Co-integration of Groundnut Markets in India with Special Reference to Karnataka State

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Authors’ contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

ABSTRACT

Aims: Market integration is an indicator that explains how different markets are related to each other. The main aim of the paper is to examine the market integration of groundnut seed and oil markets in India.

Study Design: This paper examines the market integration in six major groundnut oil markets and four groundnut pod markets using monthly wholesale prices of groundnut.

Methodology: Test for stationarity was done using Dickey Fuller Test. The Engle-Granger two-step method is used to test for co-integration between the variables. Johansen co-integration test was applied to analyse the long run equilibrium among the groundnut markets.

Results: Unit root test indicated that the price series in each location are non-stationary at their levels and stationary at their first differences. The Granger causality test indicated that all the market pairs are well co-integrated, some of the markets have bidirectional relationship and some have unidirectional relationship at five per cent level of significance, which implies that the groundnut prices have an equally long run association.

Conclusion: In overall, the study suggests that regional markets for groundnut in India are strongly co-integrated. Therefore, the Government can stabilize the price in one key market and rely on commercialization to produce a similar outcome in other markets. This reduces the cost of stabilization considerably.
Keywords: Groundnut; co-integration; price; markets; causality.

1. INTRODUCTION

India is fortunate to have a wide range of oilseeds crops grown in its different agro climatic zones. There are nine cultivated oil seed crops, namely groundnut, rapeseed, mustard, sesame, safflower, niger, soybean and sunflower forming the edible group, while linseed and castor comprising the non-edible group. Among the oilseed crops, groundnut enjoys a predominant status in the oilseeds profile of the country. The groundnut also known as ‘peanut’ is a member of family Papilionaceae and is called as “king of oilseeds” as well as ‘wondernut’ and ‘poor man’s cashew nut’. It is known for its ability to survive in less favourable agro-climatic conditions, peanuts have 44.50 - 50 per cent of oil content. It is used as edible oil in many parts of world.

Groundnut is the single largest source of edible oils in India and constitutes roughly 50 per cent of the total oilseed production. India grows in nine million tons of groundnut (shell). Currently four types of groundnut were grown in India, though marketed under many names; e.g., Coromandel, Bold, Khandesh (or Peanuts), and Red Natal. The prices of groundnut and its products in the country and states are mainly centered on groundnut and its oil. The price of groundnut kernel is usually influenced by prices of groundnut oil prevailing in the wholesale markets. The factors that determine the price of groundnut and its products include quality of matured groundnut, size of shell, kernel size, oil content, marketing cost, marketing methods involved in marketing of fresh produce. The groundnut shells produced on farm move through many agencies like producers, collectors, wholesalers and processors, before reaching the consumers in various forms. The involvement of number of agencies across the marketing channels is also deciding factors of groundnut and its oil prices.

In a market driven economy, the pricing mechanism is expected to transmit orders and directions to determine the flow of marketing activities. Pricing signals guide and regulate production, consumption and marketing decisions over time, form and place [1]. In developing economies, there are several impediments to efficient functioning of markets, particularly for the agricultural commodities. These include insufficient transportation infrastructure, difficulties in accessing market information, government-imposed restrictions on the movement of goods between regions. If the markets are not well integrated then it could result in wrong price signals leading to inefficient allocation of resources, improper distribution of marketed surplus ultimately decreasing economic welfare. As postulated by law of one price, integrated markets is an indicator of absence of market imperfection and inefficiencies. Thus, integrated markets are effective, efficient and maximizes overall social welfare.

Market integration occurs when prices among different locations or related goods follow similar patterns over a period of time. Groups of good often move proportionally to each other and when this relation is very clear among different markets, it is said that the markets are integrated. Thus market integration is an indicator that explains how different markets are related to each other. Market integration shows the extent to which prices in different markets move together [2]. Well integrated markets have very similar prices the difference being just the cost of transportation of the commodity from one market to another. If the markets are not integrated presents inaccurate picture about price information, which may distort production decisions of the producers and contribute to inefficiencies in agricultural markets, harm the ultimate consumers and lead to low production and sluggish growth [3]. Therefore, market integration plays a vital role in determining pattern and pace of diversification towards high value crops [4]. Further, it becomes difficult to comprehend trade policy as several obstructions such as stocking limits, inefficient markets, weak supply chains and trade cartels often restrict the efficient functioning of the markets [5].

In India, the cultivation of oilseeds is in high risk regions where there are uncertain returns on investments. Managing production, marketing and price risks in oilseed cultivation is an area where little attention has been paid in the past. The present scenario needs to be changed. There is a growing realization for successful management of risks in production and marketing is vital for the stakeholders to continue cultivation of oilseeds, for this the prioritization of risks and identification of critical risks along the supply chain are important.

The literature pertains to cointegration techniques which concerns the market
integration of agricultural commodities in India [6,7,8,9]. Presence of perfect market integration and price transmission are crucial for efficient management of marketing system. In an efficient marketing system, new information is confounded simultaneously into markets when they are co-integrated. This system has a considerable significance for deriving maximum gains for producers, consumers and middleman along the marketing chain. Keeping the above issues in view, an attempt has been made to analyze the marketing efficiency of groundnut markets at regional levels, with the overall objective to analyze the direction of causality among groundnut markets.

2. MATERIALS AND METHODS

In India, Andhra Pradesh, Gujarat, Tamil Nadu and Karnataka put together contributes more than 80 per cent of the country's total groundnut production [9], so markets from Andhra Pradesh, Gujarat, Tamil Nadu and Karnataka states were selected purposively. The study is based on monthly wholesale price data for nine major groundnut oil markets namely, Delhi, Rajkot, Bhopal, Mumbai, Jaipur, Vijaywada, Bengaluru, Chennai and Hyderabad. Six groundnut pod markets namely, Ballary, Challakere, Raichur, Tumkur, Adoni, Karnool and two groundnut seed markets Bengaluru and Mysore for the period from January 2009 to February 2020 were analysed. All the relevant data have been collected from Krishi marata vahini, Agmarknet and NIC.

The following steps are used to check the cointegration.

2.1 Check for Stationarity

Test for stationarity was done using Dickey Fuller Test. The test is based on the Dickey Fuller value statistic of \( \beta_1 \) given by the following equation.

\[
\Delta P_t = \beta_0 + \beta_1 P_{t-1} + \sum_{i=1}^{N} \delta_i \Delta P_{t-i} + \eta_t
\]

Where, \( \Delta P_t = P_t - P_{t-1} \)

2.1.1 If data is non-stationary make it stationary

If the given data is already stationary i.e., if \( I(0) \) for both the series then we say they are Co-integrated. The price series fluctuate around their mean value. If not, make the data stationary by differencing.

2.1.2 Determine the order of integration

A series, which becomes stationary after first differencing is said to be integrated of order one and it is expressed as \( I(1) \). Generally, a series may have been differenced 'd' times to become stationary in which it is termed as \( I(d) \). If the order of integration is same for both the series i.e., \( Pt \sim I(d) \), for \( \text{ex: if } Pt(2), \text{and } Pj(2) \) then test for Co-integration. If the order of the integration is not same for the two series i.e., \( Pt(1), Pj(2) \), then conclude that the series are not co-integrated. Having established that the variables are stationary, then test for Co-integration.

2.2 Test for Co-integration

The Engle-Granger two-step method is used to test for co integration between the variables. Johansen co integration test was applied to analyze the long run equilibrium among the groundnut markets.

3. RESULTS AND DISCUSSION

The results of Augmented Dickey-Fuller test on the price series before and after differentiation are presented in Table 1. The null hypothesis of non-stationarity was tested based on the critical values reported by MacKinnon. All the price series appeared non stationary in the levels, but all the series were stationary after taking first differences.

The results of Augmented Dickey-Fuller test on the price series before and after differentiation are presented in Table 1. The null hypothesis of non-stationarity was tested based on the critical values reported by MacKinnon. All the price series appeared non stationary in the levels, but all the series were stationary after taking first differences.

The bi-variate co integration technique of Engle and Granger was tested for the presence of long run relationship existing between groundnut price in different markets. The causal relationship among the markets price of major groundnut markets in India were approached through Grangers Causality technique and presented in Table 2 (A,B,C,D). It could be seen that existence of both unidirectional as well as bidirectional relationship among groundnut markets. Thus a strong integration of major groundnut markets in India is confirmed that the price of one market influence the price of other markets. The test for causality is based on F statistics.

The Fig. 1 shows the unidirectional as well as bidirectional relationship between groundnut pod and oil markets. The unidirectional relationship
was found for the pair of Karnool_ap_pod to Bengaluru_oil indicates that price of Karnool_ap_pod market influence the price of Bengaluru_oil market. While the price of Bengaluru_oil market does not influence the price of Karnool_ap_podmarket. Karnool_ap_pod market is the place where price discovery took place which was transmitted to Bengaluru_oil market. Similar findings were observed by [9] and [6] highlighting that the regional markets have price linkages and thus are spatially integrated. Price transmission revealed that bidirectional relationships exists within domestic markets which indicated the price transmission happening in short run adjustments and presence of long run equilibrium existed among the groundnut markets in AP, TAN, GUJ and KAR. Similarly, unidirectional causality was found between Ballary_pod to Hyderabad_oil, Chennai_oil and Mumbai_oil markets, Delhi_oil to Tumkur_Sira_pod markets and Chennai_oil to Tumkur_Sira_pod market. There is a bidirectional causality between Challakere_pod and Chennai_oilmarket. Thus a strong integration of major groundnut markets in India is confirmed that the price of one market influence the price of other markets.

The Fig. 2 shows both unidirectional and bidirectional relationship between groundnut oil markets. Unidirectional causality was exerted on Hyderabad_oil by Chennai_oil, Delhi_oil and Rajkot_oil markets, Bengaluru_oil market by Mumbai_oil and Hyderabad_oil markets, Delhi_oil market by Chennai_oil, Rajkot_oil and Mumbai_oil markets, Chennai_oil by Rajkot_oil. Price signals are getting transmitted from Chennai_oil, Delhi_oil and Rajkot_oil markets to Hyderabad_oil market, Mumbai_oil and Hyderabad_oil markets to Bengaluru_oil market, Chennai_oil, Rajkot_oil and Mumbai_oil markets to Delhi_oil market and Rajkot_oil market to Chennai_oil market. The similar study conducted by [10] highlighted that price integration between groundnut oil and sunflower oil in Mumbai market. The Granger causality test revealed that prices of sunflower oil influenced the prices of groundnut oil. Thus, the study had proved the existence of integration between prices of edible oils.

| SN | Markets            | Augmented dickey-fuller (ADF) test value |
|----|--------------------|-----------------------------------------|
|    |                    | Level | 1st difference | Critical value (1%) |
| 1  | Ballary_pod        | -3.078519 | -12.61174 |
| 2  | Challakere_pod     | -2.186934 | -14.94678 |
| 3  | Karnool_ap_pod     | -2.967615 | -15.90092 |
| 4  | Tumkur_sira_pod    | -3.360310 | -11.34894 |
| 5  | Bengaluru_oil      | -0.607627 | -11.50012 | -3.480425 |
| 6  | Chennai_oil        | -2.032727 | -11.05694 |
| 7  | Delhi_oil          | -1.886530 | -13.20098 |
| 8  | Hyderabad_oil      | -2.628623 | -10.14485 |
| 9  | Mumbai_oil         | -2.287107 | -12.17502 |
| 10 | Rajkot_oil         | -2.202640 | -10.75945 |

Table 1. ADF tests for unit root in prices of groundnut oil/pod/seed markets

Fig. 1. Causal relationship among major groundnut pod to oil markets under study
### Table 2(A). Granger causality test for different groundnut oil and pod markets in India

| Null hypothesis                                      | F-statistic | Prob.   | Reject H0 |
|------------------------------------------------------|-------------|---------|-----------|
| Bengaluru_oil does not Granger Cause Ballary_pod     | 2.19755     | 0.1153  | Accept    |
| Ballary_pod does not Granger Cause Bengaluru_oil     | 0.36827     | 0.6927  | Accept    |
| Chennai_oil does not Granger Cause Ballary_pod       | 2.26222     | 0.1083  | Accept    |
| Ballary_pod does not Granger Cause Chennai_oil       | 3.56144     | 0.0313  | Reject    |
| Delhi_oil does not Granger Cause Ballary_pod         | 0.34916     | 0.706   | Accept    |
| Ballary_pod does not Granger Cause Delhi_oil         | 1.81552     | 0.167   | Accept    |
| Hyderabad_oil does not Granger Cause Ballary_pod     | 0.10671     | 0.8989  | Accept    |
| Ballary_pod does not Granger Cause Hyderabad_oil     | 6.02648     | 0.0032  | Reject    |
| Mumbai_oil does not Granger Cause Ballary_pod        | 2.56025     | 0.0813  | Accept    |
| Ballary_pod does not Granger Cause Mumbai_oil        | 3.90491     | 0.0226  | Reject    |
| Rajkot_oil does not Granger Cause Ballary_pod        | 2.57794     | 0.0799  | Accept    |
| Ballary_pod does not Granger Cause Rajkot_oil        | 1.06735     | 0.347   | Accept    |
| Challakere_pod does not Granger Cause Bengaluru_oil  | 0.92713     | 0.3983  | Accept    |
| Bengaluru_oil does not Granger Cause Challakere_pod | 0.81790     | 0.4437  | Accept    |
| Karnool_ap_pod does not Granger Cause Bengaluru_oil  | 2.84293     | 0.062   | Accept    |
| Bengaluru_oil does not Granger Cause Karnool_ap_pod | 3.07775     | 0.0495  | Reject    |
| Tumkur_sira_pod does not Granger Cause Bengaluru_oil | 0.12642     | 0.8814  | Accept    |
| Benguluru_oil does not Granger Cause Tumkur_sira_pod | 1.05850     | 0.35    | Accept    |
| Chennai_oil does not Granger Cause Challakere_pod    | 4.13104     | 0.0183  | Reject    |
| Challakere_pod does not Granger Cause Chennai_oil    | 3.61599     | 0.0297  | Reject    |
| Delhi_oil does not Granger Cause Challakere_pod      | 0.85918     | 0.4084  | Accept    |
| Challakere_pod does not Granger Cause Delhi_oil      | 0.38782     | 0.6793  | Accept    |
| Hyderabad_oil does not Granger Cause Challakere_pod | 3.33748     | 0.0387  | Reject    |
| Mumbai_oil does not Granger Cause Challakere_pod     | 0.61280     | 0.5434  | Accept    |
| Challakere_pod does not Granger Cause Mumbai_oil     | 1.31140     | 0.2731  | Accept    |
| Rajkot_oil does not Granger Cause Challakere_pod     | 1.06380     | 0.3482  | Accept    |
| Challakere_pod does not Granger Cause Rajkot_oil     | 0.49871     | 0.6085  | Accept    |
| Karnool_ap_pod does not Granger Cause Chennai_oil    | 0.19024     | 0.827   | Accept    |
| Chennai_oil does not Granger Cause Karnool_ap_pod    | 0.01679     | 0.9672  | Accept    |
| Tumkur_sira_pod does not Granger Cause Chennai_oil   | 8.71846     | 0.0003  | Reject    |
| Chennai_oil does not Granger Cause Tumkur_sira_pod   | 1.61782     | 0.8457  | Accept    |
| Karnool_ap__pod does not Granger Cause Delhi_oil     | 0.27503     | 0.76    | Accept    |
| Delhi_oil does not Granger Cause Karnool_ap_pod      | 0.86076     | 0.4253  | Accept    |
| Tumkur_sira_pod does not Granger Cause Delhi_oil     | 3.04895     | 0.0509  | Reject    |
| Karnool_ap_pod does not Granger Cause Hyderabad_oil  | 1.54225     | 0.2179  | Accept    |
| Hyderabad_oil does not Granger Cause Karnool_ap_pod | 0.04282     | 0.9581  | Accept    |
| Tumkur_sira_pod does not Granger Cause Hyderabad_oil | 2.89891     | 0.0587  | Accept    |
| Karnataka_oil does not Granger Cause Tumkur_sira_pod | 2.01511     | 0.1375  | Accept    |
| Mumbai_oil does not Granger Cause Karnool_ap_pod     | 0.01870     | 0.9815  | Accept    |
| Karnool_ap_pod does not Granger Cause Mumbai_oil      | 0.66835     | 0.5143  | Accept    |
| Rajkot_oil does not Granger Cause Karnool_ap_pod     | 0.53517     | 0.5869  | Accept    |
| Karnool_ap_pod does not Granger Cause Rajkot_oil     | 0.03339     | 0.9672  | Accept    |
| Tumkur_sira_pod does not Granger Cause Rajkot_oil    | 2.45709     | 0.0897  | Accept    |
| Mumbai_oil does not Granger Cause Tumkur_sira_pod    | 2.89018     | 0.0592  | Accept    |
| Tumkur_sira_pod does not Granger Cause Rajkot_oil    | 1.30096     | 0.2759  | Accept    |
| Rajkot_oil does not Granger Cause Tumkur_sira_pod    | 1.05127     | 0.3525  | Accept    |
Table 2 (B). Granger causality test for different groundnut oil markets in India

| Null hypothesis                                           | F-statistic | Prob.  | Reject H0 |
|-----------------------------------------------------------|-------------|--------|-----------|
| Chennai_oil does not Granger Cause Bengaluru_oil          | 0.28857     | 0.7498 | Accept    |
| Bengaluru_oil does not Granger Cause Chennai_oil          | 0.70751     | 0.4948 | Accept    |
| Delhi_oil does not Granger Cause Bengaluru_oil            | 0.98838     | 0.375  | Accept    |
| Bengaluru_oil does not Granger Cause Delhi_oil            | 0.24353     | 0.7842 | Accept    |
| Hyderabad_oil does not Granger Cause Bengaluru_oil         | 3.20482     | 0.0439 | Reject    |
| Bengaluru_oil does not Granger Cause Hyderabad_oil        | 0.03171     | 0.9688 | Accept    |
| Mumbai_oil does not Granger Cause Bengaluru_oil            | 0.12475     | 0.8828 | Accept    |
| Bengaluru_oil does not Granger Cause Mumbai_oil           | 0.21262     | 0.8088 | Accept    |
| Rajkot_oil does not Granger Cause Bengaluru_oil            | 0.02980     | 0.9707 | Accept    |
| Bengaluru_oil does not Granger Cause Rajkot_oil           | 0.17102     | 0.843  | Accept    |
| Delhi_oil does not Granger Cause Chennai_oil               | 1.07677     | 0.3438 | Accept    |
| Chennai_oil does not Granger Cause Delhi_oil               | 8.46487     | 0.0004 | Reject    |
| Hyderabad_oil does not Granger Cause Chennai_oil           | 0.26513     | 0.7675 | Accept    |
| Chennai_oil does not Granger Cause Hyderabad_oil           | 8.40842     | 0.0004 | Reject    |
| Mumbai_oil does not Granger Cause Chennai_oil              | 10.9200     | 4.00E-05 | Reject  |
| Chennai_oil does not Granger Cause Mumbai_oil              | 3.12952     | 0.0471 | Reject    |
| Rajkot_oil does not Granger Cause Chennai_oil              | 7.19691     | 0.0011 | Reject    |
| Chennai_oil does not Granger Cause Rajkot_oil              | 2.37205     | 0.0974 | Accept    |
| Hyderabad_oil does not Granger Cause Delhi_oil             | 10.2754     | 7.00E-05 | Reject  |
| Delhi_oil does not Granger Cause Hyderabad_oil             | 3.31226     | 0.0396 | Reject    |
| Mumbai_oil does not Granger Cause Delhi_oil                | 9.64634     | 0.0001 | Reject    |
| Rajkot_oil does not Granger Cause Mumbai_oil               | 0.59141     | 0.5551 | Accept    |
| Rajkot_oil does not Granger Cause Delhi_oil                | 7.37011     | 0.0009 | Reject    |
| Delhi_oil does not Granger Cause Rajkot_oil                | 0.82737     | 0.4395 | Accept    |
| Mumbai_oil does not Granger Cause Hyderabad_oil            | 5.54297     | 0.0049 | Reject    |
| Hyderabad_oil does not Granger Cause Mumbai_oil            | 1.32749     | 0.2688 | Accept    |
| Rajkot_oil does not Granger Cause Hyderabad_oil            | 5.22806     | 0.0066 | Reject    |
| Hyderabad_oil does not Granger Cause Rajkot_oil            | 5.16547     | 0.007  | Reject    |
| Rajkot_oil does not Granger Cause Mumbai_oil               | 0.84487     | 0.432  | Accept    |
| Mumbai_oil does not Granger Cause Rajkot_oil               | 5.85981     | 0.0037 | Reject    |

Table 2 (C). Granger causality test for different groundnut pod markets in India

| Null hypothesis                                           | F-statistic | Prob.  | Reject H0 |
|-----------------------------------------------------------|-------------|--------|-----------|
| Challakere_pod does not Granger Cause Ballary_pod         | 2.17615     | 0.1177 | Accept    |
| Ballary_pod does not Granger Cause Challakere_pod         | 10.7851     | 5.00E-05 | Reject  |
| Karnool_ap_pod does not Granger Cause Ballary_pod         | 0.29247     | 0.7469 | Accept    |
| Ballary_pod does not Granger Cause Karnool_ap_pod         | 11.7027     | 2.00E-05 | Reject  |
| umkur_sira_pod does not Granger Cause Ballary_pod         | 2.34064     | 0.1004 | Accept    |
| Ballary_pod does not Granger Cause Tumkur_sira_pod        | 17.8974     | 1.00E-07 | Reject  |
| Karnool_ap_pod does not Granger Cause Challakere_pod      | 0.03773     | 0.963  | Accept    |
| Challakere_pod does not Granger Cause Karnool_ap_pod      | 5.49584     | 0.0051 | Reject    |
| Tumkur_sira_pod does not Granger Cause Challakere_pod     | 0.19380     | 0.8241 | Accept    |
| Challakere_pod does not Granger Cause Tumkur_sira_pod     | 25.8824     | 4.00E-10 | Reject  |
| Tumkur_sira_pod does not Granger Cause Karnool_ap_pod     | 2.08516     | 0.1285 | Accept    |
| Karnool_ap_pod does not Granger Cause Tumkur_sira_pod     | 2.96373     | 0.0552 | Accept    |

Bidirectional causality between Hyderabad_oil and Delhi_oil markets and Chennai_oil and Rajkot_oil markets. Thus, a strong integration
of major groundnut markets in India confirming that the price of one market influence the price of other markets. In a similar study conducted by [10] examined the integration of Mumbai groundnut oil prices with the international groundnut oil prices in Rotterdam during the three time periods i.e., Pre-Technology Mission on Oilseeds (Pre-TMO) period (1970-71 to 1985-86), Period of Technology Mission on Oilseeds (TMO) (1986-87 to 1994-95) and Post-World Trade Organization (Post-WTO) period (1995-96 to 2006-07). It was observed that there existed a bi-directional influence between groundnut and groundnut oil markets during post-WTO period.

The Fig. 3 shown a uni-directional relationship between groundnut pod markets. The unidirectional relationship was found for the pair of Challakere_pod to Tumkur_Sira_pod market indicates that price of Challakere_pod market influence the price of Tumkur_Sira_pod market while the price of Tumkur_Sira_pod market does not influence the price of Challakere_pod market during the investigation period. Price discovery occurred in Challakere_pod market and was transmitted to Tumkur_Sira_pod market. Similarly, Ballary_pod market influences the price of Tumkur_Sira_pod, Challakere_pod and Karnool_ap_pod, means price discovery in bellary pod market which was transmitter to Tumkur_Sira_pod, Challakere_pod and Karnool_ap_pod. Challakere_pod influences the prices of Karnool_ap_pod means price discovery occurred in Challakere_pod market and was transmitted to Karnool_ap_pod market. Thus, there is a strong integration of major groundnut pod markets in India. In a similar study conducted by [11] examined the spatial price integration of groundnut in regulated markets of Thindivanam, Thiruvannamalai and Virudhachalam of Tamil Nadu using co-integration test.

Since all the price series are non-stationary at level form and stationary at first difference, Johansen co integration test was applied to analyze the long run equilibrium among the groundnut markets. Co integration between the stationary price series has been tested using Johansen’s Trace and Maximum Eigen-value presented in Table 3 (A and B).

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Fig. 2. Causal relationship among major groundnut oil markets under study

Fig. 3. Causal relationship among major groundnut pod markets under study
The results of trace test revealed that trace statistic values were 349.94, 245.85 and 166.43 greater than the critical values of 239.24, 197.37 and 159.53, respectively which indicated the presence of two co-integrating equations at five per cent level. The results of maximum eigenvalue revealed that trace statistic values 104.09, 79.45 and 55.89 were greater than the critical values 64.50, 58.43 and 52.36, respectively which indicated the presence of two co-integrating equations at five per cent level of significance. These results reflect that there is at least two co integration at 5 per cent level of significance. Hence, it is concluded that long run equilibrium exists among the groundnut markets. Any shocks in these markets would affect the prices in other markets. A similar study conducted by [6] examined the integration of wholesale prices of groundnut complex by using Johansen co-integration test and reported that four out of eleven markets, four out of ten markets and two out of five markets were integrated for groundnut pod, groundnut oil and oilcake at 5 per cent level of significance, respectively.

4. CONCLUSION

The present investigation reveals that though the markets are geographically well separated, none of them acted as a separate market and there are very less market distortions. All the market pairs are well co-integrated, which implies that the groundnut prices have an equally long run association. There is a unidirectional relationship between pod markets and oil markets except between Challekere pod market to Channai oil market. In oil markets, Hyderabad and Rajkot, Hyderabad and Delhi, Chennai and Mumbai oil market showed bidirectional causality while the remaining markets showed a unidirectional relationship. The groundnut pod markets have shown a unidirectional relationship. Co-integration has shown that the regional markets have price linkages, and thus are spatially integrated. The results of causality confirmed that Mumbai oil market is the key groundnut oil market and Bellary market is the leading groundnut pod market. Therefore, the price signals from Mumbai market are quickly transmitted to other oil markets in the country.
while the price signals in Bellary pod market are quickly transmitted to other pod markets in Karnataka. In view of vertical integration, Bellary pod market and Chennai oil markets are the key markets. The study concluded that if government stabilize the price in these three key markets and rely on commercialization of produce a similar reaction is observed in other markets. Thus, it reduces the cost of price stabilization considerably.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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