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Market Integration and Causality in Pear in India

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Abstract

The current study focuses to explore the degree of market integration in William Bartlett variety of pear grown in Kashmir, commonly known as Bagughosha, through co-integration analysis on the wholesale weekly prices of its two commercial grades Bagughosha Super and Bagughosha Special, collected from two national fruit markets of India (Delhi and Mumbai), from August, 2005 to October, 2013. The results reveal that Pear markets were co integrated and competitive. A disequilibrium ranging from 16.47 to 50.33% among the selected grades of the fruit was observed.VAR and VECM models were used to study the behaviour of market prices, which revealed that Delhi market turned most dominating market for higher prices of the selected variety and grades.

Keywords: Pear, market integration, cointegration, causality, Kashmir, India

The State of Jammu and Kashmir (J&K) produces more than 22% of Pear in the country, while 33% of Pear is produced in Uttarakhand, 20% in Punjab and rest of the 25% is produced by other states. More than 80% of the Pear produced in the state of Jammu and Kashmir is the marketed surplus and is exported to the other states of the country. Marketing of pear in the state is characterised by insufficient and inefficient transportation infrastructure and poor market intelligence coupled with uncertainty in the future prices, has all through been a concern for producers and consumers (Singh, 2001: Acharya, 2001 and Sahadevean, 2002). A reasonable idea about future prices to prevail at a future date could prove helpful for producers to rationalise their resources for profit maximization. In this backdrop market integration and price forecasting could help in stabilising the prices by removing the market imperfections, and attain market efficiency. Market integration can be defined as a measure of the extent to which demand and supply in one location are transmitted to another (Negassa *et al.* 2003). The basis for cointegration analysis was established by Granger (1981, 1986), Granger and Weiss (1983), Engle and Granger (1987), Johansen (1988, 1995 and 1996), Banerjee *et al.* (1993), Harris (1995) and others, which led to the ascendancy of 'equilibrium-correction' models in econometric modelling.

Accordingly, more recent research on agricultural economics using this broad class of vector 'equilibrium-correction' (VEC) models has been producing important advances in overcoming the modelling faults and resulting forecast failures. The present study uses VAR and VECM models for estimating price behaviour data in selected markets.

The distanced fruit mandies in India depends upon the dynamics of market integration and poor policies of the Government which can be too costlier (Ravallion, 1986). Emphasis has always been given to the production and area coverage under pear in the state, while very little attention has however, been paid to estimating the price signals of this fruit traded in different markets of the country. The present study is therefore, directed to empirically estimate the degree of integration of pear in two important national markets in order to help the growers to take efficient decisions while allocating resources for production and marketing of the fruit in and outside the state.

Methodology

The Data

Pear is available for almost three months from August to October every year in the market. Pear from the state of Jammu and Kashmir reaches different secondary wholesale markets from the place of the produce .The fruit is individually transported to these markets located in the different parts of the country. The data for the prices is available from the government designated market functionaries of a particular market. The channel wise primary data like from producer – wholesaler – retailer etc. has not been considered for the study, instead the prices have been collected directly from the designated market sources. Again the pear is marketed in about five major secondary wholesale markets in the country, however, two markets (Delhi and Mumbai,) based on the highest volume of the arrivals were selected. A part of the day wise data on wholesale prices box^{-1}(each box weighing 18 kg fruit) from 2005 to 2013, of two important commercial grades of pear, viz Bagughosha Super and Bagughosha Special were collected from the functionaries of fruit and vegetable mandies of the selected markets during the year 2013-14, under ICAR, sponsored project on Market Intelligence and part of data was collected during 2014-15 under UGC sponsored Rajiv Gandhi Chair in contemporary studies on livelihood and food Security and later processed to suit the present publication. This data was later averaged to the weekly wholesale prices. In the end we had continuous market and grade wise data set from August to October every year for each selected market. Thus the weekly data averaged for 90 weeks, was considered sufficient enough to suit the analytical techniques chosen for the analysis of the data. In addition secondary data from the state development departments of Horticulture, Horticulture planning and Marketing, Statistics and Economics, Government of Jammu and Kashmir, and other Published sources was also collected through a specially designed schedule prepared in accordance with the objectives of the study. Following analytical techniques were used to analyze the data. A brief description of the methodologies used in the present study is given below:

Vector Autoregressive (VAR) process

If a multiple time series y_t of n endogenous variables is considered, it is possible to specify the following data generating procedure and model y_t as an unrestricted VAR involving up to k lags of y_t,

$$Y_t = \upsilon + A_1 Y_{t-1} + \ldots + A_k Y_{t-k} + u_t, \quad u_t \quad IN\ 0, \Sigma) \tag{1}$$

where, $y_t = (y_{1t}, y_{2t}, \ldots, y_{nt})'$ is (n×1) random vector, each of the A_i is an (n×n) matrix of parameters, υ is a fixed (n×1) vector of intercept terms. Finally, $u_t = (u_{1t}, u_{2t}, \ldots, u_{nt})$ is a n-dimensional white noise or innovation process, i.e., $E(u_t)=0$, $E(u_t u'_t)= \Sigma$ and $E(u_t u'_s)=0$ for $s \neq t$. The covariance matrix Σ is assumed to be non-singular.

Cointegration process

The Cointegration analysis reflects the long-run movement of price indices, although in the short run they may drift apart. Johansen's (1988) multivariate Cointegration approach was used to examine Cointegration between two price indices. Before conducting Cointegration test, it is mandatory to perform stationarity test. Augmented Dickey-Fuller (ADF) unit root test (Dickey and Fuller, 1979) was performed in this study to check stationarity for both the series.

A co integrated system can be written as:

$$\Delta y_t = \sum_{i=1}^{k} \Gamma_i \Delta y_{t-i} + \alpha\beta y_{t-k} + \varepsilon_t \tag{2}$$

Where y_t is the price series, Δy_t is the first difference i.e., ($\Delta y_t = y_t - y_{t-1}$), and the matrix $\alpha\beta'$ is n × n with rank ($0 \leq r \leq n$), which is the rank of linear independent Cointegration relations in the vector space of matrix. The Johansen's method of cointegrated system is a restricted maximum likelihood method with rank restriction on matrix $\Pi = \alpha\beta'$. The rank of Π can be obtained by using λ_{trace} or λ_{max} test statistics. The test statistics can be given as:

$$\lambda_{trace} = -T \sum_{i=r+1}^{n} 1n\left(1 - \hat{\lambda}_t\right) \forall r = 0,1,\ldots n-1 \tag{3}$$

where $\hat{\lambda}_t$'s are the Eigen values representing the strength of the correlation between the first difference part and the error-correction part. Now the following hypotheses are tested, under null hypothesis, H_0: rank of $\Pi = r$ and under alternative hypothesis, H_1: rank of $\Pi > r$. Where r is the number of cointegration equations. The above test is carried under the condition of cointegrating equation has only intercept (no trend) and the original price series follows a trend since the mean and variance are non-constant over a period of time (non-stationary).

To this end, VECM model was also used for understanding the short run dynamics of pear price in selected markets. The analysis was done using SAS Software Package Version 9.3.

Results and Discussion

The study analyses the price changes in two different country level markets in India. The criterion for selecting the markets was the volume of transactions. In addition, availability of data too was important for selecting the markets. Price variability is the major component of market risk for both producers and consumers (Schumpeter 1999). Usually under the commodity group of fruits and vegetables, the hill and mountainous states are the most sufferers, despite the significant potential of pushing growth in agriculture beyond targeted growth of 4% under 12th plan. It is in place to mention here that more than 90% of market surplus in fruits and more than 60% of vegetables are sold in open market arrangements in these states. Under such situation the discovery of price behaviour under various market situations becomes important for risk management.

Variability across the markets

The Table 1 summarizes the simple descriptive statistics and variability of prices under two selected markets in terms of co-efficient of variation. A perusal of table 1 indicates that the maximum pear price was observed in Delhi market for Bagughosha-Super (₹ 810 box^{-1}), whereas the minimum price is observed in Mumbai market (₹ 160 box^{-1}) for the same variety of pear. The results reveal the variability as explained by the coefficient of variation (%) ranging between 28.764 to 29.678 and 21.472 to 28.136, respectively, in the Bagughosha Super and Bagughosha special. Therefore, out of the two commercial varieties, highest co-efficient of variation was observed in Badgoush Super (29.67%) in Mumbai market and the lowest in Badgoush special (21.47%) in Delhi market. However, across the markets and varieties the co-efficient of variations ranged between 21.47 to 29.68%.

Efficiency of the markets

The market efficiency evaluation under co-integration analysis recognizes that the time series prices for the selected markets are usually non-stationery variables. (Shen and Wang, 1990; Fortenbery and Zapata, 1993; Wang and Ke, 2005) and if these series are

Table 1. Descriptive statistics of selected Pear varieties/grades/markets

	Bagughosha Super		Bagughosha Special	
	Delhi	Mumbai	Delhi	Mumbai
Mean	469.047	367.931	519.019	392.780
Median	458.330	354.250	527.500	387.500
Max	810.000	650.000	750.000	650.000
Min	201.660	160.000	275.000	175.000
Standard Deviation	134.920	109.197	111.444	110.514
Skewness	0.722	0.685	-0.133	0.269
Kurtosis	3.258	3.218	2.425	2.709
CV (%)	28.764	29.678	21.472	28.136

Table 2. Augmented Dickey-Fuller Unit root tests on market prices of selected Pear varieties/grades/markets

	Bagughosha Super				Bagughosha Special			
	Level		Ist difference		Level		Ist difference	
Market	**Tau**	**Pr<Tau**	**Tau**	**Pr<Tau**	**Tau**	**Pr<Tau**	**Tau**	**Pr<Tau**
Delhi	-2.41	0.143	-3.34	0.019	-0.81	0.805	-3.88	0.004
Mumbai	-1.46	0.543	-3.67	0.008	-1.14	0.688	-3.31	0.020

Note: P-value less than 0.05 indicates that the corresponding series is stationary at 5% level of significance.

found to be non- stationery then it becomes necessary to test these series for co-integration, as a pre-condition for market efficiency and un-biasedness (Kallar *et al.* 1999) and also finding of no-integration of markets is normally interpreted to imply market in-efficiency. To overcome this problem the ADF at level and first difference unit test were performed. Table 2, presents the results of unit root test for two commercial grades of the fruit in selected markets. The results reveal that the null of the unit root cannot be rejected for all the price series, as Pr < Tau was significant at 5% level; therefore, we could conclude that all the prices in selected markets are non-stationery.

The data was put to test for cointegration applying Johansen's method of reduced rank regression using Vector Error Correction model. Akaike Information Criteria (AIC) and Schwarz Bayesian Criteria (SBC) were used to select the best model for the data under consideration. On the basis of minimum AIC and SBC as presented in Table 3, it was found that for both the selected markets, VAR model of order one was best.

Table 3. Information of criteria of selected VECM model

	Information Criteria	
	Bagughosha Super	**Bagughosha Special**
AICC	17.760	18.048
HQC	17.811	18.099
AIC	17.751	18.039
SBC	17.913	18.202
FPEC	5.1E+07	6.8E+07

Cointegration among markets

The zero order correlation matrix was obtained prior to the cointegration analysis and all the coefficients were found significant at 1% level of significance Table 4. The 2nd step was to determine the long term relationship among markets and prices. Table 5 documents the trace test results. The figures reveal that there is one co-integrated vector, this is owing to the fact that the first statistical value is greater than the 5% critical value, whereas, the last statistical value was less than 5% critical value. The result thus indicated that one price series is strongly co-integrated and as such converge to the long run equilibrium, which implies that one market prices can be expressed in terms of another price, which also means the law of one price (LOP) holds true. The discussion above is suggestive of the fact that even if there is geographical dispersion of markets which are spatially segmented, still the prices are linked together indicating that the market locations are in the same economic market system.

Table 4. Pearson's Correlation coefficients among the markets

	Prob > |r| under H0: Rho=0			
	Delhi_ Super	**Delhi_ Special**	**Mumbai_ Super**	**Mumbai_ Special**
Delhi_Super	1.000	0.975**	0.647**	0.676**
Delhi_Special	0.975**	1.000	0.610**	0.636**
Mumbai_Super	0.647**	0.610**	1.000	0.964**
Mumbai_Special	0.676**	0.636**	0.964**	1.000

** denotes significant at 1% level

The foregone discussion suggests that even though the markets are integrated, but there could still be disequilibrium in the short run due to the price adjustments across the markets, which might not happen instantaneously or simultaneously.

Table 5. Johansen's co integration test statistics for selected Pear varieties/grades/markets

H0: Rank=r	H1: Rank>r	Trace	5% Critical Value	H0: Rank=r	H1: Rank>r	Trace	5% Critical Value
Badgoush Super				Badgoush Special			
0	0	26.074	19.99	0	0	28.907	19.99
1	1	8.411	9.13	1	1	7.929	9.13

Table 6. Long run coefficient ( ) and adjustment coefficient (~)

	Badgoush Super		Badgoush Special	
Market	**β**	**α**	**β**	**α**
Delhi	-0.009	43.343	0.0120	-50.330
Mumbai	0.0107	-22.258	-0.009	16.476

Table 7. Results of Vector Error Correction Model

Equation	Parameter	Estimate	Standard Error	t Value	Pr > |t|
Parameter estimates for Bagughosha Super					
D_Y1	CONST1	-43.5	25.986	-1.67	0.101
	AR1_1_1	-0.407	0.157		
	AR1_1_2	0.463	0.179		
D_Y2	CONST2	34.389	19.043	1.81	0.078
	AR1_2_1	0.209	0.115		
	AR1_2_2	-0.238	0.131		
Parameter estimates for Bagughosha Special					
D_Y1	CONST1	48.6412	18.5614	2.62	0.0123
	AR1_1_1	-0.6086	0.17212		
	AR1_1_2	0.45436	0.12851		
D_Y2	CONST2	-5.8337	16.0469	-0.36	0.7181
	AR1_2_1	0.19922	0.1488		
	AR1_2_2	-0.1487	0.1111		

Table 8. Granger causality test statistics for selected pear varieties/grades and markets

Null Hypothesis	Bagughosha Super			Bagughosha Special		
	χ^2	Pr > χ^2	Relationship	χ^2	Pr > χ^2	Relationship
Delhi is not influenced by Mumbai	2.000	0.157	Not Significant	2.48	0.115	Not Significant
Mumbai is not influenced by Delhi	0.370	0.540	Not Significant	0.58	0.447	Not Significant

Disequilibrium among the market prices

Once the disequilibrium is observed among the prices and the markets (Table 6), sometime is generally required for spatial adjustment in the price behaviour, therefore, to account for this kind of adjustment an Error Correction Model could be an appropriate tool, that takes into account the kind of adjustment in the short and long run disequilibrium of prices in the distantly located markets. The result of the VECM model (Table 7) shows that some the estimated coefficients turned positive for the selected markets. These coefficients measure the ability of the prices for adjustment to deviation from the long run equilibrium which could be removed in every period of one week. The long run equilibrium of pear market prices justifies the use of vector error correction model (VECM) for showing the short run dynamics.

Causality in various markets/varieties

The co-integration tests performed indicated only the existence of long run relationship among the prices of the selected pear varieties and the selected markets. The direction of the relationship among price series and markets is equally important for which Granger Causality Tests were performed. The results presented in Table-8, showed no causal relation in Bagughosha Super and Bagughosha Special between Delhi and Mumbai markets, indicating that the Delhi prices may cause undue increase in the prices of the two grades of pear which is not a health sign.

This implies that the markets by and large do not have enough ability to predict subsequent prices among them.

Conclusion

The study made an assessment of the degree of the spatial market integrating in distantly located two national pear markets of India, using co-integration and error correction model to the weekly wholesale data from August 2005 to October 2013. The results revealed that the selected pear markets are cointegrated of order one Further, Delhi market turned the most dominant market for higher market price. The results of the study revealed disequilibrium of 16.47 to 50.33% among the selected grades of the selected pear variety, which could be removed in each period in the identified markets in one week.

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