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Co-integration of Cotton Prices in Indian Markets

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Abstract

The present study analyses the co-integration of cotton prices in seven major cotton producing states of India. Seven important markets of country, one each from the selected states were chosen on the basis of annual market arrivals of cotton. Price transmission and spatial integration of sample cotton markets were analyzed through employing various statistical/econometric techniques viz. correlation analysis, Johansen Methodology, Granger Causality Test and Vector Error Correction Model (VECM). The analysis showed that the cotton prices in different markets at national level moved together and were well integrated, however integration was stronger in case of closely situated markets as compared to those situated at long distances. Out of the seven sample markets, four were found to be having short run equilibrium and in most of the markets, the cotton prices were being influenced by their own lagged prices as well as the current and lagged prices of other cotton markets.

Keywords: *Cotton, Market integration, India*

JEL Classification: *Q1, Q11*

Introduction

Cotton is a perennial shrub that has been cultivated by man for several thousand years. This crop is also known as 'white gold' and enjoys a predominant position amongst all cash crops in India. It is an important raw material for Indian textile industry, constituting about 65 per cent of its requirements (Ajjan *et al*, 2012). The important cotton growing countries of the world are China, India, United States of America (USA), Pakistan, Brazil, Uzbekistan and Australia. World cotton trade is largely defined by its two dominant participants: China for imports and the USA for exports. Each of both countries accounts for about 40 per cent of world trade, and China's share is rising overtime. India has progressed substantially in improving both production and productivity of cotton in the recent years, transforming from a net importer of cotton to becoming one of the largest exporters, shipping 5.5 million bales in 2010-11, second only to the USA. It is estimated that more than 5.8 million farmers cultivate cotton in India and about 40-50 million people are employed directly or indirectly by the cotton industry (Prasad *et al*, 2012).

Agricultural prices have enormous economic implications since it is an important signal of marketing system. There are several impediments to the efficient functioning of any market in a developing economy like India (Beag and Singla, 2014). Market imperfections, appropriate marketing policies, government intervention and determinants of marketing efficiency had always remained major debatable issues. In case of cotton, there are considerable seasonal as well as regional price variations. Violent price fluctuations in cotton prices were frequently observed not only from year to year but also during the same marketing period. Government export-import policy and international price has major impact on the ruling cotton prices in country. Variations in stocks, open market operations, zonal restrictions, price fixation and procurement operations are the other factors having significant impact on cotton prices and

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price fluctuations as well as the overall market performance. The study of market integration is one of the ways to analyze the market performance (Mukhtar and Javed, 2007). The market integration can be measured in terms of strength and speed of price transmission between markets across various regions of the country (Ghafoor *et al*, 2009). The degree to which consumers and producers would benefit depends on how domestic markets are integrated with world markets and how different regional markets are integrated with each other (Varela *et al*, 2012). Even though regional markets are geographically dispersed, prices across different market centers within and across states have exhibited long-run spatial linkages, suggesting that all the exchange locations are integrated and that prices provide relevant market signals. There are, however, regional variations in the extent of market integration, which could be due to regional disparities in infrastructure and the institutional structure of agricultural markets (Ghosh 2010; Ghosh, 2013). Thus, it is very important to quantify the spatial integration among major markets in the country as the results will have important implications for agricultural price policy. The present study is thus, an attempt to investigate the co-integration of cotton markets in India.

Data Sources and Methodology

The study was undertaken on a macro framework based on secondary data. To meet the objectives of this study, the time series data regarding weekly/monthly cotton prices and arrivals in the major markets from 2005 to 2015 were collected from various secondary sources like Agmark.net, www.cotcorp.gov.in, www.indiastat.com, www.fao.org, www.agmarknet.nic.in, www.usda.gov etc.

The study was carried out in the leading cotton producing states of India. Which were selected on the basis of their share in total production in the country. The selected states of Gujarat, Maharashtra, Andhra Pradesh, Haryana, Punjab and Madhya Pradesh accounted for 29.43, 22.49, 18.23, 7.07, 5.95 and 5.63 per cent respectively of national cotton production during TE 2013-14. Overall, the selected states accounted for 88.8 per cent of total production of cotton in the country. From each selected state, based upon cotton market arrivals and data availability, at least one important market was taken for the study. The selected markets at national level were Adoni (Andhra Pradesh), Adilabad (Telangana or erstwhile Andhra Pradesh), Akot (Maharashtra), Rajkot (Gujarat), Sendhwa (Madhya Pradesh), Abohar (Punjab) and Sirsa (Haryana).

Analysis of data

Market integration is central to design of any agricultural policy in many developing countries and has been an important area of agricultural market research. Cotton price transmission and spatial integration of cotton markets were analyzed through employing statistical/econometric techniques viz. correlation analysis, Johansen Methodology, Granger Causality Test and Vector Error Correction Model (VECM). The details in this regard are as following:

Correlation analysis

One simple way to study market integration is to consider the correlation of price series for different markets. Correlation coefficient is a measure of degree of linear association between two variables. Karl-Pearson's correlation coefficient (r) used to analyze integration of price series in pair of cotton markets (X and Y) was estimated as follow:

$$r(X,Y) = \frac{Cov\ (XY)}{\sqrt{Var\ (x), Var\ (y)}}$$

To test the significance of correlation coefficient ®, t-test was used with Null Hypothesis (H0): þ = 0 and Alternate Hypothesis (H1): þ 0 as following:

$$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}} \sim t \text{ (n-2) degrees of freedom}$$

Stationarity of the time series

Markets are considered to be integrated when long term equilibrium exists between them. However, price series need to be stationary to establish such relationship. In the absence of stationarity, the estimated relationship may be spurious without any significant meaning. The relationship is expected to hold good when price series are found stationary at the same level of differencing. The price-series in different markets were checked for stationarity by using Augmented Dickey-Fuller (ADF) unit root test. If the data generating process at levels is following a unit root and therefore non-stationary, then the data has to be transformed into first differences and the unit root test has to be repeated. The test was applied after running regression of the following form:

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \sum_{i=1}^{m} a_i \Delta Y_{t-i} + \varepsilon$$

Where,

Y_t = Price of cotton in a given market at time t

Y_t = Y_t - Y_{t-1}

ε = Pure white noise error term
m = Optimal lag value which is selected on the basis of Schwartz Information Criterion (SIC) and Akaike Information Criterion (AIC).

To test for a unit root in the price series accepting the null hypothesis i.e., $\delta=0$ indicates that time series is non stationary. While rejection of null hypothesis and acceptance of the alternative hypothesis i.e., <0 indicates that the time series is stationary.

Cointegration test

Cointegration explains the extent of deviation from the long run equilibrium relationship by the non-stationary series. In fact, cointegration is the link between integrated processes and steady state equilibrium and hence provides the relevant theoretical framework for analyzing dynamics of instantaneous changes in a pair of series along with their valuable long run information. Once it was confirmed that all of the price-series were stationary at the level or at same order of differences, the long run co-integration of markets were tested by Johansen maximum-likelihood techniques (Johansen and Juselius, 1990) Maximum likelihood ratio test statistics are proposed to test number of cointegrating vectors. The null hypothesis of atmost 'r' cointegrating vectors against a general alternative hypothesis of more than 'r' cointegrating vectors is tested by trace statistics. Similarly, the null hypothesis of 'r' cointegrating vector against the alternative hypothesis of 'r+1' is tested by Maximum-Eigen-Value-Statistic. The number of cointegrating vectors indicated by the tests is an important indicator of the extent of co-movement of prices. An increase in the number of co-integrating vectors implies an increase in the strength and stability of price linkages.

Granger Causality Test

The causal relationship between the price series in cotton markets were approached through Granger's causality technique. The Granger causality test conducted within the framework of a Vector Auto Regressive (VAR) model was used to test the existence and direction of long-run causal price relationship between the markets. An Autoregressive Distributed Lag (ADL) model for the Granger-causality test was specified as below 2:

$$X_1 = \sum_{i=1}^{m} a_i Y_{t-i} + \sum_{j=1}^{m} \beta_i X_{t-j} + u_{1t}$$
$$Y_1 = \sum_{i=1}^{n} \lambda_i Y_{t-i} + \sum_{j=1}^{n} \delta_i X_{t-j} + u_{2t}$$

Where, X and Y are the prices series of different markets, t is the time period and, u_{1t} and u_{2t} are the error terms,

Error Correction Method (ECM)

If the series are stationary at first difference then one could run regressions in their first differences. However, by taking first differences, the long run relationship that is stored in data being lost. This implies that one needs to use variables in levels as well. The Error Correction Methodology (ECM) incorporates variables both at their level and first differences. By doing this, ECM captures short run disequilibrium situations as well as long run equilibrium adjustments between the prices. A generalized ECM formulation estimating both short run and long run transmission of cotton prices in different market through taking the autoregressive distributed lag equation is as following 2:

$$Y_1 = \alpha_{01} X_t + a_{11} X_{t-1} + a_{12} Y_{t-1} + \varepsilon_t$$
$$\Delta Y_t = a_0 \Delta X_t + (1 - a_{12}) \left[\frac{(a_{01} + a_{11})}{(1 - a_{12})} X_{t-1} - Y_{t-1} \right] + \varepsilon_1$$

The generalized form of this equation for k lags and an intercept term is as follows:

$$\Delta Y_t = a_{00} + \sum_{i=0}^{k-1} a_{i1} \Delta X_{t-i} + \sum_{i=0}^{k-1} a_{i2} \Delta Y_{t-i} + m_0 [m_1 X_{t-k} - Y_{t-k}] + \varepsilon_t$$

Where,
$$m_0 = (1 - \sum_{i=0}^{k} ai_2)$$
$$m_1 = \sum_{i=0}^{k} ai_1 / m_0$$

The parameters m_0 measures the rate of adjustment of the short-run deviations towards the long run equilibrium. Theoretically, this parameter lies between 0 and 1. The value 0 denotes no adjustment and 1 indicates an instantaneous adjustment. A value between 0 and 1 indicates that any deviations will have gradual adjustment to the long-run equilibrium values. For the present analysis, Johansen's Vector Error Correction Model (VECM) has been used. It permits the testing of cointegration as a system of equations in one step. Another advantage of this approach is that we do not need to carry over an error term from one step into the rest. In addition, it does not require the prior assumption of endogeneity or exogeneity of the variables.

Results and Discussion

The extent to which prices in spatially separated markets move together reflect the degree of integration. The results on integration of cotton markets analyzed through correlation analysis, Johansen Methodology, Granger Causality Test and VECM are discussed hereafter.

Correlation analysis

Price in one market varies with the actions of buyer and seller in other markets. The degree to which price formation in one market is related to the process of price formation in other markets can be shown through a zero-order correlation matrix. The approach presumes that with random price behaviour expected in non-integrated market, the bi-variate correlation coefficient of price movements will tend to be zero. Conversely in a perfectly integrated market, correlation coefficient of price movements is expected to unity. The results pertaining to correlation analysis of monthly prices of cotton in major markets are presented Table 1.

It is clearly evident from the analysis that the correlation coefficients of cotton prices between different pairs of markets at national level were highly significant at one per cent level. Among selected cotton markets at national level, the correlation coefficients (r) ranged from 0.82 to 0.95. The r-value was highest of the order of 0.95 between Abohar and Sirsa markets. The high coefficient was due to the close proximity of these two markets. The r-value was 0.92 between the cotton markets of Adoni and Rajkot followed by 0.91 between Sendhwa and Adoni, 0.90 between Rajkot and Sendhwa and 0.90 between Adilabad and Adoni markets. The r-value was 0.89 for the market pairs Abohar-Rajkot, Adilabad-Akot and Adilabad-Sendhwa. The r-value was 0.88 between market pairs Ailabad-Rajkot and Rajkot-Sirsa. The r-value between the cotton market pairs with long distances like Abohar-Adoni and Akot-Sirsa was relatively low at 0.87 and 0.82 respectively. Overall the result of correlation analysis showed that the prices in cotton markets moved together and were well integrated at national level. However, integration was stronger in case of closely situated markets as compared to that having long distances between them.

Augmented Dickey-Fuller test (ADF)

As correlation analysis provide only rough estimates on price movements, the weekly time series data on cotton prices from 2005 to 2015 in different selected markets has been used to study the integration of markets at national level through using advanced econometric techniques like Johansen Co-integration Test, Granger Causality Test and Vector Error Correction Model. To avoid spurious results there is a need to check whether the variables are stationary or not. Therefore, it is necessary to examine the time series properties of the variables. Further to establish the long-run equilibrium relation among the price series, it is necessary to cointegrate them. Cointegration among the variables in turn requires checking the order of integration among the variables and variables cannot be integrated in the presence of unit root, the same can be examined through conducting a stationarity test.

The Augmented Dickey Fuller (ADF) based unit root test procedure was applied to check whether the price series of cotton are stationary at their level, followed by their differences. The results presented in Table 2 indicate that ADF test values for cotton price series for all the markets except Abohar (Punjab) were less than the critical value given by MacKinnon statistical tables at level implying the existence of unit root. At first difference, the ADF values for cotton price series of Abohar (Punjab), Adilabad (Andhra Pradesh), Adoni (Andhra Pradesh), Akot (Maharashtra), Rajkot (Gujarat), Sendhwa (Madhya Pradesh) and Sirsa (Haryana) were more than critical value indicating that these series were stationary and free from consequences of unit root at their first differences.

Table 1. Correlation coefficients of monthly cotton prices in different markets of India

Markets	Abohar	Adilabad	Akot	Adoni	Rajkot	Sendhwa	Sirsa
Abohar	1.00*						
Adilabad	0.86*	1.00*					
Akot	0.83*	0.90*	1.00*				
Adoni	0.87*	0.90*	0.84*	1.00*			
Rajkot	0.90*	0.89*	0.84*	0.92*	1.00*		
Sendhwa	0.86*	0.89*	0.85*	0.91*	0.90*	1.00*	
Sirsa	0.95*	0.83*	0.82*	0.85*	0.89*	0.85*	1.00*

**Significant at one per cent level*

Table 2. Results of Augmented Dickey-Fuller (ADF) test

Markets	At level	Stationarity	At first difference	Stationarity	Critical values (at 1% level)
Abohar	-6.520	Stationary	-10.786	Stationary	-4.066
Akot	-4.008	Non-stationary	-8.492	-do-	
Adilabad	-3.325	-do-	-10.341	-do-	
Adoni	-3.209	-do-	-11.747	-do-	
Sendhwa	3.793	-do-	-13.070	-do-	
Rajkot	-3.477	-do-	-7.806	-do-	
Sirsa	-3.182	-do-	-10.501	-do-	

Johansen Co-integration Test

The integration among national cotton markets was analyzed by applying the Johansen multiple co-integration procedure and the estimated results are presented in Table 3. Unrestricted co-integration rank tests (Trace and Maximum Eigen Value) indicated the presence of at least 7 co-integrating equations at 5 per cent level of significance. This indicated that cotton prices in markets of major producing states of country were having long run equilibrium relationship.

Granger Causality Test

The results of causal relationship between the prices series in major national cotton markets approached through Granger Causality technique are presented in Table 4. Among the selected national cotton markets, the cotton price in Adilabad market showed bidirectional causality in price transmission with cotton price of Akot, Rajkot, and Sirsa markets and it had a unidirectional impact on the cotton prices of Abohar, Adoni and Sendhwa markets. The Akot cotton market revealed bidirectional causality with the Adoni, Rajkot, Sendhwa and Sirsa markets and it had also influenced the cotton prices of the Abohar market in one way. The cotton price in Adoni market while showed bidirectional causality in price transmission with the selected markets of Rajkot, Sendhwa and Sirsa, it had also influenced the prices of Abohar market in one way. The Adoni market itself was influenced by prices of Adilabad market in a unidirectional manner. The cotton price in Rajkot market exhibited bidirectional causality with the prices of Sirsa market in price transmission along with its unidirectional relationship with Sendhwa and Abohar markets. While Sendhwa market had unidirectionally influenced the price of Sirsa market and Abohar market, cotton prices

Table 3. Results of Johansen co-integration test

Hypothesized No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.214	363.985	150.558	0.000
At most 1 *	0.196	278.087	117.708	0.000
At most 2 *	0.180	200.039	88.803	0.000
At most 3 *	0.124	128.960	63.876	0.000
At most 4 *	0.098	81.652	42.915	0.000
At most 5 *	0.078	44.569	25.872	0.000
At most 6 *	0.0423	15.546	12.518	0.015

Note: *Price series: Abohar, Adilabad, Adoni, Akot, Rajkot, Sendhwa and Sirsa; Number of observations: 358 after adjustments; Trend assumption: Linear deterministic trend (restricted); Lags interval (in first differences): 1 to 3*
**denotes rejection of the hypothesis at the 0.05 level*
***Mackinnon-Haug-Michelis (1999) p-values*

Table 4. Results of Granger causality test

Null Hypothesis:	Observations	F-Statistic
ADL does not Granger Cause ABH	358	25.477*
ABH does not Granger Cause ADL		0.887
AKT does not Granger Cause ABH	358	29.492*
ABH does not Granger Cause AKT		2.410**
ADN does not Granger Cause ABH	358	28.557*
ABH does not Granger Cause ADN		0.102
RAJ does not Granger Cause ABH	358	27.787*
ABH does not Granger Cause RAJ		2.073
SEN does not Granger Cause ABH	358	30.604*
ABH does not Granger Cause SEN		0.681
SIR does not Granger Cause ABH	358	28.759*
ABH does not Granger Cause SIR		0.220
AKT does not Granger Cause ADL	358	104.181*
ADL does not Granger Cause AKT		7.749*
ADN does not Granger Cause ADL	358	1.509**
ADL does not Granger Cause ADN		7.104*
RAJ does not Granger Cause ADL	358	51.507*
ADL does not Granger Cause RAJ		4.3868
SEN does not Granger Cause ADL	358	1.630**
ADL does not Granger Cause SEN		71.907*
SIR does not Granger Cause ADL	358	36.755*
ADL does not Granger Cause SIR		8.987*
ADN does not Granger Cause AKT	358	4.410*
AKT does not Granger Cause ADN		67.299*
RAJ does not Granger Cause AKT	358	6.550*
AKT does not Granger Cause RAJ		17.914*
SEN does not Granger Cause AKT	358	13.473*
AKT does not Granger Cause SEN		27.922*
SIR does not Granger Cause AKT	358	8.615*
AKT does not Granger Cause SIR		17.188*
RAJ does not Granger Cause AND	358	47.581*
ADN does not Granger Cause RAJ		4.307*
SEN does not Granger Cause AND	358	48.578*
ADN does not Granger Cause SEN		4.538*
SIR does not Granger Cause AND	358	28.991*
ADN does not Granger Cause SIR		6.090*
SEN does not Granger Cause RAJ	358	1.591**
RAJ does not Granger Cause SEN		15.017*
SIR does not Granger Cause RAJ	358	8.463*
RAJ does not Granger Cause SIR		13.393*
SIR does not Granger Cause SEN	358	28.104*
SEN does not Granger Cause SIR		16.250*

(Price series: ABH-Abohar, ADL-Adilabad, AKT-Akot, ADN-Adoni, RAJ-Rajkot, SEN-Sendhwa, SIR-Sirsa)
$^*p<0.05$, $^{**}p<0.1$

in Sendhwa has been influenced by the markets of Rajkot and Adilabad in unidirectional manner. The cotton price in Sirsa market showed unidirectional causality in price transmission with cotton market of Abohar.

The results reveals that the Adilabad market influenced the prices of most of the selected cotton markets in unidirectional manner at national level except Akot, Rajkot and Sirsa markets with which it exhibited bidirectional causality relationship. So Adilabad market can be considered as lead cotton market among all the selected markets taken for the study. Rajkot cotton market was the second most important cotton market in influencing the other cotton markets in unidirectional way.

Vector Error Correction Model

Since the national cotton markets are integrated in the long run, it is important to study the short run and long run equilibrium among the markets. Vector Error Correction Model (VECM) was employed to know the speed of adjustments among the markets for long run equilibrium among the major markets of country and results on error correction terms has been presented in Table 5. The number of lags in the VECM was taken to be two as the Akaike Information Criterion (AIC) was lowest at this order (2) in the system for all the seven selected cotton markets i.e., Abohar, Adilabad, Akot, Adoni, Rajkot, Sendhwa and Sirsa. The error correction term indicates the speed of adjustment among the variable before converging to equilibrium in the dynamic model. The results of error correction terms were interpreted in order to study the nature of market (stable/unstable/random), endogeneity and the movement towards the long run equilibrium, i.e., efficiency of the market. Thereafter, the short-term causality in the prices of selected markets included in the system, i.e., which market impacts the price of other market was also explained.

Table 5 reveals that in case of Abohar, the sign of the first co-integrating vector of normalized co-integrating coefficients was negative which indicated the stability of short run price movements. The coefficients of the error correction terms indicate the speed of convergence to the long run equilibrium rate of growth to a shock in their own prices. The estimated error correction coefficient indicated that about 22 per cent adjustment towards long run equilibrium in the case of Abohar market occurs in one week. The results indicated that cotton prices in Abohar market were affected by the prices in Adoni market with lag of two weeks as well as that of Rajkot prices with one and two week lags. For Adilabad market, the negative and significant first co-integrating vector of normalized co-integrating coefficient implied the presence of stable short run price movements and about 43 per cent adjustment towards long run equilibrium rate of growth occurred in one week. The chi square value of Wald test was significant for the markets of Akot, Adoni and Rajkot which indicate the existence of short run equilibrium with Adilabad market or in other words the cotton price in Adilabad market was influenced by the lagged prices of Adoni, Akot and Rjkot market. The Akot cotton market also exhibited the long run equilibrium with the other selected cotton markets at national level to an extent of 7 per cent. The negative sign implied that the short run price movements were stable in Akot market. The significance of error correction terms for Rajkot and Sendhwa markets indicated the presence of short run equilibrium of these markets with Akot market. The positive and significant coefficient of first co-integrating vector of normalized co-integrating for Adoni market indicated the divergence of cotton prices in long run. The results indicated that that price movements in Adoni were random and the speed of adjustment towards long run equilibrium was slow. However, the chi square value of wald test were significant for the markets of Adilabad, Akot, and Rajkot which indicated the existence of short run equilibrium with Adoni market. In Rajkot, the first co-integrating vector of normalized co-integrating coefficient was found to be negative which implies that the short run price movements were stable and prices converged to equilibrium in long run. The chi square values of Wald test for both one and two lag variables were significant for Akot, Sendhwa and Sirsa markets which indicated the presence of short run equilibrium of these markets with the Rajkot market. For Sendhwa and Sirsa markets, the first co-integrating vector of normalized co-integrating coefficients were found to be non-significant which implies the absence of long run equilibrium in these markets with the other selected cotton markets. The Wald test conducted for both one and two lag variables of all the selected cotton markets at national level indicated the existence of short run equilibrium among Adilabad, Akot and Sirsa with Sendhwa market. Similarly, Adilabad, Rajkot and Sendwha markets were found to be in short run equilibrium with the Sirsa market.

Conclusion and Policy Implications

The results of various analytical techniques revealed that cotton price in major cotton producing states of India were fairly integrated. The correlation analysis showed that cotton prices in different markets at national

Table 5. Results of vector error correction model

Particulars	D(ABH)	D(ADL)	D(AKT)	D(ADN)	D(RAJ)	D(SEN)	D(SIR)
CointEq1	-0.218	-0.437	-0.065	0.070	-0.120	-0.033	-0.002
	-0.032	-0.073	-0.022	-0.021	-0.034	-0.048	-0.011
	[-6.806]	**[-5.999]**	**[2.928]**	**[3.401]**	**[-3.805]**	[-0.682]	[-0.144]
D(ABH(-1))	0.086	0.032	-0.001	0.007	0.007	-0.009	0.011
	-0.058	-0.029	-0.022	-0.030	-0.015	-0.022	-0.019
	[1.491]	[1.081]	[-0.060]	[0.231]	[0.424]	[-0.415]	[0.594]
D(ABH(-2))	0.082	0.051	0.032	0.027	0.024	0.008	0.008
	-0.057	-0.029	-0.021	-0.029	-0.015	-0.021	-0.019
	[1.450]	[1.774]	[1.476]	[0.921]	[1.591]	[0.379]	[0.449]
D(ADL(-1))	0.148	-0.188	-0.088	0.102	-0.033	-0.251	-0.167
	-0.206	-0.104	-0.077	-0.0706	-0.055	-0.077	-0.067
	[0.719]	[-1.803]	[-1.137]	**[1.985]**	[-0.593]	**[-3.238]**	**[-2.488]**
D(ADL(-2))	0.316	-0.005	-0.014	0.053	0.012	-0.205	0.010
	-0.192	-0.097	-0.072	-0.099	-0.051	-0.072	-0.063
	[1.647]	[-0.051]	[-0.191]	[0.539]	[0.242]	**[-2.838]**	[0.161]
D(AKT(-1))	-0.185	0.239	-0.135	0.208	0.109	0.242	-0.006
	-0.180	-0.091	-0.068	-0.092	-0.048	-0.068	-0.059
	[-1.030]	**[2.616]**	[-1.993]	**[2.247]**	**[2.265]**	**[3.569]**	[-0.102]
D(AKT(-2))	0.176	0.412	-0.080	0.444	0.133	0.175	0.082
	-0.179	-0.091	-0.068	-0.092	-0.048	-0.067	-0.059
	[0.981]	**[4.531]**	[-1.184]	**[4.822]**	**[2.782]**	**[2.593]**	[1.393]
D(ADN(-1))	-0.448	-0.443	-0.048	-0.690	-0.052	-0.006	0.071
	-0.196	-0.100	-0.074	-0.101	-0.053	-0.074	-0.064
	[-2.283]	**[-4.449]**	[-0.649]	[-6.852]	[-0.986]	[-0.079]	[1.112]
D(ADN(-2))	-0.483	-0.341	-0.086	-0.429	-0.065	0.058	-0.008
	-0.199	-0.101	-0.075	-0.102	-0.053	-0.075	-0.065
	[-2.427]	**[-3.377]**	[-1.147]	[-4.202]	[-1.217]	[0.780]	[-0.124]
D(RAJ(-1))	0.582	0.371	0.258	0.361	-0.035	0.097	0.231
	-0.244	-0.124	-0.092	-0.125	-0.065	-0.092	-0.080
	[2.386]	**[2.998]**	**[2.807]**	**[2.883]**	[-0.532]	[1.058]	**[2.900]**
D(RAJ(-2))	0.026	0.188	0.082	-0.006	-0.074	-0.054	-0.105
	-0.242	-0.123	-0.091	-0.124	-0.065	-0.091	-0.079
	[0.107]	[1.530]	[0.896]	[-0.045]	[-1.146]	[-0.597]	[-1.319]
D(SEN(-1))	-0.245	0.090	0.191	0.161	0.109	-0.019	0.143
	-0.186	-0.094	-0.070	-0.095	-0.050	-0.070	-0.061
	[-1.319]	[0.956]	**[2.726]**	[1.684]	**[2.195]**	[-0.275]	**[2.355]**
D(SEN(-2))	-0.277	-0.064	0.066	0.049	0.047	0.003	0.030
	-0.175	-0.089	-0.066	-0.090	-0.047	-0.066	-0.057
	[-1.588]	[-0.725]	[1.000]	[0.548]	[1.009]	[0.053]	[0.529]
D(SIR(-1))	-0.028	0.127	-0.043	0.152	0.068	0.254	-0.036
	-0.179	-0.091	-0.067	-0.092	-0.048	-0.067	-0.058
	[-0.156]	[1.399]	[-0.645]	[1.659]	[1.425]	**[3.773]**	[-0.610]
D(SIR(-2))	-0.036	-0.060	-0.069	0.001	-0.119	-0.016	-0.178
	-0.179	-0.091	-0.067	-0.092	-0.048	-0.067	-0.059
	[-0.200]	[-0.655]	[-1.016]	[0.010]	**[-2.481]**	[-0.240]	[-3.042]
C	9.475	4.736	5.169	5.896	5.711	5.331	6.683
	-30.856	-15.666	-11.623	-15.838	-8.261	-11.613	-10.077
	[0.307]	[0.302]	[0.444]	[0.372]	[0.691]	[0.459]	[0.663]
R-squared	0.26	0.50	0.17	0.45	0.24	0.21	0.11
Adj. R-squared	0.22	0.48	0.13	0.42	0.20	0.17	0.07
Sum sq. resids	1.15E+08	2.98E+07	1.64E+07	3.04E+07	8.28E+06	1.64E+07	1.23E+07
S.E. equation	581.96	295.46	219.22	298.71	155.80	219.02	190.05

Cont...

F-statistic	7.86	22.79	4.51	18.41	6.99	5.87	2.75
Log likelihood	-2771.18	-2529.18	-2422.63	-2533.09	-2300.71	-2422.30	-2371.66
Akaike AIC	15.61	14.26	13.66	14.28	12.98	13.66	13.38
Schwarz SC	15.79	14.43	13.84	14.45	13.15	13.83	13.55
Det res cov (dof adj.)	5.87E+32	5.87E+32	5.87E+32	5.87E+32	5.87E+32	5.87E+32	5.87E+32
Det res cov	4.26E+32	4.26E+32	4.26E+32	4.26E+32	4.26E+32	4.26E+32	4.26E+32
Log likelihood	-16956.80	-16956.80	-16956.80	-16956.80	-16956.80	-16956.80	-16956.80
AIC	95.66	95.66	95.66	95.66	95.66	95.66	95.66
SIC	96.96	96.96	96.96	96.96	96.96	96.96	96.96

level moved together and were well integrated, however integration was stronger in case of closely situated markets as compared to those situated at long distances. Cotton price series were found to be stationary at first differences and unrestricted co-integration rank tests (Trace and Maximum Eigen Value) indicated that cotton prices in markets of major producing states of country were having long run equilibrium relationship. Adilabad market was found to be the lead cotton market at national level as it influenced the prices of most of the selected cotton markets in unidirectional manner along with exhibiting bi-directional causality relationship with others. Rajkot cotton market was the second most important cotton market in influencing the other cotton markets. Out of the seven sample markets, four were found to be having the short run equilibrium and in most of the markets the cotton prices were being influenced by their own lagged prices as well as the current and lagged prices of other cotton markets.

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