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Price Volatility and Integration of Cotton Markets in Karnataka

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Abstract : Cotton is the major commercial and fibre crop of India and it is considered as 'White Gold' and 'King of Fibre'. The objective of the study is to know the fluctuations and to formulate appropriate ways and means for reducing price fluctuations. This study evaluated the spatial market integration between Karnataka's geographically distinct cotton markets using monthly price data of from January 2008 - December 2022. Top five markets *i.e.*, Vijayapura, Ranibennur, Chitradurga, Annigeri and Raichur markets were selected for study based on market arrivals. Integration of cotton markets was analyzed using Johansen co-integration, Augmented Dickey-Fuller test and Granger Causality Tests. Granger causality test revealed that bidirectional price influence in all the market pairs except Vijayapura-Ranibennur, Chitradurga-Ranibennur, Annigeri-Vijayapura, Ranibennur-Chitradurga, Annigeri-Ranibennur, Raichur-Ranibennur, Annigeri-Chitradurga and Annigeri-Raichur. All the chosen markets were significant at of 5 per cent significance level, indicating that the markets had long-run equilibrium relationships and exhibited cointegration among them. The study suggests that strengthening market intelligence in all markets along with the establishing physical infrastructure will help in the development of single uniform economic market in the region. It recommends that farmers should be provided with more accurate price information in order to take advantage of spatial price differences.

Keywords: Cotton, ganger causality, market integration, price volatility

Cotton (*Gossypium hirustum*) is the major commercial and fibre crop of India. It is considered as "White Gold" and "King of Fibre". India is the only country in the world growing all the four cultivated species of cotton, *viz., Gossypium hirustum, G. arboreum, G. herbaceaum* and *G. barbadense*. It plays a prominent role in the national and international economy. It is grown mainly for its fibre used in the manufacturing of cloth for mankind. In spite of several competition from synthetic fibres, cotton continues to enjoy a place of prime important in the textile industry. Though non cotton fibre has made significant breakthrough in many countries in the world, cotton deserves the prime position in India contributing more than 70 per cent of the total fibre consumption in the textile sector. Besides sustaining the country's textile industry, it also earns precious foreign exchange for the country from the export of raw cotton and finished goods. Cotton is of great importance to developing countries, particularly in West and Central Africa. where around 10 million people depend on the sector for their revenues. Besides being a major natural fibre crop, cotton also provides edible oil and seed by products for livestock seed. Cotton seed oil is a vegetable oil ranking fifth in the world use among edible oils (accounting for about four per cent of world consumption of vegetable oil). The cotton seed meal is usually used as roughage in the diet of cattle for its high proteinic and energetic value.

The textile industry, which consumes the cotton, as its principal raw material, contributes about 4 per cent to the GDP and is the major foreign exchange earner for the country. Hence, growth and development of cotton and cotton-based textile industry has a vital bearing on the overall development of the Indian economy. The textile industry in India is the only industry that provides huge employment for both skilled and unskilled labour. This industry is paramount to

strengthen the country's core business. At the same time, it makes a great contribution to employment generation, next to the Indian retail industry. The textile sector in India employs over 4.5 crore people directly and another 6-crore people in allied sectors, including women and rural population (Nagaraja, 2019).

India ranks first in cotton area, its productivity and second among cotton growing countries. The concerted research efforts in crop improvement and development of location specific crop production and protection technologies have increased cotton production. India has the distinction of having largest area under cotton cultivation which is about 37 per cent of the world's area under cotton cultivation. India is one of the largest producers of cotton in the world accounting for about 22 per cent of the world cotton production. The area of cotton in India is 130.61 lakh ha with the production of 343.47 lakh bale (1bale=170 kg) and productivity is 447.06 kg/ha is still lower against the world average yield of about 787 kg/ha (Anonymous, 2022b). India holds the unique distinction of being the only country in the world that grows all the four cultivated species of cotton and their hybrids in the vast divers agro-climatic situations prevailing across the length and breadth of the country. Cotton is grown in the country on different holdings with varied planting dates, soil and water conditions largely under rainfed situations.

In India, Gujarat is leading producer and processor of cotton followed by Maharashtra, Telangana, Rajasthan and Karnataka stands at fifth position in area and production of cotton in country. Area under cotton crop in Karnataka is around 673.77 lakh hectares which is 7 per cent of the country’s area. The production of the crop is 19.52 lakh bales (around 4 % of the country`s production) while productivity is 493 kg/ha. The main cotton growing districts in Karnataka are Raichur, Yadgir, Haveri, Dharwad, Mysore and Ballari. However, Raichur is called as 'Cotton bowl of Karnataka'. Raichur and Yadgir stands first and second in terms of area and production of cotton in Karnataka. In an integrated market, price of a commodity is responsive to price changes of the same quality products in other markets. As such price differences for a particular variety of product in different markets of the area as a rule should not exceed the cost involved in the transportation and handling of the produce. Market integration characterizes the degree of co-movement of prices across spatially separated markets. Hence, an attempt is made to study the integration of major cotton markets in Karnataka along with the price fluctuations of cotton in major cotton markets.

MATERIALS AND METHODS

The required secondary data related to the price and arrivals of cotton in Karnataka was collected from Krishimaratavahini (www.krishimaratavahini.kar.nic.in). Based on five years average arrivals of cotton, top five cotton markets *viz.*, Vijayapura, Ranibennur, Chitradurga, Annigeri and Raichur cotton markets were selected. Area, production and productivity of cotton in Karnataka state was collected from the Directorate of Economics and Statistics, Bangalore. ARCH-GARCH analysis was performed to examine the existence of price volatility. It was done in using E Views software. Integration of cotton markets was carried out through cotton price transmission and spatial integration of cotton markets which are analysed through correlation analysis, Johansen Methodology, Augmented Dickey-Fuller test and Granger Causality Test. All the cointegration tests were done using E views software.

Karl Pearson's correlation coefficient was used to analyse integration of cotton markets.

Correlation coefficient between two market price series X and Y

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

To test the significance of correlation coefficient (r) t-test is used.

Null Hypothesis, $H_0 = r_i = 0$

Alternate Hypothesis, $H_1 = r_i \neq 0$

The significance of correlation coefficient is tested using the following formula:

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

The price-series in different markets were checked for stationarity by using Augmented Dickey-Fuller (ADF) unit root test. If the data is non-stationarity, then the data has to be transformed into first differences and the unit root test has to be repeated (Burark *et al.*, 2013). The test was applied after running regression of the following form:

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

Where;

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

Y_{t-1}= Price of cotton in a given market at time t-1

$\in$ = Pure white noise error term

$\beta 1$ = Constant $\quad \Delta Y_t = Y^t - Y_{t-1}$

$\beta 2$ = Coefficient on a time trend

α = Adjustment parameter

m = optimal lag value which is selected on the basis of Schwartz Information Criterion (SIC) and Akaike Information Criterion (AIC).

Test for unit root in the price series,

Null Hypothesis (H0): Price series is non-stationary or unit root exists

Alternate Hypothesis (H_1): Price series is stationary

If, t* > ADF critical value then accept the null hypothesis, *i.e.*, unit root exists

t*< ADF critical value then reject the null hypothesis,

The cointegration test for the long run relationship among the price series were used. Maximum likelihood ratio test statistics are proposed to test number of cointegrating vectors. The null hypothesis of at most r cointegrating vectors against a general alternative hypothesis of more than r cointegrating vectors is tested by trace statistics. 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 movement of prices. An increase in the number of co-integrating vectors implies an increase in the strength and stability of price linkages.

The short run relationship along with the speed of adjustment towards equilibrium using an error correction model, represented by the equations:

$$\Delta lnX_t = \alpha_o + \sum \beta_1 i\, \Delta lnY_{t-i} + \sum \beta_{2i}\, \Delta lnX_{t-i} + \gamma\, ECT_{t-1}$$

$$\Delta lnY_t = \beta_o + \sum \alpha_{1i}\, \Delta lnX_{t-i} + \sum \alpha_{2i}\, \Delta lnY_{t-i} + \gamma\, ECT^{t-1}$$

Where;

ECT_{t-1} is the lagged error correction term

X and Y are two different market prices series

X_t and Y_t are the market prices transformed through natural logarithm

X_{t-i} and Y_{t-i} are the lagged values of market prices

The γ is the error correction coefficient that measures the response of the regressor in each period to departures from equilibrium. The negative and statistically significant values of γ depict the speed of adjustment in restoring equilibrium after disequilibrium, and if it is positive and zero, the series diverges from equilibrium (Burark *et al.* 2013).

The causal relationship between the price's series in the selected cotton markets was

Table 1. Price volatility of cotton in selected markets of Karnataka

Particulars	Vijayapura	Ranibennur	Chitradurga	Annigeri	Raichur
Alpha (α)	0.39	0.85	0.93	0.69	1.01
Beta (β)	0.56	0.23	-0.05	0.06	0.27
Sum of α and β	0.95	1.08	0.88	0.75	1.28

Table 2. Relationship of cotton prices in selected markets of Karnataka

Sl. No	Markets	Vijayapura	Ranibennur	Chitradurga	Annigeri	Raichur
1	Vijayapura	1				
2	Ranibennur	0.98*	1			
3	Chitradurga	0.97*	0.97*	1		
4	Annigeri	0.99*	0.99*	0.97*	1	
5	Raichur	0.99*	0.98*	0.97*	0.98*	1

Note: * Indicating significant at 1 per cent level of significance

Table 3. Pair-wise causality test of selected cotton markets in Karnataka

Null hypothesis	F-statistics	Probability	Granger cause	Direction
RNR does not Granger Cause VIJ	4.98	0.007*	Yes	(↔)(→)
VIJ does not Granger Cause RNR	2.72	0.068	No	
CTA does not Granger Cause VIJ	1.75	0.17	No	
VIJ does not Granger Cause CTA	11.16	3.E-05*	Yes	→
ANI does not Granger Cause VIJ	2.02	0.135	No	
VIJ does not Granger Cause ANI	33.33	6.E-13*	Yes	↔
RCR does not Granger Cause VIJ	6.45	0.002*	Yes	↔
VIJ does not Granger Cause RCR	27.16	6.E-11*	Yes	↔
CTA does not Granger Cause RNR	18.6	5.E-08*	Yes	↔
RNR does not Granger Cause CTA	4.44	0.013	Yes	↔
ANI does not Granger Cause RNR	0.66	0.515	No	→
RNR does not Granger Cause ANI	15.35	7.E-07	Yes	↔
RCR does not Granger Cause RNR	2.42	0.091	No	→
RNR does not Granger Cause RCR	6.61	0.001	Yes	↔
ANI does not Granger Cause CTA	5.03	0.007	Yes	→
CTA does not Granger Cause ANI	14.4	2.E-06	Yes	↔
RCR does not Granger Cause CTA	8.83	0.002	Yes	↔
CTA does not Granger Cause RCR	9.46	0.000	Yes	↔
RCR does not Granger Cause ANI	21.7	4.E-09	Yes	↔
ANI does not Granger Cause RCR	1.67	0.190	No	→

Price series: VIJ-Vijayapura, RNR-Ranibennur, CTA-Chitradurga, ANI-Annigeri, RCR- Raichur ; Bidirectonal (↔) Unidirectional (→)

approached through Granger's causality technique. If a variable Y is Granger-caused by variable X, it means that the values of variable X help predict the values of variable Y and vice versa. The Granger causality test conducted within the framework of a vector auto regression (VAR) model, which will be used to test the existence of a long run causal price relationship between markets and the direction of that relationship.

RESULTS AND DISCUSSION

Price volatility of selected cotton markets in Karnataka

To assess the presence of price fluctuations in major markets of cotton, ARCH-GARCH analysis was carried out for the market price series of Vijayapura, Ranibennur, Chitradurga, Annigeri and Raichur markets.

The sum of Alpha and Beta indicated ARCH-GARCH effect for given markets. The value close to one indicates persistence of volatility in the markets. From the Table 4 it could be concluded that cotton prices in Vijayapura

market were comparatively more volatile, followed by Ranibennur, Chitradurga, Raichur and Annigeri markets. Similar results obtained from Burark *et al.,* (2013) where the existence of prices volatility in coriander prices in Baran market was relatively more volatile than other market price.

Relationship of cotton prices in selected markets of Karnataka

The results pertaining to correlation analysis of monthly prices of cotton to check the market integration of cotton markets are presented Table 2. Amongst the markets, the correlation coefficient value was highest of the order of 0.99 between Annigeri and Vijayapura markets, Annigeri and Ranibennur markets, Raichur and Vijayapura markets followed by 0.98 between Ranibennur and Vijayapura markets, Raichur and Ranibennur markets, Raichur and Annigeri markets. r-value of 0.97 between Chitradurga and Vijayapura,

Table 4. Long term relationship between the selected cotton markets in Karnataka

Markets	D (VIJ)	D (RNR)	D (CTA)	D (ANI)	D (RCR)
Co-integration equation	-0.17	0.03	0.25	-0.09	-0.16
	(0.05)	(0.07)	(0.06)	(0.05)	(0.04)
	[-3.42]	[0.40]	[3.90]	[-1.62]	[-3.75]
D (VIJ (-1))	0.38	0.33	-0.07	0.56	0.58
	(0.10)	(0.16)	(0.13)	(0.12)	(0.09)
	[3.60]	[1.92]	[-0.54]	[4.52]	[6.39]
D (VIJ (-2))	-0.08	0.10	0.04	0.07	0.32
	(0.12)	(0.19)	(0.15)	(0.14)	(0.10)
	[-0.70]	[0.52]	[0.31]	[0.49]	[3.15]
D (RNR (-1))	-0.06	-0.32	0.11	-0.07	-0.10
	(0.05)	(0.09)	(0.07)	(0.07)	(0.05)
	[-1.04]	[-3.47]	[1.54]	[-1.11]	[-1.96]
D (RNR (-2))	-0.12	-0.07	0.14	0.05	-0.08
	(0.05)	(0.09)	(0.07)	(0.06)	(0.04)
	[-2.16]	[-0.84]	[1.94]	[0.84]	[-1.71]
D (CTA (-1))	0.004	0.60	0.23	-0.001	0.12
	(0.06)	(0.10)	(0.08)	(0.08)	(0.05)
	[0.06]	[5.51]	[2.65]	[-0.02]	[2.05]
D (CTA (-2))	-0.11	0.03	-0.19	-0.08	-0.13
	(0.07)	(0.12)	(0.09)	(0.09)	(0.06)
	[-1.47]	[0.26]	[-1.97]	[-0.91]	[-2.09]
D (ANI (-1))	-0.01	0.01	0.09	-0.38	-0.03
	(0.06)	(0.10)	(0.08)	(0.07)	(0.05)
	[-0.28]	[0.16]	[1.11]	[-5.04]	[-0.63]
D (ANI (-2))	-0.04	-0.05	0.04	-0.23	-0.07
	(0.06)	(0.09)	(0.07)	(0.07)	(0.05)
	[-0.73]	[-0.53]	[0.55]	[-3.29]	[-1.49]
D (RCR (-1))	-0.26	-0.72	-0.32	-0.02	-0.42
	(0.11)	(0.18)	(0.15)	(0.14)	(0.10)
	[-2.22]	[-3.84]	[-2.12]	[-0.17]	[-4.15]
D (RCR (-2))	0.35	0.089	0.14	0.37	-0.0008
	(0.11)	(0.18)	(0.15)	(0.13)	(0.10)
	[2.99]	[0.48]	[0.98]	[2.70]	[-0.008]
C	29.94	35.67	21.61	28.04	23.91
	(32.80)	(51.81)	(42.02)	(38.74)	(28.09)
	[0.91]	[0.68]	[0.51]	[0.72]	[0.85]
R-squared	0.19	0.26	0.20	0.29	0.31

Note: Standard errors in ( ) & t-statistics in [ ]

Chitradurga and Ranibennur, Annigeri and Chitradurga markets, Raichur and Chitradurga markets. The r-value was very high when compared to other pairs which was due to the close proximity of these markets. Overall, all the coefficients of pairs of cotton markets of Karnataka were closer to unity and since correlation coefficients directly measure how closely prices of a cotton move together in spatially dispersed market, hence the selected cotton markets in Karnataka were integrated and efficient.

Pairwise causality test of selected cotton markets in Karnataka

The causal relationship between the price series in major cotton markets in Karnataka was approached through Granger Causality technique and the results are presented in Table 4. If the probability values are less than 0.05 per cent indicating the bi directional causality with each other and thus transmitted the prices in both ways. In other words, the prices of one market were influenced by the other selected cotton markets. All most all markets showing bidirectional causality relationship in price transmission except Vijayapura- Ranibennur, Chitradurga-Vijayapura, Annigeri-Vijayapura, Annigeri-Ranibennur, Raichur-Ranibennur and Annigeri-Raichur showing unidirectional causality relationship. The results are lined with findings of Burark *et al.,* (2013) where unidirectional influence of prices of Kota market on Ramganj and Baran markets.

Long-term relationship between the selected cotton markets in Karnataka

Since the selected 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 Karnataka. The error correction terms' (ECT) negative and statistically significant values in each of the chosen markets showed how quickly equilibrium was restored after a disequilibrium.

The information flow is more in Chitradurga (25%) followed by Vijayapura (17%), Raichur (16%), Annigeri (9.6%) and Ranibennur (3%). Price adjustment occurs more quickly in Chitradurga followed by Vijayapura and Raichur markets than other markets. similar results obtained in Nagaraj (2019) study. Haveri, Ranibennur and Raichur markets had significant long term effects with prices of other markets. Haveri, Ranibennur and Raichur markets had 9.29 per cent, 12.21 per cent and 13.13 per cent error corrections respectively. Vijayapura market did not have long term effects with prices of other markets.

The co integration equation reveals that if the t-statistic was less than -1.96 or more than 1.96, the decision was that the markets are co-integrated. On the other hand, if it was in between the -1.96 to 1.96, the decision was that markets are not integrated. In case of Vijayapura price model of cotton, the coefficient of one month (0.38) lagged own price was positive and significant at 5 per cent level of significance while the coefficient of two month (-0.12) lagged Ranibennur market prices was negative and significant at 5 per cent level of significance. The coefficient of one month (-0.26) and two month (0.35) lagged Raichur market price was significant at 5 per cent level of significance. In case of long run, Vijayapura price was influenced by the its own price with one month lag period, Ranibennur market price with two-month lag period and Raichur market price with one- and two-month lag period. In Ranibennur market model, the coefficient of one month (-0.32) lagged own price was positive and significant at 5 per cent level of significance while the coefficient of one month (-0.60) lagged Chitradurga market prices was positive and significant at 5 per cent level of significance. The coefficient of one month

(-0.72) lagged Raichur market prices was negative and significant at 5 per cent level of significance. In case of long run, Ranibennur price was influenced by the its own price with one month lag period, Chitradurga market price with one-month lag period and Raichur market price with one-month lag period.

In Chitradurga market model, the coefficient of one month (0.23) and two month (-0.19) lagged own price significant at 5 per cent level of significance while the coefficient of one month (-0.32) lagged Raichur market prices was negative and significant at 5 per cent level of significance. In case of long run, Chitradurga price was influenced by the its own price with one and two month lag period and Raichur market price with one month lag period. In Annigeri market model, the coefficient of one month (0.56) lagged Vijayapura price was positive and significant at 5 per cent level of significance while the coefficient of one month (-0.60) and two month lagged own market prices was negative and significant at 5 per cent level of significance. The coefficient of two month (0.37) lagged Raichur market prices was positive and significant at 5 per cent level of significance. In case of long run, Annigeri price was influenced by the its own price with one and two month lag period, Vijayapura market price with one-month lag period and Raichur market price with two-month lag period.In Raichur market model, the coefficient of one month (0.58) and two month (0.32) lagged Vijayapura price was positive and significant at 5 per cent level of significance while the coefficient of one month (0.12) and two month (-0.13) lagged Chitradurga market prices significant at 5 per cent level of significance. The coefficient of one month (-0.42) lagged Raichur market prices was negative and significant at 5 per cent level of significance. In case of long run, Raichur price was influenced by the its own price with one month lag period, Vijayapura market price with one and two month lag period and Chitradurga market price with one- and two-month lag period.

Overall, all the correlation coefficients of pairs of cotton markets of Karnataka were closer to unity, hence the selected cotton markets in Karnataka were integrated and efficient. Results of Augmented Dickey-Fuller test states that all the price series of cotton in selected markets of Karnataka become stationary first difference which is obvious from the calculated values for all markets are less than the critical value and free from the consequence of unit root test. All most all markets showing bidirectional causality relationship in price transmission except Vijayapura- Ranibennur, Chitradurga-Vijayapura, Annigeri-Vijayapura, Annigeri-Ranibennur, Raichur-Ranibennur and Annigeri-Raichur showing unidirectional causality relationship.Unrestricted co integration rank tests (Trace and Maximum Eigen value) indicated the presence of at least 4 co-integrating equations at 5 per cent level of significance, thus revealing that all the selected cotton markets in Karnataka were having long run equilibrium relationship. Vector Error Correction Model (VECM), the information flow is more in Chitradurga (25%) followed by Vijayapura (17%), Raichur (16%), Annigeri (9.6%) and Ranibennur (3%). Price adjustment occurs more quickly in Chitradurga followed by Vijayapura and Raichur markets than other markets. The policy implications from the study that all the selected cotton markets were integrated thereby influencing the prices from one market to other market thereby farmer can sell the cotton in any market except change in transportation charges. The selected cotton markets were integrated in terms of monthly prices which indicated that the price movements of cotton lead to stability over space.

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