Journal of Tropical Agriculture 58 (1): 125-129, 2020

Short Communication

Price integration of Nendran banana markets in Kerala

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Received 13 October 2019; received in revised form 05 May 2020; accepted 01 June 2020

Abstract

The study has investigated market integration across three major wholesale Nendran banana markets, *viz.,* Kozhikode, Ernakulam, and Thiruvananthapuram of Kerala. Co-integration analysis of monthly wholesale Nendran banana prices in the above markets were carried out by adopting Johansen's multivariate cointegration approach after confirming the stationarity of price series using Augmented Dickey Fuller (ADF) test. The study has confirmed the presence of cointegration, implying the price association among the markets. To get the additional evidence as to whether and in which direction price transmission is occurring between the market pairs, Granger causality test was used, which confirmed Thiruvananthapuram to be the price-determining market. The existence of unidirectional causality from Kozhikode market to Ernakulam market and from Thiruvananthapuram market to Kozhikode and Ernakulam markets was proved. Bidirectional causality was absent between all the pairs. The study concluded that Nendran banana farmers were earning comparable prices at a particular point of time and market intervention or policy in one market would impact the price in other markets. The major implication of the study is the need for capacity building in market intelligence and designing of a network of agricultural wholesale markets for Nendran banana across the country to enhance market integration and better price transmission among them.

Key words: Causality, Cointegration, Market integration.

Kerala has produced 565.8 million kg of banana from an area of 62108 hectares with a productivity of 9110 kg per hectare in the year 2017-18 (GOK, 2018). Nendran is one of the most important commercial varieties of banana grown in Kerala, occupying about 50 per cent of the total area under banana. The variety is grown for both fruit and vegetable purpose. Kerala is the biggest consumer of Nendran banana. Banana being a smallholder's crop, is marketed in localized primary markets near the production unit and prices differ in each market, indicating a weak association among these markets. Market integration exists when prices of homogenous commodities in spatially separated markets move mutually in response to the forces of demand and supply. Indian markets of banana show poor integration (Praveen and Inbasekar, 2015) and if the markets are not spatially or inter-temporally integrated it could be indicative of the existence of market inefficiencies. According to Barrett (1996), studies on market integration provide information on market performance which is necessary for proper policy formulation and macroeconomic modeling. The degree to which consumers and producers would benefit, depends on how domestic markets are integrated with world markets and how different regional markets are integrated with each other (Varela et al., 2012).

The price integration assessed for banana markets in south India by Pauline and Ajjan (2014), showed that price changes are synchronous and are transmitted simultaneously to other markets. The co integration results show that the regional markets have price linkages, and thus are spatially integrated. If markets are not spatially or inter-temporally

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integrated it could be indicative that market inefficiencies exist as a result of, amongst others, collusion and market concentration which result in price fixing and distortions in the market. Therefore this study was conducted with the twin objectives of analyzing the extent of market integration and causal relationship between Nendran banana markets in Kerala.

The present study was based on the time series data on monthly Nendran banana prices collected from Kozhikode, Ernakulam, and Thiruvananthapuram markets for the period from 2003 to 2018.

Augmented Dickey-Fuller (ADF) Test

An implicit assumption in Johansen's cointegration approach is that the variables should be non-stationary at level, but stationary after first differencing. The Augmented Dickey-Fuller test is utilized to check the order of integration by using the model (1):

$$\Delta Y_t = \beta_1 + \delta P_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta P_{t-i} + \epsilon_t \quad \ldots(1)$$

where, $\Delta Y_t = Y_t - Y_{t-1}$, $\Delta Y_{t-1} = Y_{t-1} - Y_{t-2}$, and $\Delta Y_{t-2} = Y_{t-2} - Y_{t-3}$, etc.,'$P_t$' denotes (nx1) vector of I(1) prices, ϵ_t is pure white noise term, α is the constant term, t is the time trend effect, and p is the optimal lag value which is selected on the basis of Schwartz information criterion (SIC). The null hypothesis is that δ, the coefficient of P_{t-1} is zero.The alternative hypothesis is: $\beta_1 < 0$. A non-rejection of the null hypothesis suggests that the time series under consideration is non-stationary (Gujarati, 2010).

Cointegration analysis using Johansen's multivariate cointegration approach

The Johansen procedure (Johansen and Juselius, 1990) examined a vector auto regressive (VAR) model of Y_t, an (n × 1) vector of variables that are integrated of the order one I (1) time series. This VAR can be expressed as equation (2):

$$\Delta P_t = \sum_{i=1}^{K-1} \Gamma_i \Delta P_{t-i} + \Pi_i P_{t-k} + \mu + \beta_t + e_t \quad (t = 1, 2, \ldots t)\ldots(2)$$

Where, $\Pi_i = -(1 - \Pi_1 - \ldots\ldots - \Pi_t)$; i= 1, 2… K-1; $\Pi = -(1 - \Pi_1 - \ldots. - \Pi_k)$. '$P_t$' denotes (nx1) vector of I (1) prices, each of the Π_1 is an n x n matrix of parameters; 'e_t' is an identically and independently distributed n-dimensional vector of residuals with zero mean and variance matrices; 'μ' is a constant term and t is trend. The presence of at least one cointegrating relationship is necessary for the analysis of long-run relationship of the prices to be plausible. To detect the number of co-integrating vectors, Johansen proposed two likelihood ratio tests: trace test and maximum Eigen value test, shown in equations (3) and (4), respectively.

Trace statistic (λ-trace) = $-T \Sigma \ln(1-\lambda_i)$…(3)

Eigen value statistic (λmax) = $-T \ln(1-\lambda_{r+1})$….(4)

Where, T is the sample size and λ_i is the i^{th} largest canonical correlation. The trace test examines the null hypothesis of r cointegrating vectors against the alternative hypothesis of n cointegrating vectors. The maximum Eigen value test, on the other hand, tests the null hypothesis of r cointegrating vectors against the alternative hypothesis of r+1 cointegrating vectors (Hjalmarsson and Osterholm, 2010).

Granger causality Test

The Granger causality test conducted within the framework of a VAR model is used to test the existence and the direction of long-run causal price relationship between the markets (Granger, 1969). It is an F-test of whether changes in one price series affect another price series. If two markets are integrated, the price in one market 'P_D' would be found to Granger-cause the price in the other market, 'P_I'and/or vice versa. The test involves estimating the following pair of regressions

$$P_{Dt} = \sum_{i=1}^{n} \alpha_i P_{It-i} + \sum_{j=1}^{n} \beta_j P_{Dt-j} + u_{1t} \ldots..(5)$$

$$P_{It} = \sum_{i=1}^{n} \lambda_i P_{It-i} + \sum_{j=1}^{n} \delta_j P_{Dt-j} + u_{2t} \ldots.(6)$$

where, *D* and *I* are the two markets, *P* stands for price series and t is the time trend variable. The subscript stands for the number of lags of both variables in the system. The null hypothesis in Equation (5), i.e., H_0: $\beta_1 = \beta_2 = ... = \beta_j = 0$ against the alternative, i.e., H_1: Not H_0, is that P_{It} does not Granger cause P_{Dt}. Similarly, testing H_0: $\delta_1 = \delta_2 = ... = \delta_j = 0$ against H_1: Not H_0 in Equation (6) is a test that *P ln Dt* does not Granger cause *P ln At*. In each case, a rejection of the null hypothesis will imply that there is Granger causality between the variables (Gujarati, 2010).

Augmented Dickey-Fuller (ADF)

The results of the Augmented Dickey-Fuller (ADF) unit root test applied at level and first difference to the prices of banana are given in Table 1. The result suggests that price series was nonstationary at their level form. The null hypothesis of nonstationarity at level form could not be rejected for all price series as the values of the ADF statistics were below the 5 per cent critical values. Thus, it was concluded that all the price series were non-stationary at their level forms. The data became stationary after the first difference as absolute values of the ADF statistics were greater than the 5 per cent critical values of the test statistics. Since the stationarity of price series confirmed and it was integrated of the order 1, test for cointegration among the selected Nendran banana markets using Johansen's maximum likelihood approach was applied.

Table 1. Results of Augmented Dickey Fuller tests for monthly prices of banana

	Market	t-statistic
Levels	Kozhikode	-1.50
	Ernakulam	-4.77
	Thiruvananthapuram	-1.88
First difference	Kozhikode	-7.34**
	Ernakulam	-15.42*
	Thiruvananthapuram	-10.98**

* Denotes significance at 5 per cent level
** Denotes significance at 1 per cent level

Pair-wise Cointegration

The results of pair-wise cointegration test across the markets are given in Table 2. This test showed that each market pair, viz., Kozhikode and Ernakulam market, Ernakulam and Thiruvananthapuram markets, and Kozhikode and Thiruvananthapuram markets had one cointegrating equation. The null hypothesis of presence of cointegration (r ≤1) was confirmed at 5 per cent level of significance with critical value for r = 0 and r≤1 as 15.49 and 3.84 respectively.The results implied that these market pairs were cointegrated and there existed long-run price association between them.

Table 2. Results of pairwise cointegration tests between prices of banana

Markets	Eigen value	Null hypothesis	Trace statistics
Ernakulam and	0.099	r =0	21.44
Kozhikode	0.011	r ≤1	2.09
Thiruvananthapuram	0.184	r =0	41.89
and Ernakulam	0.017	r ≤1	3.35
Kozhikode and	0.201	r =0	45.98
Thiruvananthapuram	0.018	r ≤1	3.38

Note: Critical value for r = 0 is 15.49 and r ≤ 1 is 3.84 at five per cent level

Multiple cointegration

The multivariate cointegration tests for three markets (Table 3) confirmed that the null hypothesis of no cointegration (r=0) could be rejected at five per cent level of significance. But the null hypothesis of r ≤2 was accepted confirming that there were two or less than two cointegrating vectors among the three markets. Thus, Johanson cointegration test showed that even though the selected wholesale markets were geographically isolated and spatially segmented, they were connected in terms of prices of Nendran banana, demonstrating that the selected markets had long-run price linkage across them.

Granger causality tests

After finding cointegration among different

Table 3. Results of multiple cointegration tests between prices of banana

Markets	Eigen value	Null hypothesis	Trace statistics
Ernakulam,	0.361	r =0	124.89
Kozhikode	0.174	r ≤1	9.66
and Thiruvananthapuram	0.018	r ≤2	3.38

Note: Critical value for r = 0 is 29.79, r ≤ 1 is 15.49, and r ≤2 is 3.84 at five per cent level

Table 4. Results of the Granger causality tests for monthly prices of banana

Null hypothesis	F statistic	Probability
Kozhikode does not Granger Cause Ernakulam	59.46**	0.00
Ernakulam does not Granger Cause Kozhikode	7.5	0.01
Thiruvananthapuram does not Granger Cause Kozhikode	36.9**	0.00
Kozhikode does not Granger Cause Thiruvananthapuram	1.9	0.17
Thiruvananthapuram does not Granger Cause Ernakulam	59.91**	0.00
Ernakulam does not Granger Cause Thiruvananthapuram	0.11	0.74

** Denotes significant at one per cent level

Nendran banana markets, Granger causality was also estimated between the selected pairs of markets in India. The Granger causality shows the direction of price formation between two markets and related spatial arbitrage, i.e., physical movement of the commodity to adjust the prices difference (Ghafoor et al., 2009). The results of Granger causality tests are presented in Table 4 which shows that two F-statistics for the causality tests of wholesale prices in Thiruvananthapuram market on other markets were statistically significant. The null hypothesis of no Granger causality was rejected in each case.

The results of the analyses proved the existence of unidirectional causality between Kozhikode and Ernakulam, Thiruvananthapuram and Kozhikode, and Thiruvananthapuram and Ernakulam market prices. This implied that a price change in the former market in each pair granger caused the price formation in the latter market, whereas the price change in the latter market was not fed back by the price change in the former market in each pair. Bidirectional causality was absent among the selected markets.

Pairwise and multiple co-integration analysis of Nendran banana prices in the above markets were carried out after confirming the stationarity of price series using Augmented Dickey Fuller (ADF) test. The results showed that the markets were integrated, inferring the presence of price association among the markets indicating that banana farmers were earning similar prices at a particular point of time. This was due to the similarity in the arrival pattern of the markets. In order to provide additional evidence on direction of price transmission, Granger causality test was carried out and the existence of unidirectional causality from Kozhikode market to Ernakulam market and from Thiruvananthapuram market to Kozhikode and Ernakulam markets was proved. Thiruvananthapuram market was concluded as the price determining market for Nendran banana. The study concluded that despite the geographical separation, the Nendran banana markets of Kerala were well integrated and the prices were in unison. Market integration and price transmission play an important role in determining the production decisions of farmers and diversification to high value products in horticultural crops including Nendran banana. Therefore capacity building in market intelligence which is the key in mitigating many of the market related problems was necessary. The marketing system which was found to be efficient in the study was amenable for innovations in market structure. The major implication of the study was the need for designing a network of agricultural wholesale markets for Nendran banana with improved market structure across the country.

Acknowledgement

We would like to express our sincere gratitude to Kerala Agricultural University, College of Horticulture, Vellanikkara and teachers of Department of Agricultural Economics for their comments and critical evaluation during the studies.

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