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Research Article

A STUDY ON THE HORIZONTAL INTEGRATION OF SELECTED GROUNDNUT MARKETS OF INDIA

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Abstract- Groundnut *(Arachis hypogea L.)* is the fifth largest oilseed crop after soybean, rapeseed, cotton and sunflower in the world, which account for 7.3 per cent of the total world oilseed production (www.soystats.com). Augmented Dickey Fuller test, Johansen's Multiple Co-integration analysis, Vector Error Correction Model and Granger causality tests were employed in this study. The results indicated that the selected groundnut markets were integrated and prices in Kurnool market and Yemmiganur market exhibited a bidirectional influence at five per cent level of significance, whereas unidirectional influence was exhibited by Gondal market on Kurnool and Yemmiganur markets. The results of the test pointed out that Gondal market was the lead market.

Keywords- Groundnut, Co-integration, Granger causality, Vector error correction model

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Introduction

India is known as the fifth largest vegetable oil economy in the world, which accounted for about 14.49 per cent of the oilseed area and around 7 per cent of the production of world, after USA, China, Brazil and Argentina in 2014. When compared to other countries, USA ranks first with 99.02 million tons of world's total 532.2 million tons of production, followed by Brazil (90.24 million tons), China (58.89 million tons), Argentina (57.02 million tons) and India (36.8 million tons). The share of these 5 countries to the total world production is around 65 per cent in 2014. Total oilseed production in the world is nearly 532.2 million tonnes. Soybean ranks first with 315.1 million tonnes of production. Soy bean constitutes approximately 59 per cent of world's oilseed production other oilseeds are rapeseed with 71.3 million tonnes, cottonseed with 45 million tonnes, sunflower with 39.8 million tonnes, groundnut with 39 million tonnes and palm kernel with 16.5 million tonnes.

Among the oilseed crops, groundnut enjoys a predominant status in the oilseeds profile of the country. Groundnut *(Arachis hypogea L.)* is also known as "king of oilseeds" as well as wonder nut and poor man's cashew nut. Groundnut is the fifth largest oilseed crop after soybean, rapeseed, cotton and sunflower in the world and accounted for about 7.3 per cent of the world oilseed production. India is the largest producer of groundnut in the world next to China, as it is cultivated over 5.53 million hectares and the production was 9.67 million tonnes, of which 3.5 million tonnes was crushed for oil. Gujarat is the largest producer of groundnut in India with an area of 1.84 million hectares and production of 5.016 million tonnes, which occupy 33 per cent of area and 51 per cent of the production in India, followed by Andhra Pradesh (25 % of area and 12 % of production), Tamil Nadu (6% area and 9.4% of production) and Rajasthan (8% area and 9.27% of production). With this background the present study has been taken up to study the horizontal integration of groundnut among the selected markets in the country.

MaterialsandMethods

The markets selected for the study were Kurnool and Yemmiganur (Andhra Pradesh) and Gondal (Gujarat). The daily modal price data of groundnut for the period April 2013-March 2014 was collected and analysed for the study. Market integration was examined by estimating price linkages among the selected markets. To check the stationarity of the price series in each market Augmented Dickey Fuller (ADF) test was conducted. The techniques used for analyzing horizontal integration were Johansen's multiple co-integration analysis to find out the long run equilibrium among the markets, Vector Error Correction Model (VECM) to capture the speed of adjustment to deviations in long run equilibrium and Pair wise Granger Causality test to analyze the influence of prices of each market on all other markets.

Johansen's Multiple Co - integration analysis

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.

Once the variables are checked for stationarity and are of the same order, integration between them can be tested using Johansen's Multiple Co-integration Analysis. Primarily this test was introduced by **Engel and Granger (1987**) and then developed **by Johansen (1988),** again this is modified by **Johansen and Juselius (1990**). Following **Engel and Granger (1987),** a time series X_t which has a stationary, invertible, non- deterministic ARMA representation after differencing d and is denoted by $X_t \sim I(d)$. The components of the vector X_t are said to be co-integrated of order *d, b* denoted as CI (d,b), if

all the components of X_t are I(d);

there exists a vector V' X_t is 1 (d-b), b>0
The vector V is then called a co-integrating vector. A necessary condition for co-integration is that the data series for each variable involved exhibit similar statistical properties, i.e., to be integrated to the same order with evidence of some linear combination of the integrated series.
Johansen and Juselius (1990) developed Co-integration test to test the long run relationship among the price series and likelihood ratio test statistics are proposed to test number of co-integrating vectors. Trace- statistic and maximum Eigen values are used to test the null hypothesis of at most 'r' co-integrating vectors against 'more than r' (the alternative hypothesis co-integrating vectors.

Trace statistic (λ – trace) = $-T \sum_{i=r+1}^{n} \ln(1-\hat{\lambda}_i)$

Maximum Eigen value statistic (λ – max) = $-T \ln(1-\hat{\lambda}_{r+1})$

λ_i s are the estimated Eigen values (characteristic roots) obtained from the ∏ markets T is the number of usable observations. The number of co-integrating vectors indicated by the tests is an important indicator of the existence of co-movement of the prices. As the number of co-integrating vectors increases, it implies the strength and stability of price linkages.

$$P_{it} = \alpha_0 + \alpha_1 P_{jt} + \varepsilon_t \quad [1]$$

Where,
P_i = Price series of groundnut in i[th] market.
P_j = Price series of groundnut in j[th] market.
ε_t = Residual term assumed to be distributed identically and independently
α_0 = Represents domestic transportation costs, processing costs and sales taxes.

Error Correction Model (ECM)
After establishing the existence of long run relationships and rank of the co-integrating vectors, to investigate further on the short-run interaction among variables and also to know the speed of adjustment from short-run dis-equilibrium to the long-run equilibrium ECM was applied. If price series are integrated of order one, then we can run regressions in their first differences. But, by doing this, the long run relationship that is stored in the data is being lost. This indicates to use variables in levels as well. The advantage of the Error Correction Methodology (ECM) is, it incorporates variables, both at their levels and first differences, So that, ECM captures the short-run dis-equilibrium situations and also the long-run equilibrium adjustments between prices. ECM can incorporate short-run and long-run changes in the price movements. The derivation of the error correction model starts with the assumption that both Y and X are integrated and demonstrates that the error correction model captures the equilibrium causal movements between these two co-integrated processes. The starting point of the ECM is Autoregressive Distributed Lag (ADL) model (**Luke Keele and Suzanna De Boef, 2004**). A generalized ECM formulation to understand both the short run and long run behavior of prices can be considered by first taking the Auto regressive Distributed Lag (ADL) equation as follows.

$$Y_t = \alpha_{01} X_t + a_{11} X_{t-1} + a_{12} Y_{t-1} + \varepsilon_t \quad [2]$$

$$\Delta Y_t = a_{01} \Delta X_t + (1-a_{12}) \left[\frac{(a_{01}+a_{11})}{(1-a_{12})} X_{t-1} - Y_{t-1} \right] + \varepsilon_t \quad [3]$$

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

$$\Delta Y_t = a_{00} + \sum_{i=0}^{k-1} a_{i1} \Delta X_{t-i} + \sum_{i-1}^{k-1} a_{i2} \Delta Y_{t-i} + m_0 [m_1 X_{t-k} - Y_{t-k}] + \varepsilon_t \quad [4]$$

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

The parameter m_0 measures the rate of adjustment of the short-run deviation towards the long run equilibrium and it lies between 0 and 1. The value 0 represents no adjustment and 1 denotes an instantaneous adjustment. A value between 0 and 1 indicates that any deviation will have gradual adjustment to the long-run equilibrium values.
For the present analysis, Johansen's vector error correction model (VECM) was applied. It permits the testing of co-integration as a system of equations in one step. Another advantage of this approach is that one does not need to carry over an error from one step into the rest. In addition, it does not require the prior assumption of endogeneity or exogeneity of the variables.

Granger Causality Test
The Granger test is based on a principle that, if forecasts of some variable, say X, obtained by using both the past values of X and the past values of another variable Y, is better than the forecasts obtained using past values of X alone, Y is then said to cause X, the model proposed **by Granger (1969**) was:

$$Y_i = a_i Y_{t-i} + b_i X_{t-i} + e_i \ldots\ldots\ldots\ldots\ldots \quad [5]$$

$$X_i = c_i Y_{t-i} + d_i X_{t-i} + v_i \ldots\ldots\ldots\ldots\ldots \quad [6]$$

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 one I (1), first difference of the variable is normally taken which is stationary. By minimizing Akaike's Information Criterion (AIC) we can determine the optimal lag length of the variables. Based on [Eq-5 and 6], unidirectional 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 5 is statistically non-zero as a group and the set of lagged Y coefficient is zero in equation 6. Similarly, unidirectional causation from Y to X (i.e. Y Granger causes X) is implied if the estimated coefficient on the lagged Y in equation 6 are statistically different from zero as a group and the set of estimated coefficient on the lagged X variable in [Eq-5] 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 [Eq-5] and on lagged Y variable in [Eq-6] are statistically different from zero. Finally, independence exists when the coefficients of both X and Y variables are equal to zero.

Results and Discussion
Results of Stationarity and Unit Root Test
Co-integration analysis can be done only after checking the uni-variate time-series properties of the data and confirming that all the price series are stationary. ADF test was conducted for the daily prices in the selected groundnut markets (**Gondal, Kurnool and Yemmiganur**).

Table-1 *Unit root test (ADF) for the daily prices (2013-14) of groundnut in selected markets*

Particulars		Lag	ADF statistic	Critical value (1%)
Gondal	Level 0	1	-1.676203	-3.983684
	Difference 1	0	-28.59097	
Kurnool	Level 0	3	-3.975677	
	Difference 1	2	-17.65089	
Yemmiganur	Level 0	2	-3.978038	
	Difference 1	1	-20.92510	

The results of ADF test are furnished in [Table-1]. From the table it could be inferred that ADF test values were above the critical value (one per cent) given by MacKinnon statistical tables at levels implying that, the series were non stationary signifying the existence of unit root. After taking first difference, all the series became stationary which is evident from the fact that the calculated values for all the markets were less than the critical values at the significance level of one per cent and were free from the consequences of unit root.

Results of Johansen's Multiple Co-integration analysis

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

Table-2 *Johansen's multiple co-integration analysis of groundnut in selected markets*

Hypothesized number of CE(s)	Eigen value	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.143226	84.67722	42.91525	0.0000
At most 1 *	0.064008	28.56436	25.87211	0.0226
At most 2	0.012463	4.552495	12.51798	0.6614

Trace test indicates 2 coin tegrating eqn(s) at the 0.05 level
*denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Based on the Johansen's Multiple Co-integration procedure, the integration between the markets was analyzed through E-Views software, which indicated the presence of two co-integrating equations at five per cent significance level as shown in [Table-2]. Hence, it could be inferred that the selected markets are having long run equilibrium relationship.

Results of Vector Error Correction Model (VECM)

Since different groundnut markets are integrated in the long run, it is important to study the short run and long run association for equilibrium among markets. Hence, Vector Error Correction Model (VECM) was employed to know the speed of adjustments among the markets for long run equilibrium. The error correction term indicates the speed of adjustment among variables before come together to equilibrium in the dynamic model. The coefficients show how quickly variables return back to equilibrium. The results are presented in [Table-3].

Table-3 *Vector error correction model of groundnut in selected markets*

Error Correction:	D(KUR)	D(YEM)	D(GON)
Coint Eq-1	-0.343228	0.165285	0.011606
	(0.05182)	(0.05732)	(0.03069)
	[-6.62383]	**[2.88333]**	[0.37819]
D(KUR(-1))	-0.368285	-0.064318	0.025978
	(0.04938)	(0.05463)	(0.02925)
	[-7.45815]	[-1.17738]	[0.88827]
D(YEM(-1))	-0.088933	-0.409266	-0.009815
	(0.04463)	(0.04937)	(0.02643)
	[-1.99286]	**[-8.28996]**	[-0.37136]
D(GON(-1))	0.107641	0.041524	-0.381642
	(0.08250)	(0.09127)	(0.04886)
	[1.30477]	[0.45497]	**[-7.81099]**
C	-5.695570	-10.87345	-16.48850
	(18.9504)	(20.9645)	(11.2235)
	[-0.30055]	[-0.51866]	[-1.46911]
R-squared	0.373300	0.228111	0.156972

Note: KUR – Kunool, YEM – Yemmiganur, GON – Gonda

The co-integration equation of error correction mechanism was significant in Kurnool and Yemmiganur markets. The analysis revealed that, any disturbances in price would get corrected in 8 hours in Kurnool market and 4 hours in Yemmiganur market. In long run, price series with negative coefficients converge to the long-run equilibrium. The Vector Error Correction coefficient was estimated at -0.368 for Kurnool market, -0.40 for Yemmiganur market and -0.381 for Gondal market. This indicated that how quickly the selected market prices absorbed and attuned themselves for the disequilibrium errors of the preceding period. In other words, the coefficient measures the ability of the prices to incorporate shocks in the market. In this case, Kurnool, Yemmiganur and Gondal markets absorbed 36 per cent, 40 per cent and 38 per cent of the price shocks respectively to bring about the equilibrium in prices. The information flow was more in Yemmiganur market as evident by the magnitude of the coefficient (-0.409). Hence, Yemmiganur market was more efficient than the Kurnool and Gondal markets in terms of reaction to news on price. It can be concluded that all the three selected markets were influenced by their own daily lags for equilibrium.

Results of Pair-wise Granger Causality Test

In order to know the direction of causation between selected groundnut markets, Granger Causality test was employed. When there is a co-integration relationship between two variables, Granger Causality test can be used to analyze the influence of price of each market on all other markets.

From [Table-4] it could be inferred that Kurnool groundnut market and Yemmiganur groundnut market exhibited bidirectional causality and prices were transmitted vice versa i.e., mutual influence was exerted by the markets on each other, whereas price in Gondal market exhibited unidirectional causality with Kurnool market and Yemmiganur market. It means price discovery occurred in Gondal market of Gujarat state and was transmitted to Kurnool and Yemmiganur markets of Andhra Pradesh. The results of the test pointed out that Gondal market was the lead market. This may be due to the reason that Gujarat state is having highest area under groundnut and Gondal is the major market for groundnut trading.

Table-4 *Pair-wise Granger causality test of groundnut in selected markets*

Null Hypothesis:	Obs	F-Statistic	Prob.	Direction of trade
YEM does not Granger Cause KUR	364	49.8173	0.0000	KUR ⇔ YEM
KUR does not Granger Cause YEM		27.9675	0.0000	
GON does not Granger Cause KUR	364	10.5484	0.0013	GON ⇒ KUR
KUR does not Granger Cause GON		1.50740	0.2203	
GON does not Granger Cause YEM	364	6.50926	0.0111	GON ⇒ YEM
YEM does not Granger Cause GON		0.09886	0.7534	

Note: KUR- Kurnool, YEM- Yemmiganur, GON- Gondal

Conclusion

Johansen's Multiple Co-integration procedure indicated the presence of two co-integration equations at 5 per cent level of significance. Hence, markets were having long run equilibrium relationship. Kurnool and Yemmiganur markets came to short run equilibrium within 8 hours and 4 hours respectively as indicated by VECM, while all the markets *viz.,* Kurnool, Yemmiganur and Gondal were influenced by their own daily lags for long run equilibrium. According to Granger causality test, prices in Kurnool groundnut market and Yemmiganur groundnut market exhibited a bidirectional influence at five per cent level of significance, whereas unidirectional influence was exhibited by Gondal market on Kurnool and Yemmiganur markets. The results of the test pointed out that Gondal market was the lead market.

Conflict of Interest: None declared

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