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Market integration of soybean in Marathwada region of Maharashtra

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Abstract
Soybean (*Glycine max* L.) is known as 'golden bean' and grown in India for dual purpose that is oil seed as well as pulse crop. About 120 soybean growers were selected from two districts (Nanded and Parbhani) in Marathwada region of Maharashtra for study. Cross sectional data were collected from soybean growers with the help of pretested schedule by personal interview method. The data pertains for the year of 2015-16. In case of market integration, the results of ADF test showed that in first difference with lag one, the Augmented Dickey- Fuller (ADF) values of Parbhani (-12.75503) and Nanded market (-13.90505) are lower than that of the critical value (-4.010143) at one per cent level i.e. this implied that the prices series become stationary at first difference level. Co-integration test showed one co-integration equation was significant at five per cent level of significance. It indicated that the selected soybean markets having long run equilibrium relationship and there exists Co-integration between them. The Granger causality test showed that there is unidirectional causality in soybean prices between Parbhani and Nanded markets. As the prices of Parbhani market exhibited unidirectional causality they affect the prices of Nanded market. While the prices of Nanded market does not show any cause and effect. In case of presence of price volatility, the results of ARCH-GARCH analysis revealed that high Alpha (α) which is often associated with a low Beta (β) produces GARCH volatilities with high Vol-of-Vol. It was observed that among the markets the sum of Alpha and Beta is nearer to one i.e. 1.007663 and 1.013004 for Parbhani and Nanded respectively, which indicated that the volatility shocks in the prices of soybean are quite persistent in these markets. The estimates of VECM model revealed that co-integration equation value of Nanded (-4.17290) was significant therefore Nanded market attained short run equilibrium rapidly while Parbhani market came to equilibrium in long run.

Keywords: Soybean, market integration, augmented dickey-fuller, vector error correction model

Introduction

Soybean (*Glycine max* L.) is known as 'golden bean' and grown in India for dual purpose that is oil seed as well as pulse crop. It is important natural source of protein with number of amino acids essential for good health. *Glycine* is derived from Greek word 'Glykus' and probably refers as 'sweet tuber.' The genus Glycine is wild and member of family leguminoceae, sub-family tribe phaseolae and native of China. The phaseolae is the most economically important tribe of leguminoceae family. It is a major oilseeds crop of the world. In USA, it is called as 'Cinderella crop', 'a king without a crown', 'a marvel bean'. In China, it is known as 'Yellow Jewell', great treasurer 'Chinese cow' and 'vegetable meat'. The Yellow river region in China is generally considered as origin center of soybean and the earliest record of soybean in China.

Market integration concept explains the relationship between two markets that are spatially separated. One of the important indicators of efficient functioning of market is that the markets should be spatially integrated. Integrated markets are those where the prices are determined independently. If the markets located at different places are not integrated, there will be wide differences among the prices in different markets which can not be explained by transport costs. In an integrated markets, price of commodity is responsible to price changes of same quality product in other markets, as such price differences for a particular variety of product in different markets of area, should not exceed the cost involved in the transportation and handling of the produce. The analysis of price movement for variety of commodity in the corresponding and linked markets helps in judging the extent of efficiency of marketing system in the region for selected crops. (Vasudeva Naik 2012) [8].

In Maharashtra during 2014-15 area under soybean cultivation was 36.40 lakh hectares with annual production of 18.21 lakh tons with an average productivity of 500 kg/ha.In Marathwada region during 2014-15 area under soybean cultivation was 12.22 lakh hectare with an annual production of 5.16 lakh tons with an average productivity of 401.50 kg/ha

(Source: www.mahaagri.gov.in). In Parbhani district during 2014-2015 area under soybean cultivation was 1.88 lakh hectares with annual production of 0.584 lakh tons with an average productivity of 1255 kg/ha. In Nanded district during 2014-2015 area under soybean cultivation was 2.61 lakh hectares with annual production of 0.690 lakh tons with an average productivity of 1287 kg/ha (Source: www.mahaagri.gov.in).

Materials and Methods

1. Market integration

The common methodology was used for testing market integration involves estimation of bivariate correlation coefficient (r) between price changes in different selected market. [Acharya and Agarwal (1994)].

$$r = \frac{\sum (P_{11} - P_1)(P_{21} - P_2)}{\sqrt{(\sum (P_{11} - P_1)^2 (P_{21} - P_2)^2)}}$$

Where,

r = Simple correlation coefficient.

P_{11}= Price of the commodity in first market.

P_{21}= Price of the commodity in second market.

P_1 = Mean of prices in first market.

P_2 = Mean of the prices in second market.

2. Stationarity and volatility in prices of soybean of selected markets of Marathwada region

a) Testing of stationarity in price series of soybean

Before analyzing any time series data testing for stationarity is pre-requisite. The stationarity of time series data on soybean prices was tested by applying the Augmented Dickey-Fuller test (ADF). The ADF test is the test for the unit root in a time series sample. A stationary series is one whose parameters are independent of time, exhibiting constant mean and variance and having autocorrelations that are invariant through time. If the series is found to be non-stationary, the first differences of the series are tested for stationary. The number of times (d) a series is differenced to make it stationary is referred to as the order of integration, I(d)

ADF unit root test are based on the following three regression forms:

a) Without constant and trends $\Delta Y_t = \delta Y_{t-1} + u_t$

b) With constant $\Delta Y_t = \alpha + \beta T + \Delta Y_{t-1} + u_t$

c) With constant and trend

The hypothesis is: Ho: $\delta = 0$ (unit root)

H_1: $\delta \neq 0$

If t* > ADF critical value then accept the Null hypothesis, i.e. unit root exists and

If t* < ADF critical value then reject the Null hypothesis, i.e. unit root does not exists.

b) Presence of price volatility

To access the presence of price volatility the ARCH-GARCH analysis was carried out. Auto Regressive Conditional Heteroscedasticity (ARCH) models are specifically designed to forecast conditional variances. ARCH model introduces by Engel (1982) and Generalized as GARCH by Bollersllev (1986). These models are widely used in various branches of econometrics, especially in financial time series analysis. The GARCH model has two distinct specifications one for the conditional variance and the standard GARCH (1,1) specification is prepared below

$$Yt = y_0 + y_1 X_{1t} + \ldots\ldots\ldots\ldots + y_k X_{kt} + e \quad \text{-----------------(1)}$$

$$\sigma^2_t = \omega + \alpha\, e^2_{t-1} + \beta\, \sigma^2_{t-1} \quad \text{-----------------(2)}$$

Equation (1) is the mean equation and equation (2) is the conditional variance equation. The ARCH component (α) indicate the lag of the squared residual from the mean equation and the GARCH term (β) the last period's forecast variance and the resultant sum of these coefficient (α + β) are presented. The sum coefficient very close to "one" would indicate that the volatility shocks are quite persistent in the series.

3. Co-integration among selected markets of soybean of Marathwada region

Johansen's Multiple Co-integration test was employed to determine the long run relationship between the price series of selected markets. The test shows whether the selected soybean markets are integrated or not. Johansen (1988) [11] has developed a multivariate system of equations approach, which allows for simultaneous adjustment of both or even more than two variables. The multivariate systems of equations approach are more efficient than single equation approach since it allows estimating the co-integration vector with smaller variance. The second advantage of the multivariate approach is that in the simultaneous estimation it is not necessary to presuppose erogeneity of either of the variables.

4. Causality/ co-movement of price signals between selected markets

The Granger causality test was applied to study the price integration and to know the direction of causation between the selected markets. It is named after the first causality tests performed by Clive Granger (1969). It analyses the extent to which the past variations of one variable explain (or precede) subsequent variations of the other. When a co-integration relationship is present for two variables, a Granger Causality Test can be used to analyze the direction of this co-movement relationship. Granger causality tests come in pairs, testing weather variable x_t Granger causes variable y_t and vice versa. All permutations are possible:

1) Univariate Granger causality from x_t to y_t or from y_t to x_t

2) Bivariate causality or absence of causality.

Formally, the Granger causality test analyses weather the unrestricted equation:

$$y_t = \alpha_0 + \sum T_i = 1\ \alpha_1 i\ y_{t-i} + \sum T_j = 1 \alpha_2 i\ x_{t-j} + \varepsilon_t \text{ with } 0 \leq I, j \leq T$$

Yield better results than the restricted equation:

$$y_t = \beta_0 + \sum T_i = 1\ \beta_1 i\ y_{t-i} + \varepsilon_t \text{ with } \sum T_j = 1 \alpha_2 j\ x_{t-j} = 0$$ (The Null hypothesis)

i.e. if H_0, in which $\alpha_{21} = \alpha_{22} = \ldots\ldots\ldots\ldots = \alpha_2 T = 0$, is rejected then one can state "variable x_t Granger causes variable y_t"

Theoretically, a variable is said to Granger cause another variable, if the current value is conditional on the past value.

5. Short run and long run equilibrium behaviour of soybean market prices

Vector Error Correction Model (VECM) was used to test the short run and long run behaviour of soybean markets prices. Even if one demonstrates market integration through co-integration, there should be disequilibrium in the short run i.e. price adjustment across markets may not happen instantaneously. It may take some time for the special price adjustments. Error correction model can incorporate such short-run and long-run changes in price movement. A generalized VECM formulation to understand both the short-run and long-run behaviour of prices can be considered by first taking the autoregressive distributed lag (AdL). The generalized form of this equation for k lags and an intercept term is as follows:

$$\Delta Y_t = a_{00} + \sum a_i 1 \Delta x_{t-1} + m_0 [m_1 x_{t-k} - y_{t-k}] + \varepsilon_t$$

Where,

$$M_0 = (1 - a_i 2)$$

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

Analysis and Interpretation

1. Testing stationary in price series

The Augmented Dickey-Fuller (ADF) test based on unit root test produce was carried out to check whether soybean prices are stationary in the selected markets. The test was applied for Nanded and Parbhani markets during the period of 2000 to 2014 and the results are presented in Table 1. From the table it is observed that at level with lag one, the ADF values of Parbhani (-3.249206) and Nanded (-3.67579) more than the critical value at one per cent (1%) level of significance i.e. -4.010143 indicating the existence of unit root implied that the price series of two markets namely Parbhani and Nanded are non-stationary. The table further showed that in first difference with lag one, the Augmented Dickey- Fuller (ADF) values of Parbhani (-12.75503) and Nanded market (-13.90505) are lower than that of the critical value at one per cent level i.e. -4.010143. This implied that the prices series become stationary at first difference level.

Table 1: ADF test results of Soybean prices for selected markets

Particular	Markets	
	Parbhani	Nanded
Level (ADF)	-3.249206	-3.67579
First Difference (ADF)	-12.75503	-13.90505
Critical value at 1%	-4.010143	-4.010143

2. Market Co-integration

Johansen's multiple Co-integration test is employed to determine the long run relationship between the price series of soybean. Co-integration is used instead of regular regression method because of its capacity in dealing with non-stationary series. The most popular Co-integration method developed by Johansen (1988) [11] and Johansen and Juselius (1990) [12] was applied. The test shows whether the selected soybean markets are integrated or not. The results of the test were presented in Table 2. Presence of one Co-integration equation at five per cent level of significance confirms that there exists long run equilibrium relation in the market. Likewise, from the table it is revealed that the results of Co-integration test showed one co-integration equation was significant at five per cent level of significance. It indicated that the selected soybean markets having long run equilibrium relationship and there exists Co-integration between them.

Table 2: Multiple co-integration analysis of Soybean prices for selected markets

Hypothesized number of Co-integrating equation (CE)	None*	At most one
Eigen value	0.147909	0.053739
Trace statistic	37.89266	9.721711
0.05 critical value	25.87211	12.51798
Prob.**	0.001	0.1404
Number of Co-integrating equation (CE)	One	

Trace test indicates one co-integrating equation at 0.05level

3. Causality of price signals between selected markets

Granger Causality test is a statistical tool which used F-test to know the cause and effect relationship between the two time series of selected soybean markets. When a co-integration relationship is present for two price series, a Granger Causality test is used to analysis the direction of this co-movement relationship. The results of the test showing the relationship between selected soybean markets were presented in Table 3. It was observed that there is unidirectional causality in soybean prices between Parbhani and Nanded markets. As the prices of Parbhani market exhibited unidirectional causality they affect the prices of Nanded market. While the prices of Nanded market does not show any cause and effect.

Table 3: Pair wise Granger Causality test for Soybean prices for selected markets

Null Hypothesis	Observation	F-statistic	Prob.
Parbhani does not Granger c ause Nanded	178	37.4795	3.00E-14
Nanded does not Granger cause Parbhani		0.95156	0.3882

4. Presence of price volatility

To assess the presence of price fluctuation in the prices of soybean in Parbhani and Nanded markets, ARCH-GARCH analysis was carried out and the results are presented in Table 4. It was observed from the table that the sum of Alpha (α) and Beta (β) i.e. (α + β) indicated ARCH and GARCH effect for the given market. GARCH volatility with relatively high Alpha (α) and relatively low Beta (β) are more spiky than those with relatively low Alpha (α) and relatively high Beta (β). In other words high Alpha (α) which is often associated with a low Beta (β) produces GARCH volatilities with high Vol-of-Vol. It was observed that among the markets the sum of alpha and beta is nearer to one i.e. 1.007663 and 1.013004 for Parbhani and Nanded respectively, which indicated that the volatility shocks in the prices of soybean are quite persistent in these markets.

Table 4: ARCH-GARCH analysis of Soybean prices for selected markets

Parameters	Markets	
	Parbhani	Nanded
Alpha (α)	0.896046	1.072327
Beta (β)	0.111617	-0.059323
Sum (α + β)	1.007663	1.013004

5. Short run and long run behaviour of market prices

Since the Johansen's multiple co-integration test results showed that the selected soybean markets having long run equilibrium relationship and there exists co-integration between them. Hence the Vector Error Correction model (VECM) among the selected markets of soybean is employed to know the speed of adjustments for the prices of soybean among selected markets, for short run and long run equilibrium of prices. The results of VECM showed in Table 5. From the table of estimates of VECM model revealed that co-integration equation value of Nanded (-4.17290) was significant therefore Nanded market attained short run equilibrium rapidly while Parbhani market came to equilibrium in long run. One month lag price of Nanded market was affecting current prices of Parbhani market and current prices of same market. One month lag prices of Parbhani market were affecting current prices of Nanded market. Two month lag price of Nanded market was affecting current prices of same market. Three months lag price of Nanded is affecting current prices of Parbhani market. Two month lag prices of Parbhani market were affecting current prices of Nanded market.

Table 5: Vector Error Correction Model for Soybean prices for selected markets

Error Correction	D(Nanded)	D(Parbhani)
CointEq1	-0.636378	-0.009224
	-0.1525	-0.14535
	[-4.17290]	[-0.06346]
D[Nanded(-1)]	-0.012365	0.127105
	-0.13925	-0.13272
	[-0.08879]	[0.95767]
D[Nanded(-2)]	-0.143211	-0.063124
	-0.12214	-0.11641
	[-1.17252]	[-0.54224]
D[Nanded(-3)]	-0.011576	0.021354
	-0.10226	-0.09747
	[-0.11320]	[0.21909]
D[Parbhani(-1)]	0.217837	-0.036017
	-0.16532	-0.15757
	[1.31769]	[-0.22858]
D[Parbhani(-2)]	-0.040096	-0.122613
	-0.15121	-0.14412
	[-0.26517]	[-0.85077]
D[Parbhani(-3)]	0.19974	-0.03837
	-0.12608	-0.12017
	[1.58422]	[-0.31930]
C	10.48036	15.32565
	-14.8319	-14.1365
	[0.70661]	[1.08412]
R-squared	0.343098	0.044031
Adj. R-squared	0.315727	0.004199
Sum Sq. resids	6355299	5773331
S.E. Equation	194.4972	185.3782
F-statistics	12.53514	1.105415
Log likelihood	-1173.233	-1164.781
Akaike AIC	13.4231	13.32706
Schwarz SC	13.56721	13.47117
Mean dependent	13.48295	14.01705
S.D. dependent	235.1249	185.7686

Conclusions

As consideration of ADF test this implied that the prices series become stationary at first difference level. Johansen's multiple Co-integrations test indicated that the selected soybean markets having long run equilibrium relationship and there exists Co-integration between them. Results of Granger Causality test indicated that there is unidirectional causality in soybean prices between Parbhani and Nanded markets. ARCH-GARCH analysis indicated that the volatility shocks in the prices of soybean are quite persistent in these selected markets. The estimates of VECM revealed that co-integration equation value of Nanded (-4.17290) was significant therefore Nanded market attained short run equilibrium rapidly while Parbhani market came to equilibrium in long run.

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