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Research Article

MARKET INTEGRATION OF MAJOR SUNFLOWER OIL MARKETS OF INDIA

PANT D.K.* AND SHARMA M.L.
Department of Agricultural Economics, College of Agriculture, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, 263145, Uttarakhand, India
*Corresponding Author: Email - deveshpant43677@gmail.com

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Abstract: Indian ecosystem has a diversity of agro-ecological conditions such that oilseeds occupy an important place after food crops and account for about 14 per cent of overall cultivated area of all agricultural production. But still India fulfils 60 per cent of vegetable oil requirements through imports. To reduce supply gap in oils, marketing efficiency should be enhanced through market integration between the oilseed and oil markets. This study attempted to investigate the market integration between 5 major sunflower oil markets of India *viz*., Bengaluru, Vijayawada, Mumbai, Chennai and Kolkata. For the analysis 10 years monthly price data was collected for the time period from January 2010 to December 2019. It was observed from the Johansen's co-integration analysis that there exists a long-run relationship between the selected markets. And pair-wise Granger causality test also indicated the direction of causality and observed that there exist bidirectional as well as unidirectional causality between the markets. But no relationship also existed between Mumbai and Bengaluru and also between Mumbai and Vijayawada. This calls for urgent policy intervention with respect to market intelligence to encourage all the market functionaries to adopt rational decisions accordingly.

Keywords: *Market Integration, Sunflower oil, Johansen's co-integration, Granger Causality, Market Intelligence*

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Introduction

Indian agriculture has made considerable achievements in respect of food crops such as wheat and rice, however good performance in case of other crops particularly oilseeds, pulses, and coarse cereals, has been a serious issue. Oilseeds occupy an important place in the agricultural economy of India, accounting for about 14 per cent of the cultivated area and value of all agricultural produce [1]. The diverse agro-ecological conditions in the country are favorable for growing nine annual oilseed crops of utmost importance. In addition, oilseeds of tree and forest origin, which grow mostly in tribal inhabited areas contribute significantly as minor source of oil, including coconut and oil palm. Oilseed crops provide oils for human diet and also serve as an important raw material for manufacturing soap, paints and varnishes, auxiliaries, pharmaceuticals, and several other industrial products. Oil cakes are also used as animal feed and manure. After soybean, rapeseed-mustard and groundnut, sunflower is the 4th most important oilseed crop grown in the world, which account for about 12 per cent of total oilseed production in the world. Russia and Ukraine are the largest producer of sunflower in the world by contributing together about 54 percent of total sunflower production in the world. India occupied 21st position in terms of sunflower production, as growth of area under sunflower and sunflower production had undergone negative growth of -17.07 and -15.03 per cent per annum over the period of 2008-2018.

India currently produces about 10 million tons of edible oil and it imports about 15 million tons of edible oils to meet its domestic demand in 2019-20. It indicates huge supply gap to meet the growing demand for edible oils in India. To reduce supply gap in oils, both production and marketing efficiency needs to be improved. One way to increase market efficiency is to enhance market integration across regions. Market integration may be a situation in which arbitrage causes prices in different markets to move together. The price of oilseeds in one market responds to the change in price of oilseeds in other markets. *i.e*., horizontal integration between markets of oilseeds.

In the light of above problematic situation, the study was conducted to investigate the co-movement of prices among different domestic markets of sunflower oil.

Material and Methods

The monthly time series data on prices of sunflower oil for the period of January 2010 to December 2019 was collected from different market yards of India. Five markets (two from each major states) for sunflower crop based on the quantity of arrivals of crop were selected purposively for the study. Data on wholesale prices of sunflower in different selected markets of India was collected from AGMARKNET portal of Directorate of Marketing and Inspection (DMI), Ministry of Agriculture & Farmer's Welfare.

Market Integration

Spatial market integration refers to co-movements of prices and more generally, to smooth transmission of price signals and information across spatially separated markets [3].

Before conducting market integration test, stationarity of time series was tested. For each market ADF test was conducted to check the stationarity of the price series. Johansen's multiple co-integration test was used to find out the long run equilibrium among the markets, and Pair wise Granger Causality test was used to analyze the influence of prices of each market on all other markets.

To test the stationary properties of the price series formal unit root test *i.e*., Augmented Dickey Fuller (ADF) test given by Dickey and Fuller [4] was used. This unit root test considers the null hypothesis that a given series is non-stationary, *i.e*., it has a unit root. The ADF test was applied by running the regression in the following form:

$$\Delta Y_t = \beta_0 + \beta_1 \Delta Y_{t-1} + e_t$$

ΔY_t explains the change in Y at t time from the level at t-1. If the coefficient $\beta 1$ is statistically significant, it implies that the series is not stationary, therefore the series has a unit root.

Table-1 *Descriptive Statistics of monthly prices for Sunflower oil in Indian markets*

	Bengaluru	Vijayawada	Mumbai	Chennai	Kolkata
Mean	8182.89	7933.84	6993.55	8602.52	7790.19
Median	8207.15	8046.03	6955.38	8886.99	8000.00
Maximum	9600.00	9030.00	8451.96	10473.52	9120.00
Minimum	5126.67	5050.00	5664.52	5006.00	5113.33
Std. Dev.	943.93	858.88	611.76	1218.85	856.21
C.V.	11.54	10.83	8.75	14.17	10.99

Table-2 *Unit root test results for testing stationarity*

Markets	ADF				PP			
	At levels		At first difference		At levels		At first difference	
	t-statistic	Prob.	t-statistic	Prob.	t-statistic	Prob.	t-statistic	Prob.
Bengaluru	-4.631	0.000	-6.078	<0.001	-2.758	0.068	-6.477	<0.001
Vijayawada	-2.924	0.046	-6.781	<0.001	-2.462	0.128	-6.781	<0.001
Mumbai	-2.404	0.143	-9.633	<0.001	-2.428	0.136	-10.940	<0.001
Chennai	-2.051	0.265	-9.716	<0.001	-2.055	0.263	-9.723	<0.001
Kolkata	-2.971	0.041	-8.833	<0.001	-2.941	0.044	-8.812	<0.001

Once it is established that the two price series are stationary, and then analysis for co-integration was done as follows.

Johansen's Multiple Co-integration analysis

Johansen co-integration test was given by the Johansen and Juselius [5] to test the long run relationship among the price series. To detect the number of co-integrating vectors, Johansen proposed two likelihood ratio tests: trace test and maximum Eigen value test.

The null hypothesis of at most 'r' co-integrating vectors against a general alternative hypothesis of 'more than 'r' co-integrating vectors is tested by the trace-statistic given below.

$J_{trace} = -T\sum_{i=r+1}^{n} \ln\left(1 - \widehat{\lambda_i}\right)$

The null hypothesis of 'r' co-integrating vector against the alternative of 'r +1' is tested by the maximum eigen value statistic.

$J_{max} = -T \ln\left(1- \widehat{\lambda_{r+1}}\right)$

Where, T is the sample size and $\widehat{\lambda_i}$ is the i^{th} largest canonical correlation. The number of co-integrating vectors indicated by these tests is an important indicator of the existence of co-movement of the prices.

To examine horizontal integration between two markets, the following basic relationship commonly used.

$P_{it} = \alpha_0 + \alpha_1 P_{jt} + \varepsilon_t$

Where,

P_i = Price series of sunflower seed in i^{th} market.

P_j = Price series of sunflower seed 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.

Granger Causality Test

If the Johansen co-integration test explains that co-integration exists among variables, then Granger causality must also exist either unidirectional or bidirectional. The Granger test is based on a premise 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 [4] was:

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

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

Where,

X_i and Y_i are two stationary time series with zero mean, are two correlated series.

Result and Discussions

Our market price data consisted of monthly prices of sunflower oil (Rs. /quintal) in five major wholesale markets of India *viz*., Bengaluru, Vijayawada, Mumbai, Chennai and Kolkata during the period from January 2010 to December 2019. The price trend of all the major markets of sunflower oil is presented in [Fig-1], which depicts that there exists symmetric behavior in the prices in all the markets across time.

Descriptive Statistics

The descriptive analysis of all the price series is presented in [Table-1], it shows that the highest mean price of Sunflower oil was found in Chennai market, while the lowest average price was observed in case of Mumbai market. The table also showed that price of Sunflower oil remained most volatile in Chennai market followed by Bengaluru as measured by Coefficient of variation (CV).

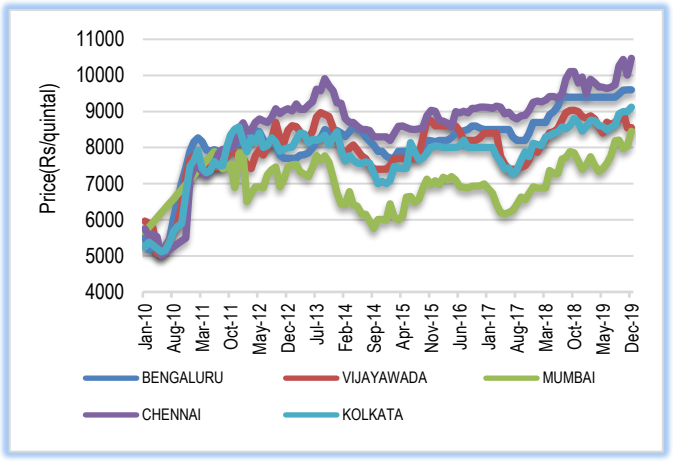

Fig-1 Movement of Soybean Oil market prices

Test of Stationarity

In order to check the stationarity of price series of Sunflower oil, the standard Augmented-Dickey-Fuller (ADF) test and Phillips-Perron (PP) unit root test was applied. Before testing of stationarity, all the price series were converted in natural log form. And then Unit root test was conducted. The estimated test statistics from the ADF test and PP test for the sunflower oil market prices in levels and first difference were reported in [Table-2]. It can be seen from the table that null hypothesis of existence of unit roots was accepted in the levels but rejected in case of first difference. Hence, the price series of all the markets were stationary at their first difference.

Co-integration analysis

After confirming the stationarity of all the price series, long-run relationship was tested using the Johansen co-integration test. It involves 3 basic steps, first stationarity of price series was confirmed using ADF and PP test, second appropriate lag length *i.e*., 2 was chosen as suggested by AIC criteria. In the third step, two tests *i.e*., Trace and Max Eigen test were conducted, whose result has been presented in [Table-3]. The perusal of this table indicated that both the tests rejected the null hypothesis of no co-integration.

Trace test statistic indicated that there exist 2 co-integrating relationship between these 5 selected markets, whereas Max-Eigen test statistic showed that there exist 1 co-integrating relationship between the markets. Therefore, through both the tests, it was suggested that there exists long-run relationship among the five sunflower oil markets.

Table-3 *Johansen co-integration test results*

Hypothesized No. of CE(s)	Trace test		Max-Eigen test	
	Trace Stastistic	Prob**	Max-Eigen Statistic	Prob**
None *	132.441	0.0000	66.2385	0.0000
At most 1*	66.2024	0.0315	28.558	0.1281
At most 2	37.6445	0.1524	19.1077	0.2981
At most 3	18.5368	0.3090	12.1507	0.4013
At most 4	6.38609	0.4129	6.38609	0.4129

Table-4 *Granger-Causality tests for selected Sunflower oil markets of India*

Null Hypothesis:	F-Statistic	Prob.	Relationship
LNVIJAYAWADA does not Granger Cause LNBENGALURU	3.82253	0.0248	Bidirectional
LNBENGALURU does not Granger Cause LNVIJAYAWADA	4.64478	0.0115	
LNCHENNAI does not Granger Cause LNBENGALURU	1.52064	0.223	Unidirectional
LNBENGALURU does not Granger Cause LNCHENNAI	10.3395	8.00E-05	
LNMUMBAI does not Granger Cause LNBENGALURU	0.63201	0.5334	No relation
LNBENGALURU does not Granger Cause LNMUMBAI	0.1504	0.8605	
LNKOLKATA does not Granger Cause LNBENGALURU	3.34674	0.0387	Bidirectional
LNBENGALURU does not Granger Cause LNKOLKATA	5.29863	0.0063	
LNCHENNAI does not Granger Cause LNVIJAYAWADA	1.01305	0.3664	Unidirectional
LNVIJAYAWADA does not Granger Cause LNCHENNAI	28.6191	9.00E-11	
LNMUMBAI does not Granger Cause LNVIJAYAWADA	2.39861	0.0955	No relation
LNVIJAYAWADA does not Granger Cause LNMUMBAI	0.34051	0.7121	
LNKOLKATA does not Granger Cause LNVIJAYAWADA	3.85857	0.0239	Bidirectional
LNVIJAYAWADA does not Granger Cause LNKOLKATA	13.5618	5.00E-06	
LNMUMBAI does not Granger Cause LNCHENNAI	3.68391	0.0282	Unidirectional
LNCHENNAI does not Granger Cause LNMUMBAI	0.45249	0.6372	
LNKOLKATA does not Granger Cause LNCHENNAI	24.1398	2.00E-09	Unidirectional
LNCHENNAI does not Granger Cause LNKOLKATA	0.16947	0.8443	
LNKOLKATA does not Granger Cause LNMUMBAI	0.08026	0.9229	Unidirectional
LNMUMBAI does not Granger Cause LNKOLKATA	3.74813	0.0265	

Results of Pair-wise Granger Causality test

Along with testing the long-run equilibrium between the price series of all the selected sunflower markets of India, the direction of causality relationship is also significant. This test recognizes the direction of causation between two markets for the prices. The results of pair-wise Granger causality test have been presented in [Table-4], this table showed that there exists bidirectional causality relationship between Vijayawada and Bengaluru, Kolkata and Bengaluru & Kolkata and Vijayawada. Which indicated that price shocks in one of the markets of market pairs transmitted to other market in that pair smoothly. The prices of Bengaluru market and Vijayawada markets influenced the market price of Chennai market, likewise there existed the unidirectional relationship which direct from Mumbai and Kolkata to Chennai. The prices of Mumbai also influenced the prices of Kolkata in unidirectional way.

Conclusion and Policy Recommendations

This study investigated the presence of market integration in the five major wholesale markets of Sunflower oil in India. The results of ADF and PP test showed that all price series are stationary at first difference of logarithmic price series. And it was observed from the results of Johansen's co-integration analysis with trace and max-Eigen test statistic that, all the price series are co-integrated in the long-run. Which meant that there exists a long-run equilibrium between the markets with respect to wholesale prices of sunflower oil and these markets share a common long-run price information for a homogeneous commodity. The results of Granger causality test observed the unidirectional causality relationship from all other four markets *i.e*., Kolkata, Vijayawada, Mumbai and Bengaluru to Chennai market. There existed bidirectional causation between Bengaluru and Vijayawada & Kolkata and Vijayawada markets. And there was no relationship with regard to price transmission between Mumbai and Bengaluru and also between Mumbai and Vijayawada. This calls for urgent policy intervention with respect to market intelligence to encourage all the market functionaries to adopt rational decisions accordingly.

Application of research: Findings of this research may be useful in strengthening the agriculture market intelligence system and promotes predictability and appreciates businesses to take appropriate decisions which would also be in the farmer's interest.

Research Category: Market Integration, causality analysis

Abbreviations: ADF-Augmented Dickey-Fuller, PP-Phillips Peron
CE-Co-integrating equations, CV-Coefficient of Variation

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