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Spatial Market Integration between Two Markets of Sorghum in Karnataka and Maharashtra State of India

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Abstract

The study examined the spatial price behaviour, which is an important indicator of the overall market performance. Markets that are not integrated may convey inaccurate price signals that might distort producers' marketing decisions and contribute to inefficient product movements. Secondary data was used for the study obtained from Agmarknet.com based on the frequent arrivals, two district were selected from Karnataka and Maharashtra states (ie Bangalore and Sholapur respectively) using the modal prices from January 2003 to May 2015.The results revealed that after the first differencing the Augmented- Dickey Fuller (ADF) test the series is non stationary and co-integrated, with Bangalore market influencing Sholapur market in the long run.

Introduction

Sorghum is one of the most drought tolerant cereal crops currently under cultivation. It offers farmers the ability to reduce costs on irrigation and other on-farm expenses. Having better nutritional value, the sorghum has taken an important place in the consumption basket of high income group people. Minimum Support Price as well as market price is also higher than the other cereals like wheat, maize and paddy. Sorghum in India is a grown by small farms in rain fed regions. Despite the significant growth in sorghum production, there is huge inefficiency in the production system of sorghum production. An improvement in the efficiency of production system will have direct positive impact on agricultural growth, nutritional security and rural livelihood in a country like India. Spatial price behavior in regional markets is an important indicator of the overall market performance. In case of those markets which are not integrated, inaccurate price information are conveyed that might distort marketing decisions and contribute to inefficient product movements. Integrated markets are defined as markets in which prices of differentiated products do not behave independently (Monke and Petzel, 1984). In other words integrated markets are those markets where prices of the commodities are determined interdependently. It is assumed that the price changes in one market will be fully transmitted to the other markets. If price movements of a commodity in one market are completely irrelevant to forecast price movements of the same commodity in other markets the markets are characterized as segmented. In case of those markets which are not integrated inaccurate price information are conveyed that might distort marketing decisions and contribute to inefficient product movements.

Markets aggregate demand and supply across actors distributed in space. At the international level, monetary policy, exchange rate adjustment and the distribution of the gains from trade depend fundamentally on how well prices equilibrate across countries, as vast literatures on the law of one price and purchasing power parity emphasize (Froot and Rogoff, 1995; Anderson and van Wincoop, 2004). At the national level, well functioning markets ensure that macro-level economic policies (for example, with respect to exchange rates, trade, and fiscal or monetary policy) change the incentives and constraints faced by micro-level decision-makers. Therefore well-functioning markets underpin growth stimuli originating in micro-level phenomena.

Methodology

In India the first and second highest sorghum producing states Maharashtra and Karnataka was purposively selected. Two markets namely Bangalore and Sholapur were selected from Karnataka and Maharashtra respectively. The markets were selected based on the frequent monthly arrivals and availability of the secondary data on monthly modal prices.The study period was taken from January 2003- May2015. In view of objectives of the present study, for the estimation of long run equilibrium disturbances that come from perception of non-stationary of macroeconomic time series data defined in terms of time variant mean and variance, the co-integration technique was used. The non stationary variables derived from "stochastic trends" which include seasonal components, are called integrated variables. Two integrated variables can be co-integrated when they converge in the long run despite short period divergences .The co-integration method was used to verify the notation of the long-run convergence between the prices prevailing of the sorghum in the two markets considering the monthly prices for the period of twelve years.

Two series are said to be co-integrated when there exists a long run equilibrium relationship between them. In case of any two markets, co-integration between their prices series implies long- run dependence between them. To examine the price relation between two markets, the following basic relationship commonly used for the existence of market integration

$\boldsymbol{P}_{it} = \alpha_0 + \alpha_1 \boldsymbol{P}_{jt} + \varepsilon_t$……………………........(1)

Where $\boldsymbol{P}_i$ and $\boldsymbol{P}_j$ are price series of a specific commodity in two market i and j. ε is the residual term assumed to be distributed identically and independently. The test of market integration is straight forward if $\boldsymbol{P}_i$ and $\boldsymbol{P}_j$ are stationary variables. The economic variables are non stationary in those cases the conventional tests are biased towards rejecting the null hypothesis. Therefore, before proceeding to further analysis, it is important to check for the stationarity of the variables

Stationarity Test:

Stationarity series is defined as one whose parameters that describe the series (namely the mean, variance and autocorrelation) are independent of time; or rather display constant mean and variance and have autocorrelation that are invariant through time i.e.the series is not a random walk or has no unit root. Once the non-stationarity status of the variables is determined, the next step is to test for the presence of co-integrating (long-run equilibrium) relationship between the variables.The augmented Dickey Fuller test (ADF test) was used to determine the stationarity of a variable. The test is based on the Dickey Fuller value statistic of β_1 given by the following equation (Dickey and Fuller, 1979):

$$\Delta P_t = \beta_0 + \beta_1 P_{t-1} + \sum_{K=1}^{N} \delta_k \Delta P_{t-k} + \eta_t$$

Also,

$\Delta P_t = P_t - P_{t-1}$

Where P_t is the log of price, β_0 and δ_k are constant parameters and η_t is a random disturbance term.

The test statistic is simply the t statistic which can be compared with the critical values given in the Dickey Fuller Table. In estimating equation (2), the null hypothesis is H_0: P_t is I(1), which is rejected [in favour of I(0)] if β_1 is found to be negative and statistically significant. The above test can also be carried out for the first difference of the variables. That is, we estimate the following regression equation:

$$\Delta^2 P_t = \theta_0 + \theta_1 \Delta P_{t-1} + \sum_{k=1}^{N} \Phi_k \Delta^2 P_{t-k} + \mu_t \ldots\ldots\ldots\ldots (3)$$

Where the null hypothesis is H_0: P_t is I(2), which is rejected [in favour of I(1)] if θ_1 is found to be negative and statistically significant. In general, a series P_t is said to be integrated of order 'd', if the series achieves stationary after differencing d times, denoted $P_t \sim I(d)$. Consequently, if P_t is stationary after differencing once, this we may denote as $P_t \sim I(1)$.

Having established that the variables are non stationary in level, and then we test co-integration. Only variables that are of the same order of integration may constitute a potential co-integrating relationship.

Co-integration Test:

In the Johansen Co-integration test there are two conditions; viz. the data must be non stationary and the data must be integrated of the same order. When there are 'n' price series, the potential co-integrating relationships is 'n-1'.This procedure first tests the null of zero co-integrating relationships. If that is rejected, it then tests the null that there is only one co-integrating relationship and if that is also rejected it goes for two, three…up to (n-1) co-integrating relationships. Here two tests are used to determine the number of co-integration vectors: the Maximum Eigen value test and the Trace Test. The Maximum Eigen value statistic tests the null hypothesis of r co-integrating relations against the alternative of r+1 co-integrating relations for r = 0, 1,. The trace statistics are computed as the following: $LR_{max}(r/n+1) = -T * \log(1-\hat{\lambda})$

Where λ is the Maximum Eigen value and T is the sample size.

Trace statistics investigate the null hypothesis of r co-integrating relations against the alternative of n co-integrating relations, where n is the number of variables in the system for r = 0, 1, 2… n-1. It is computed according to the following formula:

$$LR_{tr}(r/n) = -T * \sum_{i=r+1}^{n} \log(1-\hat{\lambda}_i)$$

Vector Error Correction Model (VECM) Test:

If co-integration has been detected between the series then there is long term equilibrium between them, then only we apply VECM in order to evaluate short run properties of the co-integrated series. In case the variables are not co-integrated we can only run unrestricted VAR.

In this model all the variables are stationary. The error correction representation is given below.

$$\Delta z_t = \Phi_k \Delta z_{t-k} + \Pi z_{t-1} + \mu + \varepsilon_t$$

Where z_t is for one vector of I(1). The rank of Π equals the number of co-integrating vectors. The number of lags used in the model has been decided on the basis of Akaike information criterion (Akaike, 1969).In order to run this model, variables have to be stationary.

Results and Discussions

The Dickey –Fuller test for stationary for sorghum in the selected markets of India is presented in Table 1.The t statistic values for the ADF test before differencing for the

Bangalore and Sholapur markets were found to be -0.8962 and -1.583305, its probability were not significant, hence the null hypothesis is rejected; indicating there is a no unit root in the two markets, that is there is no stationary between the 2 market at 1 %level of significant

Table 1: Dickey–Fuller test for stationarity of the price series for sorghum in the selected markets of India before differencing

Markets	Augmented Dickey-Fuller test statistic before differencing	Test critical value@1%
Bangalore	-0.896201	-3.475184
Sholapur	-1.583305	-3.475184

Table 2: Dickey–Fuller test for stationarity of the price series for sorghum in the selected markets of India after differencing

Markets	Augmented Dickey-Fuller test statistic after differencing	Test critical value@1%
Bangalore	-16.43420	-3.475184
Sholapur	-16.18511	-3.475184

Table 2 revealed that t statistic value for the ADF test at the first difference were found to be -16.43420 and -16.1851 respectively for Bangalore and Sholapur markets, the probabilities were not significant, the null hypothesis was accepted about the presence of unit root. Thus both the series were integrated of the order one, which means that there is stationarity in the series at 1% level of significant after the first differencing.

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Table 3: Augmented Dickey Fuller Unit root Test on DBANGALORE

Variable	Coefficient	Probability
D(Bangalore(-1))	-1.312967	0.0000
Intercept(C)	4.485557	0.8653
Trend	0.138835	0.6509

From the Table 3 it is apparent that the price series of the Bangalore market do not include the constant and the trend term since the P values for the intercept and trend respectively are more than 0.05 or 5 percent. To determine the lag length, a Schwartz info criterion was used

Table 4: Augmented Dickey Fuller Unit root Test on DSHOLAPUR

Variable	Coefficient	Probability
D(SHOLAPUR(-1))	-1.288298	0.0000
Intercept(C)	18.51976	0.5209
Trend	-0.095942	0.7742

From the Table 4 it is apparent that the price series of the Sholapur market do not include the constant and the trend term since the P values for the intercept and trend respectively are more than 0.05 or 5 percent. To determine the lag length, a Schwartz info criterion was used

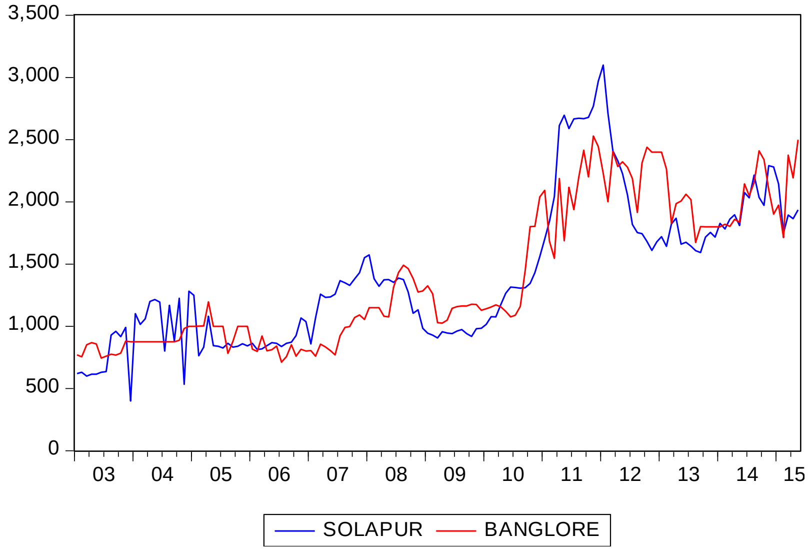

Table 4 Results of Unrestricted Co-integration Rank Test (Trace)

Hypothesized No. of Co-integrating equation(s)	Trace Statistic	0.05 Critical Value	Probability
None *	18.46872	12.32090	0.0041
At most 1	0.327746	4.129906	0.6293

Table revealed that the none trace statistics valves are higher than the corresponding critical value at 5% significance level. The null hypothesis of one co-integrating vector was accepted because the probability for at most 1 is greater than 5 so we accept the null hypothesis so there is a co-integration between the markets, there is at most 1 co-integration between the two markets.

Table 5: Results of Unrestricted Co-integration Rank Test (Maximum- Eigen value)

Hypothesized No. of Co-integrating equation(s)	Maximum- Eigen Statistic	0.05 Critical Value	Probability
None *	18.14097	11.22480	0.0027
At most 1	0.327746	4.129906	0.6293

Table 5 revealed that for the none Maximum- Eigen Statistic values are higher than the corresponding critical value at 5% significance level. The null hypothesis of one co-integrating vector was accepted because the probability for at most 1 is greater than 5 so we accept the null hypothesis so there is a co-integration them, there is at most 1 co-integration between the two markets.

Vector Error Correction Model Test:

Table 6: Long Run Model

Adjustment coefficients (standard error in parentheses)

BANGALORE	SHOLAPUR
-1.000	-0.084898
(1.9E-09)	(0.09450)

Since the both market have negative sign it implies that there is a long run relationship among the markets.

Table 7: VECM results when dependent variable is Bangalore market prices and independent variable is Sholapur market prices.

	Bangalore		Sholapur	
Variables	coefficient	t value	Coefficient	t value
Equilibrium error	-0.142290	-3.24132	0.087697	1.78404
Bangalore (-1)	-0.246799	-2.91082	-0.009193	-0.09683
Sholapur(-1)	-0.191706	-2.35401	-0.231672	-2.54050
Bangalore (-2)	0.016681	0.20024	0.054399	0.58315
Sholapur(-2)	-0.104522	-1.33012	0.022422	0.25482

Table 8: VECM Target model results when dependent variable is Bangalore market prices and independent variable is Sholapur market prices.

Variables	Coefficient	P value
Equilibrium Error(C(1))	-0.092345	0.0766
D(Bangalore(-1)) (C(2))	-0.231672	0.0122
D(Sholapur(-1)) (C(3))	0.022422	0.7992

D(Bangalore(-1)) (C(4))	-0.009193	0.9230
D(Sholapur(-1)) (C(5))	0.054399	0.5607
D(Bangalore(-1)) (C(6))	10.40490	0.4691

Table 9: VECM results when dependent variable is Sholapur market prices and independent variable is Bangalore market prices.

	Sholapur		Bangalore	
Variables	coefficient	t value	Coefficient	t value
Equilibrium error	0.149832	3.24132	-0.092345	-1.78404
Sholapur(-1)	-0.246799	-2.91082	-0.191706	-2.35401
Bangalore (-1)	-0.009193	-0.09683	-0.231672	-2.54050
Sholapur(-2)	0.016681	0.20024	0.054399	0.58315
Bangalore (-2)	-0.104522	-1.33012	0.022422	0.25482

Table 10: VECM Target model results when dependent variable is Sholapur market prices and independent variable is Bangalore market prices.

Variables	Coefficient	P value
Equilibrium Error(C(7))	-0.149832	0.0015
D(Sholapur(-1)) (C(8))	-0.191706	0.0200
D(Bangalore(-1)) (C(9))	-0.104522	0.1856
D(Sholapur(-1)) (C(10))	-0.246799	0.0042
D(Bangalore(-1)) (C(11))	0.016681	0.8416
D(Sholapur(-1)) (C(12))	16.06904	0.2114

Table 11: Results of the Wald test Statistics when dependent variable is Bangalore market prices and independent variable is Sholapur market prices.

Test Statistic	Coefficient	P value
Chi-square	5.796565	0.0551

Table 12: Results of the Wald test Statistics when dependent variable is Sholapur market prices and independent variable is Bangalore market prices.

Test Statistic	Coefficient	P value
Chi-square	0.428479	0.8072

Table 6, 7, 8, 9, revealed the speed of adjustment, One month lag period was considered sufficient to make the error correction model free of autocorrelation. The coefficient of error correction estimates indicated the speed of adjustment at which price series return to the equilibrium. These coefficients are referred to as the speed of adjustment factors and measure the short run deviation from the long run equilibrium. As coefficients value approach zero, the paths are slow to adjust back to long run deviation. Farther it is from zero, the more rapid the price series are likely to reach equilibrium.

Table 6 shows the Vector Error Correction Model, taking Bangalore market price variables as dependent and Sholapur market price variables as independent. The positive error coefficients showed absence of long run causality. Vector Error Correction Target Model Equation for the above case is as follows.

D(BANGALORE) = C(1)*(BANGALORE(-1) - 1.05300808464*SHOLAPUR(-1) + 83.3690485066) + C(2)*D(BANGALORE(-1)) + C(3)*D(BANGALORE(-2)) + C(4)*D(SHOLAPUR(-1)) + C(5)*D(SHOLAPUR(-2)) + C(6)

Table shows that C(1) which is speed of adjustment towards long run equilibrium is positive and insignificant since P value is 7.66 percent, therefore it indicates absence of long run causality running market Bangalore to market Sholapur. So market Sholapur did not influences the market Bangalore in the long run. There was existence of unidirectional short run causality in the selected markets. Table shows the Vector Error Correction Model, taking Sholapur market price variables as dependent and Bangalore market price variables as independent. The negative error coefficients showed presence of long run causality. The speed of adjustment towards long run equilibrium was 14 % and 9 % for Sholapur and Bangalore market respectively.

Thus according to the magnitude of error correction for the markets a lag of 2-4 weeks period in the transmission of information from Bangalore market to Sholapur market was observed.

Table 11 and 12 gives the result for the presence of short run causality using Walds test statistics. Here the P value for the corresponding Chi square t statistic is 0.055 (0.55 %) and 0.8072(80%) which is greater than 5 %. Therefore the null hypothesis is accepted , Therefore there is no short run causality running from market Bangalore to market Sholapur.

Vector Error Correction Target Model Equation for the above case is as follows.

D(SHOLAPUR) = C(1)*(SHOLAPUR(-1) - 0.949660325111*BANGALORE(-1) - 79.172277709) + C(2)*D(SHOLAPUR(-1)) + C(3)*D(SHOLAPUR(-2)) + C(4)*D(BANGALORE(-1)) + C(5)*D(BANGALORE(-2)) + C(6)

According to the Table 11, for the above equation, C(1) which is the speed of adjustment towards long run equilibrium is negative(-0.14) and significant i.e. P value is 0 percent, therefore there is long run causality running market Bangalore to market Sholapur. So market Bangalore influences the market Sholapur in the long run. This is consonance with the following studies Kumawat and Kumar (2006), Meena *et al.* (*2011),* Alwar, Bharatpur,Baran, Dholpur, Hanumanagarh, Nagaur, Sriganganagar, Sawaimadhopur, and Tonk where the results revealed that almost all the selected markets were mutually integrated though the degree of integration varied from the market pair to another within and across the years.

Conclusion

It can be concluded that the price series is non stationary and co-integrated, with Bangalore market influencing Sholapur market in the long run.

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