MARKET INTEGRATION OF DOMESTIC AND INTERNATIONAL COTTON PRICES

ABSTRACT

Market integration is perceived as a precondition for effective market reform in developingcountries. The current study on cointegration analysis was taken up to analyse how different spatially separated cotton markets are inter-connected and impact theprice change in one market on other markets.Monthly pricesfor the period January 2010 to February 2024 from the markets viz., Cotlook-A Index, Chinese spot market, Rajkot in Gujarat, Hinganghat in Maharashtra, Adilabad and Warangal in Telangana were used for the analysis. Augmented Dickey-Fuller (ADF),Johansen's multivariate Cointegration approach, Granger causality test, and Vector Error Correction Model (VECM) were used to test the study the long-run spatial integration. The study confirmed the presence of marketcointegration. The pair-wise Granger causality test identified the bidirectional and unidirectional relationship between markets chosen.Cotlook A- Index, China and Adilabad markets affected most of the markets unidirectionally and acted as lead markets. The VECM inferred that China, Rajkot and Hinganghat markets attained equilibrium rapidly in short run. Thus, the cotton markets were highly integrated in India. Thus, Stabilizing the prices in one market would influence the other marketsimproving competitiveness and market efficiency.

Keywords: Market integration, Augmented Dickey-Fuller (ADF),Johansen's multivariate Cointegration approach, Granger causality test, Vector Error Correction Model, Cotlook A-Index

INTRODUCTION

Cotton known as ‘king of fibres’ plays a pivotal role in the industrial and agricultural economy. Cultivation of cotton crop provides livelihood to nearly 100 million cotton growing farmers worldwide and more than 250 million people earn their living through cotton processing. About, 90 per cent of the cotton is cultivated in marginal and small holdings located in developing countries. It employs almost seven per cent of labour force in developing countries (OECD, 2021).

Major cotton producing countries during 2020-21 were, China (37.73 million bales) followed by India (35.30 million bales), USA (18.69 million bales), Brazil (13.85 million bales) and Pakistan (5.76 million bales). The total world cotton production in 2020-21 stood at 142.78 million bales but the global consumption was 155.84 million bales (ICAC, 2022). The growing demand from global textile mills, apparel manufacturing market, fashion industry and other markets has over taken the production.

As per ICAC, cotton occupied world area of 31.42 million hectares, out of which 13.29 million hectares was held by India. Nearly 42 per cent of the world cotton area was under India during 2020-21. India stood as the second largest cotton producing and consuming country and third largest exporting country providing livelihood to 5.8 million cotton farmers and engaging 40-50 million people in cotton processing and trade (PIB,2021).

During the year 2020-21, India produced 353.4 lakh bales of cotton. The major share in production was held by Maharashtra with 101.05 lakh bales in 44.91 lakh hectares followed by Gujarat (72.18lakh bales), Telangana (57.97 lakh bales), Rajasthan (32.07 lakh bales) and Karnataka (23.20 lakh bales)(Ministry of textiles, 2021).

Despite being the major producer, the productivity is below world average productivity(ICAC, 2022). Cotton cultivation in India is affected by pest and disease infestation, harsh weather and poor soil conditions etc. which influences the market supply and prices(Gajbhiye, 2001).

With the varying level of supply and demand the prices of cotton undergo high level fluctuation in international markets. Such variation in world markets is not without effect on local markets. The extent of these shocks vary across countries as some are more dependent on international markets than others. Number of factors determine the degree of price transmission in a country, such as trade flows, transactions costs, trade policies, availability of price information across markets, and installed infrastructures (Goundan and Tankari, 2016).

Market integration is perceived as a precondition for effective market reform in developingcountries. The high degree of market integration means themarkets are quite competitive and provide little justificationfor extensive and costly government intervention designed toimprove competitiveness to enhance market efficiency.Markets that are not integrated may convey inaccuratepicture about price information that might distort

productiondecisions and contribute to inefficiencies in markets, harmthe ultimate consumer and lead to low production andsluggish growth (Kumari *et al.*, 2021).

The current study on cointegration analysis was taken up to analyse how different spatially separated markets are inter-connected and the impact of price change in one market on other markets.

MATERIALS AND METHODS

For assessing the long runrelationship among the cotton markets, the monthly time series data on modal prices of cotton prevailing in major domestic markets of India and two international markets was collected for the period January 2010 to February 2024. The Indian markets were chosen as they had the highest arrivals. Markets chosen were viz., Cotlook-A Index, Chinese spot market, Rajkot in Gujarat, Hinganghat in Maharashtra, Adilabad and Warangal in Telangana. The domestic prices were collected from Agmarknet while,the international prices of cotton were collected from world bank pink data sheet and Chinese cotton price index. All the prices were converted into Indian rupees considering the exchange rates.

Stationary Test

Stationarity of data implies constant mean and constant variance. The Theunit root testusing anautoregressivemodel was employed to examine whether atime series variable is non-stationary. To carry out the unit root test for stationarity the Augmented Dickey-Fuller (ADF) test and Philips and Peron test was used.

The ADF test statistic and Peron test were used to test the joint hypothesis $H_0: \rho = 0$ for the presence of unit root. Failure of the rejection of null hypothesis means that the series is non-stationary and vice-versa. ADF and PP tests determine the order of difference at which the series becomes stationary.

Cointegration Test

Cointegration refers to a linear combination of non-stationary variables which defines the presence of a long-run equilibrium to which the system converges over time. All variables must be integrated of the same order to form a cointegrating relationship.All variables having the same order of integration i.e. I(d), are said to be cointegrated. The Johansen's maximum likelihood procedure was used for testing the long run cointegration among the markets.

Granger causality test

The causal relationship between the price series in cotton markets were approached through Granger's causality technique. The Granger causality testconducted 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.

Vector Error Correction Model (VECM)

To know short-run interaction causality among variables and to distinguish the speed of adjustment from short-run dis-equilibrium to the long run equilibrium, Error Correction Model (Engle and Granger,1987) was applied to capture deviations from the long run path. When the coefficients of the lagged residual term from the first stage are negative, it suggests that the system comes back to the long run path or adjusts. Therefore, there exists an error correction mechanism. The error correction term provides an estimate of the speed of adjustment of the variable Y_t.The error correction mechanism **(ECM)** representation can be specified as:

$$\Delta Y_t = \alpha_{0+}\alpha_1 \Delta Z^* - \alpha_2 (Y_t - Z_t)_{t-1} + \mu_t$$

Where,

Z^* = is vector of explanatory variables

Y_t&Z_t= Cointegrating variables

α_2 = Coefficient of the lagged error term represents error correction mechanism (ECM)

α_1 = Coefficient of the vector of parameters

α_0 = Error correction terms i.e. loading factors or speed of adjustment

μ_t = Residuals of cointegrating equation (Sengupta and Roy, 2011).

RESULTS AND DISCUSSION

Correlation between prices prevailing in selected cotton markets

The correlation analysis helps in understanding the extent and type of association between the market prices prevailing in different markets. The results on correlation presented in Table 1. inferred that there was positive correlation among different selected markets. There was higher degree of correlation among the market prices ranging from 0.627 to 0.927. The extent of relationship was highest for market prices of Hinganghat and Adilabad (0.92) while, least association was observed between the market prices of China and Rajkot (0.62).

Table 1. Correlation between prices prevailing in selected cotton markets

	Adilabad	Warangal	Hinganghat	Rajkot	Cotlook A-Index	China
Adilabad	1.00					
Warangal	0.91***	1.00				
Hinganghat	0.92***	0.91***	1.00			
Rajkot	0.71***	0.82***	0.78	1.00		
Cotlook A-Index	0.73***	0.78***	0.76**	0.66***	1.00	
China	0.73**	0.74**	0.76***	0.63**	0.86***	1.00

Note:*** Significant at 1%, ** significant at 5%

Table 2. Unit root test for selected markets

Sl. No.	Markets	Augmented Dicky Fuller		Phillips-Perron Test	
		Level	1st Difference	Level	1st Difference
1.	Adilabad	-1.61	-8.42***	-1.63	-11.28***
2.	Warangal	-1.71	-7.92***	0.26	-11.65***
3.	Hinganghat	-2.18	-8.36***	-0.69	-15.08***
4.	Rajkot	-3.02	-5.43***	-1.56	-12.11***
5.	Cotlook A- Index	-3.08	-4.22***	-1.36	-6.90***
6.	China spot prices	-3.351	-4.704***	-0.656	-9.246***

Note: Critical value= -3.477, -2.881 and -2.557 at 1, 5 and 10 % Level of Significance
*** Significant at 1%

2. ADF and Phillips-Perron test for stationarity

To perform cointegration test between different selected markets of cotton, its obligatory to confirm the stationarity and order of integration of time series data (Kumari *et al*., 2019). This was done using Augmented Dickey Fuller (ADF) test and Phillips-Perron test. The cotton markets selected for testing the unit root property were Adilabad, Warangal, Hinghanghat, Rajkot, CotlookA-Index, and China Spot prices.

The ADF and PP values for the cotton price series at their level were less than the critical value and were found to be non-stationary, while after first differencing the prices were found to be stationary indicating integration of markets at order I as presented in the Table 2.Thus, these markets shared common long run dynamic process. The results were supported by the study conducted by Nayak (2020) on oilseed crops and the study on cotton by Mahadevaiah*et al.*(2002).

3. Prices prevailing in the domestic and international markets

Four domestic markets were selected for the study based on the highest arrivals from the top three cotton producing states and these markets' prices were compared with Chinese spot market and the Cotlook A-index prices as pictographically presented in Figure 1. It was observed that the Chinese domestic prices were highest followed by CotlookA-index. During the year 2010-11, there was huge spike in cotton prices dueto a mix of high oil and polyester prices and unexpected high demand (OECD, 2021) The prices prevailing in the domestic markets *viz.*, Warangal. Adilabad, Rajkot and Hinganghat revealed that the prices were moving in the similar pattern with minimum difference in the prices over the period.

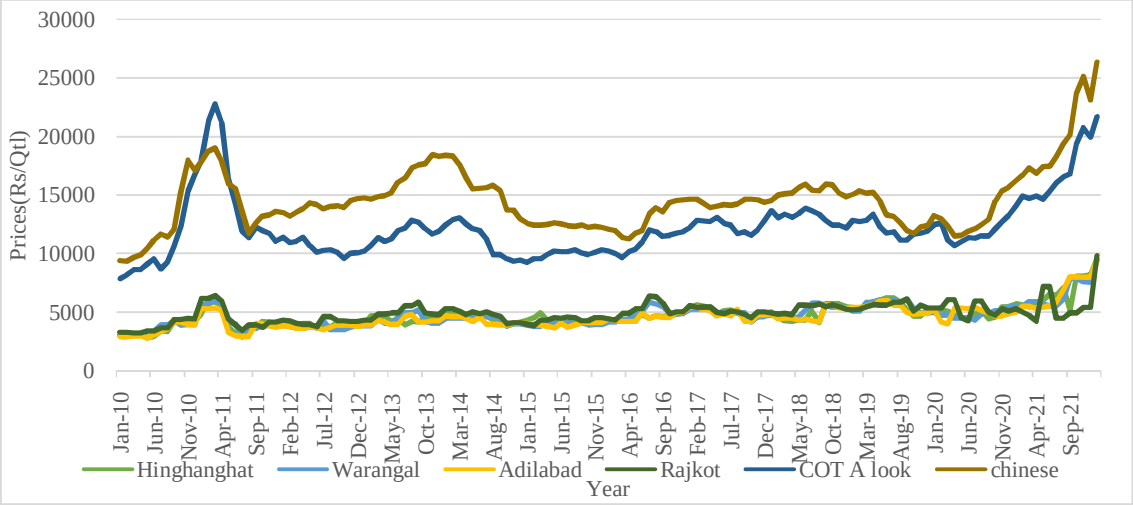

Figure 1. Prices prevailing in selected cotton markets (Jan-2010 to Jan-2022)

4.Johansen's Multiple Cointegration Test

The long run relationship between the domestic and international prices was assessed using multivariate Johansen cointegration test and the outcome was depicted in Table 3. The Johansen's maximum likelihood estimation procedure (Johansen, 1988)inferred the presence of two cointegrating vector based on the Max-Eigen and Trace Statistic. The Maximum Eigen

value and trace statistic revealed that test statistic values were higher than the MacKinnon table values. Hypothesis of no cointegration was rejected for two cointegrating vectors at 5 per cent level of significance. The test thus revealed that, there was long run equilibrium relationship existing between prices series. Similar outcome was seen in the study by Sundarmoorthy (2012).

Table 3. Johansen cointegration test for domestic and international cotton prices

Hypothesized No. of CE(s)	Max-Eigen statistic	0.05 Critical value	Trace Statistic	0.05 Critical value
None*	62.47	40.07	145.09	95.75
At most 1*	35.21	33.87	82.62	69.82
At most 2*	27.90	27.58	48.40	47.86
At most 3	13.85	21.13	20.20	29.80
At most 4	6.03	14.26	6.35	25.49
At most 5	0.31	3.84	0.31	3.84

Note: *Denotes reject rejection of the hypothesis at the 0.05 level

** MacKinnon_Haug-Michelis(1999) p-values

5. Pair-wise Granger causality test

Granger causality test studies the direction of causation between the markets. It analyses the direction of movement of relationship for two cointegrating variables. The Granger causality test was applied for examining the direction of causation between selected cotton markets. It could be witnessed from the Table 4. and Figure 2. that there was both unidirectional and bidirectional relationship existing between the markets. Markets such as Rajkot-Adilabad, China-Cotlook A-Index, Warangal- China, Warangal-Cotlook A-Index, Warangal-Hinganghat and Rajkot-Hinganghat exhibited bi-directional relationship. This means that the former market caused the price transmission in the latter market and vice-versa. There was unidirectional relationship existing between the markets viz., Adilabad-China, Adilabad- Cotlook A-Index, Adilabad-Hinganghat, Adilabad- Warangal, China-Hinganghat, China- Rajkot, Cotlook A-Index- Hinganghat, Warangal- Rajkot meaning the former caused the price formations in the latter. It could be observed that the Cotlook A-Index and Chinese markets played major role in price causation in the domestic markets. Thus, it could beconfirmed that international market prices viz., Cotlook A- Index and China and Adilabad markets affected most of the markets unidirectionally. Similar outcome was in

the study conducted by Suresh *et al*. (2017) where Adilabad market acted as a lead cotton market followed by Rajkot market. In the current study Warangal market had bidirectional price transmission with the international prices, this might be because the Warangal market is the second largest market in Asia and the Warangal market had highest arrivals as compared to other markets and huge volume of transactions.

Table4. Pair-wise Granger causality test for monthly prices of cotton

Null Hypothesis	**F- Statistic**	**Prob.**	**Direction**
Chin does not Granger cause Adil	0.82	0.43	→
Adil does not Granger cause Chin	4.83	9.E-03	
CotA does not Granger cause Adil	0.74	0.47	→
Adil does not Granger cause CotA	8.64	3.E-04	
Hing does not Granger cause Adil	1.87	0.15	→
Adil does not Granger cause Hing	23.16	2.E-09	
Raj does not Granger cause Adi	2.65	0.07	↔
Adil does not Granger cause Raj	17.73	1.E-07	
War does not Granger cause Adil	1.65	0.20	→
Adil does not Granger cause War	13.44	5.E-06	
Cotlook does not Granger cause Chinese	2.47	0.08	↔
Chinese does not Granger cause Cotlook	2.88	0.05	
Hing does not Granger cause Chinese	0.32	0.72	→
Chinese does not Granger cause Hing	5.32	5.E-03	
Raj does not Granger cause Chinese	0.13	0.88	→
Chinese does not Granger cause Raj	9.63	1.E-04	
War does not Granger cause Chinese	3.71	0.02	↔
Chinese does not Granger cause War	2.91	0.05	
Hing does not Granger cause Cotlook	0.91	0.40	→
Cotlook does not Granger cause Hing	5.60	4.E-03	
Raj does not Granger cause Cotlook	2.68	0.07	→
Cotlookdoes not Granger cause Raj	6.64	1.E-03	
War does not Granger cause Cotlook	5.87	3.E-03	↔
Cotlook does not Granger cause War	3.31	0.03	
Raj does not ranger cause Hing	3.16	0.04	↔

Hing does not Granger cause Raj	15.57	8.E-07	
War does not Granger cause Hing	11.78	2.E-05	↔
Hing does not Granger cause War	8.31	4.E-04	
War does not Granger cause Raj	15.77	7.E-07	→
Raj does not Granger cause War	1.13	0.32	

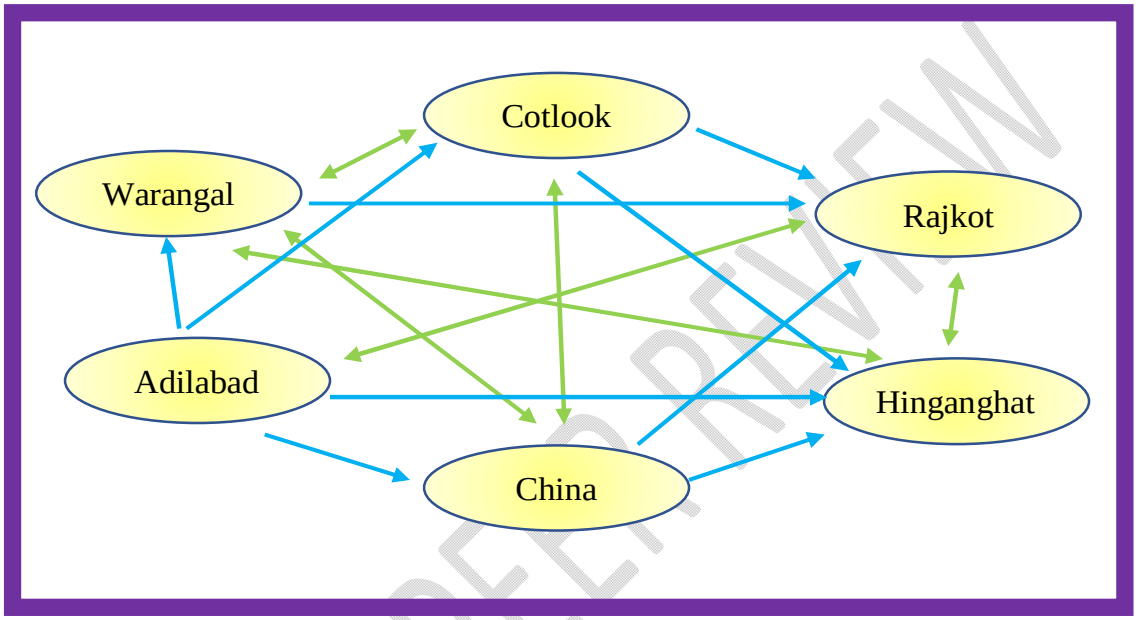

Figure 2. Granger Causality direction between cotton markets

6. Vector Error Correction Model for cotton prices

The speed of adjustment between different markets was estimated using Vector Error Correction Model. The short run and the long run equilibrium adjustments indicates the external and the internal forces (Lavanya *et al.*, 2018).The VECM estimates presented in Table 5 revealed that China, Rajkot and Hinganghat markets attained equilibrium rapidly. One month lagged prices of China market affected the current prices of Adilabad, Warangal, Rajkot and Hinganghat. China market's two month lagged prices affected the current prices in Warangal market. One month lagged prices of Adilabad market affected current prices of Warangal. Adilabad market two month lagged prices affected current prices of Adilabad market. Cotlook A-Index one month lagged prices affected the current prices of Adilabad and Hinganghat. Warangal one and two lagged prices affected current market prices of Hinganghat. Rajkot two month lagged prices affected the current prices of Adilabad, Rajkot

and Hinganghat markets. Hinganghat one month lagged prices affected current prices of Rajkot.

Table 5. Results of Vector Error Correction Model for domestic and International Prices

Particulars	D (China)	D (Adil)	D (CotA)	D (War)	D (Raj)	D (Hing)
CointEq1	0.033 [**2.451**]	0.006 [0.817]	0.026 [1.935]	-0.011 [-1.566]	0.023 [**2.025**]	0.056 [**7.735**]
D(China(-1))	0.069 [0.636]	-0.134 [**-2.155**]	-0.032 [-0.299]	-0.133 [**-2.290**]	-0.344 [**-3.739**]	-0.137 [**-2.329**]
D(China(-2))	-0.141 [-1.233]	0.019 [0.297]	0.026 [0.230]	0.187 [**3.057**]	0.208 [2.141]	-0.083 [-1.339]
D (Adil (-1))	0.223 [1.138]	-0.121 [-1.085]	0.401 [0.072]	0.353 [**3.386**]	-0.123 [-0.737]	0.035 [0.334]
D (Adil (-2))	0.259 [1.333]	-0.266 [**-2.382**]	0.310 [1.161]	0.144 [1.385]	-0.053 [-0.324]	-0.081 [-0.770]
D (CotA(-1))	0.164 [1.417]	0.161 [**2.436**]	0. 427 [3.731]	0.079 [1.277]	0.137 [1.410]	0.192 [**3.057**]
D (CotA(-2))	0.139 [1.256]	-0.015 [-0.241]	-0.029 [-0.268]	0.007 [0.127]	0.065 [0.694]	0.054 [0.905]
D (War(-1))	0.043 [0.189]	0.102 [0.786]	-0.023 [-0.105]	-0.047 [-0.398]	-0.089 [-0.467]	-0.345 [**-2.834**]
D (War(-2))	-0.104 [-0.477]	-0.094 [-0.749]	-0.350 [-1.629]	0.050 [0.433]	0.258 [1.392]	-0.292 [**-2.475**]
D (Raj (-1))	-0.008 [-0.067]	-0.035 [-0.502]	0.222 [1.830]	-0.023 [-0.350]	0.052 [0.504]	0.219 [3.293]
D (Raj (-2))	0.222 [1.762]	-0.168 [**-2.330**]	0.209 [1.677]	-0.107 [-1.589]	-0.240 [**-2.241**]	0.207 [**3.028**]
D (Hing(-1))	-0.055 [-0.272]	0.183 [1.582]	-0.045 [-0.230]	-0.091 [-0.845]	0.358 [**2.085**]	0.040 [0.371]
D (Hing(-2))	-0.179 [-1.043]	0.098 [0.999]	-0.133 [-0.782]	-0.089 [-0.976]	-0.053 [-0.356]	0.135 [1.454]

C	83.507 [1.348]	45.675 [1.287]	37.787 [0.617]	25.721 [0.778]	48.918 [0.929]	51.170 [1.525]
R^2	0.261	0.186	0.380	0.212	0.234	0.457
Adj. R^2	0.187	0.105	0.318	0.133	0.157	0.403
Akaike AIC	16.093	14.979	16.068	14.838	15.769	14.867

POLICY IMPLICATION

Analysis of various techniques revealed that there existed cointegration among the domestic and international markets. Correlation analysis inferred that markets possessed significant relationship. ADF and Phillips-Perron tests of stationarity inferred that the prices were stationary at 1st difference indicating integration of markets at order I.Johansen's multiple cointegration test confirmed the existence of long run equilibrium among the markets and there were two cointegrating vectors.

The pair-wise Granger causality test identified the bidirectional and unidirectional relationship between markets chosen. Warangal had bidirectional relationship withCotlook A- Index and China spot prices. Adilabad market unidirectionally caused most of the domestic markets and acted as the lead market domestically. The international market prices influenced the domestic market prices unidirectionally.The VECM analysis inferred that China, Rajkot and Hinganghat markets attained equilibrium rapidly in short run.Thus, the cotton markets were highly integrated in India. Stabilizing the prices in one market would influence the other markets.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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