Market Integration among Major Wheat Markets in India

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Authors' contributions

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ABSTRACT

The study is based on secondary data which tests the price movement and integration between major national wheat markets i.e. Lakhimpur, Agra, Vidisha, Dewas, Kota and Baran markets. Monthly wheat prices data of 15 years from 2007-08 to 2021-22 which was collected from www.agmarknet.gov.in. To analyze the market integration among major wheat markets, the Augmented Dickey-Fuller test, Johansen Co-integration test and Granger Causality test were applied with the help of E-views statistical package. The results indicated the strong market integration in terms of price linkages among major wheat markets. The results revealed that the major markets of wheat have strong price linkages and thus are spatially integrated. It could be seen that existence of mostly (10) unidirectional causality with few (3) bidirectional causality among selected wheat markets. It was further revealed from the analysis that, any disturbance in price will get corrected in about 5 days in Lakhimpur market, 3 days in Agra market and 3 days in Kota market in short-run equilibrium. The transfer of price signals from one market to another helps in stabilizing the prices over space and create a healthy competitive environment. This would also

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help to protect the interest of producer-sellers. In order to achieve the goal of integration, the government should strengthen the market intelligence and communication within markets. The following study recommendations were made: a) Government should subsidize provide is transportation. b) Government and stakeholder should advise commercial banks to give low interest long-term loans to farmers because many impoverished farmers can't afford crop mechanization. c) Government and other i.e, NGO advertising should be increased to raise knowledge about improved agricultural machinery. d) Government and other i.e, NGO should educate farmers. Farmers can employ technology if they are trained and educated. They should also be told how much fertilizer to use so it yields more.

Keywords: Co-integration; wheat; ADF unit root test; granger causality test and VECM.

1. INTRODUCTION

The world's population, particularly among emerging countries, is growing at an alarming rate. Feeding the world's growing population is a difficult task for developing-country planners as well as global bodies. Agriculture is critical to the Indian economy. Wheat is a cereal grain that belongs to the grass genus *Triticum*. The durum wheats most likely originated in Abyssinia, whereas the entire group of soft wheats, which includes bread wheats, most likely originated in Pakistan, specifically in the South Western and Southern regions of mountainous Bokhara. It is mostly grown in temperate and subtropical climates around the world. Although there are several wheat species recognized around the world, only three are commercially cultivated in India: *Triticum aestivum* (Bread wheat), *Triticum durum* (Macaroni wheat), and *Triticum dicoccum* (Emmer wheat). Wheat is globally the leading source of carbohydrate in human food, with content of about 71 per cent, apart from this, it also contains 13 per cent proteins which is very high as considered to cereals and hence is also a major source of proteins around the world.

Wheat's health advantages are highly dependent on how it is ingested. While whole wheat is incredibly nutritious, the advantages of wheat are diminished when consumed as white flour, which is created by processing after just 90 per cent of the grain is extracted in Indian conditions. According to several studies and researches, wheat and wheat flour are becoming increasingly significant in the administration of India's food economy. With the second greatest population, it is also the second largest consumer of wheat after China, with a massive and expanding wheat demand. Uttar Pradesh is the largest producer of wheat contributing for about 32 per cent. Madhya Pradesh accounting for about 18 per cent followed by Punjab for about 16 per cent, Haryana for about 11 per cent and Rajasthan for

about 10 per cent of the total wheat output in the country.

Prices determine what is supplied as well as how much is generated. The price framework is an excellent tool for communicating basic financial information and fostering proper decision-making by producers and buyers. Furthermore, price is the most crucial profit or loss aspect in an agricultural operation [1]. Because crops are sown in one season and harvested in another, time is critical in an agricultural operation. One of the aspects of marketing efficiency is the pricing efficiency of marketing system which can be analyzed by studying the differences in prices between the spatially separated markets as well as through examining the correspondence in the movement of prices in one market with that in other ones [2]. The extents to which prices in spatially separated markets move together reflect the degree of integration. With this backdrop, the present paper highlighted market integration among major wheat markets in India.

2. METHODOLOGY

Depending upon the highest area under wheat and consistency of monthly arrivals data, Uttar Pradesh, Madhya Pradesh and Rajasthan states were selected for the completion of the specific objectives of the study. Punjab and Haryana states were not included for the study. Because, monthly arrivals data were not available throughout the study period. Selection of markets for the study was done on the basis of maximum quantity of arrivals for different markets in selected states. For the selection of markets, data were collected from www.agmarknet.gov.in for each state and average wheat arrivals during the last three years of the study (2019-2021) were calculated.

In the second stage, looking into the average arrivals in different markets and also based on

the availability of data, two major markets were selected from each selected state. Thus, the six major markets selected for the study were Lakhimpur and Agra markets from Uttar Pradesh, Vidisha and Dewas markets from Madhya Pradesh and Kota and Baran markets from Rajasthan states.

2.1 Co-integration: In EVIEWS

This analysis was carried out to ascertain the response of price change in one market that is transmitted to other markets. The Co-integration analysis was carried out for this purpose to know the inter market price relationship between the major wheat markets in India.

Price relations are widely used to indicate the overall market performances; the usual definition is that integrated markets are those whose prices are determined interdependently i.e the changes in one market will be fully transmitted to the other markets [3].

In the present study co-integration method has been adapted with the use of E-views 12 software to study the market integration for modal prices of the selected markets. To carry out the analysis data has been made stationary mean that the process of generating the data is in equilibrium around a constant value and that the variance around the mean remains constant over a time. If mean changes over time and variance is not reasonably constant, then the series is non-stationary. To decide the stationarity of the data, for each the market ADF test (Augmented Dickey –Fuller Unit root test) has been conducted. If calculated probability value of respective market in ADF test is less than 0.05 then that market's price data is already stationary. But if the ADF values are greater than 0.05, data is subjected to 1st order differencing or 2nd order differencing until it becomes stationary [4].

Johansen co integration test can be applied to analyze the long run equilibrium among the selected wheat markets. As a part of co-integration analysis, Granger causality Test was used to know if co integration exists between two markets or not. Finally vector Auto regression Estimates are calculated for all the markets. The VER estimates will provide the short term Co-integration with in the markets and between the markets which will be expressed in percentage. The t-Statistics are calculated to know the significance of the markets within them and also between markets, which will be greater than 1.96

then the integration values are considered as significant otherwise they are non-significant and will not be considered for drawing the inferences [5].

3. RESULTS

3.1 Extent of Market Integration among the Major Markets of India

One aspect of marketing efficiency is the pricing efficiency of marketing systems, which can be studied by examining price differences between spatially separated markets as well as the correspondence in the movement of prices in one market with that in others. The degree of integration is reflected in the extent to which prices in physically distinct markets move together. Co-integration is an analytic technique for common trends in multivariate time series and modeling long run and short run dynamics. Two or more predictive variables in a time series model are co-integrated when they share a common stochastic drift. Variables are considered to be co-integrated if a linear combination of them produces a stationary time series [6].

Co-integration was studied to analyze the integration between selected major wheat markets of India using monthly prices data of fifteen years (2008-09 to 2021-22). Augmented Dickey Fuller (ADF) unit root test, the Johansen Co-integration test, the Granger causality test and the Vector Error Correction Model were used to examine the integration of selected wheat markets. The first step in Co-integration analysis is performing the Augmented Dicky Fuller Unit Root Test (ADF test) which was conducted to check the data for the stationarity. On conducting ADF test for all the selected wheat markets i.e., Lakhimpur, Agra, Vidisha, Dewas, Kota and Baran data were made stationary by taking First Difference (Table 1).

Since all the price series were non-stationary at level form and stationary at first difference level, Johansen co integration test can be applied to analyze the long run equilibrium among the selected wheat markets. The results of the analysis showed that there existed at least three co-integrations which were significant at one per cent probability level (Table 2). Hence, it was concluded that long run equilibrium exists among the six major markets. Any shocks in these markets would affect the prices of the other markets.

Table 1. Stationarity of wheat prices in major markets of India (ADF Unit Root Test)

Variable	Level	P-value	First differencing	P-value	Remarks
Lakhimpur	-0.6995	0.8419	-8.9434	0.0000**	
Agra	0.6220	0.9898	-8.9190	0.0000**	
Vidisha	-2.2035	0.2062	-11.5895	0.0000**	Stationary after first differencing
Dewas	-1.6658	0.4459	-12.2121	0.0000**	
Kota	0.0550	0.9609	-9.6318	0.0000**	
Baran	0.1724	0.9698	-10.1214	0.0000**	

*Note: **Significant at 1 percent level*

Table 2. Long term integration of wheat prices in major markets of India (Johansen's multiple co-integration test)

Trace statistics of Series Kota, Lakhimpur, Vidisha, Dewas, Agra and Baran				
No. of CE(s)	Eigen value	Statistic	Critical value	Probability
None	0.2375	156.50	117.70	0.0000**
At most 1	0.2002	109.05	88.80	0.0008**
At most 2	0.1614	69.94	63.87	0.0141**
At most 3	0.1414	39.13	42.91	0.1135
At most 4	0.0468	12.45	25.87	0.7796
At most 5	0.0229	4.05	12.51	0.7337

*Note: * Denotes rejection of the hypothesis at the 0.05 level*
Critical values based on MacKinnon (1999)
Trace test indicated 3 co-integrating equations at the 0.05 level

As a part of co-integration analysis, Granger causality test was carried out to know if co integration exists between two pairs of markets or not. The causal relationship among the market prices of major wheat markets in India were approached through above technique and results are presented in Table 3 and Fig. 1. It could be seen from the table that, some of the selected markets were highly co-integrated with each other. If the value of probability is less than 0.05, then the markets are said to be highly co-integrated. In this study, any changes in wheat price in Baran market causes changes in wheat price in Agra market. But Agra market does not cause a price change in Baran market. Hence, the price flow is unidirectional in this case. Similarly, unidirectional causality is observed in majority of market pairs, expect in the cases of Agra: Vidisha, Dewas: Kota and Vidisha: Lakhimpur markets, where bidirectional causality was observed. Thus results of the study indicated a strong integration among major wheat markets in India. So it is confirmed that the price of one market influence the price of other markets. The test for causality was based on F statistics.

In order to know the extent of co-integration between the major wheat markets considered under study, the Vector Error Correction Mechanism was conducted and the results of the same are presented in Table 4. The co-integration coefficients were tested for their significance by comparing with the critical t value (1.96) and the significance was established where calculated t value is greater than critical t value. The co-integration coefficients were significant only with Lakhimpur, Agra and Kota markets. For other markets, i.e., Vidisha, Dewas and Baran markets the co-integration coefficients were found to be non-significant.

In order to know the impact of lagged prices on establishing current prices in the markets under study, VECM was extended to lagged prices of various co-integrated wheat markets and the results are depicted in Table 4. Only those markets with significant t value were considered for further interpretation.

One month lagged prices of Lakhimpur market would have an impact on the present prices in Agra market to an extent of 19.53 per cent in positive direction. Two month lagged prices of Lakhimpur market would influence the existing market price of same market to the tune of 20.61 per cent in a negative direction. One month lagged prices of Agra market would influence on the present prices in Dewas market to an extent of 34.79 per cent in negative direction. Two month lagged prices of Lakhimpur market month lagged prices of Agra market would influence the existing market price of same market to the tune of 23.03 per cent in a negative direction. One

month lagged prices of Dewas market would have an impact on the present prices in Kota market to an extent of 20.01 per cent in positive direction. Two month lagged prices of Dewas market would have an impact on the present prices in Lakhimpur market and Kota market to an extent of 14.69 per cent and 14.87 per cent respectively in positive direction. Similarly, one month lagged prices of Kota market would have an impact on the present prices in Agra market to an extent of 24.09 per cent in positive direction. In all other markets through there exists co-integration between the prices but they were non-significant.

4. DISCUSSION

Integration of markets is a better indicator of efficiency in the marketing system. The present study has examined co-integration between the markets and price transmission in major wheat markets in India – Lakhimpur, Agra, Dewas,

Vidisha, Kota and Baran markets. The results of overall co-integration test have revealed that different wholesale wheat markets in the country were well-integrated even though they are geographically dispersed, and have long-run price association across them indicating that these markets are competitive and efficient at the wholesale level. But, in short run, market prices fluctuate from their equilibrium but converge with in few days, particularly in Lakhimpur, Agra and Kota markets. The pair-wise co-integration test has confirmed that all the different market pairs considered had price association between them and Baran market has emerged as the price leader as it influenced the prices of most of the selected markets. The results have revealed disequilibrium of 17 per cent, 11 per cent and 9 per cent, in Lakhimpur, Agra and Kota markets respectively which could be corrected within one week. The interstate movement of wheat is determined by the transportation cost among various markets.

Table 3. Pairwise direction of wheat prices in major markets of India

Null hypothesis	F – statistic	P –value	Direction
BARAN does not Granger Cause AGRA	34.6329	0.0000**	Unidirectional
AGRA does not Granger Cause BARAN	0.69410	0.5009	
DEWAS does not Granger Cause AGRA	10.0299	0.0000**	Unidirectional
AGRA does not Granger Cause DEWAS	1.89714	0.1531	
KOTA does not Granger Cause AGRA	22.9838	0.0000**	Unidirectional
AGRA does not Granger Cause KOTA	0.73320	0.4826	
LAKHIMPUR does not Granger Cause AGRA	1.12553	0.3281	Unidirectional
AGRA does not Granger Cause LAKHIMPUR	12.3378	0.0000**	
VIDISHA does not Granger Cause AGRA	4.12141	0.0178*	Bidirectional
AGRA does not Granger Cause VIDISHA	3.86408	0.0228*	
DEWAS does not Granger Cause BARAN	0.67805	0.5097	Unidirectional
BARAN does not Granger Cause DEWAS	3.11826	0.0016**	
KOTA does not Granger Cause BARAN	0.61794	0.5409	Unidirectional
BARAN does not Granger Cause KOTA	6.04971	0.0032**	
LAKHIMPUR does not Granger Cause BARAN	0.13067	0.2732	Unidirectional
BARAN does not Granger Cause LAKHIMPUR	20.4787	0.0000**	
VIDISHA does not Granger Cause BARAN	0.64285	0.5277	Non-significant
BARAN does not Granger Cause VIDISHA	1.88047	0.1573	
KOTA does not Granger Cause DEWAS	2.12461	0.0074**	Bidirectional
DEWAS does not Granger Cause KOTA	4.56948	0.0034**	
LAKHIMPUR does not Granger Cause DEWAS	1.27409	0.2837	Unidirectional
DEWAS does not Granger Cause LAKHIMPUR	10.4158	0.0000**	
VIDISHA does not Granger Cause DEWAS	3.29207	0.0393*	Unidirectional
DEWAS does not Granger Cause VIDISHA	2.17691	0.1169	
LAKHIMPUR does not Granger Cause KOTA	0.15976	0.8289	Unidirectional
KOTA does not Granger Cause LAKHIMPUR	16.2270	0.0000**	
VIDISHA does not Granger Cause KOTA	1.72337	0.1909	Non-significant
KOTA does not Granger Cause VIDISHA	1.69455	0.1868	
VIDISHA does not Granger Cause LAKHIMPUR	6.51341	0.0019**	Bidirectional
LAKHIMPUR does not Granger Cause VIDISHA	4.65389	0.0107**	

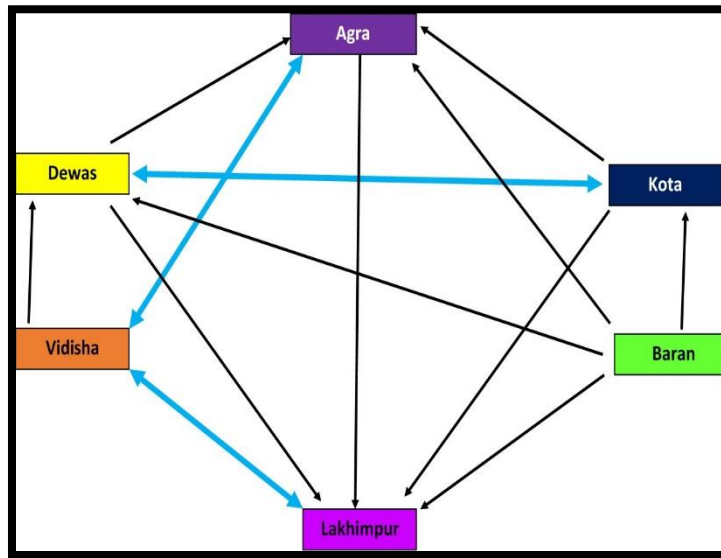*Note: **Significant at 1 percent level; * Significant at 5 percent level*

Fig. 1. Pairwise direction of wheat prices in major markets of India

Table 4. Short term integration of wheat prices in major markets of India

Error Correction:	D(LAK)	D(AGR)	D(VID)	D(DEW)	D(KOT)	D(BAR)
ECM	-0.1712	-0.1177	-0.0638	0.0141	-0.0992	0.0064
	[-4.8686]	[-3.2714]	-0.8635	0.2514	[-2.4974]	0.1524
D(LAK(-1))	-0.1032	0.1953	0.1792	0.0746	0.0396	-0.0486
	-1.2180	[2.2528]	1.0061	0.5498	0.4138	-0.4808
D(LAK(-2))	-0.2061	0.0780	-0.1229	0.0771	-0.0478	-0.0147
	[-2.4117]	0.8920	-0.6842	0.5631	-0.4956	-0.1440
D(AGR(-1))	0.1763	-0.1618	0.1849	-0.3479	-0.9010	-0.0802
	1.7749	-1.5913	0.8854	[-2.1854]	-0.8027	-0.6760
D(AGR(-2))	-0.0761	-0.2303	0.1405	-0.2351	0.0412	-0.0284
	-0.8007	[-2.3680]	0.7033	-1.5438	0.3844	-0.2507
D(VID(-1))	-0.0526	-0.0749	-0.0867	0.0110	0.0004	-0.0155
	-1.3068	-1.818	-1.0237	0.1715	0.0089	-0.3236
D(VID(-2))	0.0254	0.0536	0.0260	0.0363	0.0234	0.0566
	0.6157	1.2712	0.3007	0.5504	0.5025	1.1485
D(DEW(-1))	-0.0512	0.0466	0.0227	-0.1604	0.2001	0.1340
	-0.8049	0.7146	0.1696	-1.5715	[2.7812]	1.7606
D(DEW(-2))	0.1469	0.1033	-0.0776	0.0310	0.1487	0.1204
	[2.3569]	1.6205	-0.5923	0.3111	[2.1135]	1.6171
D(KOT(-1))	0.1106	0.2409	0.0302	0.0996	-0.0484	-0.0308
	1.0163	[2.1636]	0.1320	0.5714	-0.3939	-0.2370
D(KOT(-2))	0.1735	0.1640	0.0132	0.1537	-0.0192	0.1682
	1.6432	1.5185	0.0595	0.9087	-0.1618	1.3338
D(BAR(-1))	-0.0223	0.1072	-0.2281	0.2390	-0.1112	0.0857
	-0.1758	0.8246	-0.8543	1.1746	-0.7753	0.5650
D(BAR(-2))	-0.2002	-0.2303	0.0344	0.0929	-0.1346	-0.2566
	-1.6340	-1.8368	0.1335	0.4734	-0.9725	-1.7530

Note: LAK - Lakhimpur, AGR – Agra, VID – Vidisha, DEW – Dewas, KOT – Kota and BAR – Baran

As evinced by the Table 4, the current market prices of wheat in Agra market were influenced to the extent of 19.53 per cent positively. It is inferred that total increase in the current market price of Agra market the influence of one month lagged prices of Lakhimpur prices was to the extent of 19.53 per cent and the remaining variation in the current market price was

attributable to the local factors existing in Agra market. Similarly, current prices of Lakhimpur market was negatively influenced by two month lagged prices of Lakhimpur market itself. Thus, two month lagged prices of Lakhimpur market would have negative impact on the current prices of the same to the extent of 20.61 per cent. One month lagged prices Agra market had negatively influenced the current prices of wheat in Dewas market to the extent of 34.79 per cent. In the same way two month lagged prices Agra market had drifted down effect on the current prices of Agra market to the extent of 23.03 per cent. Again, one month lagged prices of Dewas market has its share to the extent of 20.01 per cent in increase of current price of Kota market. Two month lagged prices of Dewas market had 14.69 per cent and 14.87 per cent increase impact on current wheat prices in Lakhimpur and Kota markets respectively. Similarly, one month previous prices prevailing in Kota market had influenced the current prices in Agra market to an extent of 24.09 per cent. The remaining variations, either increase or decrease in the current prices of respective markets where due to the factors that were prevailing in those markets.

Present study suggested that co-integration among various markets aids in transfer of price signals from each market to another market and thereby stabilizing the prices over space. Understanding the efficiency of the marketing system would be influenced by knowledge of market integration, policymakers, producers and traders could derive benefit from the results of the study. In order to get faster movement of market information, strengthening market intelligence along with the establishing of online marketing system through computerization and networking is need of the hour. The market price information should be made available to the stakeholders through electronic and print media immediately. Development of market infrastructure including transportation, storage and communication facilities are the need of time in order to fully integrate the markets. Similar results were found in the study carried out by Sreepriya and Kumar [7] who reported in their work entitled an analysis of co-integration among major potato markets in India.

5. CONCLUSIONS

The study has examined co-integration and price transmission in major wheat markets in India – Lakhimpur, Agra, Vidisha, Dewas, Kota and Baran markets. The results of overall co-integration test have indicated that different wholesale wheat markets in the country even if geographically dispersed, are well-integrated and have long-run price association across them suggesting that these markets are competitive and efficient at the wholesale level. However, in short run, market prices do deviate from their equilibrium but converge in few days [8]. The market pair-wise co-integration test has confirmed that all the different market pairs considered had price association between them and Baran market was realized as the price leader as it influenced the prices of all other markets except Vidisha market. The foregone discussion suggests that co-integration among different markets help in transfer of price signals from one market to another and thereby stabilizing the prices over space. The knowledge on market integration will be a guiding principle for understanding the efficiency of the marketing system and policy makers, producers and traders can use the results to their benefits [9].

6. RECOMMENDATIONS

The Following study recommendations were made: a) Government should subsidize provide is transportation. b) Government and stakeholder should advise commercial banks to give low interest long-term loans to farmers because many impoverished farmers can't afford crop mechanization. c) Government and other i.e, NGO advertising should be increased to raise knowledge about improved agricultural machinery. d) Government and other i.e, NGO should educate farmers. Farmers can employ technology if they are trained and educated. They should also be told how much fertilizer to use so it yields more [10].

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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