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Market outlook of major paddy markets in India

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ABSTRACT

Monthly modal prices of paddy corresponding to Nizamabad and Suryapet markets became stationary at level as well as at first difference, where as the prices of Sindhanur and Toofanganj markets became stationary only after first differencing. Johansen's multiple co-integration tests revealed long-run equilibrium relationship among the markets. The causality test revealed a bi-directional influence of paddy prices between Sindhanur and Nizamabadand, Suryapet and Nizamabadand and Sindhanur and Suryapet markets. The Toofanganj market prices have depicted uni-directional causality on the prices of Nizamabad and Sindhanur and Suryapet market prices have shown uni-directional causality with Toofanganj market prices. Nizamabad market came to short run equilibrium within 24 days as indicated by co-efficient values. The results of Vector Error Correction Model (VECM) showed that most of the markets considered under this study were integrated to each other.

Key words: *Augmented dickey fuller, granger causality, long-run equilibrium, market integration, vector error correction model*

INTRODUCTION

Paddy is the most important and extensively grown cereal crop in the world. It is the staple food of more than 60 per cent of the world's population. One-fifth of the world's population *i.e.*, more than a billion people depend on rice cultivation for their livelihoods. Rice is produced in about 42 countries and recognized as staple food in Asia, Latin America, parts of Africa, Middle East and serve as a primary source of food for more than half of the world's population. The world rice market is also featured by a high degree of concentration as the data shows that most of the rice produced is consumed domestically, only 7 per cent of global production is internationally traded (FAO, 2012). Rice is not a uniform commodity and consumer preferences for specific types and qualities are often well-established so there is limited scope for substitution in rice (FAO, 2004). Asia, where about 90 per cent of rice is grown, has more than 200 million rice farms, most of which are smaller than one hectare (FAO, 2012). Rice-based farming is the main economic activity for hundreds of millions of rural poor in this region.

The global area of rice was 157.46 million ha, with a production and productivity of 701.52 million tonne and 4.46 t/ha respectively in 2015 (www.usda.gov). China was the leading rice producer followed by India, Indonesia and Bangladesh in 2014-15 (www.agricoop.nic.in). India tops among the paddy growing countries globally for 2014-15 with an area of 42.75 million ha, production of 154.52 million tonnes and productivity of 3.61 tonne/ha (http://ricestat.irri.org:8080/wrs2/entrypoint.htm).

Agricultural commodities are typically produced over extensive spatial area and are costly to transport relative to their total value. Fackler and Goodwin (2002) noted that these characteristics of agricultural products yield a complex set of spatial price linkages which needed to be studied to gain insights into the performance of markets. The accuracy and speed at which price change in one market gets transmitted to other markets is taken as an indicator of integration

(inter dependence) among the markets. The extent of integration gives signals for efficient resource allocation, which is considered essential for ensuring greater market efficiency, price stability and food security. Test of integration also plays a key role in determining the geographical level at which agriculture price policy should be targeted, at least in the short-run to ensure regular availability of food and price stability (Jha et al., 2005). If price changes in one market are fully reflected in an alternate market then these markets are said to be spatially integrated, it indicates the overall market performance. In an integrated market, prices of a commodity are responsive to price changes of the same quality products in other markets. As such price differences of a particular variety of product in different markets of the area as a rule should not exceed the cost involved in transportation and handling of the produce. The ultimate objective of the planners and policy makers in the field of agricultural marketing is to develop efficient markets for the agricultural produce produced by the farmers. 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. The present study aims at studying the integration of paddy markets in India.

MATERIALS AND METHODS

The volume of transactions of paddy (Sona masuri) was the basis for selecting major markets. This criterion led for the selection of four major markets, Nizamabad and Suryapet (Andhra Pradesh), Sindhanur (Karnataka) and Toofanganj (West Bengal) were selected for the study purposively.

Before analysing any time series data, testing for stationarity is necessary (Davidson and Mackinnon, 1993) since the data has the presence of trend components. Time series stationarity is the statistical characteristics of a series such as its mean and variance over time. If both are constant over time, then the series is said to be stationary *i.e.*, there is no random walk or unit root. If the series was found to be non-stationary, then the first differences of the series were to be tested for stationarity. The number of times (d) a series was differenced to make it stationary is referred as the order of integration, I (d). The Augmented Dickey Fuller (ADF) test was applied by running the regression of the following formula

$$\Delta Y_{t\,i} = B\beta_1 + \delta Y_{ti\,-\,1} + \alpha_i \sum \Delta Y_{t\,-\,1} + e_t \qquad ...(1)$$

where, Y_i denoted price series of paddy markets and *i*=1,2,...5 (1- Nizamabad, 2-Suryapet, 3-Sindhanur and 4-Toofanganj). For a series to be stationary β must be less than unity in absolute value. Hence stationarity requires that $-1 < \beta < 1$ (Vavra & Goodwin, 2005). A series without differencing is integrated of order zero; denoted as I (0) while a series stationary at first difference is integrated of order one, denoted as I (1). Once the variables were checked for stationarity and were of same order, integration between them could be tested using Johansen maximum likelihood test.

Two series are said to be co-integrated when there exists a long run equilibrium relationship between them. In other words, two series cannot drift from one another in the long run. That is, there exists an equilibrium mechanism to bring the two series together. Applying this concept to any two given markets, co-integration between their price series implies long run dependence between them. Since the very essence of market integration is the price dependence across markets, it follows that co-integration between prices in two given markets implies integration of the markets.

To examine the price relation between two markets, the following basic relationship commonly used to test for the existence of market integration may be considered.

$$P_{it} = \alpha_0 + \alpha_1 P_{jt} + \varepsilon_t \qquad ....(2)$$

Where,

P_i = Price series of paddy in ith market.

P_j =Price series of paddy in jth market.

ε_t = is the residual term assumed to be distributed identically and independently

α_0 = represent domestic transportation costs, processing costs and sales taxes.

The test of market integration is straight forward

if P_i and P_j are stationary variables.

Often, however, economic variables are non - stationary in which case the conventional tests are biased towards rejecting the null hypothesis. Thus, before proceeding to further analysis, it is important to check for the stationarity of the variables.

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 Model (ECM) is that it incorporates variables both in their levels and first differences. By doing this, ECM captures the short-run dis-equilibrium situations as well as the long-run equilibrium adjustments between prices. ECM can incorporate such short-run and long-run changes in the price movements. A generalized ECM formulation to understand both the short-run and long-run behaviour of prices can be considered by first taking the Autoregressive Distributed Lag (ADL) equation as follows:

$$Y_t = \alpha_{01}\ X_t + a_{11}X_{t-1} + a_{12}Y_{t-1} + \varepsilon_t$$

$$\Delta Y_t = a_{01}\Delta X_t + (1 - a_{12})\left[\frac{(a_{01} + a_{11})}{(1 - a_{12})}\ X_{t-1} - Y_{t-1}\right] + \varepsilon_t$$

The generalized form of this equation for k lags and an intercept term is as follows:

$$\Delta Y_t = a_{00} + \sum_{i=0}^{k-1} a_{i1}\Delta X_{t-i} + \sum_{i-1}^{k-1} a_{i2}\Delta Y_{t-i} + m_0[m_1 X_{t-k} - Y_{t-k}] + \varepsilon_t$$

where $$m_0 = (1 - \sum_{i=1}^{k} a_{i2}), and\ m_1 = \frac{\sum_{i=0}^{k} a_{i1}}{m_0}$$

The parameters m_0 measures the rate of adjustment of the short-run deviations towards the long run equilibrium. Theoretically, this parameter lies between 0 and 1. The value 0 denotes no adjustment and 1 indicates an instantaneous adjustment. A value between 0 and 1 indicates that any deviations will have gradual adjustment to the long-run equilibrium values.

Granger Causality Test

Granger (1969) developed a methodology to examine whether changes in one series cause changes in another. If the current value of Y can be predicted by using the past values of X and considering other relevant information including the past values of Y, it may be concluded that X causes Y. Similarly, if the current values of X can be predicted by considering past values of Y and past values of X, it is concluded that Y causes X. The following two OLS regressions used in Granger causality test explains the above concept.

$$Y_i = a_i Y_{t-i} + b_i X_{t-i} + e_i \ldots\ldots\ldots 3$$

$$X_i = c_i Y_{t-i} + d_i X_{t-i} + v_i \ldots\ldots\ldots 4$$

Where, X_i and Y_i are two stationary time series with zero mean: e_i and v_i are two correlated series. Since the series of the variable are usually non-stationary and integrated of order I (1), first difference of the variable is normally taken which is stationary. The optimal lag length of the variables is determined by minimising Akaike's Information Criterion (AIC). Based on equations 3 and 4, uni-directional causation from one variable X to Y (*i.e.,* X Granger causes Y) is observed if the estimated coefficient on the lagged X variable in equation 3 is statistically non-zero as a group and the set of lagged Y coefficient is zero in equation 4. Similarly, uni-directional causation from Y to X (*i.e.,* Y Granger causes X) is implied if the estimated coefficient on the lagged Y in equation 4 are statistically different from zero as a group and the set of estimated coefficient on the lagged X variable in equation 3 is not statistically different from zero. Feedback or mutual causality (bi-directional) would occur when the set of coefficients on the lagged X variable in equation 3 and on lagged Y variable in equation 4 are statistically different from zero. Finally, independence exists when the coefficients of both X and Y variables are equal to zero.

For the present study, to analyse the integration among the selected markets monthly modal price data for the period from January 2005 to December 2015 for paddy crop was utilised.

RESULTS AND DISCUSSION

Augmented Dickey Fuller (ADF) Test

Before conducting co-integration tests, it is needed to examine the uni- variate time-series properties of the data and confirm that all the price series are stationary and integrated with the same order. This is performed

Table 1. Results of unit root test (ADF) for the monthly prices (2005-2015) of paddy in selected markets

Particulars		ADF statistic	Critical value (1%)
Nizamabad	Level 0	-5.901031	-4.0301
Suryapet	Level 0	-4.8560	
Sindhanur	Level 0	-3.4236	
	Difference 1	-13.7861	
Toofanganj	Level 0	-2.8742	
	Difference 1	-12.5547	

*MacKinnon (1996) one-sided p-values.

by using the ADF test developed by Dickey and Fuller. ADF test was conducted for the monthly prices in the selected paddy markets *viz.*, Nizamabad, Suryapet, Sindhanur and Toofanganj.

The results of this exercise are presented in the Table 1. The price series corresponding to Nizamabad and Suryapet markets are found to be stationary at level as well as at first difference, as the null hypothesis of the presence of a unit root could be rejected. However, the prices of Sindhanur and Toofanganj became stationary only after first differencing.

Johansen's Multiple Co-integration Test

After establishing that the price series are stationary and integrated at the same order, Johansen's multiple co-integrating test analysis was used to test the long-run relation among the price series of paddy. Co-integration test was used instead of regular regression because of its capacity in dealing with non-stationary variables.

Based on the Johansen's Multiple Co-integration procedure, the integration between the markets was analysed using E-Views software. The long-run relationship was examined based on trace test likelihood ratio and maximum Eigen values are presented

Table 2. Unrestricted Co-integration Rank Test (Trace) between paddy markets

Hypothesized No. of CE(s)	Eigen value	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.213173	77.84194	63.87610	0.0022
At most 1 *	0.197771	47.15426	42.91525	0.0178
At most 2	0.106302	18.94804	25.87211	0.2839
At most 3	0.035016	4.562441	12.51798	0.6599

Trace test indicates 2 co-integrating equations at the 0.05 level, * denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 3. Unrestricted Co-integration Rank Test (Maximum Eigen value) between paddy markets

Hypothesized No. of CE(s)	Eigen value	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.213173	30.68768	32.11832	0.0740
At most 1 *	0.197771	28.20622	25.82321	0.0238
At most 2	0.106302	14.38560	19.38704	0.2293
At most 3	0.035016	4.562441	12.51798	0.6599

Trace test indicates 2 co-integrating equations at the 0.05 level, * denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 4. Pair-wise Granger Causality test for monthly prices of paddy in selected markets

Null Hypothesis	Obs	F-Statistic	Probability	Direction of Relationship
NIZ does not Granger Cause TOOF	129	2.16616	0.0955	→
TOOF does not Granger Cause NIZ		2.99429	0.0335	
SIN does not Granger Cause TOOF	129	4.40081	0.0056	→
TOOF does not Granger Cause SIN		1.50961	0.2154	
SUR does not Granger Cause TOOF	129	3.60723	0.0154	→
TOOF does not Granger Cause SUR		2.49239	0.0633	
SIN does not Granger Cause NIZ	129	5.77782	0.0010	↔
NIZ does not Granger Cause SIN		6.07086	0.0007	
SUR does not Granger Cause NIZ	129	5.77052	0.0010	↔
NIZ does not Granger Cause SUR		4.38866	0.0057	
SUR does not Granger Cause SIN	129	10.9012	2.E-06	↔
SIN does not Granger Cause SUR		3.68033	0.0140	

(NIZ- Nizamabad; SUR-Suryapet; SIN- Sindhanur; TOOF- Toofanganj)

Table 5. Vector Error Correction Model for monthly prices of paddy in selected markets

Error Correction	D(NIZ)	D(SUR)	D(SIN)	D(TOOF)
CointEq1	-0.821552	-0.189790	0.184516	-0.054339
	(0.16587)	(0.18193)	(0.12497)	(0.05350)
	[-4.95296]**	[-1.04319]	[1.47649]	[-1.01566]
D(NIZ(-1))	0.122685	0.437663	0.033055	0.050763
	(0.15543)	(0.17049)	(0.11711)	(0.05013)
	[0.78930]	[2.56714]**	[0.28226]	[1.01253]
D(NIZ(-2))	0.176748	0.408648	-0.007057	-0.008928
	(0.13808)	(0.15145)	(0.10403)	(0.04454)
	[1.28008]	[2.69828]**	[-0.06784]	[-0.20047]
D(NIZ(-3))	0.118953	0.167867	-0.068905	-0.009183
	(0.10648)	(0.11679)	(0.08022)	(0.03434)
	[1.11714]	[1.43732]	[-0.85890]	[-0.26737]
D(SUR(-1))	0.042705	-0.557971	0.264068	0.043614
	(0.09261)	(0.10158)	(0.06977)	(0.02987)
	[0.46112]	[-5.49297]**	[3.78460]**	[1.46009]
D(SUR(-2))	0.180400	-0.377729	0.079174	0.053544
	(0.10163)	(0.11147)	(0.07657)	(0.03278)
	[1.77508]	[-3.38859]**	[1.03402]	[1.63344]
D(SUR(-3))	0.076068	-0.119003	0.011955	0.036877
	(0.09511)	(0.10433)	(0.07166)	(0.03068)
	[0.79975]	[-1.14069]	[0.16683]	[1.20204]
D(SIN(-1))	-0.313000	0.000634	-0.254649	0.010610
	(0.14422)	(0.15819)	(0.10866)	(0.04652)
	[-2.17022]**	[0.00401]	[-2.34352]**	[0.22809]
D(SIN(-2))	-0.117405	-0.087461	-0.076700	-0.065784
	(0.13958)	(0.15310)	(0.10516)	(0.04502)
	[-0.84112]	[-0.57127]	[-0.72934]	[-1.46117]
D(SIN(-3))	-0.165730	-0.167445	-0.034693	-0.018535
	(0.11362)	(0.12462)	(0.08560)	(0.03665)
	[-1.45867]	[-1.34365]	[-0.40529]	[-0.50578]
D(TOOF(-1))	0.014589	-0.588693	-0.070483	-0.102389
	(0.29006)	(0.31815)	(0.21853)	(0.09356)
	[0.05030]	[-1.85039]	[-0.32253]	[-1.09441]
D(TOOF(-2))	-0.274379	-0.658552	-0.326140	0.002647
	(0.29487)	(0.32343)	(0.22216)	(0.09511)
	[-0.93049]	[-2.03615]**	[-1.46803]	[0.02783]
D(TOOF(-3))	0.096110	-0.214488	-0.287600	-0.028493
	(0.29239)	(0.32071)	(0.22029)	(0.09431)
	[0.32870]	[-0.66879]	[-1.30553]	[-0.30212]
C	2.793219	20.38922	4.314848	8.225935
	(29.2068)	(32.0351)	(22.0048)	(9.42048)
	[0.09564]	[0.63647]	[0.19609]	[0.87320]

**denotes rejection of the hypothesis at the 0.05 level, (NIZ- Nizamabad, SUR-Suryapet, SIN- Sindhanur and TOOF-Toofanganj)

in Tables 2 and 3. Likelihood ratio indicated the presence of two co-integrating equations at 5 per cent level of significance as the null hypothesis r=0 is rejected. At the same time, co-integration among markets was also confirmed with minimum Eigen value test. Similar results were obtained by Khatkar et al., (2014) for Basmati paddy and Mahalle et al., (2015) for wheat.

Pair-wise Granger Causality Test

In order to know the direction of causation between the markets, Granger causality test was employed. When co-integration relationship is present for two variables, a Granger causality test can be used to analyse the direction of this movement relationship.

It was observed in Table 4 there was bi-

directional influence of prices of Sindhanur and Suryapet. The Nizamabad market price has revealed a bi-directional influence on the prices of Sindhanur and Suryapet. Toofanganj market prices have depicted uni-directional causality on the prices of Nizamabad and Sindhanur and Suryapet market prices have shown uni-directional causality with Toofanganj market prices. This finding is supported by the earlier studies carried out by Ismail and Wim (2010), Khatkar et al. (2014) for basmati paddy, Mahalle et al. (2015) for wheat.

Vector Error Correction Model (VECM)

To study the short-run and long-run association for equilibrium and to know the speed of adjustments among the paddy markets for long-run equilibrium VECM was employed and the results presented in Table 5. The findings revealed the existence of short-run dis-equilibrium in a given market got corrected by changes in its prices and with changes in prices of other markets. The co-efficients of the error correction term indicated the speed of convergence in the long-run as a result of shocks in their own prices and shocks in the prices of other selected markets. But it is still to be seen whether such effects are uni-directional or bi-directional. This was examined using Granger Causality test.

As it could be seen from the Table 5 that the Nizamabad market came to short-run equilibrium as indicated by level of significance and speed of adjustment was rapid. Any disturbance in price would get corrected within 24 days in Nizamabad as indicated by co-efficient values. The findings also showed that the price movements of Suryapet market prices at one month lag and two month lag period and Sindhanur market at one month lag period were influenced by the price changes in Nizamabad paddy market to the tune of 43, 40 and 31 per cent, respectively. Suryapet market prices influenced it own prices in one month and two month lag period and also Sindhanur market prices in one month lag period and the speed of convergence was at 58, 38 and 26 per cent, respectively. The co-efficient of own lagged price of Sindhanur market was found significant and revealed that the impact of its own price gets corrected within one month lag period. In this case the speed of convergence was at 25 per cent with short-run price movements along the long-run equilibrium path. The price movements in Sindhanur were influenced by one month lagged prices of Suryapet market besides being influenced by its own lagged prices. The error correction estimates for Toofanganj market revealed that it was not at all affected by any other selected market prices in the long-run equilibrium path and it was found to be a separate market and at the same time the short-run dis-equilibrium of the Toofanganj market with relation to the Suryapet market was found significant at 2 month lag period and the speed of convergence was at 65 per cent.

CONCLUSION

Johansen's Multiple Co-integration procedure (trace test and maximum eigen value test) indicated the presence of two co-integration equations at 5 per cent level of significance. Hence markets were having long run equilibrium relationship. Granger causality test revealed that there was bi-directional influence of prices of Sindhanur and Suryapet. Nizamabad market prices have revealed a bi-directional influence on the prices of Sindhanur and Suryapet. Toofanganj market prices have depicted uni-directional causality on the prices of Nizamabad and Sindhanur and Suryapet market prices have shown uni-directional causality with Toofanganj market prices. Nizamabad market came to short run equilibrium within 24 days as indicated by co-efficient values. The results of Vector Error Correction Model (VECM) showed that most of the markets considered under this study were integrated with each other. This amply demonstrates that the geographical location and distance among the markets holds key regarding the commodity movement and price discovery. The location of the present paddy markets provides such a favourable marketing environment, thereby keeping a check on the high marketing margins.

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