International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(6): 2019-2021

Received: 12-09-2018
Accepted: 13-10-2018

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Cointegration analysis and granger casualty test of garlic for major markets of Maharashtra

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Abstract
Garlic is one of the important commercial spice crop belonging to the family Alliaceous. India is one of the leading Garlic producing country. Spices account for 2.2% of total agricultural produce in India. Huge fluctuations in prices of farm produce were observed during past few years. Prices show considerable volatility that could pose considerable risk to different stakeholders. For study purpose the data related to monthly average prices and arrivals of Garlic were collected for major markets of Maharashtra viz. Ahmednagar, Karad, Pune and Nagpur for the period 2005 to 2016. Johansen multiple cointegration trace test was applied for indicating the long-run relationship between the price series of selected markets. Co-integration is used instead of regular regression method because of its capacity in dealing with non-stationary series. The results of Co-integration test showed two co-integration equations were significant at 5% level of significance which implied that there existed cointegration among the markets. Granger Causality Test is a statistical tool which used F-test to know the cause and effect relationship between the two time series and this technique is employed to know the relationship between the prices of selected Garlic markets. It was observed that there is bidirectional causality in Garlic prices between Pune and Ahmednagar. The prices of Ahmednagar market exhibited unidirectional causality and affects the prices of Karad and Nagpur market respectively. Pune market also showing the unidirectional causality and affected the prices of Karad and Nagpur markets. Karad market showing unidirectional causality and affected the prices of Nagpur market.

Keywords: Cointegration analysis, granger casualty test, garlic, major markets, Maharashtra

Introduction
Agricultural marketing plays a significant role in the movement of commodity from the producer to the consumer and in stabilizing the prices. Marketing plays an important role in the economic development as it stimulates production, avoids unnecessary fluctuation in output as well as prices and reduces cost of production. Price instability affects both producers and consumers and has macroeconomic implications as well. In order to reduce the price fluctuations of agricultural commodity there is need to have a thorough understanding of the price behaviour over a time. The knowledge on the interrelations between the arrival and prices of farm product is required for assessing the extent of price fluctuations over a time. The analysis of arrival and prices over time is important for formulating a sound agricultural price policy; price trade helps to understand the month to month variation in arrivals and prices and helps the farmer to make decision about when to sell their produce. Market efficiency helps the farmer to make decision about where or in which markets to sell their produce so as to earn more profit. Higher the marketing efficiency higher is the profit earned. In such a situation it is important to study analysis of price behavior which is essential requirement for policy formulation.

Methodology
The present study "Price analysis of Garlic for major markets of Maharashtra" was carried out at the Department of Agricultural Economics and Statistics, Dr. PDKV, Akola during the year 2016-17. The study was based on secondary data. Secondary data consisting of monthly prices and arrivals of Garlic were collected from four Agriculture Produce Market Committee (APMC)'s namely, Ahmednagar, Karad, Nagpur and Pune. The website www.agmarknet.nic.in was also used for the purpose. The study has been confined to the Maharashtra state. Four APMC major markets at four district places of Maharashtra namely Ahmednagar, Karad, Nagpur and Pune were selected purposively for the study.

For the study, monthly time series data on the prices and arrivals of Garlic were collected for the period from 2005 to 2016. Johansen multiple co-integration trace test was applied for indicating the long-run relationship between the price series of selected markets. Co-integration is used instead of regular regression method because of its capacity in dealing with non-stationary series. Granger Causality Test is a statistical tool which used F-test to know the cause and effect relationship between the two time series and this technique is employed to know the relationship between the prices of selected Garlic markets.

Results and Discussion

The data collected were analyzed in relation to each of the specific objective of the study and results have been tabulated.

Market Co-integration

Johansen multiple cointegration trace test was applied for indicating the long-run relationship between the price series of selected markets. Co-integration is used instead of regular regression method because of its capacity in dealing with non-stationary series. The results of the test were presented in Table 1. Presence of at least two co-integration equations at 5 per cent level of significance confirms that there exists long run equilibrium relation in the markets. The results of Co-integration test showed two co-integration equations were significant at 5% level of significance which implied that there existed cointegration among the markets.

Table 1: Results of multiple co-integration analysis of Garlic prices for the selected markets

Hypothesized No. of CE(s)	Eigen Value	Trace Statistics	Critical Value 5%	Prob**	No. of Co-integrating Equation CE(s)
None *	0.285509	99.58635	63.8761	0	
At most 1 *	0.209989	52.52053	42.91525	0.0042	2
At most 2	0.097948	19.5213	25.87211	0.2511	
At most 3	0.035702	5.08963	12.51798	0.5836	

Causality of price signals between selected markets

Granger Causality Test is a statistical tool which used F-test to know the cause and effect relationship between the two time series and this technique is employed to know the relationship between the prices of selected Garlic markets. The results of the test showing the relationship between selected Garlic markets were presented in Table 2. It was observed that there is bidirectional causality in Garlic prices between Pune and Ahmednagar. The prices of Ahmednagar market exhibited unidirectional causality and affects the prices of Karad and Nagpur market respectively. Pune market also showing the unidirectional causality and affected the prices of Karad and Nagpur markets. Karad market showing unidirectional causality and affected the prices of Nagpur market.

Table 2: Results of Pair wise Granger Causality Test for Garlic prices

Null Hypothesis:	Obs	F-Statistic	Prob.
Karad does not Granger Cause Ahmednagar	142	0.22459	0.7991
Ahmednagar does not Granger Cause Karad		25.9436**	3.00E-10
Pune does not Granger Cause Ahmednagar	142	15.6159**	8.00E-07
Ahmednagar does not Granger Cause Pune		3.29414**	0.0401
Nagpur does not Granger Cause Ahmednagar	142	0.20793	0.8125
Ahmednagar does not Granger Cause Nagpur		8.05676**	0.0005
Pune does not Granger Cause Karad	142	28.4996**	4.00E-11
Karad does not Granger Cause Pune		1.22539	0.2968
Nagpur does not Granger Cause Karad	142	2.26873	0.1073
Karad does not Granger Cause Nagpur		9.2497**	0.0002
Nagpur does not Granger Cause Pune	142	2.00958	0.138
Pune does not Granger Cause Nagpur		11.8038**	2.00E-05

Conclusion

1. The selected Garlic markets having long run equilibrium relationship for the prices of Garlic and there exists co-integration among them as indicated by the results of Johansen's Multiple Co-integration Test.
2. There was bi-directional causality observed in Garlic prices between Pune and Ahmednagar.
3. The prices of Ahmednagar and Pune markets exhibited unidirectional causality and affects prices of Karad and Nagpur respectively.

Policy Implications

In order to minimize the price risk and to protect the price risk and to protect the price security of farming community under Garlic crop of Maharashtra state which is very volatile commodity in terms of market prices, it is recommended that the long term procurement policy should be adopted to maintain price stability throughout the year by declaring the MSP and procurement by Nodal agencies at least for major markets of the state.

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