FMC) emerged as a regulator of the Commodity Futures Market.

Thereafter, Indian Pepper and Spice Trade Association (IPSTA) initiated the Futures trading in Spice commodities. But in 1996, Futures trading was prohibited in all commodities due to scarcity and price fluctuation exempt turmeric, linseed, castor seed, and pepper. During this period, the government provided a Minimum Support Price (MSP) for specific agricultural commodities. It provides protection to farmers against unfavorable price fall. But, the Government faces many issues to sustain this Minimum Support Price like fixing price, purchases, storing, distribution, transport, etc.

During 1969-1980. Two expert committee was constituted to study the need of the derivative market, namely Dantwala Committee (1966) and Khusro Committee (1980). Both this committee were recommended to reintroduce the commodity futures market. Finally, in early 80's Government permitted forward trading which has not influenced the economic like jute, pepper, turmeric, Castor seeds, etc. In June 1993, Kabra committee was constituted and they submitted the detailed report on the Derivatives market in 1994. In 2003, Futures trading was reintroduced based on this committee recommendation which was prohibited in1966. Thereafter, commodity became an important asset class for portfolio construction. Another milestone of future market is occurred on 28th September 2015, repeal of the Forward Contracts Act, 1952 and FMC was fused with the Securities and Exchange Board of India (SEBI). Thereafter, SEBI was regulator of the commodity futures market under the Securities Contracts Act, 1956.

An Overview: Cotton

Cotton is cultivated for its fiber because around 35 percent of the World Textile Industry is relying on fiber. The reputation of Cotton not only ending with clothes and it's continuous in Space Suit, Livestock Feed, Edible Oil, etc. And, Cottonseed oil is one of the most consumed Edible Oil in the World. Almost, eighty countries are producing the Cotton, but only a few Countries are dominated in Export. The United States carrying out a vital role in export by contributing one-third of World export and Bangladesh recorded as the largest importer of cotton in 2016. The world's top five producers of cotton are India, China, United States, Pakistan, and Brazil. They are contributing more than 70 percent of the world production.

India plays a predominant role in production, consumption, and export in the world. In 2016, India alone contributes 25 percent of world cotton production and second largest exporter followed by the United States. The major Cotton producing states are Gujarat, Maharashtra, and Telangana and they produce more than

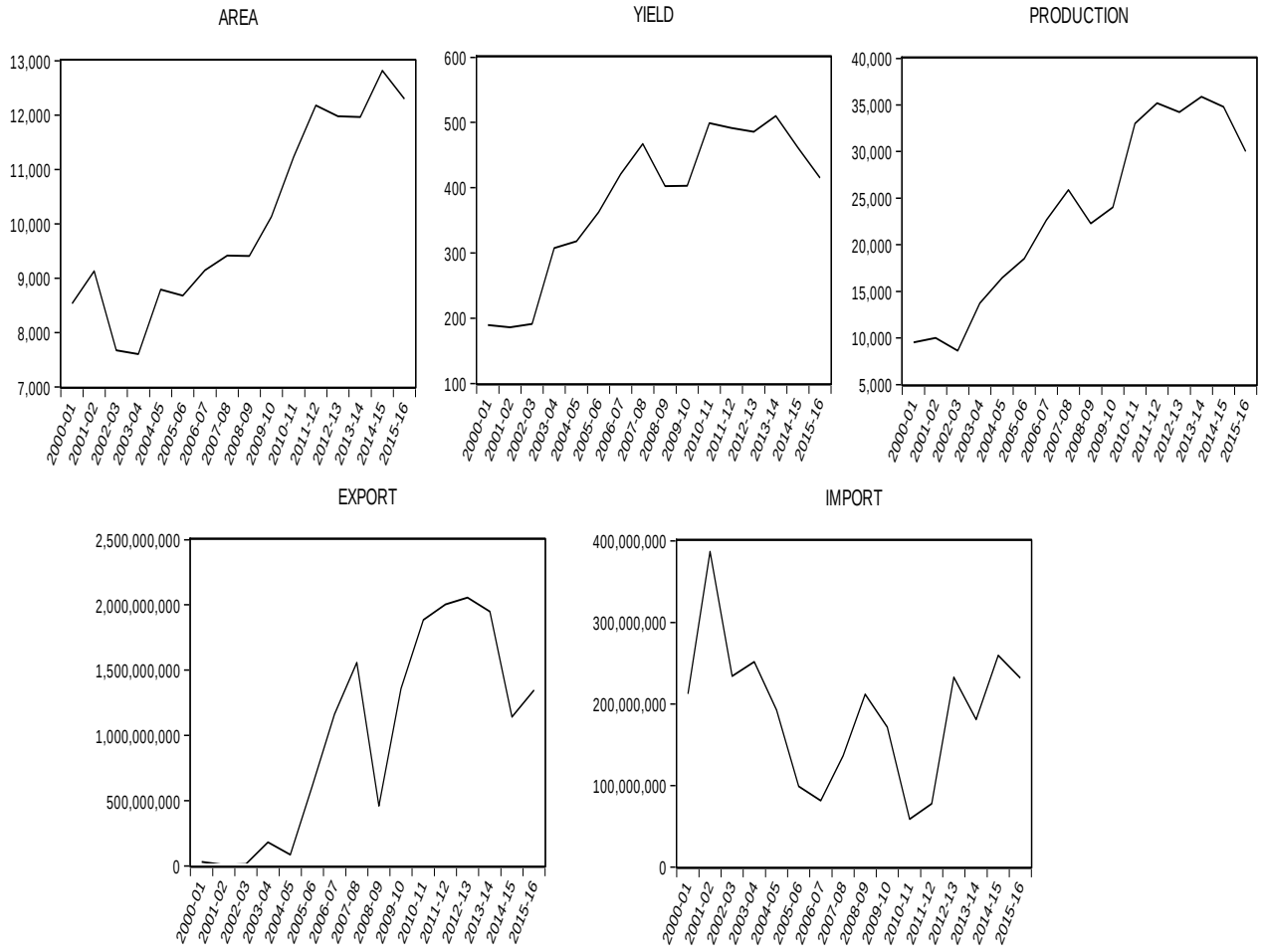
65 percent of total production in India. The following table shows the trend of the Area, Production, Yield, Import, and Export.

Table1: Summary statistics of Area, Production, Yield, Import, and Export

Year	Area ('000hectares)	Production ('000 bales)	Yield (Kg./Hectare)	Import (Quantity)	Export (Quantity)
2000-01	8,534.40	9,520.00	189.60	212,361,618	30,187,816
2001-02	9,131.80	9,997.00	186.10	387,036,399	8,227,012
2002-03	7,669.60	8,623.70	191.10	233,859,317	11,832,940
2003-04	7,597.90	13,729.00	307.20	251,673,595	179,603,722
2004-05	8,786.60	16,428.60	317.90	192,179,053	86,637,440
2005-06	8,677.10	18,499.00	362.40	98,752,152	614,802,474
2006-07	9,144.50	22,631.80	420.70	81,474,812	1,162,218,767
2007-08	9,413.70	25,884.10	467.40	136,486,276	1,557,589,608
2008-09	9,406.70	22,276.20	402.60	211,683,922	457,562,720
2009-10	10,131.70	24,021.80	403.10	171,419,551	1,357,982,106
2010-11	11,235.00	33,000.00	499.30	58,386,009	1,885,766,192
2011-12	12,178.00	35,200.00	491.40	77,425,088	2,003,587,753
2012-13	11,977.00	34,220.00	485.70	232,554,037	2,056,696,754
2013-14	11,960.00	35,902.00	510.30	180,976,336	1,947,696,518
2014-15	12,819.00	34,805.00	461.60	259,413,913	1,142,532,048
2015-16	12,292.00	30,005.00	415.00	231,807,810	1,347,090,580

(Sources: CMIE Database)

Figure1: Performances of Cotton Commodity



II. REVIEW OF LITERATURE

Ali et al (2011) analyzed the market efficient in twelve major agricultural commodities by using average spot and futures price which was collected from the India's leading agricultural commodities exchange NCDEX through econometric tools. The Johansen co-integration test reveals the existences of long-run relationship for all agriculture commodities except rice and wheat. And they found out the information flow between spot and futures market by the Granger causality test. The test result shows that stronger information flow from the direction of futures to spot in major commodities while in maize, black lentil, and pepper influenced in both directions.

Behera (2015) examined the "price discovery and market efficiency in the Indian commodity market". The study considered the polled spot price and futures price of five commodities viz, gold, copper, silver, crude oil, and natural gas from MCX exchange for the period of 2005-2011. Their findings reveal that flow of information moves from futures market to spot market except for gold commodity and also they found the stable long-run relationship.

Brajesh et al (2011) investigated the "price discovery and volatility spillover in the Indian commodity market" through spot and futures return observation for eleven different commodities. They found evidence that the futures market is not efficient in industrial metal commodities because futures market is influenced by spot market, but in case of energy and precious metal commodities futures market influencing the spot market. And, in agricultural commodities, both markets influence each other. Further, they extended the research to find out the effect of harvest and lean period in agricultural commodities. Their result shows that in the harvest period futures market leads the spot market but in case of lean period, both markets are influencing each other because large volumes of futures trading in harvest period is high.

Chander et al (2015) examined the observations from 2011-2014 of four agricultural commodities to find out the price discovery function through Johansen co-integration, Granger causality and VECM. The result of Johansen co-integration test provided an evidence of the long run relationship in all commodities and also they found both markets shared their long stand information. Granger causality test confirms the price discovery function on both sides of the market, but in the case of maize, the spot market is not leading the futures market. It shows that futures market serves the price discovery mechanism very efficiently.

Chauhan et al (2013) have conducted a study on Agricultural Sector Perspective entitled "Market Efficiency and Volatility Spillovers in Futures and Spot Commodity Market". In their articles, they were used Guar seed and Chana contract from 2014-2012. The result of their study provides an adequate evidence for futures market efficiency. They found existences in the bidirectional relation between spot and futures market for guar seed, whereas in Chana it only shows an only unidirectional relationship. Further, they extended the analyzed to volatility spillover effect and they found evidence that futures market volatility influences spot market volatility in guar seed, but in case of Chana, spot market volatility influences the futures market.

Chhajed et al (2013) explored the "market behavior and price discovery in the Indian agriculture market" for nine commodities from 2009-2010. This study tries to find out the effect of changes in futures price on changes in the spot price and vice versa for formulating a strategy of hedging or speculation. They tracked the information flow from futures to spot market in major commodities.

Deepthy et al (2011) used spot and futures sequence to study the price discovery in precious metal for the period 2014-2016 through econometric tools. Johansen co-integration test identified the presences of the long run relationship between spot and futures market. Granger causality test shows both markets perform the price discovery function. The result of a VECM shows futures market leads spot market, whereas in the silver bidirectional relationship in the long run. The Wald test reveals that bidirectional in gold and unidirectional from futures to spot market in the short run.

Kumar Mahalik et al (2014) empirically studied "the price discovery and volatility spillover in the Indian commodity market" through VECM and EGARCH. This study used spot and futures price of the index of MCX. The outcomes of a VECM reveals that only futures index influence the spot market index but not vice versa. Further, Johansen co-integration result provided an evidence of existing long-run relationship in all indexes except metal. EGARCH indicates the futures market volatility significantly influencing the spot volatility whereas in Agri index spot volatility influencing the futures market.

III. DATA AND METHODOLOGY

Daily spot and Near-month futures closing prices of the cotton is collected from the MCX official website to investigate the Information Flow and Causality Relationship between Spot and Futures Market for the period of 2011 to 2017. We transformed the price series into natural logarithm to avoid heteroscedasticity problem. And, we employed econometric tools to achieve the objective namely unit root test, cointegration test, VECM, Breusch-Godfrey, CUSUM and Causality Test.

IV. DATA ANALYSIS

Unit Root Test

The statistical nature of non-stationary is mean, variance and covariance changing over the period. Usually financial series are non-stationary at their level because of his nature. If any analysis carried out with non-stationary data it may lead us to the unreliable or spurious outcome. So, we employed the Augmented Dickey-Fuller (ADF) and Phillips Perron (PP) test to find out the stationarity and also the level of integration by the following regression equation.

Augmented Dickey-Fuller (ADF):

We considered the following equation for the ADF unit root test.

$$\Delta Y_t = a_0 + a_1 time + \rho_0 Y_{t-1} + \sum_{i=1}^{k} \rho_i \Delta Y_{t-i} + \varepsilon_t$$

Here $a_0, a_1, \rho_0 and\ \rho_i$ are the parameters, Where Y_t= price at time, a_0 is a constant, ρ_0 the coefficient on time, ρ the lag order of the autoregressive process, ε_t is a white noise error and ΔY_{t-1}= $(Y_{t-1} - Y_{t-2})$, $\Delta\ Y_{t-2}$= $(Y_{t-2} - Y_{t-3})$, etc. MacKinnon's prescribed critical values are used to find the significance level with $\rho_0\ (\rho_0 = p - 1)$. The ADF tests the null hypothesis of H0: p =1 against the alternative hypothesis (one-sided) of H1: p<1. If the test statistic value is more negative, it provide strong evidence to accept the alternative hypothesis (no unit root or no random work).

(a) Phillips Perron (PP):

The following equation is used for the PP Regression

$$X_i = \alpha_0 + \alpha X_{t-1} + \mu_t$$

Where, μ_t is the error term. the null hypothesis is (Ho:α=1) denoted by t_d, is adjusted non parametrically to account for possible serial correlation in μ_t

Table2: Results of Unit Root Test

Particular	Spot Price				Future Price				Order of Integration
	Level		First Difference		Level		First Difference		
	T-Statistic	Prob.	T-Statistic	Prob.	T-Statistic	Prob.	T-Statistic	Prob.	
ADF test	-1.866	0.672	-32.000	0.000	-2.174	0.503	-37.642	0.000	I(1)
PP Test	-2.275	0.447	-33.010	0.000	-2.224	0.475	-37.647	0.000	I(1)

The result of unit root has shown in the table 2. Both ADF and PP test reveals that spot and futures prices are non-stationary at level. To avoid spurious relationship, we transformed the both price into first differences. Then, we extended our test with first differences series. Finally, we found spot and futures prices are stationary at first differences and also integrated of first order I (1).

Johansen's cointegration test

After finding the order to integration, the next step is cointegration relationship among the variable by the following Vector Auto Regression (VAR) equation

$$y_t = \mu + A_1 y_{t-1} + ... + A_p y_{t-p} + \varepsilon_t$$

Where y_t is an nx1 variable vector of order one or non-stationary I(1) and ε_t is an *n*x1 innovation vector. The equation is rewritten as a vector auto regression (VAR) as follows:

$$\Delta y_t = \mu + \prod y_{t-1} + \sum_{t=1}^{p-1} \Gamma_i \Delta y_{t-1} + \varepsilon_t$$

Where

$\Pi = \sum_{i=1}^{p} A_i - I$

$\Gamma_i = \sum_{j=i+1}^{p} A_j$

The coefficient framework matrix of $\prod$ has rank r<*n*, at that point there, occurs *n x r* grids α and β and both have a rank (r) in such a technique, that $\prod = \alpha\beta^{/} and\ \beta^{/} y_t$ is stationary. *R* specifies the no. of cointegration, α is the adjustment parameter in VECM and β stand for the cointegrating vector. We evaluate the $\prod$ coefficient framework from an unrestricted VAR model and tried to terminate the limits implied by the decreased rank of $\prod$ using two Likelihood ratio namely the trace statistic and the maximal eigenvalue statistic.

$$\lambda_{Trace} = -T \sum_{i=r+1} log\,(1-\lambda_i)$$

$$\lambda_{Max} = -T\,log(1-\lambda_{r+1})$$

Where sample size is T and $\hat{\lambda}_I$ is the i^{th} eigenvalue. We used test hypothesis (null) of r co-integrating vectors against alternative of r+1 co-integrating vectors. Accordingly, the null hypothesis r = 0 is verified against above mentioned alternative hypothesis of r = 1 and against extended alternative of r = 2 and so forth.

Table3: Results of Lag Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	3868.163	NA	5.78E-06	-6.385075	-6.376654	-6.381904
1	7613.478	7472.073	1.20E-08	-12.56396	-12.5387	-12.55445
2	7651.149	75.03246	1.13E-08	-12.61957	-12.57746*	-12.60372*
3	7653.481	4.636619	1.14E-08	-12.61681	-12.55786	-12.59462
4	7656.994	6.974091	1.14E-08	-12.61601	-12.54022	-12.58747
5	7663.934	13.75349*	1.13e-08*	-12.62087*	-12.52823	-12.58599
6	7665.308	2.719062	1.14E-08	-12.61653	-12.50705	-12.57531
7	7665.896	1.160181	1.14E-08	-12.61089	-12.48457	-12.56333
8	7669.445	6.998937	1.14E-08	-12.61015	-12.46698	-12.55624

Table4: Results of Johansen Cointegration Test

Null Hypothesis	λ_{trace}	Prob.	λ_{max}	Prob.	Decision
r = 0	49.6019	0.0000	43.6558	0.0000	Indicates One Co-Integration
r<=1	5.9461	0.4672	5.9461	0.4672	

Table 4 shows the Results of Johansen Cointegration test between spot and futures prices. The lag length for Johansen Cointegration was tested with the different Lag Selection Criteria. Three out of five Lag Selection Criteria models prescribed lag 5 for optimal lag length. The test statistic of Trace and Maximum Eigenvalue confirmed the presence of a long run relationship between spot and futures prices. Cotton market is having one cointegration equation at 1 percent level of significance, it indicates that they sharing the information for the longer period.

Vector Error Correction Model (VECM)

VECM is also known as restricted VAR model because it was designed for non-stationarity series (at level) it means we can perform the VECM model only on cointegrated series. If series are cointegrated then error correction or mean reverting process will exist at least from one direction. We tried to find the error correction or mean reverting by the following equation.

$$\Delta S_t = \alpha_s + \sum_{i=1}^{n} \beta_{si}\,\Delta S_{t-i} + \sum_{i=1}^{n} \theta_{si}\,\Delta F_{t-i} + \gamma_s Z_{t-1} + \varepsilon_{st}$$

$$\Delta F_t = \alpha_f + \sum_{i=1}^{n} \beta_{fi}\,\Delta S_{t-i} + \sum_{i=1}^{n} \theta_{fi}\,\Delta F_{t-i} + \gamma_f Z_{t-1} + \varepsilon_{ft}$$

Table5: Results of Vector Error Correction Model

Particular	SR	FR
C	5.01e-05	5.92e-05
	[0.17275]	[0.15020]
SR (-1)	-0.041996	0.085885
	[-1.10871]	[1.66786]
SR (-2)	0.027528	0.081837
	[0.72793]	[1.59185]
SR (-3)	0.087662	0.088458

	[2.33080]	[1.73010]
SR (-4)	0.101155	0.115822
	[2.70885]	[2.28153]
SR (-5)	0.003511	0.06142
	[0.09909]	[1.27488]
FR (-1)	0.123354	-0.120034
	[4.13645]	[-2.96084]
FR (-2)	0.00755	-0.060582
	[0.24913]	[-1.47041]
FR (-3)	-0.029561	-0.065737
	[-0.98164]	[-1.60579]
FR (-4)	-0.049895	-0.112084
	[-1.67537]	[-2.76844]
FR (-5)	-0.000377	-0.033055
	[-0.01328]	[-0.85714]
Z_{t-1}	-0.066123	0.013692
	[-4.53589]	[0.69089]

Note: SR- Spot Return, FR-Futures Return, and T-statistics in [ ]

Table6: Breusch Godfrey Test

F-statistic	0.022771	Prob. F(1,1200)	0.8801
Obs*R-squared	0.023017	Prob. Chi-Square(1)	0.8794

Figure2: CUSUM Test

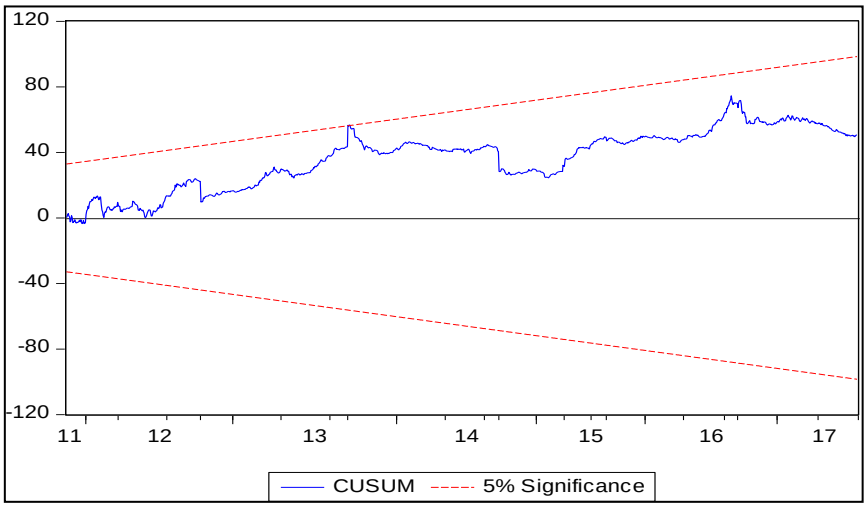


Table 5 shows the result of VECM, Only spot return ECM is found to be significant and negative whereas in future return ECM is insignificant. Therefore, we concluded that spot return ECM is responded to the mean reverting process and also we found causality relationship from future return to spot return it means future market leads the spot market. Futures return makes 6 percent adjustment towards its reestablished equilibrium position. The diagnostic test of Breusch-Godfrey confirms that absence of serial correlation and CUSUM test reveals the satisfied stability of parameter.

Granger Causality Test

To find out the information flow between spot and futures market, we used Granger causality technique which is proposed by the Granger (1969). If the variables are cointegrated, then causality relationship exist at least from one direction.

$$\Delta Y_t = \alpha_0 + \sum_{i=1}^{k} \alpha_i \Delta Y_{t-i} + \sum_{j=1}^{k} \beta_j \Delta X_{t-j} + \mu_{Yt}$$

$$\Delta X_t = \alpha_0 + \sum_{i=1}^{k} \alpha_i \Delta Y_{t-i} + \sum_{j=1}^{k} \delta_j \Delta X_{t-j} + \mu_{Xt}$$

$$H_{0a}: \beta_1=\beta_2=\ldots=\beta_k= 0$$
$$H_{0b}: \alpha_1=\alpha_2=\ldots=\alpha_k= 0$$

i. If $H_{0b}$is rejected and H_{0a} accepted, it indicated the Uni-Directional flow from 'Y' to 'X
ii. If $H_{0b}$is accepted and H_{0a} rejected, it indicated the Uni-Directional flow from 'X' to 'Y
iii. If both H_{0b} and H_{0a} are rejected, it indicated the Bi-Directional flow between 'X' to 'Y
iv. If H_{0b} H_{0a} are accepted, it indicated No Causality flow between 'X' to 'Y

Table7: Results of Granger Causality Test

Lag	Null Hypothesis	F-Statistic	Prob.	Result	Direction	Information Flow
1	$\Delta FP \nRightarrow \Delta SP$	34.3549	0.0000	Accepted	$FP \rightarrow SP$	Uni-Directional
	$\Delta SP \nRightarrow \Delta FP$	2.40754	0.1210	Rejected		
2	$\Delta FP \nRightarrow \Delta SP$	18.9264	0.0000	Accepted	$FP \rightarrow SP$	Uni-Directional
	$\Delta SP \nRightarrow \Delta FP$	2.30652	0.1000	Rejected		
3	$\Delta FP \nRightarrow \Delta SP$	12.7847	0.0000	Accepted	$FP \rightarrow SP$	Uni-Directional
	$\Delta SP \nRightarrow \Delta FP$	2.06329	0.1033	Rejected		
4	$\Delta FP \nRightarrow \Delta SP$	10.1031	0.0000	Accepted	$FP \leftrightarrow SP$	Bi-Directional
	$\Delta SP \nRightarrow \Delta FP$	3.40823	0.0088	Accepted		
5	$\Delta FP \nRightarrow \Delta SP$	8.22617	0.0000	Accepted	$FP \leftrightarrow SP$	Bi-Directional
	$\Delta SP \nRightarrow \Delta FP$	2.95658	0.0117	Accepted		

Note: $\nRightarrow$ *does not Granger Cause*

The result of Granger Causality Test is reported in the table 7. It shows that future return is lead the spot return in all lags it indicated futures market is more efficient than spot market because of Lower transaction costs and margin, higher liquidity facility, comfort leverage positions, rapid implementation, and short positions flexibility. And spot return also lead the future return after three lags it means market participant getting spot information delay of three lags.

V. CONCLUSION

The present study was conducted to investigate the information flow and causality relationship between spot and futures market for cotton commodity using daily closing price from 2011 to 2017 through Johansen's cointegration test, VECM and Granger Causality Test. The study confirms the co-movement and long-run relationship between spot and future market by Johansen's cointegration test. VECM found evidence that only spot return is responded to the mean reverting process because Futures return makes 6 percent adjustment towards its reestablished equilibrium market position. Granger Causality Test found that futures market is more efficient than spot market in all lags.

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