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Market integration of arecanut in Karnataka state: An error correction model approach

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Abstract

Arecanut, being an important commercial and plantation crop of Karnataka, its influence on state economy is significant and profound. To stabilize the vital arecanut economy in the state, government has to emphasize on both production and market related issues. But the existing government policies are favoring the production related aspects. While the existing fewer government policies related to marketing are devised devoid of information on market integration, which is unscientific. In order to formulate scientific policies in case of arecanut, consideration of market integration becomes imperative. In order to assess the existence of market integration in arecanut, data on monthly modal prices of arecanut was collected through Agmarknet from seven representative markets in Karnataka state. Cointegration and error correction model were employed to test the presence of market integration and the results of the study revealed that the arecanut markets in the state are integrated with high speed of adjustment. Thus, it can be concluded that integrated arecanut markets are efficient in price transmission. Hence, in order to stabilize arecanut economy government has to stabilize the prices in one important market, which will be transmitted to other markets automatically with a speed equal to coefficient of error correction, eventually reducing the cost of stabilization.

Keywords: Arecanut, cointegration, error correction model, market integration

Introduction

In a market driven economy, the pricing mechanism is expected to transmit orders and directions to determine the flow of marketing activities. Pricing signals guide and regulate production, consumption and marketing decisions over time, form and place (Kohl and Uhl, 1998). In developing economies, there are several impediments to the efficient functioning of markets, particularly for the agricultural commodities. These include insufficient transportation infrastructure, difficulties in accessing market information, government-imposed restrictions on the movement of goods between regions. If the markets are not well integrated then it could result in wrong price signals leading to inefficient allocation of resources, improper distribution of marketed surplus ultimately decreasing economic welfare. As postulated by law of one price, integrated markets is an indicator of absence of market imperfection and inefficiencies. Thus integrated markets are effective, efficient and maximizes overall social welfare.

Market integration is an alternative approach to stabilize prices, allocate resources efficiently and rectify various market imperfections such as monopolies or monopsonies, inadequacy and expensive market information. If markets are well integrated then government can stabilize the price in one imperative market and the same will be transmitted to other markets since the markets are integrated. This reduces the cost of stabilization. Further, farmers will not be constrained by local demand conditions, leading to equitable distribution of farm income.

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Spatial market integration refers to co-movements or a long run relationship of prices. It is defined as the smooth transmission of price signals and information across spatially separated markets (Golleti *et al.*, 1995). Spatial market integration may be evaluated in terms of a relationship between the prices of spatially separated markets. In the developing countries like India, for spatially dispersed regional markets, the nature and extent of their market integration is of immense importance for drawing most advantageous policies, thereby the massive cost of incorrect policies can be minimized (Ravallion, 1986).

The present study is a modest attempt to evaluate empirically the degree of market integration of arecanut in Karnataka state. Since Karnataka is the leading producer of arecanut with production of 2.24 lakh tones accounting about 46.8 per cent of the total production from an area of 1.84 lakh ha accounting to 46 per cent of total area under arecanut in India. Currently, arecanut is cultivated in 140 out of its 175 (80%) taluks. In Karnataka, the investment made on arecanut gardens by farmers is around forty thousand crores rupees (2011 prices). Thus, the annual expenditure made on it accounted to Rs. 2750 crores (Prakash, 2012). The share of arecanut to the state's gross agricultural domestic product (GSDP) is around 8 per cent which indicates its importance to state economy as a whole. It also provides livelihood security for three million farmers belonging to the major areca growing districts of Karnataka state. Therefore, more emphasis has to be given to stabilize arecanut economy in the state. Stabilization can be achieved with the existing level of production by supplimenting it with the efficient marketing system. In this regard, state has given meager importance for its efficient marketing. Thus, the government should comprehend how the price transmission takes place in the domestic arecanut market and should draw optimal policy leading to efficient marketing. Such information is important from the view point of arecanut growers and others pivotal in the arecanut value chain since it affects their marketing decisions (buying and selling), which in turn affects decisions related to logistical matters and eventually profits realized.

The studies on market integration in arecanut is wanting, as the past studies focused only on production related aspects. So there is a need to undertake the study in market related aspects. In order to evaluate the spatial integration, it is necessary to compare the prices of arecanut in one market with the prices of comparable varieties among the other selected markets of the state. To study this, we hypothesized that the arecanut markets are spatially integrated when wholesale prices are taken into consideration. Conventional bi-variate correlation method and advanced error correction method developed by Engle and Granger (1987) was used to confirm whether arecanut markets are integrated or not.

Materials and methods

To estimate empirically the spatial integration of arecanut market in Karnataka state, seven major arecanut markets based on their maximum arrivals and their true representation about the different types (white chali and red boiled) of arecanut were selected. Out of seven, three of them are the major and representative markets for white chali type (WCT) of arecanut and remaining four are the major and representative markets for red boiled type (RBT) of arecanut. From the selected major markets data on monthly modal wholesale prices were collected for a period of six years from 2005 to 2011 from Agmarknet source. Markets considered for present study are shown in the Table1.

Table 1. Bivariate correlation matrix of arecanut price series of selected RBT markets

	Correlation matrix			
Markets	**Sagara**	**Shimoga**	**Davangere**	**Sirsi**
Sagara	1.00	0.93	0.94	0.96
Shimoga	0.93	1.00	0.95	0.93
Davangere	0.94	0.95	1.00	0.91
Sirsi	0.96	0.93	0.91	1.00

Conventional approach

Market integration may be a situation in which the arbitrage causes prices in different markets to move together. Price in one market varies with the actions of buyers and sellers in other markets. In a competitive market there will be free flow of market information, therefore the price difference between the two spatially separated markets will always be equal to or less than the transportation cost between them. The degree in which price formation in one market is related to the process of price formation in other markets can be revealed through a correlation matrix of prices in these markets, conventionally, using simple correlation coefficients tested market integration. This measure is used to estimate the degree of association between the different markets with respect to the wholesale price of the considered commodity.

Modern approach

The newly developed method in the theory of time series and co-integration was also employed to test the market integration. To test the market integration, Augmented Dickey Fuller (ADF) test, Phillip-Perron (PP) test, Engle Granger test, Johansen co-integration test and error correction model were employed.

Test of stationarity

To test the null hypothesis of non-stationarity against an alternative of stationarity of the time series data, Dickey and Fuller (1979) has developed unit root test. In Dickey and Fuller (DF) test, assumption of white noise on stochastic error term will be made. Under violation of this assumption, Dickey and Fuller have developed an alternative test called Augmented Dickey fuller test (ADF) by augmenting DF test equations with lagged dependent variables. Phillip Perron test (PP) could also be employed for the same purpose. Though PP test is non-parametric but is relatively more powerful in testing stationarity compared to the parametric ADF test.

Co-integration

Regression of a non-stationary time series on another non stationary time series may cause spurious regression or non sense regression. Granger and Newbold (1974) have given a thumb rule to suspect spuriousness in estimated regression. If estimated regression model is spurious then it cannot be used for prediction or forecasting purpose. Perhaps model can be used to establish long run equilibrium relation (cointegration) if the residual from the regression model is stationary.

The concept of co-integration (Granger, 1981) and the methods for estimating the co-integrated relation or system (Engel and Granger, 1987; Johansen, 1988) provides a framework for estimating and testing the long run equilibrium relationships between the non-stationary integrated variables. If p_{1t} and p_{2t} are the prices in two spatially separated markets (or different levels of the supply chain),if they *possess* the stochastic trends and are integrated of the same order, say I (*d*), the prices are said to be co-integrated. It can be expressed as below,

$$p_{1t} = \beta p_{2t} + u_t \ldots\ldots\ldots\ldots \text{(1) where } u_t \;\; I(0)$$

Where, β is the co-integrating coefficient and the equation (1) is referred to be as the co-integrating regression model. The above relationship can be estimated by using either the ordinary least **s**quares (OLS) (Engel and Granger, 1987), or a full information maximum likelihood method developed by Johansen (1988, 1991).

Johansen's co-integration test relies on maximum likelihood method. This procedure is based on the relationship between the rank of a matrix and its characteristic roots. Johansen derived the maximum likelihood estimation using sequential tests for determining the number of co-integrating vectors. Johansen suggested two test statistics to test the null hypothesis that there are at most 'r' co-integrating vectors. This can equivalently be stated as the rank of the coefficient matrix ("), is at most 'r' for r = 0, 1, 2, 3…n-1. The two test statistics are based on the trace and maximum eigen values, respectively.

$$\Delta Y^t = \alpha + \beta t + (p - 1)\, Y_{t-1} + \theta_1 \Delta Y_{t-1} + \ldots \ldots \ldots + \theta_{k-1} \Delta Y_{t-k+1} + W_t \quad \ldots\ldots(1)$$

$$\lambda_{trace} = -T \sum_{t=r+1}^{n} \text{In}\,(1 - \lambda_t) \quad \ldots\ldots(2)$$

$$\lambda_{trace} = T\, \text{In}\,(1 - \lambda_{r-1}) \quad \ldots\ldots(3)$$

In testing for efficiency of two spatially separated markets (which is the necessary condition for market integration) the null hypothesis should be tested for r = 0 and r = 1. If r = 0 cannot be rejected, it can be concluded that there is no co-integration. On the other hand, if r = 0 is rejected and r = 1 cannot be rejected then it can be concluded that there is a co-integrating relationship. Co-integration implies that there exist a co-integrating vector β. The hypothesis in market efficiency can be tested by imposing restrictions on the co-integrating vector β. Then the standard likelihood ratio test can be applied in this case. Specifically, the test statistics can be expressed by the canonical correlations as (Johansen and Juselius, 1990).

$$LR = T \sum_{t=1}^{r} \text{In}\,(1-\lambda_t^*) - \text{In}\,(1-\lambda_t^*) \quad ....(4)$$

Where λ_t^*, ...λ_r^* are the largest squared canonical correlations under the null hypothesis, the restricted model. The test statistics follows an asymptotic chi-square distribution with the degree of freedom equaling the number of restrictions imposed. This methodology was employed by Khalid Musthaq *et al* (2008) in their study on "Apple market integration: Implication for sustainable agricultural development".

Error correction model

From the results of either Engle- granger test or Johansen co-integration test, if the price series under consideration are found to be co-integrated then, the residuals from the equilibrium regression can be used to estimate the error correction mechanism (ECM). It is performed with an intention to analyze the long term and short term effects of the variables as well as to find the speed of adjustment of disequilibrium to the original equilibrium condition. This coefficient is the lagged residual terms of the long run relationship. Its functional form is represented as below,

$$\Delta p_{1t} = C + \delta u_{t-1} + \beta \Delta p_{2t} + e_t$$

Where, e_t is identically and independently distributed (iid) and $\delta = (\alpha - 1)_t$ is the *co*efficient of the term u_{t-1} which is the error correction coefficient and is also called as the adjustment coefficient. It tells us how much of the adjustment to equilibrium takes place in each period, or how much of the equilibrium error is corrected. This error correction coefficient is expected to be negative and statistically significant. Because, if the error term is negative then only we can say that the two variables can converge to equilibrium. Convergence is a prerequisite for the presence of co-integration because if there is no convergence then the two variables cannot maintain a long run equilibrium relationship. This methodology was employed to test cointegration of potato market in Hooghly district of West Bengal by Jyothish Prakash Basu and Soumyananda Dinda in 2003.

Results and discussion

The perusal of Table 1 and Table 2 provides the information on the bi-variate correlation coefficients among the price series of the selected market pairs for red boiled type (RBT) and white chali type (WCT) of arecanut in Karnataka state. The highest correlation among the RBT markets was observed between the prices of arecanut in Sagara and Sirsi market (0.95). This can be attributed to the fact that they have got the spatial proximity (70 km) and other likely reason could be the dominance of homogeneous grade (rasi) being sold in the markets. Whereas, the lowest correlation among RBT markets was found between the price series of Sirsi and Davangere arecanut markets, as they are distantly located. Similarly, the highest correlation was noticed between Kundapura and Manglore markets because of their propinquity. The lowest correlation was observed between Manglore and Bantwala markets. Though they have the spatial proximity, they are not integrated because of lack of infrastructural facilities available in Bantwala market. From the traditional analogy it can be interpreted that all the markets under consideration are said to be highly integrated. Amongst them, higher integration was observed between Sagara and Sirsi markets for red boiled type of arecanut. Similarly for white chali type the highest degree of integration was between Kundapura and Mangalore.

Table 2. Bivariate correlation matrix of arecanut price series of selected WCT markets

	Correlation matrix		
Markets	**Mangalore**	**Kundapura**	**Bantwala**
Mangalore	1.00	0.95	0.93
Kundapura	0.95	1.00	0.95
Bantwala	0.93	0.95	1.00

For testing the stationarity, the null hypothesis of nonstationarity against the alternative hypothesis of stationarity was formulated. The results of both ADF and PP tests conducted for all the price series at their level and at first difference are shown in Table 3 and 4. The null hypothesis of non stationarity cannot be rejected for the unit root test conducted at level, revealing the presence of unit root or non-stationarity for all the price series. The null hypothesis of ADF and PP test for all the price series

Table 3. **Unit root test for monthly prices of RBT arecanut in selected markets**

Markets	At level			
	Philip Perron	P value	ADF	P value
Sagara	-1.90949	0.3259	-1.53207	0.5105
Shimoga	-2.59777	0.0991	-2.69163	0.0815
Davangere	-2.39903	0.1464	-1.59475	0.4787
Sirsi	-2.14473	0.2285	-1.13264	0.6969
	After first difference			
Markets	**Philip Perron**	**P value**	**ADF**	**P value**
Sagara	-10.8727	0.002	-10.1247	0.0012
Shimoga	-14.8105	0.001	-6.57014	0.0023
Davangere	-11.1522	0.008	-8.09634	0.0031
Sirsi	-11.37	0.009	-8.307	0.0023

at their first difference can be rejected at 5 per cent level indicating that they will become stationary or do not possess unit root if they get differenced. From this result it can be inferred that the price series are integrated of order 1 *i.e.*, I (1).

Table 4. **Unit root test for monthly prices of WCT arecanut in selected markets**

Markets	At level			
	ADF	P	PP	P
Mangalore	-1.75041	0.4024	-1.75041	0.4024
Kundapura	-2.09198	0.2484	-2.13241	0.2328
Bantwala	-0.56366	0.8719	-0.64773	0.8531
	At first difference			
Markets	**ADF**	**P**	**PP**	**P**
Mangalore	-7.89198	0.0029	-7.94013	0.0015
Kundapura	-7.02788	0.02	-8.49619	0.031
Bantwala	-12.1208	0.0001	-12.3691	0.0001

Since all of the price series in the study are integrated of the same order, it is appropriate to proceed with co-integration analysis using Johansen co-integration test. In the Johansen co-integration test the issue of finding optimal lag length is very crucial to know the Gaussian error terms. The optimal lag length (2 lags) was selected based on Akaike Information criteria and Schwartz based criteria. The results of Johansen's cointegration relationship between the price series of selected arecanut markets are presented in Table 5 and Table 6. The Johansen's test statistics of the null hypothesis is that there are atmost ($0<r<K$) cointegrating vectors and thus (n-r) common stochastic trend. In the above results the null hypothesis H_0: r = 0 at one

Table 5. **Results of Johansen's cointegration test for RBT arecanut markets**

Market pairs		No. of coint. equation	trace stat value	trace stat P	Max eigen value Value	Max eigen value P
Sagara	Shimoga	R=0	20.68967	0.0075	18.54075	0.0099
		R=1	2.148919	0.1427	2.148919	0.1427
Sagara	Davangere	R=0	26.24133	0.0008	24.04398	0.0011
		R=1	2.197354	0.1382	2.197354	0.1382
Sagara	Sirsi	R=0	22.90293	0.0032	20.51167	0.0045
		R=1	2.391261	0.122	2.391261	0.122
Shimoga	Davangere	R=0	29.09037	0.0003	24.18349	0.001
		R=1	4.906882	0.0267	4.906882	0.0267
Shimoga	Sirsi	R=0	18.48941	0.0171	15.7758	0.0286
		R=1	2.71361	0.0995	2.71361	0.0995
Davangere	Sirsi	R=0	29.16382	0.0003	26.22562	0.0004
		R=1	2.9382	0.0865	2.9382	0.0865

per cent level except for Bantwala was rejected. But the null hypothesis of H_0: r = 1 cannot be rejected even at one per cent level of significance from both trace and max eigen statistics, indicating presence of 1 co-integrating equation. The evidence of integration between these markets is due to their close proximity and availability of good communication and infrastructural facilities. Whereas between Bantwala and Mangalore markets there is no existence of co-integration, which might be ascribed to the fact that the infrastructural facilities like storage facility available at Bantwala market is not adequate and the market is at its nascent stage regarding functioning.

Table 6. **Results of Johansen's cointegration test for WCT arecanut markets**

Market pairs		No. of coint equation	trace stat value	trace stat P	Max eigen value value	Max eigen value P
Bantwala	Mangalore	R=0	10.295	0.38	7.901	0.25
		R=1	2.394	0.12	2.394	0.12
Kundapura	Bantwala	R=0	23.324	0.001	23.264	0.0015
		R=1	0.0602	0.8061	0.0602	0.8061
Kundapura	Mangalore	R=0	16.935	0.0301	13.842	0.0582
		R=1	3.0934	0.0786	3.0934	0.0786

The arecanut markets in Karnataka state are integrated and market mechanism play an important role through influencing the price change in one market to another market. Table 7 presents the results of the error correction model for both RBT and WCT arecanut markets. It is revealed from the table that the coefficients of error correction term in all

Table 7. Estimated error correction models

Error Correction model results for RBT

Δ Dav = –9.73171 + 0.8484 Δ sag – 0.64371 e_{t-1}
(0.90) (0.001) (0.01)

Δ Dav = –12.3961 + 0.8104 Δ sir – 0.64273 e_{t-1}
(0.8967) (0.002) (0.0007)

Δ Dav = –6.92457 + 0.7822 Δ shiv – 0.73867 e_{t-1}
(0.9249) (0.0012) (0.0017)

Δ Sag = –2.2253 + 0.65523 Δ shiv – 0.6073 e_{t-1}
(0.98) (0.0002) (0.012)

Δ Sag = –3.9302 + 0.8762 Δ shir – 0.6453 e_{t-1}
(0.95) (0.0019) (0.0028)

Δ shiv = – 7.6146 + 1.007 Δ shir – 0.6719 e_{t-1}
(0.93) (0.003) (0.0023)

Figures in parenthesis indicate the probability values.
Where Δ Sag = 1st difference of arecanut price series of Sagara market.
Δ Shiv = 1st difference of arecanut price series of Shimoga market.
Δ Shir = 1st difference of arecanut price series of Sirsi market.
Δ Dav = 1st difference of arecanut price series of Davangere market

Error Correction model results for WCT

Δ kund = 3.79 + 0.8363 Δ mang –0.66 e_{t-1}
(0.98) (0.001) (0.0023)

Δ bant = 22.75 + 0.75 Δ kund – 0.72 e_{t-1}
(0.97) (0.002) (0.0034)

Where Δ Kund = 1st difference of arecanut price series of Kundapura market.
Δ Mang = 1st difference of arecanut price series of Mangalore market.
Δ Bant = 1st difference of arecanut price series of Bantwala market.

possible combination are negative and statistically significant, implying that there exists short run dynamics with the long run equilibrium. This implies that if there exist any divergence from long run equilibrium in time period 't-1', it will be adjusted towards equilibrium level in time period 't'. The speed at which the long run equilibrium restores from its divergence is given by the 'speed of adjustment' coefficient or 'error correction term'. The result of the speed of adjustment for both RBT and WCT arecanut markets is given in Table 8. Highest speed of adjustment was found between Davangere and Shimoga in case of RBT (74%). It means that any disequilibrium in prices in the previous period is corrected at the rate of 74 per cent monthly. Highest speed of adjustment in case of WCT was found between Bantwala and Kundapura (72%). The magnitude of structural adjustment coefficient depends on complex gamete of factors such as close proximity, connectivity in the form of roads, access to market information, concentration of market power, availability and access to scientific storage *etc*.

Table 8. Estimated error correction coefficients (%)

Markets	Mangalore	Kundapura	Markets	Sagara	Shimoga	Sirsi
Bantwala	66	72	Davangere	64	74	64
			Sagara		60	64
			Shimoga			67

The results of conventional correlation method indicated that Sagara-Sirsi in RBT markets and Kundapura-Mangalore in WCT markets are highly integrated. In contrast to this, the results of error correction model signaled that Davangere-Shimoga (RBT) and Bantwala -Kundapura (WCT) are integrated with highest speed of adjustment. This contrasting result was accredited to inefficiency of correlation approach to account for non stationarity in the price series, which may yield spurious correlation. Because of this inefficiency, correlation approach fails to signal the true nature of integration among the markets. So, ECM an alternative approach comes in handy, since it is devoid of problem associated with non-stationarity. Hence, the results obtained from this approach is reliable and realistic.

Empirically, using co-integration analysis, it was proved that the arecanut markets in Karnataka are integrated. This can be credited to the recent initiatives put forth by the government in the field of marketing *inter alia* e-tendering system, electronic display boards in APMCs and online access to market information to strengthen market information system and other sought-after infrastructural facilities. The perpetual efforts of government in this arena have resulted in smooth and efficient price transmission which is apparent in the form of integrated markets. The speed of adjustment coefficients for the integrated arecanut markets are on the higher side, as expected. This is attributable to its non perishability which facilitates for spatial and temporal price adjustments. Government can still intervene in improving the extent of market integration, which is an imperative way in achieving equitable, efficient and stable arecanut markets.

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References

Basu, J.P. and Dinda, S. 2003. Market integration: An application of error correction model to potato market in Hooghly district, West Bengal. *Indian Journal of Agricultural Economics* **58**(4): 742-753.

Dickey, D.A. and Fuller, M.A. 1979. Distribution of the Estimators for Autoregressive Time Series with a Unit Root. *Journal of the American Statistical Association* **74**: 427-431.

Engle, R.F. and Granger, C.W.J. 1987. Co-integration and error correction: Representation, Estimation and Testing. *Econometrica* **49**: 251-276.

Golettie, F., Raisuddin, A. and Farid, N. 1995. Structural determinants of market integration: The case of rice markets in Bangladesh. *Developing Economies* **33**(2): 185-202.

Granger, C.W.G. 1981. Some Properties of time series data and their rise in econometric model specification. *Journal of Econometrics* **16**: 121-130.

Granger, C.W.G. and Newbold, P. 1974. Spurious regression in Econometrics. *Journal of Econometrics* **60**: 1045-1066.

Johansen, S. 1988. Statistical analysis of cointegration vectors. *Journal of Economic Dynamics and Control* **12**(2-3): 231-254.

Johansen, S. 1991. Estimation and Hypothesis testing of cointegration vectors in Gaussian Vector Autoregressive Models. *Econometrica* **59**(6): 1551-1580.

Johansen, S. 1995. A Statistical analysis of cointegration for I (2) variables. *Economic Theory* **11**(1): 25-29.

Johansen, S. and Juselius Katarina. 1990. Maximum Likelihood estimation and inference on cointegration- With application to the demand for money. *Oxford Bulletin of Economics and Statistics* **52**(2): 169-210.

Mushtaq, K., Gafoor, A. and Dad, M. 2008. Apple market integration: Implications for sustainable agricultural development. *The Lahore Journal of Economics* **13**(1): 129-138.

Kohl, S.R.L. and Uhl, J.N. 1998. *Marketing of Agril. Product.* Fifth Edition, Macmillan, New York.

Negassa, A., Meyers, R. and Gabre Maldhin, E. 2003. Analyzing the Grain market efficiency in developing countries: Review of existing methods and extensions to the party bound model. Market trade and institutions division. Discussion paper, 63p.

Prakash, T.N. Kammaradi. 2012. Arecanut Economy at the cross roads. Report of special scheme on cost of cultivation of arecanut in Karnataka, (GOI).

Ravallion, M. 1986. Testing market integration. *American Journal of Agricultural Economics* **68**(1): 45-52.