INTEGRATION OF WHOLESALE PRICES OF GROUNDNUT COMPLEX[1]

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Groundnut oil is one of the major edible oils produced and consumed in India. This paper tries to examine the cointegration of wholesale prices of groundnut pod, oil and cake (groundnut complex) in major markets of India. All-major groundnut markets have been covered. Totally 11 markets were considered for groundnut pods, 10 markets for oil and 5 markets for cake for the study from May 1996 to January 2003. Month-end wholesale price data have been used for the study. There are four terminal markets namely Mumbai, Delhi, Chennai and Calcutta. The major producing centres are Rajkot (Gujarat) and Nandhyal (Andhra Pradesh). Out of 11 groundnut pod and 10 oil wholesale price series, only 4 series are co-integrated, while in case of groundnut cake only two markets are co-integrated out of 5 major markets. In case of groundnut oil and cake, price information flows from major import/export centres like Mumbai and Chennai to major producing centres, as price of groundnut oil and other edible oils (like palm oil, soyaoil) are interrelated and being freely traded internationally, edible oil price discovery takes place in these centres and are linked to border prices. About 50% of domestic edible oil consumption is met by imports and India is a major exporter of groundnut cake. While in case of groundnut pods price information flows from major production centres (Nandyal and Rajkot) to terminal markets such as Mumbai, Chennai and Delhi, there is no large scale imports/exports of groundnut pods from India. Overall price discovery in oil and cake takes place in terminal markets like Mumbai (international trade centres), while for pods price discovery takes place in major producing centres. We have also analysed vertical cointegration among pod, oil and cake markets in the short and long run for testing of co-integration along supply chain. Only in few markets, prices of GN pods and GN oil are vertically integrated in the long run, while in most markets wholesale prices of cake are not integrated either with GN pod or oil wholesale prices in the long run. That too, the vertical integration is strong between wholesale prices of major producing centre (Rajkot) and prices in major consuming centres (Mumbai, Chennai and Hyderabad). Further low margins of processing sector confirms of vertical integration of GN pod and oil/cake wholesale prices at least in GN producing centres.

INTRODUCTION

The performance of any agricultural commodity market is assessed by spatial and temporal market integration. Markets are integrated when prices in different markets move together in response to changes in demand, supply and other factors. Weak market integration indicates markets are not efficient. Among agricultural commodities, edible oil complex (which include oilseeds, edible oil and oil cake) is more open to international markets with less government

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intervention in market prices. In oilseeds there is little international trade, while in edible oils about 50% of domestic consumption is met by imports and in the case of oil cake, India is the largest exporter (more than 50% of domestic production is exported). India currently produces about 7-8 million tonnes (Mt) of edible oil and it imports between 6-7 Mt of edible oils annually to meet its domestic demand (Table 1). It indicates huge supply gap to meet the growing demand for edible oils in India. The per capita consumption of edible oils increased from 6.6 kg/annum in TE 1986 to 12.7 kg/annum in TE 2010. To reduce supply gap in edible oils, both production and marketing efficiency needs to be improved. One way to increase market efficiency is to enhance market integration of edible oil markets (oilseed, oil and cake) across regions. Hence, this study focuses on (i) testing spatial market cointegration of wholesale prices of edible oil sector (groundnuts as case study) by analysing the market integration in groundnut pod, oil and cake markets separately in India and (ii) tests market integration along the value chain from groundnut pods to GN oil and cake among selected markets. It will reveal the efficiency of GN oil complex across value chain and linkage between GN prices with oil and cake prices within the same market place and across regions. The study selected GN complex for the study, as share of groundnuts among oilseeds in terms of area (28% of total oilseed area) and production (32% of total oilseed production) is significant. Market integration was tested separately for groundnut pods, cake and oil and also across value chain among groundnut pods, oil and cake. Both short and long run market integration is tested by using vector error correction model.

A Brief about Groundnut Complex Markets in India

There are two types of markets that exist for groundnut. They are terminal markets and secondary/primary markets. In terminal markets (Delhi, Mumbai, Chennai and Calcutta) pods and GN (groundnut) cake mainly

TABLE - 1

Edible Oil Availability in India (million tonnes). Source: FAOSTAT (2011).

Period	Oilseed Production (mt)	Edible oil Production (mt)	Edible oil Consumption (mt)	Oil Imports (mt)	Cake Production (mt)	Population (million)	Per capita Consumption of Edible Oil (kg/annum)
TE 1986	12.2	3.7	4.9 (24.3*)	1.2	10.4 (12.63#)	744.4	6.6
TE 1995	21.0	6.4	6.6 (2.8*)	0.2	18.0 (22.8#)	896.9	7.4
TE 2010	27.5	7.9	15.1 (46.9*)	7.2	23.2 (23.7#)	1189.7	12.7

*imports as % of domestic consumption; #export of cake as % of production come from major groundnut growing regions, while GN oil and its close substitutes come from both imports and domestic oil mills. In primary/secondary markets groundnut pods come from domestic groundnut producing regions, while oil comes from terminal markets or local oil mills. Market intermediaries play a key role in groundnut trade. Inter-state trade of groundnut is growing due to removal of interstate movement restrictions. Groundnut pods are sold in primary or secondary wholesale markets directly by the producer to a broker, commission agent or middlemen. The bulk of groundnut from brokers and commission agents is sold to oil millers/primary wholesalers who in turn sell it to millers and processors of groundnuts or to secondary wholesalers. A proportion of oil from oil millers and primary wholesalers goes to secondary wholesalers, and is then sold to consumers through the retailer. A little quantity of pods from secondary wholesalers is sold to frying mills, and after processing, puffed or roasted nuts/pods move to consumers via retail markets. Until 1990s, groundnut trade in India was subjected to many restrictions such as regulation under the Essential Commodities Act of 1955, compulsory levies on millers, stocking limits for private traders, milling reservation for small scale industries, occasional restriction of interstate movements and prohibition of future trading. Now there is no direct government regulation in groundnut marketing in India with small exceptions. Minimum support price (MSP) announced by the government for groundnut at the beginning of the season is a major government intervention in free market. However, for oilseeds including groundnut, the MSP has generally remained below the market price, and therefore has had no noticeable impact of MSP in price discovery. Overall, prices in groundnut complex are under less restriction by government and market prices in general reflect supply and demand conditions under free competition in open economy (for details please see Reddy *et al.*, 2011 and Reddy, 2009).

METHODOLOGY

Spatial market integration refers to a situation in which prices of a commodity in spatially separated markets move together after accounting for transport and other value additions in the supply chain and the price information transmitted smoothly across the markets, hence, used as a measure of overall market performance. Spatial market integration helps in specializing producers in specific commodities, in which they are competitive over long term. Two markets are considered to be spatially integrated if, in the presence of trade between them, the price in the importing market (P^i_t) is equal to the price in the exporting market (P^e_t) plus the transport and other transfer costs involved in moving goods between them (T_t^{ei}). This happens because of spatial arbitrage condition given by $P^i_t = P^e_t + T_t^{ei}$. Market integration does not, however, necessarily imply that markets are competitive. The spatial arbitrage condition and market integration are fully consistent with competitive pricing as well as oligopolistic pricing practices.

Test for Unit Roots

Before conducting co-integrating tests, we need to examine the univariate time-series properties of the data and confirm that all the price series are non-stationary and integrated of the same order. This is confirmed by visual examination of price series as well as by using the Augmented Dickey Fuller (ADF) test developed by Dickey and Fuller (1981) and Phillips-Perron(PP) test. The ADF test involves regressing the first-difference of a variable on a constant, it's lagged level, and k lagged first differences:

$$\Delta x_t = \beta_0 + \beta_1 x_{t-1} + \sum_{i=1}^{k} \gamma_i \Delta x_{t-i} + \varepsilon_t \quad \text{-------(1)}$$

Where X_t is the price series. Equation (1) tests for a unit root in the price series by testing the null hypothesis H_0:B_1=0, by using the ADF test statistics. The null hypothesis of a unit root is rejected in favour of the alternative of level stationarity if B_1 is significantly different from zero. However, one possible weakness in the ADF tests has been that their underlying distribution theories assume that residual errors are statistically independent and have a constant variance, which may not be true for many time series data. Phillips and Perron (1988) developed a non-parametric test statistics, which involves less-restrictive assumption on the error process. In this case, the hypothesis: H_0:B_1=0, is tested by using Γ_Γ-statistics and referring to the critical values of DF tables. The optimum lag length has been selected based on maximum Akaike information criteria.

Johansen Test

After establishing that the price series are non-stationary and integrated of the same order, following Johansen and Juselius (1990) we have used Johansen cointegration test for the long-run relationship among the price series. Likelihood ratio test statistics are proposed to test number of cointegrating vectors. The null hypothesis of at most 'r' cointegrating vectors against a general alternative hypothesis of 'more than r' cointegrating vectors is tested by the trace-statistics, The null of 'r' cointegrating vector against the alternative of 'r+1' is tested by the Maximum-eigen-value-statistic (for details, see Johansen and Juselius, 1990). The number of cointegrating vectors indicated by the tests is an important indicator of the extent of co-movement of the prices. An increase in the number of cointegrating vectors implies an increase in the strength and stability of price linkages.

Vector Error Correction Model (VECM)

After establishing existence of long-run relationships and rank of the cointegrating vectors, the ECM was applied to investigate further on the short-run interaction causality among variables and also to know the speed of adjustment from short-run dis-equilibrium to the long-run equilibrium. The error correction model for a three variable case can be expressed as follows:

$$\Delta P_{1t} = \varphi_0 \mu_{1t-1} + \sum_{i=1}^{m} A_i \Delta P_{1t-i} + \sum_{j=1}^{m} B_j \Delta P_{2t-j} + \sum_{k=1}^{m} C_k \Delta P_{3t-k} + \upsilon_{1t} \quad \text{------------(2)}$$

$$\Delta P_{2t} = \varphi_1 \mu_{2t-1} + \sum_{i=1}^{m} D_i \Delta P_{1t-i} + \sum_{j=1}^{n} E_j \Delta P_{2t-j} + \sum_{k=1}^{m} F_k \Delta P_{3t-k} + \upsilon_{2t} \quad \text{------------(3)}$$

$$\Delta P_{3t} = \varphi_2 \mu_{3t-1} + \sum_{i=1}^{m} G_i \Delta P_{1t-i} + \sum_{j=1}^{n} H_j \Delta P_{2t-j} + \sum_{k=1}^{m} L_k \Delta P_{3t-k} + \upsilon_{3t} \quad \text{------------(3)}$$

where P_1, P_2 and P_3 denote the price series in different markets. The error correction terms (load factors or speed of adjustment parameters) are μ_{t-1}, that are the residuals obtained from the co-integrating equation of co-integrating price series. The number of error correction terms in each equation depends on the number of co-integrated vectors in the price series. Note that the term μ_{t-1} in equations represents the extent of the disequilibrium levels in prices in the previous period. Thus, the VECM representation states that changes in prices in one locality not only depends on changes of the price of other locality and its own past changes, but also on the extent of the disequilibrium between the levels of prices. Hence, the past values of error term in the equation have an impact on the changes of variables P_{1t}, P_{2t} and P_{3t}. Note also that the larger is the speed of adjustment parameters (with the right signs), the greater is the convergence rate toward equilibrium. The υ_{1t},, υ_{2t} and υ_{3t} are stationary random processes capturing other information not contained in either lagged value of P_{1t}, P_{2t} and P_{3t}. Finally, the m is the optimal lag order which is determined by using the final prediction error procedures using akaike information criteria. There is a strong connection between co-integration and causality in that at least one granger causal relationship must exist in a co-integrated system. Causality from P_2 to P_1 and from P_1 to P_2 (there may be bi-directional causality) may be tested using the equation 5 to 7 of the error correction model, as in Alexander (1993). Rejection of the joint hypothesis: $B_{1=} \ldots B_m=0$ (by standard F-tests) implies causality from P_2 to P_1 because lagged P_2 provides a better prediction of current changes in P_1 once lagged P_1 has already been accounted for by the error correction term (μ_{t-1}). Similarly rejecting $D1= \ldots D_m=0$ (through F test) indicates granger causality from P_1 to P_2. Hence, the appeal of the VECM formulation is that it combines flexibility in dynamic specification with desirable long-run properties: it could be seen as capturing the transitional dynamics of the system to the long-run equilibrium suggested by economic theory.

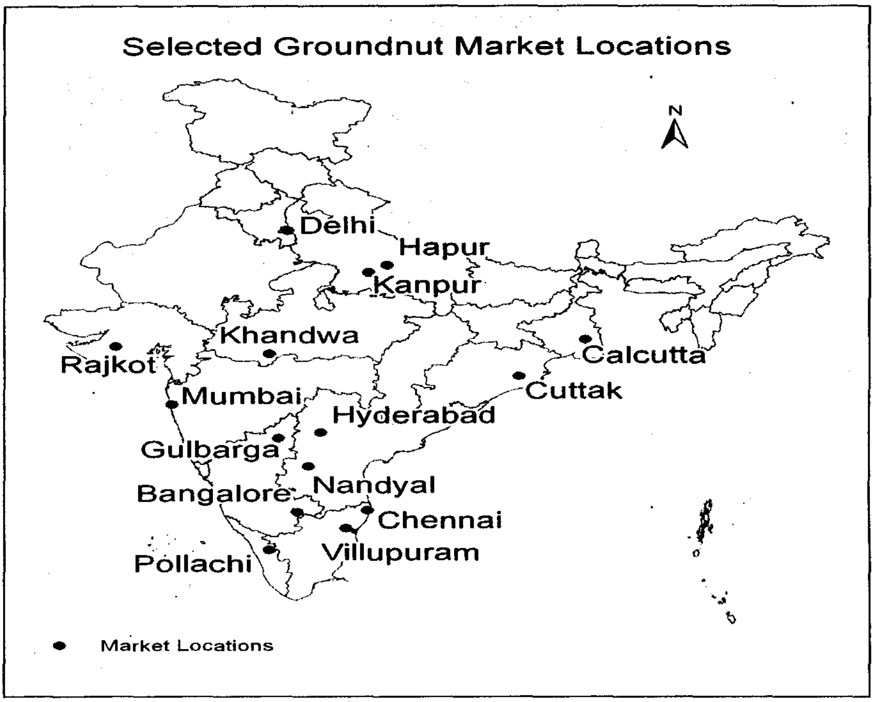
THE DATA

The data relating to the month-end wholesale prices quoted in major producing and consuming centers for groundnut pods, oil and cake collected from various issues of Agricultural Situation in India, for the period May 1996 to January 2003 were used for the study. The descriptive statistics of the markets and wholesale prices have been given in table 2 and the selected markets were depicted in Figure 1. The terminal markets are Mumbai, Chennai, Calcutta and Delhi, while markets in major producing centres are Nandyal, Rajkot, and Gulbarga. The remaining markets like Hyderabad, Bangalore, Pollachi, Villupuram, Khandwa, Kanpur, Cuttack and Hapur are both consuming and producing centres. The average transit cost per quintal from Mumbai to different markets is also given. Visual observation indicates that, wholesale prices of groundnut pods in Mumbai market is higher than the main production centres located in Andhra Pradesh, Karnataka, Gujarat and Tamil Nadu to the extent that it covers transport and other logistic expenses between producing centres and Mumbai market. In the case of groundnut oil, wholesale prices are more in producing centres than prices in Mumbai market and the difference between prices are positively related to the transport cost from Mumbai to the respective market. This is also in confirmation with the hypothesis that, edible oil wholesale prices are well linked with international prices as mostly wholesale prices of Mumbai market represent c.i.f. price at Mumbai port plus handling charges and market fees. In the case of groundnut cake, wholesale price in producing centres are lower than the wholesale prices in Mumbai market to the extent of transport and other logistic costs, in confirmation with the observation that India is an exporter in oil cake. The above results indicate the importance of wholesale prices of Mumbai market in tradable commodities (India imports large quantity of groundnut oil or its close substitutes like other edible oils and exports large quantities of oil cake) as it represents international prices and it is the entry/exit point of most of the internationally traded commodities in India.

RESULTS AND DISCUSSION

By visual examination of the groundnut price series we infer that the price of groundnut in different locations ranged between Rs.1000 and Rs.2000 during the study period and there is an upward movement of prices during the period. The first difference of price series has been taken and it seems that the series is stationary in first difference. To make objective judgment about unit roots, the ADF and Philips and Perron (PP) tests have been conducted. However, one possible weakness in the ADF tests has been that their underlying distribution theories assume that residual errors are statistically independent and have a constant variance, which may not be true for

Figure - 1



many time series data. Phillips and Perron (1988) developed a non-parametric test statistics, which involves less-restrictive assumption on the error process. In this case, the hypothesis: $H_0:B_1=0$, is tested by using Γ_{Γ}-statistics and referring to the critical values of DF tables. The 1 lag length has been selected on the basis of maximum Akaike information criteria. Given that all the price series are integrated of the same order (order one) both by measuring ADF and PP tests, we may now proceed to conduct the co-integration tests (Table 3). By choosing the comparable varieties of groundnut across the regions and states, we assume that price variability is due to spatial and seasonal effects and not due to the presence of variety differences. Similar results were obtained for both groundnut oil and groundnut cake; however to save space we have not presented them.

RESULTS OF JOHANSEN TEST

The results of the Johansen multivariate co-integration tests are reported in Table 4. On the whole, our results of co-integration test indicates that regional groundnut pod wholesale prices are integrated in the long run, as four markets are co-integrated out of 11 markets considered, and 4 markets out of 10 markets for groundnut oil

TABLE - 2

Mean of Groundnut Complex Wholesale Prices (Rs/quintal) from 1996 to 2003

Market	Distance from Mumbai (km)	Transit cost (Rs/q) from	GN pod price (Rs/q) Mumbai	Oil Price (Rs/q)	Cake Price (RS/q)
Chennai (Tamil Nadu)	1274	184	1803 (-113)	3631 (-161)	793 (50)
Hyderabad (Andhra Pradesh)	704	102	1862 (-54)	3955 (163)	656 (-87)
Mumbai (Maharastra)			1916	3792	743
Rajkot (Gujarat)	733	106	1323 (-593)	4184 (392)	731 (-12)
Bangalore (Karnataka)	989	143	982 (-934)	3873 (81)	
Nandyal (Andhra Pradesh)	857	124	1356 (-560)	3673 (-119)	
Calcutta (West Bengal)	1961	284	.	5518 (1726)	640 (-103)
Gulbarga (Karnataka)	527	76	1252 (-664)		
Hapur (Uttar Pradesh)	1404	203	1738 (-178)		
Kanpur (Uttar Pradesh)	1291	187	1597 (-319)		
Khandwa (Madhya Pradesh)	582	84	1365 (-552)		
Villupuram (Tamil Nadu)	1253	181	1750 (-166)		
Cuttack (Orissa)	1681	243		4452 (660)	
Delhi (Delhi)	1401	203		4929 (1137)	
Pollachi (Tamil Nadu)	1336	193		3807 (15)	
Average	1142	165	1540(-413)	4181(389)	713 (-30)

Note: (i) figures in parenthesis are difference between Mumbai price and local market price (positive value indicates Mumbai price is lower, negative value indicates Mumbai price is higher than respective market price); (ii) we have reported transit cost only from Mumbai to all markets, as in most of the cases Mumbai turned out to be major source of price formation in case of GN oil.

and 2 markets out of 5 markets for oil cake at five per cent level of significance. However, at 1% level of significance only two series are co-integrated in both pod and oil markets.

Results of VECM for Pods, Oil and Cake

Results of VECM have been presented in Tables 5, 6 and 7 for pods, oil and cake respectively. Among groundnut pod markets, Hyderabad, Bangalore and Nandyal are exogenous and major source of price discovery, while Kanpur, Hapur and Chennai markets are dependent on other markets including faraway markets like Rajkot, Gulbarga, Khandwa, Villupuram and Hyderabad. It indicates that in groundnut pod,

TABLE - 3

Results of the Augmented Dickey-Fuller and PP Test for the Order of Integration (GN pods)

Location	ADF test with 1 lag		Philips and Perron test for unit roots for first difference of price series	
	In level	In First difference		
	I(1) vs. I(0)	I(2) vs. I(1)	p-stat	alpha
Mumbai	-2.095	-5.154*	-6.2993*	-0.6359
Hyderabad	-2.791	-4.797*	-5.3138*	-0.5262
Chennai	-2.349	-4.960*	8.2616*	-0.9323
Villupuram	2.269	-4.436*	-4.9279*	-0.451
Hapur	-2.305	-4.757*	-9.4093*	-1.112
Kanpur	-1.891	-4.687*	-9.0506*	-0.9408
Khandwa	-2.117	-4.484*	-8.3489*	-0.9169
Nandyal	-1.882	-4.535*	-11.2554*	-1.0572
Rajkot	-2.023	-4.409*	-7.3119*	-0.7299
Gulbarga	-2.301	-4.707*	-6.7018*	-0.7333
Bangalore	-1.955	-4.599*	-6.4575*	-0.7252

Notes:

1. For ADF test * indicates significant at 1 per cent level. For n=82, 1 per cent and 5 per cent critical values for ADF statistics are -4.0052 and -3.4611 respectively. ADF is calculated with the assumption of constant and time trend.
2. For Philips and Perron test critical value are -3.4391 at 1% level of significance. * indicates significant at 1% level of significance.

the price information flows from production centres located in Andhra Pradesh, Karnataka, Gujarat and Tamil Nadu to the terminal markets like Mumbai and Chennai. Price differences in producing centres and terminal markets are generally equal to the transport cost between them. In case of groundnut oil, major consuming (and import centres) markets like Mumbai, Delhi, Calcutta and Chennai are major sources of price formation. Especially Mumbai is not dependent on any other market, but influences all other major markets. Hence, we may conclude that in the case of groundnut oil, major import centres like Mumbai, Chennai and Calcutta (along with major consuming centre Delhi) are major sources of price discovery. And prices in all other markets are dependent on Mumbai wholesale prices, and

TABLE - 4

Results of Johansen Co-integration Test for Integration of Wholesale Prices of Pod, Oil and Cake.

Maximum Rank	LL	Eigen value	Trace Statistic	5 % Critical Value
Groundnut pods				
0	-3918.2	0.9	435.27*	295.99
1	-3854.2	0.7	307.33*	250.84
2	-3851.7	0.6	230.21*	208.97
3	-3788.2	0.5	175.25*	170.8
4	-3766.6	0.4	132.01	136.61
5	-3750.2	0.4	99.26	104.94
6	-3735.5	0.3	69.78	77.74
7	-3723.9	0.3	46.62	54.64
8	-3714.3	0.3	27.41	34.55
9	-3705.6	0.2	10.01	18.17
10	-3701.1	0.01	1.03	3.74
11	-3700.6			
Groundnut oil				
0	-3909.31		337.27*	250.84
1	-3867.57	0.76	253.78*	208.97
2	-3838.33	0.63	195.3*	170.8
3	-3814.25	0.56	147.14*	136.61
4	-3791.87	0.54	102.38	104.94
5	-3771.24	0.51	61.12	77.74
6	-3760.14	0.32	38.91	54.64
7	-3752.78	0.22	24.19	34.55
8	-3746.33	0.19	11.3	18.17
9	-3743.37	0.09	5.37	3.74
10	-3740.68	0.09		
Groundnut cake				
0	-1389.86		111.71*	77.74
1	-1363.95	0.61	59.89*	54.64
2	-1346.53	0.47	25.06	34.55
3	-1337.74	0.27	7.47	18.17
4	-1335.09	0.09	2.16	3.74
5	-1334	0.04		

the prices are higher in other markets in proportion to the transport and handling cost from Mumbai to the respective market. This is also in confirmation with the hypothesis that, edible oil wholesale prices in India are linked with international prices as mostly Mumbai edible oil wholesale prices represent c.i.f. price at Mumbai port plus handling and market charges. In the case of groundnut cake, again Mumbai wholesale price is the major source of price formation, but wholesale price in other markets are lower than the Mumbai wholesale price to the extent of transport and other logistic costs, in confirmation with the observation of India as major exporter in oil cake. Mumbai is the entry and exit point of most of the internationally traded commodities and price of imports/exports play a major role in domestic wholesale prices of oil and cake as India imports large quantity of groundnut oil or its close substitutes like other edible oils and exports large quantity of oil cake to international markets. Overall, there is evidence of co-integration in groundnut pod, oil and cake markets in India and domestic market is more or less insulated from international markets in the case of groundnuts, while in case of oil and cake, international prices play a key role in price formation.

Short Term Adjustment :

The coefficient of the error correction terms (ECTs) turn out to be negative in most of the cases for all markets. These coefficients apparently reflect the speed of adjustment from short-run deviations to the long run equilibrium level; thus, the speed of adjustment from any disequilibrium towards the long-run growth path is generally interpreted from these coefficients. In the present case, the negative ECTs would indicate that the short-run disequilibrium adjustment process might lead to the stable long-run prices in most of the locations. Interstate causality appeared to be existing among groundnut markets to large extent, which indicates that state barriers are not influencing groundnut markets and information passes through interstate markets to a large extent. Overall the results show that, groundnut markets are integrated both in the long run and short run.

Vertical Integration Among Groundnut Complex Wholesale Prices :

In addition to studying separate cointegration in pod, oil and cake wholesale price series, we have also examined cointegration among pod, oil and cake wholesale prices in four locations (Hyderabad, Rajkot, Mumbai and Chennai) for which wholesale prices for pods, oil and cake is available from 1996 to 2003. We examined, whether wholesale prices of GN pods were influenced by prices of oil and cake in the same and different localities and vice versa. And what is the speed of adjustment from dis-equilibrium to long run equilibrium? The results for Johansen cointegration test and VECM are presented in Table 8 and 9 respectively, which confirm that only 5 among 12 wholesale price series are cointegrated in pod, oil and cake markets of Hyderabad, Rajkot, Mumbai and Chennai. Overall, vertical co-integration among pod, oil and cake markets exists only in few markets. Among wholesale prices of pods, only Rajkot market is influenced by wholesale prices of GN oil of Mumbai market at 10 per cent level of significant. Among wholesale prices of oil, prices in Hyderabad is influenced by wholesale prices of pods in Chennai at 10% level, while Chennai oil prices are influenced by wholesale prices of pods in Rajkot and Chennai at 5 per cent level. This indicates that, only in few markets, prices of GN pods and GN oil are vertically integrated in the long run, while wholesale prices of cake are not integrated either with GN pod or oil wholesale prices in the long run. That too, the vertical integration is strong between wholesale prices of major producing centre (Rajkot) and prices in major consuming centres (Mumbai, Chennai and Hyderabad). However, on the whole, short run adjustment from deviations from long run equilibrium is significant as observed from large and significant error correction terms in the VECM especially among groundnut pod and oil wholesale prices. Further, cost benefit analysis of value chain of groundnut processing sector from oilseed to oil and cake (Table 10) indicates that, it is running under low margins (Rs.73/quintal) with cost-benefit ratio of 1.29, which confirms vertical cointegration at least in groundnut producing and processing centre.

CONCLUSION

India is following liberal trade policies especially in edible oil complex which includes oilseeds, oil and cake since early 1990s. India is a large importer of edible oils and large exporter of oil-cake, but there is little or no trade in oil-seeds. Co-integration in wholesale prices of oil-seed, oil and cake across major markets is important in the long-run for the crops which are widely dispersed. Among cointegrated markets, geographical price differences truly reflect transport costs, which facilitate geographical specialisation. It is also important that the differences in wholesale prices of oil-seed, edible-oil and oil-cake for a particular region should not be more than the cost of value-addition along the supply chain for efficient and un-exploited markets. Keeping the importance of groundnut in edible oil complex, this paper tried to examine the cointegration of wholesale prices of groundnut pod, oil and cake across major markets of India. Totally 11 markets were considered for groundnut pods, 10 markets for oil and 5 markets for cake for the study from May 1996 to January 2003. Out of 11 groundnut pod and 10 oil wholesale price series, only 4 series are co-integrated, while in the case of groundnut cake only 2 markets are co-integrated out of 5 major markets. In the case of groundnut oil and cake, price information flows from major import/export centres like Mumbai and Chennai to major producing centres, while in case of groundnut pods price information flows from major production centres to terminal markets like Mumbai, Chennai and Delhi. Overall price discovery in GN oil and cake takes place in terminal markets like Mumbai, while for pods price discovery takes place in major producing centres. We have also analysed cointegration among pod, oil and cake markets in the short and long run for testing of vertical co-integration along value chain. The results show that, co-integration between wholesale prices of groundnut pod, oil and cake exists in few markets. Chennai oil prices are influenced by Rajkot and Chennai pod prices, while wholesale prices of cake in Mumbai are influenced by pod prices in Rajkot. This indicates that, only in few markets, prices of GN pods and GN oil are vertically integrated in the long run, while in most markets wholesale prices of cake are not integrated either with GN pod or oil wholesale prices in the long run. That too, the vertical integration is strong between wholesale prices of major producing centre (Rajkot) and prices in major consuming centres (Mumbai, Chennai and Hyderabad). Further low margins of processing sector confirms the vertical integration of GN pod and oil/cake wholesale prices at least in GN producing centres.

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TABLE - 5 : Vector Error Correction Model Results for Wholesale Prices of Groundnut Pods

Independent series	ΔMumbai		ΔNandyal		ΔHyderabad		ΔRajkot		ΔBangalore		ΔGulbarga		ΔKhandwa		ΔVillupuram		ΔChennai		ΔKanpur		ΔHapur	
	Beta	t-stat	Beta	t-stat	Beta	t-stat	beta	t-stat	beta	t-stat	beta	t-stat	beta	t-stat	beta	t-stat	beta	t-stat	beta	t-stat	beta	t-stat
ΔMumbai (t-1)	-0.114	-0.79	0.0825	0.32	0.0069	0.03	0.1092	0.37	-0.027	-0.19	0.0235	0.18	0.2788	1.34	0.1144	0.51	0.1863	0.71	0.587*	2.83	0.281*	1.91
ΔNandyal (t-1)	0.05	0.57	0.0268	0.17	0.1311	1.07	0.0452	0.26	-0.053	-0.62	0.0636	0.79	0.0183	0.14	-0.019	-1.09	0.0378	0.24	0.0134	0.11	0.0968	1.09
ΔHyderabad (t-1	0.0084	0.06	0.0732	0.31	-0.2278	-1.22	0.1896	0.7	-0.289	-0.22	-0.1154	-0.94	-0.1878	-0.98	-0.464	-0.22	0.4563	1.87	0.1258	0.66	0.0547	0.4
ΔRajkot (t-1)	-0.0948	-1.23	0.0274	0.2	0.395*	3.68	-0.1045	-0.67	0.012	0.16	-0.0216	-0.31	-0.099	-0.89	-0.0963	-0.81	0.0436	0.31	0.0611	0.56	0.269*	3.45
ΔBangalore (t-1)	0.0884	0.62	-0.2139	-0.84	0.2869	1.43	-0.2912	-1	-0.322*	-2.28	0.0863	0.66	0.1675	0.81	0.2429	1.09	-0.3712	-1.42	-0.2719	-1.32	-0.2079	-1.42
ΔGulbarga (t-1)	0.1447	0.79	0.2787	0.86	1.116*	4.38	0.3296	0.89	-0.2918	-1.63	0.2858	1.71	-0.8428	-0.32	-0.66*	-2.35	-0.425	-1.28	0.3442	1.32	0.1018	0.55
ΔKhandwa (t-1)	0.0983	1.06	-0.1281	-0.78	-0.404*	-3.14	0.184	0.99	-0.0195	-0.22	-0.1007	-1.19	0.1917	1.44	-0.1176	-0.82	0.412*	2.44	-0.2268	-1.71	-0.239*	-2.55
ΔVillupuram (t-1)	-0.0273	-0.25	-0.1478	-0.77	0.201*	1.33	0.474*	2.17	-0.1232	-1.16	-0.0172	-0.17	-0.0614	-0.39	-0.0807	-0.48	-0.1091	-0.55	0.334*	2.15	0.0609	0.55
ΔChennai (t-1)	-0.551*	-1.9	0.2048	1.2	0.400*	3.01	0.746*	3.86	0.0891	0.95	-0.1437	-1.64	-0.2577	-1.87	-0.1102	-0.74	-0.2083	-1.2	-0.0627	-0.46	0.192*	1.98
ΔKanpur (t-1)	-0.192*	-2.28	-0.061	-0.41	-0.1106	-0.94	0.387*	2.27	-0.205*	-2.49	-0.8679	-1.12	-0.2119	-1.75	0.4589	3.51	-0.1544	-1.01	-0.0147	-1.22	0.309*	3.6
ΔHapur (t-1)	-0.1669	-1.45	-0.3446	-1.68	-0.1007	-0.63	-0.811*	-3.49	0.0608	0.54	0.267*	2.53	0.471*	2.84	0.349*	1.95	-0.1106	-0.53	0.2891	1.76	-0.344*	-2.93
ECT 1	-0.085*	-3.03	0.0252	1.48	-0.0027	-0.11	-0.0082	-0.55	0.058*	2.11	0.0165	0.47	0.0284	1.58	-0.049*	-2.29	0.0071	0.38	-0.0819	-5	-129	-0.58
ECT 2	0.250*	3.04	-0.0753	-1.51	0.01	0.13	0.0241	0.55	-0.1*	-2.11	-0.5905	-0.57	-0.0821	-1.56	0.143*	2.32	-0.0202	-0.37	0.242*	5.03	0.0363	0.55
Constan	12.187	0.52	1.8738	0.13	-0.3787	-0.02	-0.7264	-0.06	11.05394	0.48	-2.6218	-0.09	2.3121	0.15	-3.1999	-0.18	1.8721	0.12	-3.3113	-0.24	9.7983	0.53

* Indicates significant at 5% level.

TABLE - 6 : Results of VECM for Groundnut Oil Wholesale Prices

Independent	Δ Nandyal	Δ Hydeabad	Δ Rajkot	Δ Bangalore	Δ Mumbai	Δ Cuttack	Δ Chennai	Δ Pollachi	Δ Calcutta	Δ Delhi
ΔNandyal (t-1)	-0.0263 (-0.17)	0.2105 (0.86)	0.0033 (0.01)	0.2158 (1.89)	0.0025 (0.01)	-0.2517 (-1.24)	-0.3025 (-0.84)	-0.2877 (-0.54)	0.0052 (0.02)	0.4402 (0.86)
ΔHyderabad (t-1)	-0.1632 (-1.82)	-0.0387 (-0.28)	0.2077 (1.25)	0.235* (3.57)	0.3894 (1.78)	0.0403 (0.34)	0.3128 (1.51)	-0.5958 (-1.93)	0.234 (1.64)	0.2264 (0.76)
ΔRajkot (t-1)	0.1405 (1.19)	0.2025 (1.10)	-0.48* (-2.23)	0.0454 (0.53)	0.3319 (1.16)	-0.0558 (-0.36)	0.4067 (1.50)	-0.3373 (-0.83)	-0.487* (-2.6)	0.4843 (1.25)
ΔBangalore (t-1)	0.0989 (0.48)	0.2275 (0.70)	0.2659 (0.69)	0.394* (2.59)	-0.1041 (-0.21)	0.1736 (0.64)	1.22* (2.55)	-1.61* (-2.26)	0.0469 (0.14)	0.5799 (0.85)
ΔMumbai (t-1)	0.063 (0.91)	-0.0028 (-0.03)	-0.0299 (-0.23)	-0.0244 (-0.48)	0.2012 (1.20)	-0.0754 (-0.83)	-0.263 (-1.65)	-0.0504 (-0.21)	0.0718 (0.65)	-0.0073 (-0.03)
ΔCuttack (t-1)	0.1312 (0.95)	0.0905 (0.42)	0.215 (0.84)	-0.051 (-0.51)	0.0245 (0.07)	0.0784 (0.44)	-0.4958 (-1.56)	-0.0307 (-0.06)	-0.0681 (-0.31)	-0.2032 (-0.45)
ΔChennai (t-1)	0.0988 (0.92)	0.325* (1.94)	-0.134 (-0.68)	0.279* (3.56)	0.1358 (0.52)	0.0607 (0.44)	-0.0633 (-0.26)	-0.2649 (-0.72)	-0.588* (-3.46)	0.757* (2.14)
ΔPollachi (t-1)	-0.0947 (-1.34)	0.1763 (1.60)	0.0382 (0.29)	0.149* (2.88)	0.1381 (0.80)	0.017 (0.18)	0.1558 (-0.96)	-0.50* (-2.06)	-0.0779 (-0.69)	0.1614 (0.69)
ΔCalcutta (t-1)	-0.0605 (-0.79)	0.1157 (0.96)	0.312* (2.19)	0.0534 (0.95)	0.1756 (0.94)	0.0171 (0.17)	-0.0138 (-0.08)	-0.4872 (-1.84)	0.3686 (3.02)	-0.1322 (-0.52)
ΔDelhi (t-1)	0.0607 (1.34)	-0.0198 (-0.28)	0.0052 (0.06)	0.0331 (1.00)	0.20008 (1.81)	0.0435 (0.74)	-0.266* (-2.55)	0.0939 (0.60)	0.069* (0.96)	0.0646 (0.43)
ECT1	0.0114 (0.40)	0.0487* (2.96)	0.0136 (0.63)	-0.107* (-2.82)	0.025* (1.98)	0.0219 (0.87)	0.0012 (0.06)	0.0236 (1.82)	0.052* (3.69)	0.024* (2.86)
ECT2	-0.4328 (-1.67)	-0.687* (-4.6)	-0.2317 (-1.18)	-0.5177 (-1.50)	-0.257* (-2.24)	0.0543 (0.24)	-0.5161 (-1.9)	-0.333* (-2.84)	-0.44* (-3.44)	-0.0662 (-0.86)
Constant	-11.4906 (-0.21)	2.9075 (0.09)	1.13 (0.03)	3.2484 (0.05)	3.4012 (0.14)	-13.4924 (-0.28)	-6.2255 (-0.17)	-1.3764 (-0.06)	5.0929 (0.19)	12.8851 (0.83)

Note: Figures in parenthesis are t-values; * indicates significant at 5% level of significance

TABLE - 7
VECM for Groundnut Cake Wholesale Prices

Independent	Δ Hyderabad	Δ Rajkot	Δ Mumbai	Δ Chennai	Δ Calcutta
ΔHyderabad	-0.298*	-0.512*	0.86*	-0.1665	-0.0069
(t-1)	(-1.98)	(-3.6)	(4.04)	(-0.79)	(-0.05)
ΔRajkot	0.0429	0.0475	0.60*	-0.144	-0.03473
(t-1)	(0.26)	(0.30)	(2.53)	(-0.61)	(-0.25)
ΔMumbai					
(t-1)	-0.1489	-0.1061	0.44*	-0.0259	0.02006
	(-1.46)	(-1.1)	(3.05)	(-0.18)	(0.23)
ΔChennai					
(t-1)	-0.1436	-0.1275	0.34*	-0.0417	-0.1242
	(-1.46)	(-1.36)	(2.41)	(-0.30)	(-1.49)
ΔCalcutta					
(t-1)	0.2422	0.0354	0.0195	-0.3127	-0.1218
	(1.43)	(0.22)	(0.08)	(-1.32)	(-0.86)
ECT1	0.1425	0.185*	0.31*	0.11*	-0.0032
	(1.80)	(2.1)	(5.69)	(1.95)	(0.04)
ECT2	0.73*	-0.89*	0.1423	0.2084	-0.1373
	(3.87)	(-4.23)	(1.11)	(1.68)	(-0.65)
Constant	-0.2358	-1.3458	-0.4397	4.5457	13.9406
	(-0.03)	(-0.15)	(-0.08)	(0.89)	(1.59)

Note: Figures in parenthesis are t-values, * indicates significant at 5% level

TABLE - 8
Results of Johansen Cointegration Test for Groundnut Complex (pod, oil and cake)

Maximum Eigen-value statistics			Trace-statistics		
Max Rank	LL	Eigen-value	Rank	Trace-statistic	critical value
0	-4133.4	.	< or = 0	461.1*	.
1	-4088.9	0.8	< or = 1	372.2*	277.7
2	-4047.5	0.8	< or = 2	289.5*	233.1
3	-4017.5	0.6	< or = 3	229.3*	192.9
4	-3993.3	0.6	< or = 4	181.1*	156.0
5	-3971.5	0.5	< or = 5	137.4*	124.2
6	-3953.0	0.5	< or = 6	100.4*	94.2
7	-3935.7	0.4	< or = 7	65.8	68.5
8	-3923.9	0.3	< or = 8	42.2	47.2
9	-3913.7	0.3	< or = 9	21.9	29.7
10	-3905.8	0.2	< or = 10	6.1	15.4
11	-3903.4	0.1	< or = 11	1.1	3.8
12	-3902.8	0.0	< or = 12	0	

TABLE - 9 : Results of VECM for Groundnut Complex (pods, oil and cake) for four Wholesale Prices

	Δ H_pod	Δ R_pod	Δ M_pod	Δ C_pod	Δ H_Oil	Δ R_Oil	Δ M_Oil	Δ C_Oil	Δ H_cake	ΔR cake	ΔM cake	Δ C cake
Constant	6.29 (0.3)	0.44 (0.0)	10.55 (0.4)	3.37 (0.3)	0.32 (0.0)	1.20 (0.0)	-6.17 (-0.3)	-2.43 (-0.1)	-0.90 (-0.1)	-0.87 (-0.1)	0.06 (0.0)	3.90 (0.7)
Δ H_pod (t-1)	-0.20 (-0.9)	0.14 (1.2)	-0.17 (-0.5)	-0.03 (-0.2)	0.48 (1.2)	-0.32 (1.0)	0.09 (0.3)	-0.23 (-0.7)	-0.11 (-1.2)	-0.10 (-0.9)	-0.10 (-1.5)	0.03 (0.4)
Δ R_pod (t-1)	-0.26 (-0.7)	-0.05 (-0.2)	0.48 (0.9)	0.13 (0.5)	0.18 (0.3)	0.73 (1.4)	0.26 (0.6)	1.11* (1.9)	0.00 (0.0)	-0.07 (-0.4)	-0.32* (-2.7)	0.09 (0.9)
Δ M_pod (t-1)	0.11 (1.0)	-0.01 (-0.2)	-0.17 (-1.0)	-0.14* (-1.9)	-0.09 (-0.5)	-0.21 (-1.3)	0.18 (1.3)	-0.46* (-2.6)	0.01 (0.3)	0.07 (1.2)	0.06 (1.8)	-0.02 (-0.8)
ΔC_pod (t-1)	0.95* (3.7)	0.10 (0.7)	-0.38 (-1.0)	0.18 (1.1)	0.47** (1.1)	0.26 (0.7)	0.48 (1.6)	0.81* (2.1)	0.15 (1.5)	0.20 (1.6)	0.12 (1.5)	-0.06 (-0.8)
ΔH_oil (t-1)	0.03 (0.5)	-0.06 (-1.6)	-0.02 (-0.2)	0.03 (0.7)	-0.04 (-0.4)	-0.15 (-1.6)	0.02 (0.3)	-0.05 (-0.5)	0.04 (1.5)	0.02 (0.6)	0.02 (0.9)	0.02 (1.2)
Δ R_oil (t-1)	0.21 (1.4)	-0.12 (-1.5)	-0.15 (-0.7)	-0.09 (-0.9)	-0.43 (-1.6)	-0.46* (-2.2)	-0.06 (-0.3)	-0.30 (1.3)	-0.02 (-0.3)	0.07 (0.9)	0.06 (1.2)	-0.03 (-0.6)
Δ M_oil (t-1)	-0.07 (-0.6)	0.09** (1.5)	0.01 (0.1)	0.03 (0.4)	0.15 (0.7)	0.11 (0.7)	0.17 (1.2)	-0.03 (-0.2)	-0.02 (-0.4)	0.09 (1.5)	0.06 (1.7)	0.02 (0.6)
ΔC_oil (t-1)	-0.26 (-1.8)	0.10 (1.4)	0.21 (1.0)	-0.02 (-0.2)	-0.03 (-0.1)	0.74* (3.7)	-0.38* (-2.2)	0.07 (0.3)	-0.03 (-0.4)	-0.05 (-0.6)	-0.04 (-1.0)	-0.05 (-1.1)
? H_cake (t-1)	0.47 (1.2)	-0.14 (-0.7)	0.18 (0.3)	0.02 (0.1)	0.25 (0.4)	0.35 (0.7)	0.05 (0.1)	0.78 (1.3)	-0.36* (-2.3)	0.24 (1.3)	-0.06 (-0.5)	-0.05 (-0.5)
Δ R_cake (t-1)	0.46 (1.2)	-0.18 (-1.0)	-0.22 -(0.4)	0.30 (1.2)	0.37 (0.6)	0.02 (0.0)	-0.55 (-1.3)	0.61 (1.1)	-0.39* (-2.6)	-0.01 (-0.1)	-0.16 (-1.4)	-0.11 (-1.1)
ΔM_cake (t-1)	-0.89 (-1.1)	0.32 (0.8)	1.91 (1.7)	-0.63 (-1.2)	-0.12 (-0.1)	-1.35 (-1.2)	0.34 (0.4)	-1.43 (-1.2)	0.78* (2.4)	0.28 (0.7)	0.32 (1.3)	0.30 (1.3)

	Δ H_pod	Δ R_pod	Δ M_pod	Δ C_pod	Δ H_Oil	Δ R_Oil	Δ M_Oil	Δ C_Oil	Δ H_cake	ΔR cake	ΔM cake	Δ C cake
ΔC_cake	-0.50	0.03	-0.71	0.11	-2.32*	-0.50	-0.66	-1.17	-0.17	0.09	0.06	-0.12
(t-1)	(-0.8)	(0.1)	(-0.8)	(0.3)	(-2.1)	(-0.6)	(-0.9)	(-1.2)	(-0.7)	(0.3)	(0.3)	(-0.7)
ECT1	-0.14	0.25*	0.25	0.43*	-0.46	1.48*	0.24	1.32*	0.09	0.10	0.08	-0.02
(t-1)	(-0.6)	(2.0)	(0.7)	(2.7)	(-1.1)	(4.4)	(0.9)	(3.6)	(0.9)	(0.9)	(1.1)	(-0.3)
ECT 2	0.10	-0.32	-0.47	0.67*	2.15*	1.27*	-0.21	0.83	0.09	-0.47*	0.05	0.10
(t-1)	(0.2)	(-1.3)	(-0.7)	(2.1)	(2.6)	(1.9)	(-0.4)	(1.1)	(0.5)	(-2.0)	(0.4)	(0.7)
ECT 3	0.06*	0.03*	-0.03	0.05*	-0.14*	0.09*	0.00	0.09*	0.00	0.03*	0.00	-0.01
(t-1)	(2.3)	(2.4)	(-0.9)	(3.0)	(3.3)	(2.8)	(0.0)	(2.3)	(-0.5)	(2.8)	(0.6)	(-1.1)
ECT 4	-1.08*	-0.16	0.85	-1.19*	-0.54	-0.93	-0.10	-1.03	-0.04	-0.23	-0.18	-0.04
(t-1)	(-2.9)	(-0.8)	(1.6)	(-4.7)	(-0.8)	(-1.8)	(-0.2)	(-1.8)	(-0.3)	(-1.2)	(-1.5)	(-0.4)
ECT 5	-0.02	0.05	-0.03	-0.12	-0.90*	0.39*	-0.18	0.14	-0.04	-0.01	-0.05	-0.06*
(t-1)	(-0.2)	(1.0)	(-0.2)	(-1.6)	(-4.7)	(2.6)	(-1.4)	(0.8)	(-0.9)	(-0.1)	(-0.05)	(-1.9)

Note: figures in parenthesis are t ratios and *indicates significant at 5% level and ** indicates significant at 10% level; H=Hyderabad, R=Rajkot, M= Mumbai, C=Chennai

TABLE - 10

Cost Benefit Analysis of Groundnut Value Chain in a Typical Processing Unit per Annum

Cost Components	all processing units
GN price (Rs/q)	1900
oil price(Rs./q)	4480
cake price (Rs./q)	870
Extraction ratio	0.38
oil sale value (Rs./q)	4480
Cake sale value (Rs./q)	870
Value Addition in processing (Rs./q)	327
processing cost(Rs/q)	254
Net Return (Rs/q)	73
Benefit Cost Ratio (value addition in processing /total cost)	1.29

Source: Field Survey in Anantapur district in the year 2007