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Research Article

MARKET CO-INTEGRATION AND CASUALTY ANALYSIS OF BARLEY IN RAJASTHAN

INDIRA[1], KUMAWAT R.C.[2] AND SHARMA HEMANT[3]

[1,2]College of Agriculture, Sri Karan Narendra Agriculture University, Jobner, Rajasthan 303328.
[3]Agro-Economic Research Centre AERC, Vallabh Vidyanagar, Anand, Gujarat 388120.
*Corresponding Author: Email-indurca007@gmail.com

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Abstract- The results of the Augmented Dickey-Fuller (ADF) unit root test for barley showed that the existing data were non-stationary but their first differences were stationary. After taking first difference, all the series becomes stationary which is obvious from the fact that calculated values (-0.566811 to -4.784065) for all the markets were less than the critical value (- 4.036983) and were free from the consequence of unit root. Hence, the barley price series were integrated of the order 1. Johansen's co-integration test for barley indicated the presence of at least five co-integration equations at 5 percent level of significance. Hence markets were having long run equilibrium relationship. Granger causality test for barley indicated the presence of bidirectional and unidirectional influences on market prices indicating the presence of long run integration among all the markets of Hanumangarh district. Public policies in Hanumangarh district could play critical roles in facilitating market integration and thereby, market efficiency through the development of agricultural market information systems and road infrastructure.

Keywords- Co-integration, Causality, Barley, ECM, ADF.

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Introduction

Agriculture is the largest private sector enterprise in India with more than 10 crore farm holdings. It contributes about 13.2 percent to national GDP, sustains livelihood of about two thirds of population, accounts for 52 percent of national work force and forms the back bone of agro based industries. Cereals play an important role in agricultural economy of India. India occupies second place among the major cereals producing countries of the world next only to China. Production of barley, a relatively small winter crop in north India, has been relatively steady at around 1.8 MMT on demand from the malting and brewing industry. Traditionally barley production in India consists of feed quality, six-row varieties, unsuitable for malting and mostly used for food and animal feed purposes. In the last few years, a few new, high quality malting grade barley varieties have been developed through public-private breeding programs; these seeds are steadily replacing older varieties. Trade sources report that some malting and brewing companies have contract farms that produce malting grade barley grain in Rajasthan, Punjab, and Haryana. Rajasthan is one of the major food grain producing states of the country. It is the seventh largest state in the country in food grain production. In Rajasthan, gross cropped area (GCA) was 21.9 million hectares and gross production 29.51 million tonnes during 2015-16 of which food grains accounted 62.27 per cent of area and 64.03 per cent of production[1]. Production is incomplete without marketing. An efficient and well-integrated marketing system is, therefore, an important means for raising the income level of the farmers by offering good marketing facilities. A well-integrated marketing system gives better prices to the farmers for their produce than the unorganized or haphazardly organized markets[2]. The government is promoting organized marketing of agricultural commodities in the country through a network of regulated markets. To achieve an efficient system of buying and selling of agriculture based produce, most of the state governments and union territories have enacted legislations (APMC Act) to ensure reasonable gain to the farmers through regulating market practices. The market integration concept explains the relationship between the prices in two markets that are spatially separated. When markets are integrated it implies that the markets in the system operate in uniform, as a single market system. Co-integration is an analytic for testing of common trends in multivariate time series and modeling long run and short run dynamic[3]. This leads to a considerable risk and uncertainty in prices. Analysis of prices of the products over time and space is, therefore, important for formulating a sound agriculture price policy. Therefore, there is a need to carry out micro level study on such aspects in different geographical areas under the varying marketing environment. Hanumangarh district was lacking in such type of study. Hence, there is a need to study the market integration of barley [1].

Methodology

The data used in the co-integration analysis consists of monthly wholesale prices of seven selected markets of Hanumangarh District (Hanumangarh, Rawatsar, Bhadra, Sangaria, Pilibanga, Nohar and Goluwala) Rajasthan for the period from 2005 to 2014.Monthly wholesale price data were for the study. In the present study co-integration method has been adopted with the use of E-view 7 software to study the market integration for modal prices of the selected markets. To carry out the analysis data were made stationary mean that the process of generating the data ids in equilibrium around a constant value and that the variance around the mean remains constant over a time. If mean change over time and variance is not reasonably constant then series is non- stationary. To decide the stationary or non-stationary of the data, for each of the market, ADF test has been conducted[4]. If calculated value of respective market in ADF test is less than critical value then data are non-stationary. Such data are subjected to 1st order difference or 2nd order differencing until it become stationary (as specified by calculated value less than critical value).

Engle-Granger causality

An autoregressive distributed lag (ADL) model for the Granger-causality test was developed following the Engle and Granger (1987) specification provided below [2]:

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

where T is the time trend, εt is the error term, and other terms are as defined in earlier equations.

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

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

$$H_0 : h_1 = h_2 = ... = h_k = 0$$

$$P_t^2 = \delta + \phi_0 T + \sum_{j=1}^{j} \Omega_j P_{t-j}^1 + \sum_{k=1}^{k} \varphi_k P_{t-k}^2 + \upsilon_t$$

$$H_0 : \varphi_1 = \varphi_2 = ... = \varphi_k = 0$$

Error Correction Modal

If price series are I (1), then one could run regressions in their first differences. However, by taking first differences, the long-run relationship that is stored in the data is being lost. This implies that one needs to use variables in levels as well. Advantage of the error correction methodology (ECM) is that it incorporates variables both in their levels and first differences[5].

Result and Discussion

The Augmented Dickey-Fuller (ADF) based unit root test procedure was followed to check the stationary in prices series of barley. From the [Table-1], it could be inferred that the original data were non- stationary in Hanumangarh, Pilibanga and Sangaria but their first differences were stationary implying the presence of unit root in the series. Thus, the original price series of barley for Hanumangarh, Pilibanga and Sangaria had a unit root. The occurrence of unit root in the price data generation process of barley gave a preliminary indication of shocks which may have permanent or long- lasting effect.

Table-1 *ADF unit root test for prices of Barley*

Markets	Augmented Dickey –Fuller test (ADF)		
	Level	1st difference	Critical value (1%)
Bhadara	-4.711359	-	
Goluwala	-4.474787	-	
Rawatsar	-4.258875	-	
Nohar	-4.784065	-	**(-4.036983)**
Hanumangarh	-0.566811	-10.72949	
Pilibanga	-2.988290	-12.30333	
Sangaria	-3.729233	-7.721636	

(MacKinnon critical values for rejection of hypothesis of a unit root)**

From the table it could be inferred that Augmented Dickey Fuller test values are above the critical value (1%) given by MacKInnon statical table at levels implying that the series are stationary for Bhadara, Goluwala, Rawatsar, and Nohar [3]. The series are non stationary for Hanumangarh, Pilibanga and Sangaria indicating the existence of unit root. After taking first difference, all the series becomes stationary which is obvious from the fact that the ADF values (-4.258875 to -12.30333) for all the markets were less than the critical value (-4.036983) and were free from the consequences of unit root Balappa and Hugor (2002) also found similar findings [4].

Multiple co-integration analysis for barley

Based on the Johansen (1988 and 1996) multiple co-integration procedure, the integration between the markets was analyzed by E-views software. Unrestricted co-integration rank tests indicated the presence of at least five co-integrating equations at 5% level of significance [5,6]. Hence markets were having long run equilibrium relationship. Similar results were obtained by Sharma and Burark (2016) while studying the market integration of wheat [7]. The results are presented in [Table-2].

Table-2 *Results of multiple co- integration analysis for barley*

Hypothesized No. of CE(s)	Eigen value	Trace Statistic	0.05 Critical Value	Prob**
None *	0.475977	200.8847	125.6154	0.0001
At most 1 *	0.313954	126.5694	95.75366	0.0008
At most 2 *	0.224234	83.23609	69.81889	0.0045
At most 3 *	0.186569	54.03714	47.85613	0.0203
At most 4 *	0.146273	30.29030	29.79707	0.0121
At most 5	0.099541	12.10381	15.49471	0.0749
At most 6	0.000400	0.046030	3.841466	0.2371

Trace test indicates 5 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values [8]

Granger causality test

As a part of co-integration analysis, Granger Causality Test was conducted to know whether co-integration exist between two-gram markets or not. The results for Granger Causality test revealed that [Table-3] there was a bidirectional influence on barley prices of Bhadara to Pilibanga, Pilibanga to Goluwala, Sangaria to Rawasar, Nohar to Goluwala, Rawatsar to Pilibanga, Pilibanga to Hanumangarh, Pilibanga to Nohar, Rawatsar to Nohar, and Hanumangarh to Rawatsar. Bhadara barley price granger cause Goluwala, Hanumangarh, Nohar, Rawatsar, and Sangaria market prices. Nohar market price influenced Hanumangarh and Sangaria market prices. There existed unidirectional causality with Hanumangarh and Sangaria barley market prices. The barley prices at Goluwala market granger cause Rawatsar, Sangaria and Hanumangarh market prices whereas the barley prices at Hanumangarh market granger cause Sangaria. Pilibanga market prices granger causes Sangaria market prices. Since in all these cases the probability value was less than 0.05. Thus, different markets of barley in the Hanumangarh district were closely linked with each other for movement of barley prices. Thus, a strong integration (both bi- directional and uni-directional) of different barley markets in Hanumangarh was confirmed through these results of the study. Similar results were obtained by Mushtaq, and Dad (2008) while studying the market integration of Apple [9,10].

Summery and Conclusion

Integration results indicated that various markets of Hanumangarh district were highly correlated with each other in regards to prices of barley. The results of the Augmented Dickey-Fuller (ADF) unit root test for different markets of Hanumangarh district for barley showed that the existing data were non- stationary in some markets but their first differences were stationary. Hence, the barley price series were integrated of the order 1. Johansen's co-integration test for barley indicated the presence of at least five co-integration equations at 5 percent level of significance. Hence markets were having long run equilibrium relationship. Granger causality test for barley indicated the presence of bidirectional and unidirectional influences on market prices indicating the presence of long run integration among all the markets of Hanumangarh district. Public policies in Hanumangarh district could play critical roles in facilitating market integration and thereby, market efficiency through the development of agricultural market information systems and road infrastructure.

Application of research:

Research Category:

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Author statement: All authors read, agree and approved the final manuscript.

Abbreviations:

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

Table-3 *Pairwise Granger Causality Tests results for barley wholesale prices*

Null hypothesis	Observation	F- statistic	Probability	Direction
G does not Granger Cause B		5.98280	0.3774	↔
B does not Granger Cause G	118	4.08341	0.0194	
H does not Granger Cause B		3.86716	0.0237	↔
B does not Granger Cause H	118	8.11111	0.0005	
N does not Granger Cause B		2.58823	0.0796	←
B does not Granger Cause N	118	6.29519	0.0026	
P does not Granger Cause B		3.31218	0.0400	↔
B does not Granger Cause P	118	7.81194	0.0007	
R does not Granger Cause B		0.46638	0.6285	←
B does not Granger Cause R	118	8.14689	0.0005	
S does not Granger Cause B		2.47843	0.0484	→
B does not Granger Cause S	118	8.14043	0.0005	
H does not Granger Cause G		6.17917	0.0028	→
G does not Granger Cause H	118	2.20008	0.1155	
N does not Granger Cause G		4.71485	0.0108	↔
G does not Granger Cause N	118	9.26778	0.2854	
P does not Granger Cause G		6.02398	0.0033	→
G does not Granger Cause P	118	2.31647	0.1033	
R does not Granger Cause G		12.0938	0.0280	→
G does not Granger Cause R	118	3.01416	0.0531	
S does not Granger Cause G		7.99685	0.0083	↔
G does not Granger Cause S	118	5.14763	0.0215	
N does not Granger Cause H		6.87504	0.0406	→
H does not Granger Cause N	118	2.43780	0.0919	
P does not Granger Cause H		9.84368	0.0130	→
H does not Granger Cause P	118	2.00292	0.1397	
R does not Granger Cause H		7.68835	0.1895	↔
H does not Granger Cause R	118	4.56813	0.0124	
S does not Granger Cause H		11.98065	0.1427	→
H does not Granger Cause S	118	2.70878	0.0409	
P does not Granger Cause N		8.54443	0.0030	↔
N does not Granger Cause P	118	12.23289	0.1119	
R does not Granger Cause N		10.0511	0.3529	↔
N does not Granger Cause R	118	4.49059	0.0133	
S does not Granger Cause N		1.88915	0.0359	←
N does not Granger Cause S	118	7.15618	0.1205	
R does not Granger Cause P		2.05373	0.1330	←
P does not Granger Cause R	118	4.57836	0.0122	
S does not Granger Cause P		9.02833	0.0363	→
P does not Granger Cause S	118	2.58257	0.0400	
S does not Granger Cause R		5.40065	0.0058	↔
R does not Granger Cause S	118	8.26695	0.0257	

(H-Hanumangarh, B- Bhadara, N- Nohar, P-Pilibanga , S-Sangaria, R-Rawatsar , G-Goluwala)

Conflict of Interest: None declared

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