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RESEARCH PAPER

Price integration analysis of major cotton domestic markets in India

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Abstract : The present study examines the performance of major cotton domestic markets *viz.*, Andhra Pradesh (Khammam), Gujarat (Gondal), Karnataka (Raichur), Maharashtra (Akola) and Tamil Nadu (Konganapuram) of India using monthly wholesale prices of cotton in terms of market integration by using co-integration test and Johansen multivariate co-integration test. Unit root test indicated that the price series in each location are non -stationary at their levels, and stationary at their first differences. Co-integration results showed that the regional markets have price linkages and thus, these markets are spatially integrated. The findings revealed that bidirectional relationships exist within domestic markets which indicated the price transmission happening in short run adjustments and the presence of long run equilibrium existed among the cotton markets in Andhra Pradesh, Gujarat, Karnataka, Maharashtra and Tamil Nadu. In case of Tamil Nadu cotton market, the speed of adjustment towards equilibrium was almost 0.34 per cent and Karnataka market was the key determinant of shocks in the cotton market of Tamil Nadu. Overall, the results imply effective price transmission mechanism in the domestic markets and any further boost to the existing infrastructure will help in improving both producer's and consumer's surpluses.

Key Words : Cotton, Time series, Spatial market integration, Price transmission

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INTRODUCTION

Prices play a vital role in predominantly agricultural economies like India. It determines not only what shall be produced but also how much to be produced. The price system is a powerful tool to transmit essential economic information and stimulate appropriate decision by producers and consumers. Price is the most important determinant of profit or loss in the farm enterprise. In farm enterprise, time factor is very important. While crops are grown in one period, they are harvested in another period. This long gestation period exercise significant influence on price determination. Therefore, the prices prevailing during the marketing period are of great consequence in deciding making.

The study of relationship between market arrivals and prices is very useful. Larger production and larger

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arrivals reflect adversely on the prices. As a result the prices go down. But in a mixed economy, a certain amount of direction is given to the market forces and this law may not always hold good. This control mechanism of the market forces may aim in regulating market supplies or consumption or both, particularly in the case of commodities in the short reaction among the sellers and buyers and effect of this reaction at a given point of time once are reflected in supply and price position. Thus, in mixed economy, it would be necessary to study the market arrivals and prices and to know the factors influencing them (Belgi, 2011).

Efficient functioning of markets thus provides a remunerative price for the produce of the farmer-sellers as well as provide reasonable prices to the innumerable consumers. The nature of the farm products coupled with the fluctuations in their demand and supply often leads to instability in their prices as well as in their arrivals at the market. Since farm production is seasonal, farm prices and market arrivals are also subjected to wide seasonal variations.

The spatial price variations are the variations in prices observed over different markets. They occur due to differences in location of production and consumption of commodities. In theory, in a perfect market, the price of a good at one market is not expected to exceed the price at other markets by more than the transport cost and nominal profit. The degree to which wholesale prices of a commodity in different markets are related to one another is an important consideration in determining the efficiency of the marketing system. The interrelation between the price movements in different markets mostly depends upon the nature and extent of competition. An analysis of such inter-relationships helps us in understanding the efficiency of the marketing systems (Reddy, 2012).

Cotton is a perennial shrub that has been cultivated by man for several thousand years. It is primarily used by the textile industry to produce thread, fabrics, linen and apparel. Cotton, also known as 'white gold', enjoys a predominant position amongst all cash crops in India. It is an important raw material for the Indian textile industry, constituting about 65 per cent of its requirements. The Indian textile industry occupies a significant place in the country's economy with over 1797 mills, 4 million handlooms, 2.5 million power looms and thousands of garment, hosiery and processing units, providing employment directly or indirectly to around 35 million people. Besides being primarily a fibre crop it also serves as a feed crop for cattle

Global cotton production steadily increased from 63.37 million bales in 1980-81 to 93.67 million bales in 1995-96 and to a maximum of 124.18 million bales in 2011-12. Drastic fall in production to 96.32 million bales in 2015-16 was observed due to significant reduction in production in major cotton growing countries and is expected to increase by seven per cent during 2016-17. The main cotton producing states of India in these three zones are Maharashtra, Gujarat, Telangana, Haryana, Punjab, Rajasthan, Karnataka and Tamil Nadu. Tamil Nadu is the largest consumer of raw cotton (60-65%) in India. In this state the area under cotton is estimated to remain the same (10.82 lakh hectares) and production is around 32.57 lakh bales during 2016-17.

Despite all the claims, the traditional problems in marketing such as information asymmetricity and inadequate infrastructural facilities continue to mar the prospects of cotton farmers.The proliferation and intensification of communication and infrastructure facilities in the semi-developed countries like India would lead to integration of markets which shall help both producers and consumers alike in the long run. On the other hand, poor allocation of resources as a result of inefficient infrastructure system would in-turn lead to poor integration of markets. In this study, an attempt has been made to study the spatial market integration of five major domestic cotton markets in India *viz.*, Andhra Pradesh, Gujarat, Karnataka, Maharashtra and Tamil Nadu. The markets were selected on the basis of their share in market arrivals and volume of transactions during the study period (*i.e.* January, 2005 to August, 2018).

The term spatial market integration refers to a situation in which the prices of a commodity in spatially separated markets move together and the price signals and information are transmitted smoothly across the markets. Hence, spatial market performance may be evaluated in terms of the relationship between prices of spatially separated markets and spatial price behaviour in regional markets may be used as a measure of overall market performance (Reddy, 2012).

In other words, if the price changes in one market are fully reflected in alternative market then these markets are said to be integrated. If the markets are integrated then the resources are allocated effectively, whereas poor integration leads to misallocation of resources which in-turn causes price fluctuations pronounced more particularly in one market or the other. In this context, the present study is employed with the specific objectives to analyses the direction of causality among cotton markets, and to estimate the price transmission within the domestic cotton markets. If the markets are integrated, a given change in price of cotton in one market should reflect in change in prices of cotton in other markets.

MATERIAL AND METHODS

The present study was based on secondary data. In India Andhra Pradesh, Gujarat, Tamil Nadu and Karnataka put together contributes more than 80 per cent of the country's total cotton production, so markets from Gujarat, Andhra Pradesh, Maharashtra, Karnataka and Tamil Nadu states were selected purposively. To analyse market integration, month-wise wholesale price data were sourced for the period between January 2005 to January, 2018 from the official website of Directorate of Marketing and Inspection (DMI), Ministry of Agriculture and Farmers Welfare, Government of India (2018). The data being of time-series type, it is necessary to ensure stationarity before fitting them in the model. Stationarity in the data series would reveal the order of differences and to carry out cointegration between market pairs, it is essential for both the markets to be in the same order.

Unit root test:

The presence of unit root (non-stationarity) in the underlying series is tested by performing Augmented Dickey-fuller test using the following regression:

a **Yt= 1 + 2t + ¢Yt-1 + 1 1** ***mi i*** ~ - = ġ a꞊**Yt** + £t ....(1)

where, εt= Pure white noise error term; Δ Yt-1=(Yt-1 – Yt-2), Δ Yt-2 = (Yt-2 – Yt-3) etc and m = Number of lag length and it is determined using Akaike or Schwarz information criteria or the Partial Autocorrelation function (PACF) of the first differenced series if data are under levels.

Engle-Granger causality:

An autoregressive distributed lag (ADL) model for the Granger-causality test was developed following Engle and Granger (1987) specification provided below:

$$P_t^1 = \alpha + \beta_0 T + \sum_{j=1}^{j} \beta_j P_{t-j}^1 + \sum_{k=1}^{k} h_k P_{t-k}^2 + \varepsilon_t$$

where, T is the time trend, ε_t is the error term.

Lags for the ADL model were selected to minimize the Akaike's Information Criterion. Granger causality tests were specified as:

$$P_t^1 = \alpha + \beta_0 T + \sum_{j=1}^{j} \beta_j P_{t-j}^1 + \sum_{k=1}^{k} h_k P_{t-k}^2 + \varepsilon_t$$

$$H_0 : h_1 = h_2 = \ldots = h_k = 0$$

$$P_t^2 = \delta + \varphi_0 T + \sum_{j=1}^{j} \Omega_j P_{t-j}^1 + \sum_{k=1}^{k} \varphi_k P_{t-k}^2 + \upsilon_t$$

H_0: ¨ N Z= ¨ O= Z= KKK= Z= ¨ k Z= M

Co-integration:

Co- integration means that despite being individually non-stationary, a linear combination of two or more time series can be stationary. The series that satisfy this requirement are said to be co-integrated.

Following Granger (1981), a time series x_t which has a stationary, invertible, non-deterministic ARMA representation after differencing d times is integrated of order d and is denoted by x_t ~l(d). The components of the vector x_t are said to be co-integrated of order d, b, denoted CI (d,b), if all the components of x_t are I(d); there exists a vector ' x_t is 1(d-b), b>0.

The vector is then called a co-integrating vector. A necessary condition for co-integration is that the data series for each variable involved exhibit similar statistical properties, that is, to be integrated to the same order with evidence of some linear combination of the integrated series.

Johansen (1988) developed a multivariate system of equations approach, which allows for simultaneous adjustment of both or even more than two variables. Johansen's approach is also widely used in many bivariate studies as it has some advantages to the single equation approach. First, the multivariate system of equations approach is more efficient than the single equation approach, *i.e.*, it allows estimating the co integration vector with smaller variance. The second advantage of the multivariate approach is that in the simultaneous estimation it is not necessary to presuppose exogeneity of either of the variables.

Maximum eigen value test:

Johansen test is based on the eigen values as rank (Π) refers to the number of co-integration relations If the rank (Π) is less than n then there is an existence of co-integration relation. But in that case, the det (Π) = 0. There by, the Eigen values are useful for solving this problem as det (Π) = λ1.λ2…λn. Eigen value of the Johansen test is computed by ordering the Eigen value by size λ1 > λ2 > … > λn. The test of maximum Eigen value is a likelihood ratio test and the test statistic is given as follows:

$$LR\ (r_0, r_{0+1}) = T \ln (1 - {}^{a}r_{0+1})$$

where, LR (r_0, r_{0+1}) is the likelihood ratio test statistic and T is the sample size or total number of usable observations. For testing whether H_0 : rank (Π) = r_0 and H_1 : rank (Π) = r_{0+1} *i.e.* H_0 : rank (Π) = 0 and H_1: rank (Π) = 1, likelihood ratio test LR (0,1) = T ln (1- λ1) is used.

Trace statistic:

The trace test statistic used in the study is as follows:

$$LR\ (r_0, n) = -T \sum_{i=r0+1} \ln (1 - {}^{a}{}_{i})$$

The test is called trace test because the trace of matrix A is Σa_{ii} (sum of diagonal element of a matrix) since in the statistic $\Sigma \ln (1-\lambda_i)$, the $(1-\lambda_i)$ occupies the diagonal position and the sum of these terms leads to the term trace statistic.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Graphical analysis of market integration:

Graphical analysis is one of the crude measures to assess market integration. By performing this analysis, the pattern of price movements between the markets is revealed. The price movements of Gondal, Khammam, Akola, Raichur and Konganapuram markets are depicted in Fig. 1. As it can be seen from the figure, in long run all the five market prices are moving together albeit there is existence of certain amount of disequilibrium or fluctuations in the shorter run. This graphical analysis is a kind of a primer to further perform the formal tests of market integration.

Description of the variables:

Generally, large variation was observed in the prices of cotton in all the five states during last 11 years. Among the five states, Andhra Pradesh (AP) has smaller variation in the cotton price (34.40 % of CV) than other four states. The cotton price in TN ranged from Rs.1950 per quintal to Rs.7245 per quintal. Higher price variation was observed in Gujarat (UP) followed by Madhya Pradesh (MP), Andhra Pradesh (AP) and Karnataka (KAR). The measure of skewness and kurtosis confirmed that prices

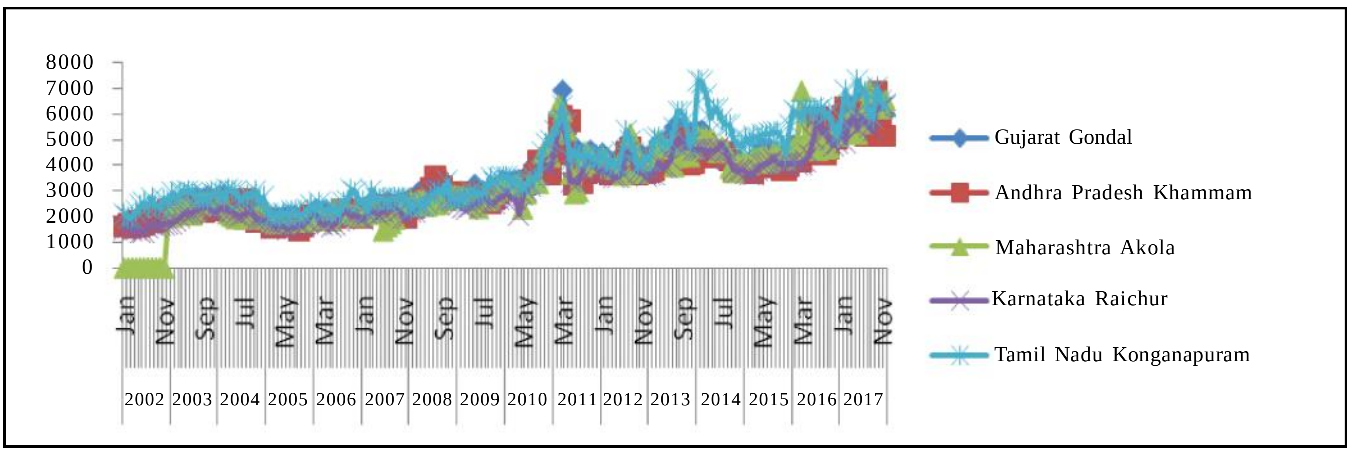

Fig. 1 : Graphical analysis of cotton domestic markets

Table 1 : Summary statistics

	Andhra Pradesh (AP)	Gujarat (GUJ)	Karnataka (KAR)	Madhya Pradesh (MP)	Tamil Nadu (TN)
Maximum	5870	6925	5832	6879	7245
Minimum	1461	1733	1400	1259	1950
Std. Dev.	1077.73	1204.36	1140.44	1192.45	1366.55
Co-efficient of variation (CV)	34.40	34.82	37.78	36.94	36.79
Skewness	0.40	0.41	0.40	0.49	0.60
Kurtosis	2.20	2.05	1.95	2.19	2.10

of AP, GUJ and KAR are normally distributed, whereas price of cotton in MP and TN are not normally distributed.

Unit root test:

In all the three price series, the unit root test on levels detected non-stationarity and only the first differences were turned out to be stationary. It indicated that all the series are integrated of order one *i.e.* I (1). This condition is necessary to perform the bivariate and multivariate co-integration test.

Causality test:

Before performing market integration test, it is necessary to know the causal relationship existing between the markets. Here causality implies Granger causality which ascertains the lead market between the market pairs.

There is a strong relationship between the Granger causality and co-integration *i.e.* there needs to be at least one market Granger to establish co-integration in the market pairs (Brooks, 2008). The test finds out which market should be regressand (dependent variable) and which should be kept as regressor (independent variable). The test was performed between ten market pairs consisting of all the five markets under study and the results are furnished in Table 3 and Fig. 2.

From the Fig. 2 it is identified that there is bi-direction causality between Gujarat and Andhra Pradesh, Andhra Pradesh and Maharashtra, Maharashtra and Tamil Nadu, Tamil Nadu and Karnataka and also between Karnataka

Table 2 : Unit root test of cotton market study

Variable	Level	First difference	Stationarity
LANP	- 1.7624	9.6377***	Stationary
LGUJ	- 1.4365	- 11.6238***	Stationary
LKAR	- 0.9587	- 10.0780***	Stationary
LMAH	- 2.1567	- 13.8250***	Stationary
LTAM	- 1.6843	- 9.9168***	Stationary

Note: Figures in parentheses are the number of significant lags,*** indicate significance of value at P=0.1 level. Crtical Value: -3.44 (5%)

Table 3 : Pairwise granger causality test for different market

Null hypothesis	Observation	F- statistic	Prob.
GUJ does not Granger Cause ANP	166	40.7806***	5.E-15
ANP does not Granger Cause GUJ		8.7656***	0.0002
MAH does not Granger Cause ANP	166	22.3424***	3.E-09
ANP does not Granger Cause MAH		2.3878**	0.0951
KAR does not Granger Cause ANP	166	38.4784***	2.E-14
ANP does not Granger Cause KAR		2.2377*	0.1100
TAM does not Granger Cause ANP	166	15.5070***	7.E-07
ANP does not Granger Cause TAM		6.3792***	0.0022
MAH does not Granger Cause GUJ	166	7.0264***	0.0012
GUJ does not Granger Cause MAH		9.9755***	8.E-05
KAR does not Granger Cause GUJ	166	3.5700**	0.0304
GUJ does not Granger Cause KAR		4.5674**	0.0118
TAM does not Granger Cause GUJ	166	2.2962*	0.1039
GUJ does not Granger Cause TAM		7.3822***	0.0009
KAR does not Granger Cause MAH	166	17.5447***	1.E-07
MAH does not Granger Cause KAR		5.1430**	0.0068
TAM does not Granger Cause MAH	166	12.9340***	6.E-06
MAH does not Granger Cause TAM		5.9502**	0.0032
TAM does not Granger Cause KAR	166	6.5749***	0.0018
KAR does not Granger Cause TAM		9.3170***	0.0001

** and *** indicate significance of values at P=0.05 and 0.01, respectively

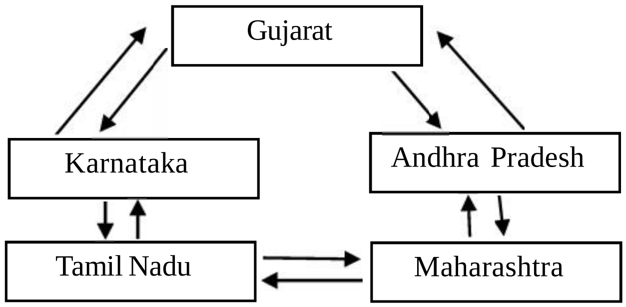

Fig. 2 : Casual relationship among domestic cotton markets under study

and Gujarat market. Bidirectional influence on cotton prices was found to exist among the markets considered.

Johansen co-integration test:

The weakness of the Engle-Granger co-integration test is that it can be applied only for a bivariate series and does not hold good to a multivariate series. As three markets were taken in the present study, the weakness of the Engle-Granger test was overcome by using multivariate Johansen co-integration technique.To perform this test, it was necessary to have the price series of all the three markets in the same order *i.e.* all the price series should be integrated in the same order of stationarity. As the findings revealed that all the five markets were stationary at I(1), the test was performed. Since the Johansen test uses the restricted VAR(p) model *i.e.* VECM model, determining optimum lag becomes a significant step. The optimum lag was selected as 1 and 10 by the AIC and SIC. For parsimonious approach, lag 1 was selected and performed. The Eigen values were obtained from the co-integration matrix (Π) as given in Table 3. As there were three market price series, three Eigen values were obtained. The number of non-zero Eigen value indicated the rank of the co-integration matrix and the rank of that matrix in turn indicated the number of co-integration relation that is stationary (Tsay, 2016). As it is clear from Table 3 that only the first two Eigen values were non-zero, thereby there are only two co-integration relations between the market pairs.

This result is supported by the determinant of the co-integration matrix which is zero; as it implies that the rank of that matrix is not three *i.e.* rank of matrix is less than three. Eigen value denotes the number of co-integration relation and it has been formally tested in the study using Johansen test and the results are presented in Table 4. The Johansen approach consists of two tests one is Trace test and other is maximum Eigen value test (Table 4) and the latter test is more powerful than the former (Reddy, 2012). As the findings show, the trace test accepts the Null hypothesis of two co-integration relation (Rank of matrix (Π) = 2) and it is supported by the maximum Eigen value test which rejects the Null hypothesis of one co-integration relation and accepts the alternative hypothesis of two co-integration relationship. Since both the tests accepted the maximum co-integration relationship in the multivariate series (*i.e.* two), the long-run integration of the markets stand confirmed.

Table 4 : Eigen value of the co-integration matrix

Eigen value	
$\lambda_{1=0.32}$	Eigen value order = 0.32>0.24>0.13>0.03>0.00
$\lambda_{2=0.24}$	$\lambda_1 \geq \lambda_2 \geq \lambda_3 \geq \lambda_4 \geq \lambda_5$
$\lambda_{3=0.13}$	Det (II) = $\lambda_1 . \lambda_2 . \lambda_3 . \lambda_4 . \lambda_{5=0}$
$\lambda_{4=0.03}$	
$\lambda_{5=0.00}$	

Johansen co-integration method is the most widely used tool to study market integration. Johansen cointegration test results are given in Table 5. Based on the test the integration between the markets are analyzed

Table 5 : Co-integration test results

Series: Andhra Pradesh, Gujarat, Karnataka, Maharashtra and Tamil Nadu				
Unrestricted co- integration rank test (Trace)				
Hypothesized No. of CE (s)	Eigenvalue	Trace statistic	0.05 critical value	Prob.**
None *	0.3231	140.7090***	69.8188	0.0000
At most 1	0.2469	77.0799***	47.8561	0.0000
At most 2	0.1344	30.8562**	29.7970	0.0376
At most 3	0.0398	7.3180	15.4947	0.5409
At most 4	0.0041	0.6824	3.8414	0.4087

Trace test indicates 1 co-integrating equations at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values using Eviews software which indicated the presence of one cointegration among the markets. To obtain two co-integration relations, possible pairs of the five markets under study *viz.*, Andhra Pradesh, Gujarat, Karnataka, Maharashtra and Tamil Nadu were considered and the findings are presented in Table 5. The co-efficients in the co-integration relationships were normalized co-efficients (Table 5). This integration of markets implied that price in the spatially separated markets move together in response to changes in the demand and supply and other economic variables. This also indicated that there is common stochastic trend or one unit root for all the five markets. Hence, cottons markets are having long run equilibrium relationship.

Conclusion:

Spatial market integration is examined by estimating price linkages among geographically separated five markets. Data used for the analysis are monthly wholesale prices of domestic cotton markets. For each location, the units root test indicated that the price series are non stationary at their levels. Results reveal that markets are spatially integrated as indicated by strong spatial price linkages among markets implying that cotton farmers throughout India would be benefitted by any change in prices of cotton and the increase or decrease would affect cotton growers throughout the nation. Among the markets, Andhra Pradesh, Gujarat and Karnataka came to short run equilibrium at a faster rate than other markets. In long run, all the markets had equilibrium adjustment, indicating that there would be a co- integrating relationship among the cotton markets in TN, MAH, AP, KAR and GUJ. Specifically, in Tamil Nadu market, the speed of adjustment towards equilibrium arises by almost 0.34 per cent. The outcomes confirm that Gujarat market significantly would affect the cotton market in Tamil Nadu. It revealed that any increase in the price of cotton in Gujarat markets would cause higher price for cotton in Tamil Nadu. Therefore, adequate precaution measures have to be undertaken to overcome the shortage in arrivals and increased price of cotton. Increase in cotton production and needed market infrastructure facilities are needed. Thus, the results of the present study indicated that cotton markets in all the states are integrated and leading to efficiency in cotton marketing.

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