

Research Paper

Co-integration of Major Vegetable Markets in Punjab, India

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ABSTRACT

The present study was formulated to analyze the level of market integration in the major vegetable markets in Punjab. The study was undertaken on a macro framework based on data collected from secondary sources through employing different tests, namely Johansen co-integration test, Granger causality test. The investigations of integration between sample markets indicated that in case of all of the vegetables the state markets are found to be well integrated among each other and also with the national market (New Delhi) with an exception in case of tomato where it was seen that there was not any integration found between Ludhiana and Jalandhar market which was due to communication problems and lack of market intelligence between those markets. Hence in order to continue the competitive condition of these markets there is need to strengthen the market intelligence and communication within markets so that a better platform could be placed for guiding the farmers in marketing their produce.

HIGHLIGHTS

- The state markets are well integrated among each other and also with the national market (New Delhi) except between Ludhiana and Jalandhar market which was due to communication problems and lack of market intelligence between those markets.

Keywords: Market arrivals, Market prices, Seasonal indices, Market integration

Market integration occurs when prices among different locations or related goods follow similar pattern over a long period of time. Groups of prices often move proportionally to each other and when this relation is very clear among different markets it is said that the markets are integrated. In order to establish the long run equilibrium relation among the price series, it is very necessary to co-integrate them. Advanced econometric techniques like Johansen Co-integration Test, Granger Causality Test and Vector Error Correction Model has been used to study the integration of markets at state and national level. Before starting any statistical test there is a need to check whether the variables are stationary or not as it will help to avoid spurious results. Therefore, it is necessary to examine the time series properties of the variables. Further to establish the long-run equilibrium relation among

the price series, it is necessary to co integrate them. The Johansen and Juselius (1990) co-integration test for the long run relationship among the price series were employed. Maximum likelihood ratio test statistics are proposed to test number of co-integrating vectors. The Granger causality test conducted within the framework of a vector auto regressive (VAR) model was used to test the existence and direction of long-run causal price relationship between the markets.

Market integration is one of the ways to focus on the issues of price fluctuation for the analysis of the market performance (Mukhtar and Javed 2007).

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When there is a change in prices in one market, it will be transmitted to another market on a “one-to-one” basis either instantly or over a number of lags (Sanogo and Amadou 2010). The degree, to which consumers and producers would get benefited, is mainly dependent on integration of domestic markets with world markets and that of regional markets with each other (Varela *et al.* 2012).

The integration between the markets can be easily calculated by the accurate estimation of strength and the speed of price transmission in between the markets across several regions of the nation (Ghafoor *et al.* 2009). The regional disparities in the extent of integration of markets are mainly caused by the regional variations found in different institutional structure of agricultural markets (Ghosh 2010; Ghosh 2013). Despite the geographical dispersion of regional markets, the long-run spatial linkages may be exhibited in prices across different market centers within and across the states. Therefore the evaluation of performances of spatially separated markets can be done by stating the relationships between the prevailing prices in those markets. Co-integration suggests that all the exchange locations are integrated and that prices provide relevant market signals. Thus, it is very important to examine the spatial integration among major vegetable markets as the results will have

important implications for agricultural price policy.

LITERATURE REVIEW

Methodology

Here in this study the major vegetables being produced in Punjab were selected based on their share in total vegetable production of the state i.e. Potato, Tomato, cauliflower and peas accounted for 55.4, 4.5, 5.5, and 5.4 per cent respectively of total vegetable production during TE 2019-20 contributing around 70.8 per cent of total production of vegetables in the state. The selected markets in Punjab for the study were Ludhiana, Amritsar and Jalandhar based on annual market arrivals and data availability. In addition, one national market viz. Delhi was also taken as sample market. Time series data regarding monthly prices and arrivals in the major markets were collected from various secondary sources like agricultural produce market committees of Amritsar, Jalandhar, Ludhiana and New Delhi, www.nhrdf.org, www.indiastat.com, www.fao.org, www.agmarknet.nic.in and www.usda.gov etc.

Co-integration Test

The degree of deviation from the long run equilibrium relationship is explicated by co integration test by

Sl. No.	Research Topic	Methodology used	Author	Results
1	Testing Market integration and convergence to the law of one price in Indian Onions	Johansen’s Multivariate Co-integration Test, Error Correction Model, LOOP analysis	Sendhil R, Sundarmoorthy C, Venkatesh P and Thomas L (2014)	Strong spatial itegration between major Indian Onion markets
2	Market Price Co-integration of Tomato: Effects to Nepalese farmers	ECM of Dickey Fuller Test, VECM estimation	Shrestha R B, Huang W and Ghimire R (2016)	Kathmandu market was well cointegrated with source markets (Chitwan and Morang) Faster Price adjustment process has affected the farmers with negative shock
3	Market integration of selected cotton markets in Haryana	ADF test, Johansen co-integration test and Granger Causality test	V. Mahesh*, R.K. Grover and R.S. Geetha (2018)	All markets found integrated with each other. Dabwali market as lead cotton market because it influenced the prices of most of selected cotton markets.
4	Cointegration, Causality and Impulse Response Analysis in Major Apple Markets of India	Granger Causality test and Impulse response	Fayaz Ahmad Beag and Naresh Singla* (2014)	Delhi is the price-determining market. Hyderabad has bidirectional causal relations with other markets. The market pairs: Ahmedabad – Kolkata and Bengaluru – Kolkata have not shown any causal relation between them.

the non-stationary series. It is the yoke between integrated processes and steady state equilibrium and hence furnishes the relevant theoretical framework for examining kinetics of instantaneous changes in a pair of series along with their valuable long run information. Once it was confirmed that all of the price-series were stationary at same order of differences, the co-integration of markets were tested by Johansen maximum-likelihood techniques. The Johansen and Juselius (1990) co-integration test for the long run relationship among the price series were employed. Maximum likelihood ratio test statistics are proposed to test number of co-integrating vectors. The null hypothesis of at most r co-integrating vectors against a general alternative hypothesis of more than r co-integrating vectors is tested by trace statistics. The null hypothesis of r co-integrating vector against the alternative hypothesis of $r + 1$ is tested by Maximum-eigen-value-statistic. The number of so integrating vectors indicated by the tests is an important indicator of the extent of co-movement of prices. An increase in the number of co-integrating vectors implies an increase in the strength and stability of price linkages.

Granger Causality Test

Granger's causality technique was used to reveal the causal relationship between the prices series in selected vegetable markets. The Granger causality test conducted within the framework of a vector auto regressive (VAR) model was used to test the existence and direction of long-run causal price relationship between the markets. An autoregressive distributed lag (ADL) model for the Granger-causality test was specified as below:

$$X_t = \sum_{i=1}^n a_i Y_{t-i} + \sum_{j=1}^n \beta_j X_{t-j} + u_{1t}$$

$$Y_t = \sum_{i=1}^n \lambda_i Y_{t-i} + \sum_{j=1}^n \delta_j X_{t-j} + u_{2t}$$

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

RESULTS AND DISCUSSION

(I) Potato

I (a) Johansen Co-integration Test

The results of Johansen multiple co-integration

procedure are presented in Table 1 (a). 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 potato markets were having long run equilibrium relationship. Further for the direction of this long run causal relationship between markets, Granger Causality test has been employed.

Table 1 (a): Unrestricted Co integration Rank Test (Trace) for selected potato markets

Hypothesized no of CE(s)	Eigenvalue	Trace	0.05	Prob.**
		Statistic	Critical Value	
None *	0.32	103.90	63.88	0.00
At most 1 *	0.22	59.32	42.92	0.00
At most 2 *	0.16	30.22	25.87	0.01
At most 3*	0.08	19.21	12.52	0.07

*Trace test indicates 4 co integrating eqn(s) at the 0.05 level; * denotes rejection of the hypothesis at the 0.05 level; Prob. ** denotes MacKinnon-Haug-Michelis (1999) one sided p-values.*

I (b) Granger Causality Test

The results of causal relationship between the price series in major potato markets in Punjab and those with the national market (New Delhi) approached through Granger Causality technique are presented in Table 1 (b).

Table 1 (b): Results of Granger Causality Test, Sample potato markets

Null Hypothesis:	Obs	F-Statistic	Prob.
JDLR does not Granger Cause ASR	118	7.10114	0.0012
ASR does not Granger Cause JDLR		3.62622	0.0298
LDH does not Granger Cause ASR	118	0.80362	0.4502
ASR does not Granger Cause LDH		2.49819	0.0868
LDH does not Granger Cause JDLR	118	2.60231	7.85E-02
JDLR does not Granger Cause LDH		13.9514	0.000004
ASR does not Granger Cause NDLS	118	0.25675	0.774
NDLS does not Granger Cause ASR		18.3028	1.00E-07

JDLR does not Granger Cause NDLS	118	2.06927	0.131
NDLS does not Granger Cause JDLR		15.861	8.00E-07
LDH does not Granger Cause NDLS	118	0.59627	0.5526
NDLS does not Granger Cause LDH		19.559	5.00E-08

Prob. denotes MacKinnon-Haug-Michelis (1999) one sided p-values; (Price series ASR- Amritsar, JDLR- Jalandhar, LDH – Ludhiana, NDLS- New Delhi).

Among the selected potato markets in Punjab, the potato price in Jalandhar market showed bidirectional causality in price transmission with potato price of Amritsar market and Ludhiana market. The potato price in Ludhiana market showed no causality in price transmission with potato price of Amritsar. The New Delhi market showed unidirectional causality in price transmission with potato price of Amritsar, Ludhiana and Jalandhar markets.

The data presented reveals that the Jalandhar market was well integrated with other selected markets of Punjab. However, it was the national market (New Delhi) which influenced the prices of potato in all of the selected markets of the state unidirectionally.



Fig. 1: Market integration among selected potato markets

(II) Tomato

II (a) Johansen Co-integration Test

Based on the Johansen multiple co-integration procedure, the integration among the selected tomato markets viz. Amritsar, Jalandhar, Ludhiana and New Delhi was analyzed using the time series data on monthly prices for period 2007 to 2016. Unrestricted co-integration rank tests (Trace and Maximum Eigen value) indicated the presence of at least 3 co-integrating equations at 5 per cent level of significance, thus revealing that most of the selected

tomato markets were having long run equilibrium relationship. The results are presented in Table 2 (a).

Table 2 (a): Unrestricted Co integration Rank Test (Trace) for selected tomato markets

Hypothesized no of CE(s)	Eigen value	Trace		Prob.**
		Statistic	0.05 Critical Value	
None *	0.30	111.89	63.88	0.00
At most 1 *	0.23	70.26	42.92	0.00
At most 2 *	0.21	39.63	25.87	0.00
At most 3	0.10	12.48	12.52	0.05

Trace test indicates 3 co integrating eqn(s) at the 0.05 level; * denotes rejection of the hypothesis at the 0.05 level; Prob.** denotes MacKinnon-Haug-Michelis (1999) one sided p-values.

II (b) Granger Causality Test

The results of causal relationship between the price series in major tomato markets in Punjab and those with the national market (New Delhi) approached through Granger Causality technique are presented in Table 2 (b).

Table 2 (b): Results of Granger Causality Test, selected tomato markets

Null Hypothesis	Obs	F-Statistic	Prob.
JDLR does not Granger Cause ASR	118	3.26	0.04
ASR does not Granger Cause JDLR		1.80	0.17
LDH does not Granger Cause ASR	118	3.32	0.04
ASR does not Granger Cause LDH		1.05	0.35
LDH does not Granger Cause JDLR	118	1.28	0.28
JDLR does not Granger Cause LDH		0.08	0.93
ASR does not Granger Cause NDLS	118	6.80	0.00
NDLS does not Granger Cause ASR		7.37	0.00
JDLR does not Granger Cause NDLS	118	1.91	0.15
NDLS does not Granger Cause JDLR		5.88	0.00
LDH does not Granger Cause NDLS	118	1.15	0.32
NDLS does not Granger Cause LDH		3.55	0.03

Prob. denotes MacKinnon-Haug-Michelis (1999) one sided p-values; (Price series ASR- Amritsar, JDLR- Jalandhar, LDH – Ludhiana, NDLS- New Delhi).

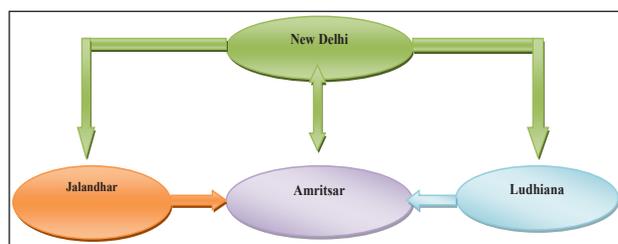


Fig. 2: Market integration among selected tomato markets

Among the selected Punjab tomato markets, the tomato price in Jalandhar and Ludhiana market showed unidirectional causality in price transmission with tomato price of Amritsar market. The tomato price in Ludhiana market had shown no causality in price transmission with tomato price of Jalandhar. The New Delhi market showed unidirectional causality in price transmission with tomato price of Ludhiana and Jalandhar markets whereas bidirectional causality in price transmission with tomato price of Amritsar market.

Thus, the analysis of prices has revealed that the Amritsar market was well integrated with other selected markets of Punjab. However, it was the national market (New Delhi) which influenced the prices of tomato in all of the selected state markets unidirectionally except Amritsar market where it had a bidirectional relationship.

(III) Cauliflower

III (a) Johansen Co-integration Test

The results of Johansen multiple co-integration procedure on the integration among the selected cauliflower markets viz. Amritsar, Jalandhar, Ludhiana and New Delhi are presented in the Table 3 (a).

Table 3(a): Unrestricted Co integration Rank Test (Trace) for selected cauliflower markets

Hypothesized no. of CE(s)	Eigen value	Trace		Prob.**
		Statistic	0.05 Critical Value	
None *	0.46	159.43	63.88	0.00
At most 1 *	0.26	88.18	42.92	0.00
At most 2 *	0.24	52.71	25.87	0.00
At most 3 *	0.17	21.43	12.52	0.00

Trace test indicates 4 co integrating eqn(s) at the 0.05 level; * denotes rejection of the hypothesis at the 0.05 level; Prob.** denotes MacKinnon-Haug-Michelis (1999) one sided p-values.

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 cauliflower markets were having long run equilibrium relationship. Similar study has been recorded by Mohapatra S (2018).

III (b) Granger Causality Test

The results of causal relationship between the price series in major cauliflower markets in Punjab and New Delhi market approached through Granger Causality technique are presented in Table 3 (b).

Table 3(b): Results of Granger Causality Test, Sample cauliflower markets

Null Hypothesis	Obs	F-Statistic	Prob.
JDLR does not Granger Cause ASR		1.07	0.38
ASR does not Granger Cause JDLR	116	3.07	0.02
LDH does not Granger Cause ASR		1.83	0.13
ASR does not Granger Cause LDH	116	4.04	0.00
LDH does not Granger Cause JDLR		2.96	0.02
JDLR does not Granger Cause LDH	116	3.42	0.01
ASR does not Granger Cause NDLS		2.16	0.04
NDLS does not Granger Cause ASR	116	3.72	0.01
JDLR does not Granger Cause NDLS		2.01	0.10
NDLS does not Granger Cause JDLR	116	2.67	0.04
LDH does not Granger Cause NDLS		1.15	0.34
NDLS does not Granger Cause LDH	116	6.29	0.00

Prob. denotes MacKinnon-Haug-Michelis (1999) one sided p-values; (Price series ASR- Amritsar, JDLR- Jalandhar, LDH – Ludhiana, NDLS- New Delhi).

The cauliflower price of Jalandhar and Ludhiana market had shown unidirectional causality in price transmission with cauliflower price of Amritsar market. The cauliflower price in Ludhiana market showed bidirectional causality in price transmission with cauliflower price of Jalandhar. The New Delhi market showed unidirectional causality in price transmission with cauliflower price of Ludhiana and Jalandhar markets whereas it had bidirectional

causality in price transmission with cauliflower price of Amritsar market. The direction of price transmission between selected markets is portrayed in Fig. 3.



Fig. 3: Market integration among selected cauliflower markets

(IV) Peas

IV (a) Johansen Co-integration Test

Unrestricted co-integration rank tests (Trace and Maximum Eigen value) indicated the presence of at least 3 co-integrating equations at 5 per cent level of significance, thus revealing that all the selected peas markets were having long run equilibrium relationship (Table 4 (a)).

Table 4 (a): Unrestricted Co integration Rank Test (Trace) for selected peas markets

Hypothesized no. of CE(s)	Eigen value	Trace	0.05	Prob.**
		Statistic	Critical Value	
None *	0.50	100.73	42.92	0.00
At most 1 *	0.10	22.19	25.87	0.13
At most 2 *	0.08	9.78	12.52	0.14

Trace test indicates 3 co integrating eqn(s) at the 0.05 level; *denotes rejection of the hypothesis at the 0.05 level; Prob.** denotes MacKinnon-Haug-Michelis (1999) one sided p-values.

IV (b) Granger Causality Test

The results of causal relationship between the price series in major peas markets in Punjab and those with the national market (New Delhi) approached through Granger Causality technique presented in Table 4 (b) indicated that the price of peas in Jalandhar market showed unidirectional causality in price transmission with price of peas of Ludhiana market. The peas price in Ludhiana market showed bidirectional causality in price transmission with peas price of New Delhi. The New Delhi market showed unidirectional causality in price transmission with peas price of Jalandhar

markets. Thus, it was found that the national market (New Delhi) was well integrated with other selected markets of Punjab

Table 4(b): Results of Granger Causality Test, Selected pea markets

Null Hypothesis	Obs	F-Statistic	Prob.
LDH does not Granger Cause JDLR	113	1.50	0.18
JDLR does not Granger Cause LDH		2.35	0.03
JDLR does not Granger Cause NDLS	113	2.56	0.04
NDLS does not Granger Cause JDLR		3.02	0.01
LDH does not Granger Cause NDLS	113	2.18	0.04
NDLS does not Granger Cause LDH		6.33	0.00

Prob. denotes MacKinnon-Haug-Michelis (1999) one sided p-values; (Price series JDLR- Jalandhar, LDH- Ludhiana, NDLS- New Delhi).



Fig. 4: Market integration among selected peas markets

CONCLUSION

The above study has concluded that among the selected four vegetables, the co-integration tests indicated that all of the four selected markets were integrated and had long run equilibrium with each other with an exception in tomato where there were found only 3 co integrating vectors. The Granger Causality Test was conducted for all of the four vegetables. In case of potato the Jalandhar market was well integrated with other selected markets of Punjab. However, it was the national market (New Delhi) which influenced the prices of potato in all of the selected markets of the state unidirectionally. In case of tomato, the Amritsar market was well integrated with other selected markets of Punjab and it was the New Delhi market which influenced the prices of tomato in all of the selected state markets unidirectionally except for Amritsar market where it had a two way price relationship. In case of cauliflower, the price in Jalandhar and Ludhiana

market showed unidirectional causality in price transmission with price of Amritsar market. The cauliflower price in Ludhiana market showed bidirectional causality in price transmission with cauliflower price of Jalandhar. The New Delhi market showed unidirectional causality in price transmission with cauliflower price of Ludhiana and Jalandhar markets whereas bidirectional causality with cauliflower price of Amritsar market. For peas the national market was well integrated with other selected markets of Punjab. Overall it can be concluded that all of the selected vegetable markets of Punjab were well integrated among each other but most of them were influenced by New Delhi market in unidirectional way i.e. the price change in selected state markets were only being influenced by the price change in New Delhi market but not influencing the price change in New Delhi market.

Policy Implications

The efficiency of vegetable marketing has not yet reached an optimal level as they are not spatially well integrated with one another in all the cases. The reasons for this might be poor market intelligence, slow transition of the information between the markets and poor physical infrastructure. The policy intervention calls for strengthening market intelligence wing in all markets along with the establishing of online marketing system through computerization and networking. The market price information should be made available to the stakeholders through electronic and print media. Development/strengthening of market infrastructure including transportation and communication facilities are the need of time in order to fully integrate the market prices.

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