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Price Transmission and Asymmetry: An Empirical Analysis of Indian Groundnut Seed and Oil Markets

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I

INTRODUCTION

Price transmission provides insights into vertical and horizontal integration of agricultural markets, and producer and consumer welfare. In a perfectly competitive market, commodity prices should move in unison in response to the forces of demand and supply. The accuracy and speed at which price change in one market (commodity) gets transmitted to other markets (close substitutes) is taken as an indicator of integration (interdependence) among the markets (commodity groups). The extent of integration gives signals for efficient resource allocation, which is considered essential for ensuring greater market efficiency, price stability and food security. Test of integration also plays a key role in determining the geographical level at which agriculture price policy should be targeted, at least in the short-run to ensure regular availability of food and price stability (Jha *et al.,* 2005; Acharya, 2001). Other arguments in favour of flexible price transmission are based on efficient market network and commercialisation of agriculture to reap the benefits of market liberalisation and globalisation (Jayasuriya *et al.*, 2007).

In this context, several studies have been done to test the magnitude of integration in agricultural markets over different time periods. Based on the notion of 'law of one price', or 'market integration', majority of the studies have provided evidence in favour of a higher and improved spatial and vertical integration, especially in the post-reform period when a series of legislative and other measures were initiated to improve the functioning of agricultural markets (Bathla, 2011 and 2009a; Kumar, 2007; Wilson 2001; Acharya 2001; Jha *et al.,* 1997). However, a complete pass through of prices of several commodities across regions has been refuted on grounds of existing stringent controls and barriers on inter-state trade in some of the commodities, regional bias in price and procurement policy, non-uniformity in taxes and levies across the states, information gaps and weak infrastructure. While some of these factors may cause persistent price gap in the vertical market system too, studies have tried to provide explanation for volatility in

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these through other factors, such as monopolistic behaviour of traders and increase in profit margins, high storage, transaction and inventory holding costs. Thus, in these kinds of situations, commodity prices may not necessarily integrate, and if at all these do, it may only be in the long-run. In the short-run, there can be a time lag in price adjustment, which essentially implies a slow speed of reconciliation of short-run behaviour with that in the long-run and hence necessitates appropriate interventions.

While testing market efficiency, the extant literature has not looked into an equally important aspect, and that is, whether the process of price transmission in agricultural markets is symmetric or asymmetric. The term 'asymmetry' signifies that the reaction of the price at one level of the marketing chain to a price change at another level depends on whether the initial change is positive or negative (von Cramon-Taubadel, 1998). Among many, Ward (1982), Kinnucan and Forker (1987), Zhang *et al.,* (1995), Goodwin and Holt (1999), Peltzman (2000), Capps and Sherwell (2005) have provided evidences of asymmetry in a number of agricultural commodities in the developed countries markets and contested that output prices are often observed to rise quickly when input prices increase, but drop slowly when input prices decrease. It implies that some group is not benefiting from a price reduction (buyers) or increase (sellers) which, under conditions of symmetry, would have taken place sooner, and have been of a greater magnitude than observed. According to Peltzman (2000), presence of asymmetric price transmission (APT) goes against the paradigmatic price theory and is a manifestation of market failure and imperfection, inefficiency and signals redistribution and net welfare losses.

This subject is little researched in the Indian context. A few studies have revealed instances of market imperfections in rice markets, collusion among sellers both in the first and the final stage of transactions, thereby indicating exploitation of the producers and the consumers (Banerjee and Meenakshi, 2001). Similarly, Jha and Nagarajan (2002) have found that the average speed of adjustment in rice markets is three times slower in the case of a price decline as compared to that for a price increase. The authors attributed asymmetries to collusion and price fixing by multiple traders each having a high proportion of margins in the wholesale and retail prices. In the presence of information asymmetry, margins overshoot their equilibrium levels, thus leading to noise trading.

Clearly, the issue of asymmetric price transmission holds importance in India as there are not many studies done to detect it. Besides, it has policy implications as private trade in agricultural markets is governed by minimum support price, legislative and other regulatory policies of the central and the state governments. Despite various interventions in these from time to time, not only do prices of various commodities tend to be volatile, but price decline at one stage due to an increase in supply is not equal to or comparable with price decline at the other stage. This paper endeavours to estimate price transmission and test for asymmetry in a vertical market system by taking the case of groundnut seed and oil prices in three important state level wholesale markets in India. It builds on the hypothesis that even if seed and oil prices integrate, the response of price at one stage could be asymmetric to the positive and negative changes in price at other stage and hence provides evidence of market failure. This exercise would enable us to understand the issue of APT in a broader context of determining market efficiency and its implications for policy and also develop an understanding on the methodological aspects for further research.

The rest of the paper is structured as follows: Section II provides a brief sketch of the marketing system for oilseeds and edible oils in India and policy interventions. Section III explains the empirical model for testing vertical price transmission and asymmetry along with the estimation of short-run and long-run elasticities of price transmission. Section IV presents the empirical findings followed by broad conclusions and implications for policy in Section V.

II

MARKETING SYSTEM FOR OILSEEDS AND EDIBLE OIL AND POLICY INTERVENTIONS

Among the nine major oilseeds, groundnut, rapeseed-mustard and soyabean contribute the maximum in terms of acreage and production. Oilseeds are cultivated mostly in the rainfed areas in the southern parts of India having low levels of productivity, per capita income and high poverty. While groundnut is grown primarily in Andhra Pradesh, Gujarat, Karnataka, Maharashtra and Tamil Nadu, soyabean is concentrated in Madhya Pradesh and Maharashtra and rapeseed-mustard in Gujarat, Haryana, Madhya Pradesh, Rajasthan, Uttar Pradesh and West Bengal. Statistics reveal that though oilseed production has increased three-fold over the period from 1971-72 to 2007-08, presently at 28.8 million tonnes, production of edible oil estimated to be nearly 7 million tonnes is inadequate to meet the growing demand. As a result, there has been an increase in the import of edible oil over the period, presently estimated at nearly 4.4 million tonnes amounting to roughly Rs. 10 thousand crores. Apart from factors like low growth in output, no technological breakthrough to improve yield, inappropriate marketing and trade policies, higher imports are attributed to tariff liberalisation pursued during the seventies and then again from mid-nineties to meet the growing demand.

The marketing system for oilseeds and edible oils has been characterised by government intervention with varying nature and degree of controls and regulations since 1970. Like many agricultural commodities, groundnut is traded primarily in the government run regulated wholesale markets and only a small quantity is procured by National Agricultural Cooperative Marketing Federation for India Ltd. (NAFED) and state level co-operatives under the Market Intervention Scheme. The produce is routed through multiple channels starting from farmers to primary wholesalers to secondary wholesalers and from traders in one market to traders in another market and then to processors. The final produce (i.e., oil) is again traded among various market intermediaries (wholesalers/traders) before reaching the consumers. Though provisions have been made under the Agricultural Produce Market Committee

(APMC) Act 2002 for direct purchase of produce from growers through contract farming and also in the wholesale markets after paying a fee, but only a few states have initiated steps in this direction. Large gaps between the farm and wholesale prices of seed, wholesale seed price and wholesale price of oil and wholesale and retail prices of oil are, thus, observed in the existing marketing system. A large spread at each level is considered to be a manifestation of market imperfections and poor competitiveness of the oilseed sector. As a result, while growers are deprived of fair returns for their produce, and they face uncertainty in their incomes and production disincentives, the consumers may find it difficult to access the goods at the right time and at reasonable prices (Chand, 2007).

In order to improve market efficiency and also raise the production of oilseeds and edible oils and reduce dependence on imports, the government initiated Technology Mission on Oilseeds, Market Intervention Operation of National Dairy Development Board and price support programme. Government also regulates internal trade in oilseed and edible oil through various legislative measures, restrictions on inter-state movement, stock limits by wholesalers, and differential value added tax (VAT) on oilseeds, oil meals, oil cakes and vegetable oils from state to state (Chand, 2009). On external trade, the quantitative restrictions and high tariffs are often placed to curb cheap imports and protect the domestic edible oil industry (Ghosh, 2008; Srinivasan, 2004).

Some of these interventions have helped in raising area and production of oilseeds in the country. However, the rate of growth in productivity has been decelerating and external trade is increasing fast. As a result, domestic prices have become susceptible to high volatility. The policy of minimum support price (MSP) announced for each oilseed is also not very effective due to large difference between the actual price received by the farmers and MSP. Empirical tests also reveal that the wholesale price of groundnut and soyabean seeds to be irresponsive to their respective MSP and are found to be positively influenced by the movement in their respective world prices[1] (Bathla, 2009b).

Furthermore, the performance of edible oil industry in the country is reported to be below par. This could be due to small scale industry reservation to the expelling industry for a longer period, which might result in adaptation of sub-optimal technology, high processing losses and hence obstruction in attaining economies of scale (World Bank, 1997). Based on primary and secondary data, Mruthyunjaya *et al.,* (2005) have found that nearly 60-70 per cent of crude edible oil refining units are small with capacity utilisation as low as 40 per cent. The technical inefficiencies in oilseeds production, on an average, have been found to be one-fourth to one-third and even higher at the farm/processing unit levels along with allocative and scale inefficiencies. The combined technical inefficiencies in the oilseeds sector have been found to be half to two-third.

Overall, the literature indicates that the oilseed industry is not fully competitive and has shown sluggish performance owing to (a) lack of timely and assured supply of quality seeds and raw materials, under-utilised and outdated processing technology, (b) stringent interventions and regulations in the marketing system under the APMC Act, high mandi tax, differential VAT from state to state and stock limits, and (c) adhocism in the export-import policy and fluctuating tariff rates. These factors, along with the fact that multiple layers of middlemen exist at each stage of marketing of both seed and oil, may manifest higher degressions in prices, asymmetries and uncertainties.

III

EMPIRICAL MODEL FOR ESTIMATION OF ASYMMETRIC PRICE TRANSMISSION

For the purpose of testing APT, consistent time series data on monthly wholesale prices of groundnut seed and oil is collected from January 1996 to December 2007 from three wholesale markets, Hyderabad in Andhra Pradesh, Rajkot in Gujarat and Chennai in Tamil Nadu. The data is collected from *Agricultural Prices in India* and www.agmarknet.nic.in, maintained by the Ministry of Agriculture, Government of India. The analysis is based on monthly nominal wholesale prices. Since time series observed at monthly frequencies often exhibit cyclical movements, the price series are adjusted for seasonality in order to remove these cyclical seasonal movements. The multiplicative adjustment method based on a 'ratio to moving average' procedure is used to estimate seasonal factors from the actual series and obtain the de-seasonalised series.

Literature highlight several approaches to test APT. In this study, pre-cointegration approach given by Houck (1977) and error correction model developed by von Cramon-Taubadel and Loy (1996) are employed to detect APT. Again, there are several variants of these tests based on the first difference in the explanatory variables and/or with and without the use of lags. However, the most acceptable technique under pre-cointegration approach is by Wolffram (1971), adopted by Houck (1977) and extended by Ward (1982). The most widely used method under cointegration-error correction approach is by von Cramon-Taubadel and Loy (1996) and Meyer and von Cramon Taubadel (2004). The following equation is the starting point based on the assumption of symmetric and linear price transmission (could be spatial or vertical). P^{out}_t and P^{in}_t are firm's output and input prices in period t also referred to as downstream and upstream prices. It is assumed that P^{out}_t is caused by P^{in}_t (in this case month-end wholesale price of oil is caused by wholesale price of seed):[2]

$$P^{out}_t = \alpha_0 + \beta_1 P^{in}_t + \mu_t \qquad \text{....(1)}$$

This technique was used by Farrell (1952) and subsequently by Tweeten and Quance (1969) in a broader sense of irreversibility. Equation 2 is translation of their original equation for supply analysis into the context of APT using the above notations.

$$P^{out}_t = \alpha_0 + \beta_1^+ D^+_t P^{in}_t + \beta_1^- D^-_t P^{in}_t + \varepsilon_t \qquad \text{.... (2)}$$

D^+_t and D^-_t are dummy variables and two following conditions have to be met.

(1) $D^+_t = 1$ if $P^{in}_t > P^{in}_{t-1}$ and $D^+_t = 0$ otherwise,
(2) $D^-_t = 1$ if $P^{in}_t < P^{in}_{t-1}$ and $D^-_t = 0$ otherwise.

Using these dummy variables, input price is split into two variables, one that includes only increasing input price and another that includes only decreasing price. As a result, two input price adjustment coefficients are estimated as shown in Equation 2. These are β_1^+ for the increasing input price phases and β_1^- for the decreasing input price phases. Based on F-test, symmetric price transmission is rejected if β_1^+ and β_1^- are significantly different from one another. A rejection of H_0 indicates asymmetry or non-reversibility in price transmission and its acceptance provides evidence in favour of symmetry (reversibility).

Wolffram (1971) proposed another variable splitting technique that explicitly includes first difference in the equation to be estimated. Houck (1977) proposed a specification (eq. 3) that is similar to Wolffram's but operationally clearer. It includes only first differences of the increasing and decreasing phases of P^{in}_t without summing these as done by Wolffram.

$$\Delta P^{out}_t = \alpha_0 t + \beta_1^+ D^+_t \Delta P^{in}_t + \beta_1^- D^-_t \Delta P^{in}_t + \gamma_t \qquad \text{....(3)}$$

Ward (1982) extended Houck's specifications by including lags of the exogenous variables:

$$\Delta P^{out}_t = \alpha_0 + \Sigma^K_{j=1} (\beta_j^+ D^+ \Delta P^{in}_{t-j+1}) + \Sigma^L_{j=1}(\beta_j^- D^- \Delta P^{in}_{t-j+1}) + \gamma_t \qquad \text{....(4)}$$

The lags-lengths K and L can differ, because there is no *a priori* reason to expect equal lag-lengths for the increasing and decreasing phases of price transmission. In many studies, lags are also used to differentiate between the magnitude and speed of price transmission (Boyd and Brorsen, 1988; Hahn, 1990).

von Cramon-Taubadel and Fahlbusch (1994) pointed out that price series are generally non-stationary, which implies that 'Houck approach' may not be consistent. Going by the Engle-Granger Representation Theorem, one has to develop an alternative specification for analysing the price transmission process. Accordingly, they applied an error correction model (ECM) that incorporates asymmetric adjustment terms. Under this approach, each variable is tested for the order of integration followed by an estimation of equation (1) using cointegration test, viz., residual based Augmented Dickey Fuller test, also called Engle Granger 'two-step' procedure (Engle and Granger, 1987) or Johansen cointegration technique (Johansen, 1988). In this paper, integration between seed and oil prices is tested using residual based ADF test. The error term of the model should be stationary for a cointegrating relationship to exist. If the test proves that equation (1) is not a spurious regression, then P^{in}_t and P^{out}_t are referred to as being cointegrated and the equation can be considered as an estimate of long-term equilibrium relationship. Once the two price series are found to be cointegrated, having long-run equilibrium relationship, errors from the cointegrating relationship, i.e., lagged residuals from estimated equation (1) are used in the ECM as follows.

$$\Delta P^{out}_t = \alpha_0 + \Sigma^K_{j=1}\, \alpha_1\, \Delta P^{out}_{t-j} + \beta_j\, \Delta\, P^{in}_t + \Sigma^L_{j=1}\, \beta_j\, \Delta P^{in}_{t-j} + \varphi\, ECT_{t-1} + \gamma_t \qquad \ldots.(5)$$

von Cramon-Taubadel and Loy (1999), referred in Capps and Sherwell (2005) modified the error correction model (equation 5) by splitting ECT into positive and negative components (i.e., positive and negative deviations from long-term equilibrium ECT^+ and ECT^-) as follows.

$$\Delta P^{out}_t = \alpha_0 + \Sigma^K_{j=1}\alpha_1 \Delta\, P^{out}_{t-j} + \Sigma^L_{j=1}\, \beta_j^+\, \Delta P^{in}_{t-j} + \Sigma^G_{j=1}\, \beta_j^-\, \Delta P^{in}_{t-j} + \varphi^+\, ECT^+_{t-1} + \varphi^-\, ECT^-_{t-1} + \gamma_t \qquad \ldots.\ (6)$$

In order to allow for more complex dynamic effects, Meyer and von Cramon-Taubadel (2004) suggested ΔP^{in} to be segmented into positive and negative components for estimating long-run (cumulative) effect of rising and falling of price transmission. The final asymmetric error correction model is represented by

$$\Delta P^{out}_t = \alpha_0 + \Sigma^L_{j=1}\, (\beta^+_j\, D^+ \Delta P^{in}_{t-j+1}) + \Sigma^G_{j=1}\, (\beta^-_j\, D^- \Delta P^{in}_{t-j+1}) + \varphi^+\, ECT^+_{t-1} + \varphi^-\, ECT^-_{t-1} + \gamma_t \qquad \ldots.(7)$$

While φ measures adjustment to deviations from long term equilibrium, β coefficient provides short-run dynamics. The error correction term allows price in one stage to respond to changes in price in other stage and corrects any deviations from long-run equilibrium between two price series that may be left over from previous periods. In other words, the coefficient indicates speed of adjustment of variables towards equilibrium.

It is evident that Houck approach is nested in this ECM model. Both equations (6 and 7) are based on linear error correction (i.e., constant parameters φ^+ and φ^-) whereby a constant proportion of any deviation from the long-run equilibrium is corrected, regardless of the size of this deviation.[3] Since cointegration and ECM are based on the idea of a long-run equilibrium, which prevents P^{out}_t and P^{in}_t from drifting apart, it is possible to consider asymmetry only with respect to the speed of price transmission, not the magnitude.[4] A joint F-test can be used to determine whether the price transmission process is symmetric or asymmetric: Ho= $\Sigma^L_{j=1}\, \beta^+_j = \Sigma^G_{j=1}\, \beta^-_j$ and $\varphi + = \varphi -$. The estimation procedure could be ordinary least squares or generalised least squares.

IV

EMPIRICAL RESULTS

IV.1 *Movement of Groundnut Seed and Oil Prices*

As shown in Table 1, from January 1996 to December 2007, the average seed price for Hyderabad market was Rs. 2,219 per quintal and the oil price was slightly more than double the seed price at Rs. 4,664 per quintal. The variability estimated using coefficient of variation is almost the same in the case of seed and oil prices at 21 per cent.

TABLE 1. AVERAGE WHOLESALE PRICE OF GROUNDNUT SEED AND OIL IN INDIA AND PRICE VARIABILITY: 1996:01 2007:12

Markets/prices (Rs./qtl.) (1)	Mean price (2)	Minimum value (3)	Maximum value (4)	Coefficient of variation (5)
Hyderabad				
Seed	2219	1563	3625	22
Oil	4664	3100	7200	21
Rajkot				
Seed	1587	950	2620	24
Oil	4865	3500	8567	21
Chennai				
Seed	2092	1465	3190	20
Oil	4440	2787	7100	24

A graphical presentation of seed and oil prices shows a co-movement over a period of time. However, there seem to be large year to year variations and differences in the two price series in each market.

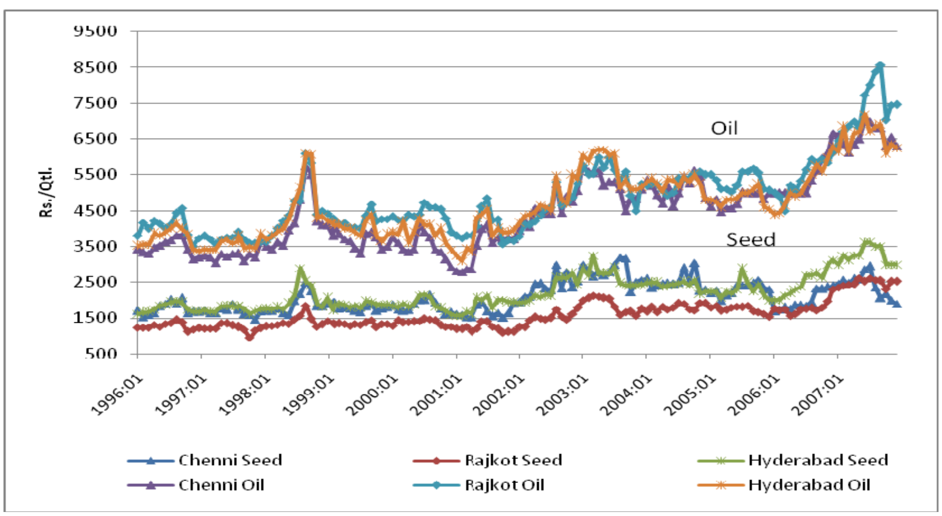

Figure 1. Wholesale Prices of Groundnut Seed and Oil in Selected Markets in India from January 1996 to December 2007

IV.2 *Price Transmission in Groundnut Seed and Groundnut Oil Markets*

As mentioned above, "Houck Procedure" in a pre-cointegration framework and "von-Taubdel approach" in an error correction framework are the two most widely used approaches for testing asymmetry. The empirical test of APT has to start with Granger Causality test to find a lead lag relationship between seed and oil prices. Studies done on this subject are based on the assumption that input price (seed price) cause output price (oil price) and not vice versa (Kinnucan and Forker, 1987). Granger causality test indicates that groundnut seed price "cause" groundnut oil price with lag length 2 in Hyderabad and Rajkot, i.e., causality runs one way from seed to oil and not the other way in these states. The causality between seed and oil prices in Chennai is not found to be statistically significant. In the second step, seed and oil prices are split as per their increase and decrease every month over the period. The observations are found to be roughly the same for the decreasing and increasing phases of seed price and hence are sufficient for undertaking a statistical analysis. The values of D+ (associated with price rise) and D- (associated with price fall) are estimated with and without lag using equation (specified as in equation 4). Table 2 presents results for each market.

TABLE 2. EMPIRICAL RESULTS ON APT IN GROUNDNUT SEED AND OIL MARKETS: JANUARY 1996 TO DECEMBER 2007

Dependent Variable:	Pre-cointegration Approach			ECM Approach	
Price of oil	Hyderabad	Rajkot	Chennai	Hyderabad	Rajkot
(1)	(2)	(3)	(4)	(5)	(6)
Constant	-9.30	14.01	-56.93	-20.66	-35.70
	(-0.31)	(0.42)	(-1.83)	(-0.68)	(-1.01)
D+ Seed (SR+)	1.20	1.76	1.05	1.34	2.05
	(6.29*)	(4.97*)	(5.67*)	(8.32*)	(6.59*)
D+ lag 1	0.45	--	0.46	--	--
	(2.23*)		(2.46*)		
(Cumulative +)	1.65	1.76	1.51	1.34	2.05
D- Seed (SR-)	1.41	0.92	0.45	1.09	0.99
	(5.65*)	(2.27*)	(2.59*)	(5.50*)	(2.79*)
D-lag 1	--	1.05	--	-0.62	--
		(2.81*)		(3.15*)	
(Cumulative -)	1.41	1.97	0.45	0.47	0.99
Lagged ECT +	--	--	--	-0.73	-0.51
				(-5.45*)	(-3.95*)
Lagged ECT -	--	--	--	-0.51	-0.57
				(-3.79*)	(-4.08*)
	142	142	142	142	143
Number of observations					
F Statistics	34.59	17.35	17.15	44.38	28.83
Prob > F	0	0	0	0	0
R-squared	0.43	0.27	0.27	0.62	0.46
Adj R-squared	0.42	0.26	0.26	0.61	0.44
Root MSE	249.4	244.11	253.37	204.98	212.77
				37.75	28.97
	--	--	--	(F 2, 136)	(F 2, 138)
Joint F Test: Prob > F				0	0

Notes: Figures in parentheses are t values. *, ** and *** indicate level of significance at 1 per cent, 5 per cent and 10 per cent level respectively.

Under Houck approach, the estimated respective values of D+ and D- are 1.20 and 1.41 in Hyderabad; 1.76 and 0.92 in Rajkot; 1.05 and 0.45 in Chennai. These values in the rising and falling phases bear positive signs and are significant at 1 per cent level of significance. The number of lags found to be statistically significant with the rising price is one in Hyderabad and Chennai. In case of falling price, the estimated value with lags is not significant in Hyderabad and Chennai. But it is significant in the case of Rajkot market at one lag. This clearly shows that oil price responds differently to seed price in its increasing and decreasing phases. A statistically significant value of F Test provides evidence in support of asymmetry in seed and oil prices in wholesale markets.

As already elicited, if two price series are cointegrated, it may not be appropriate to employ Houck procedure. Therefore, an alternative approach based on error correction representation is used, which is consistent with cointegration analysis. As mentioned above, cointegration test has to be preceded with unit root test to determine the order of integration. Test results given in Annexure Table 1 reveal prices of seed and oil to be integrated of order 1, i.e., I(1) in the selected markets. After establishing the order of integration, a long-run cointegration equation is estimated to judge the extent of price signals that have transmitted from one stage to another. Annexure Table 2 provides the estimated results. The unit root test performed on the error term indicates Hyderabad and Rajkot markets to be vertically integrated in the long-run.

For short-run estimates, a vector error correction model is estimated without splitting the estimated error term into positive and negative components as shown in Equation 5. The generated series gives an idea of the magnitude and time path of reactions of variables to deviations (shocks) from long-run relationships. Compared to the long-run behaviour, which testifies seed and oil prices to be integrated, the results of short-run behaviour reveal a slow speed of adjustment of prices towards equilibrium. A negative and significant coefficient of error term indicates that the previous period's disequilibrium in prices may be corrected in two to three weeks' time period. It also signifies large diversions in the long-run adjustment path of two price series in each market from January 1996 to December 2007. Empirical results corroborate that just like spatial integration in oilseed markets, vertical integration too appears to be far from complete.

To what extent is the response of price of oil to the price of seed asymmetric? The test of APT is based on estimation of Equations 6 and 7. Since the estimates are similar from two equations, the results obtained from Equation 7 are reported here. The lagged residuals are used in the error correction model after segregating into ECT+ and ECT-. The estimates are generated, again with and without using lag length for Hyderabad and Rajkot markets as the seed and oil prices in these two markets show a long-run association. The results under ECM approach, given in Table 2 reveal that in the case of Hyderabad, the estimated value is 1.34 when there is hike in seed price (D+ coefficient) and 1.09 when price falls (D- coefficient). The same in the case of Rajkot is 2.05 and 0.99 respectively. The cumulative effect of increase in seed price on oil price is higher (value 1.34 and 2.05) than the cumulative effect due to decrease in seed price on oil price (value 0.47 and 0.99). Further, based on lag length, one can note the time for oil price to adjust to an increase in seed price in the decreasing and increasing phases. In Hyderabad, it is faster and immediate when seed price tends to increase as there is no lag in the increasing phase. On the contrary, the decreasing phase of seed price is associated with one lag, implying oil price to adjust slowly to seed price, say in a month's time period. In contrast, in Rajkot wholesale price of oil adjusts immediately to seed price.

Further, the value of error correction term is negative and significant as expected. It is estimated to be 0.73 in Hyderabad and 0.51 in Rajkot in the rising phase (ECT^+) and 0.51 and 0.57 respectively in these markets in the falling phase (ECT^-), suggesting that the positive deviations of price from long-run equilibrium are reduced faster in a month's time period than the negative deviations in Hyderabad. In other words, both values are statistically significant but ECT^+ induces a greater change in the oil price than ECT^- in Hyderabad. However, values of ECT^+ and ECT^- are almost the same in Rajkot, indicating that deviation of prices may take similar time to adjust. From joint F Test, the hypothesis of symmetry in groundnut seed to oil price transmission in Hyderabad and Rajkot markets is rejected.

Finally, the elasticities of price transmission are estimated at sample mean. Table 3 elicits the short-run and long-run (cumulative) elasticity estimates under the two approaches associated with rising and falling seed prices. The short-run and long-run estimates under pre-cointegration approach vary when lag is taken and are also inconsistent with the ECM approach. Therefore, going by the latter approach, short-run elasticities in both rising and falling phases of seed price tend to be 0.64 and 0.52 in Hyderabad and 0.67 and 0.32 respectively in Rajkot. The estimated elasticities in the rising and falling phases indicate that an increase in seed price is passed through to oil price more fully than its decrease. The same holds true for long-run price transmission elasticities. Since seed and oil prices in Chennai are not found to be integrated, price transmission elasticities are estimated based on Houck approach. The estimates are similar to those obtained for Hyderabad and Rajkot except that large gaps exist between price transmission elasticity in the rising and falling phases, and also elasticity in the falling phase (at 0.21) is much lower than that observed in the other two markets.

TABLE 3. ELASTICITIES OF PRICE TRANSMISSION FOR GROUNDNUT SEED AND OIL MARKETS

Wholesale markets (1)	Short-run for rising prices (2)	Short-run for falling prices (3)	Long-run for rising prices (4)	Long-run for falling prices (5)
Hyderabad				
ECM Approach	0.64	0.52	0.64	0.22
Rajkot				
ECM Approach	0.67	0.32	0.67	0.32
Chennai				
Pre-cointegration Approach	0.49	0.21	0.71	0.21

V

MAIN FINDINGS AND IMPLICATIONS FOR POLICY

This paper has attempted to test the asymmetries in the prices of groundnut seed and oil in three important wholesale markets in India, viz., Hyderabad, Rajkot and Chennai using the conventional Houck Approach and the recent Meyer and von Cramon-Taubadel Error Correction Model. The empirical analysis is based on monthly wholesale prices of seed and oil during the period from January 1996 to December 2007. The results indicate that despite seed and oil markets being vertically integrated in the long-run, there is not enough evidence in support of a greater and higher degree of price transmission and symmetry in the selected markets. Price transmission elasticity of rising seed prices is larger than the corresponding elasticity of falling prices, which indicates that an increase in seed price is passed through to oil price more fully than its decrease. It also signifies that prices are sometimes observed to be sticky downward as theorised in the macro economic theory. By and large, the results validate the findings obtained in the literature that as in the case of rice markets, groundnut seed and oil markets are also marked with imperfections. In other words, a larger gap in the price difference may persist and the consequent volatility may be passed on to the producers and the consumers. It also corroborates the literature that price transmission elasticities in conjunction with rising agricultural prices are generally larger than the corresponding elasticities associated with falling agricultural prices (Capps and Sherwell, 2005; Hahn, 1990).

Asymmetric price transmission can occur due to a number of reasons. Kinnucan and Forker (1987), von Cramon-Taubadel (1998) and Peltzman (2000) have referred to non-competitive market structure and inventory holding of wholesalers and processors to be the possible causes in a vertical market system. In case of some commodities, adjustment and menu costs incurred by firms also matter. However, it may be difficult to state categorically the underlying sources of asymmetry, given large variations in the nature and quality of products, multiple intermediaries in the chain and time lag, structure and concentration of processing industry across the regions. Some of the reasons that may explain APT in India's oilseed and edible oil markets could be (a) supply shortages due to deceleration in yield and hence fluctuations in prices, (b) weak infrastructure, (c) price information gaps, (d) numerous traders function in the existing marketing system who may monopolise, may collude or form cartels and may not reduce their margins when price falls, (e) government controls and regulations on private trade in wholesale markets, and lack of uniformity in octroi and tax rates across the states (f) not so developed oil industry and hence high processing and marketing costs, (g) processors/firms may exercise market power and avoid reducing price, and (h) inventory holding behavior of firms, especially when high international price expectation leads to accumulation of stocks.

The findings obtained in this paper point towards a need for regular monitoring of commodity prices, appropriate interventions and targeting specific levels in the marketing chain, when necessary. For instance, in order to contain food inflation, the government in recent months has tried to curb hoarding by wholesalers, waive off taxes on essential commodities, ban exports and encourage imports, which seems to have worked. It is important for all the state governments to implement the suggested amendments in their respective APMC Act for direct sale/purchase of farm produce by the firms, to increase marketing options for farmers and reduce the size of the supply chain. In some states, the framework is not favourable for farmers to sell anywhere in the state other than their own notified area/market, primarily to retain APMC mandi revenue. It is equally important to fill information gaps on prices, improve marketing infrastructure, encourage competition, rework on fee/tax rate and simplify the procurement procedures. More studies are suggested to detect asymmetry at each level from farm to wholesale and then to retail along with an evaluation of linkages between market power and APT in the empirical models. So far, only a few attempts have been made to link market power of traders or firms and APT empirically, that too in the context of markets in the developed nations (Meyer and von Cramon-Taubadel, 2004). These exercises would be more meaningful for the growers and consumers in terms of identifying the possible factors that cause asymmetries at each stage and initiating corrective measures. Finally, the analysis underscores the need to use alternative models to arrive at more robust estimates as each model has certain strengths and weaknesses in its use, like seasonal nature of agricultural commodities,[5] sensitivity to the number of lags and frequency of data.

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NOTES

1. The supply response of groundnut seed to free market price is estimated to be 0.21 and that for soyabean seed to be slightly higher at 0.51 from 1980-81 to 2002-03.

2. If logarithms of prices are used, a constant relative rather than a constant absolute margin is assumed (Peltzman, 2000).

3. Several studies (Balke *et al.,* 1998) have employed variants of the asymmetric error correction model by specifying and introducing in the specified equations varying lag structures, dependent variable, and possible non-linearity in price transmission by allowing higher order polynomials of ECT to enter into the ECM.

4. APT with respect to magnitude means that there is a permanent difference between positive and negative episodes of transmission, this will, in the long-run, cause the prices to rise or fall, with the result that they cannot be co-integrated. In this context, Goodwin and Piggott (2001) and Goodwin and Holt (1999) have followed the threshold approach, which considers an intuitively appealing type of ECM in which deviations from long-run equilibrium between two price series will only lead to price responses if they exceed a specific threshold level.

5. This has been pointed out by the referee. Seasonality may not be an important factor in developed countries due to better storage and infrastructure facilities that make commodity supply round the year. Most of the empirical research on price transmission has been carried out on unadjusted data only. However, this factor seems to hold importance in India as we have found some difference in the estimates when the model is run with and without seasonally adjusted price series.

REFERENCES

Acharya, S.S. (2001), "Domestic Agricultural Marketing Policies, Incentives and Integration", in S.S. Acharya and D.P. Chaudhri (Eds.) (2001), *Indian Agricultural Policy at the Crossroads*, Rawat Publications, Jaipur.

Balke, N.S., S.P.A. Brown and M.K. Yucel (1998), "Crude Oil and Gasoline Prices: An Asymmetric Relationship?", Federal Reserve Bank of Dallas, *Economic Review*, First Quarter, pp. 2-11.

Banerjee, A. and J.V. Meenakshi (2001), *Competition and Collusion in Grain Markets: Basmati Auctions in North India,* Working Paper No. 91, Centre for Development Economics, Delhi School of Economics, Delhi University, Delhi.

Bathla, Seema (2009a), "Market Integration of Agricultural Commodities: An Analysis of Selected Cereals, Oilseeds and Horticultural Crops", Report Submitted to IASRI, New Delhi as part of the V-PAGe Project of NAIP being carried out at IASRI.

Bathla, Seema (2009b), "Macro Economic Policies and Agriculture Supply Response in India: A Commodity Level Analysis", *Indian Economic Journal*, Vol. 57, No. 2, July-September.

Bathla, Seema (2011), *Trade Liberalisation and Indian Agriculture*, Rawat Publications, Jaipur.

Boyd, M.S. and B.W. Brorsen (1988), "Price Asymmetry in the U.S. Pork Marketing Channel", *North Central Journal of Agricultural Economics,* Vol. 10, pp.103-109.

Capps Oral Jr. and Pablo Sherwell (2005), "Spatial Asymmetry in Farm-Retail Price Transmission Associated with Fluid Milk Products", Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Providence, Rhode Island.

Chand, Ramesh (2007), "Marketing and Trade Policies in a Globalising World", 4th Parthasarthy Memorial Lecture delivered during the 21st Conference of Indian Society of Agricultural Marketing, published in *Indian Journal of Agricultural Marketing,* (Conference Special), Vol. 21, No. 3.

Chand, Ramesh (2009), "Marketing and Policy Framework for Oilseeds in India", Paper presented in the National Seminar on "Vegetable Oils Scenario: Approaches to meet Growing Demand", 29-31 January, 2009, DOR, Hyderabad.

Engle, R.F. and C.W.J. Granger (1987),"Co-Integration and Error-Correction, Representation, Estimation and Testing", *Econometrica*, Vol. 55, pp.251-276.

Farrell, M.J. (1952), "Irreversible Demand Functions", *Econometrica*, Vol. 20, pp. 171-186.

Goodwin, B.K. and M.T. Holt (1999), "Asymmetric Adjustment and Price Transmission in the U.S. Beef Sector", *American Journal of Agricultural Economics*, Vol. 81, pp. 630-637.

Goodwin, B.K. and N.E. Piggott (2001), "Spatial Market Integration in the Presence of Threshold Effects", *American Journal of Agricultural Economics*, Vol. 83, No. 2, pp. 302-317.

Ghosh, Nilanjan (2008), "Effects of Trade Liberalisation on Oilseed and Edible Oil Sector in India", Paper at UNCTAD Conference in New Delhi on 14-16 October as part of the Study by UNCTAD- India, "How are the Poor Affected by International Trade in India, Empirical Approach" under the DFID-MOIC-UNCTAD Project on "Strategies and Preparedness for Trade and Globalisation in India".

Hahn, W.F. (1990), "Price Transmission Asymmetry in Pork and Beef Markets", *The Journal of Agricultural Economics Research,* Vol. 42, No.4, pp.21-30.

Houck, J.P. (1977), "An Approach to Specifying and Estimating Non-reversible Functions", *American Journal of Agricultural Economics*, Vol. 62, pp. 10-18.

Jayasuriya, Sisira, Jae H. Kim and Parmod Kumar (2007), "International and Internal Market Integration in Indian Agriculture: A Study of the Indian Rice Market", Paper/poster prepared for presentation at the 106th seminar of the EAAE- Pro-poor Development in Low Income Countries, Food, Agriculture, Trade, and Environment, 25-27 October – Montpellier, France.

Jha, Raghbendra and Hari K. Nagarajan (2002), "Noisy Vertical Markets", *Economic and Political Weekly*, Vol. 37, No. 51, December 21.

Jha, Raghbendra, K.V. Bhanu Murthy and Anurag Sharma (2005), "Market Integration in Wholesale Rice Markets in India", ASARC Working Paper 03, Australian National University, Canberra, Australia.

Jha, Raghbendra, K.V. Bhanumurthy, Hari K. Nagarajan and Ashok K. Seth (1997), *Market Interventions in Indian Agriculture*. IGIDR Paper No. 269, Indira Gandhi Institute of Development Research, Mumbai.

Johansen, S. (1988), "Statistical Analysis of Cointegration Vectors", *Journal of Economic Dynamics and Control*, Vol. 12, pp. 231-54.

Kinnucan, H.W. and O.D. Forker (1987), "Asymmetry in Farm-Retail Price Transmission for Major Dairy Products", *American Journal of Agricultural Economics*, Vol. 69, pp. 285-292.

Kumar, Pramod (2007), *Farm Size and Marketing Efficiency: Pre and Post-Liberalization*, Concept Publishing Company, New Delhi.

Meyer, Jochen and Stephan von Cramon-Taubadel (2004), "Asymmetric Price Transmission: A Survey", *Journal of Agriculture Economics*, Vol. 55, No. 3, pp. 581-611.

Mruthyunjaya, Sant Kumar, M.T. Rajashekharappa, L.M. Pandey, S.V. Ramanarao and Prem Narayan (2005), "Efficiency in Indian Edible Oilseed Sector: Analysis and Implications", *Agricultural Economics Research Review*, Vol.18, No.2, July-December, pp 153-166.

Peltzman, S. (2000), "Prices Rise Faster than they Fall", *Journal of Political Economy*, Vol. 108, No. 3, pp. 466-502.

Srinivasan, P.V. (2004), "Managing Price Volatility in an Open Economy Environment: The Case of Edible Oils and Oilseeds in India", MTID Discussion Paper No. 69, International Food Policy Research Institute, Washington, D.C., U.S.A., May.

Tweeten, L.G. and C.L. Quance (1969), "Positivistic Measures of Aggregate Supply Elasticities: Some New Approaches", *American Journal of Agricultural Economics*, Vol. 51, pp. 342-352.

von Cramon-Taubadel, S. (1998), "Estimating Asymmetric Price Transmission with the Error Correction Representation: An Application to the German Pork Market", *European Review of Agricultural Economics*, Vol. 25, pp 1-18.

von Cramon-Taubadel, S. and S. Fahlbusch (1994), "Identifying Asymmetric Price Transmission with Error Correction Models", Poster Session EAAE European Seminar in Reading.

von Cramon-Taubadel, S. and J.P. Loy (1996), "Price Asymmetry in the International Wheat Market, Comment", *Canadian Journal of Agricultural Economics*, Vol. 44, pp.311-317.

von Cramon-Taubadel, S. and J.P. Loy (1999), "The Identification of Asymmetric Price Transmission Processes with Integrated Time Series", Jahrbücher für Nationalökonomie und Statistik, Vol. 218, No. 1-2, pp 85-106.

Ward, R.W. (1982), "Asymmetry in Retail, Wholesale and Shipping Point Pricing for Fresh Vegetables", *American Journal of Agricultural Economics*, Vol. 62, pp. 205-212

Wilson, Edgar J. (2001), Testing Agricultural Market Integration: Further Conceptual and Empirical Considerations Using Indian Wholesale Prices, in S.S. Acharya and D.P. Chaudhari (Eds.) (2001), *Indian Agricultural Policy at the Crossroads,* Rawat Publications, Jaipur.

Wolffram, R. (1971), "Positivistic Measures of Aggregate Supply Elasticities: Some New Approaches - Some Critical Notes", *American Journal of Agricultural Economics*, Vol. 53, pp. 356-359.

World Bank (1997), *The Indian Oilseed Complex: Capturing Market Opportunities*, Vol. II, Report No. 15677-IN.

Zhang, P., S.M. Fletcher, and D.H. Carley (1995), "Peanut Price Transmission Asymmetry in Peanut Butter", *Agribusiness*, Vol.11, pp. 13-20.

ANNEXURE TABLE 1
UNIT ROOT TEST OF GROUNDNUT SEED AND OIL PRICES: 1996:01 TO 2007:12

	Levels		First Difference	
Markets (1)	Intercept and Trend (2)	No. of Lags (3)	Intercept and Trend (4)	No. of Lags (5)
Hyderabad:				
Seed	-2.94	1	-8.54	1
Oil	-2.88	1	-8.90	1
Rajkot:				
Seed	-2.69	1	-9.30	1
Oil	-2.87	1	-9.61	1
Chennai:				
Seed	-3.05	2	-9.33	1
Oil	-3.04	2	-8.83	1

Notes: MacKinnon critical values for rejection of hypothesis of a unit root at 1, 5 and 10 per cent levels of significance are -3.47, -2.88 and -2.57 with intercept and with intercept and trend are -4.02,-3.44 and -3.14 per cent.

ANNEXURE TABLE 2

RESIDUAL BASED ADF TEST FOR COINTEGRATION: 1996:01-2007:12

Cointegrating Regression: Oil Price = f(Seed Price) (1)	Estimated Values Hyderabad (2)	Rajkot (3)	Chennai (4)
Intercept	355.41 (3.49)	724.81 (7.75)	456.67 (1.48)
Coefficients	1.94 (43.27)	2.61 (45.47)	1.90 (13.19)
Adjusted R^2	0.93	0.94	0.55
Durbin-Watson Statistics	1.22	1.19	0.28
Calculated ADF (Residuals)	-5.97*	-6.17*	- 1.00

Notes: Figures in parentheses are t-values. The statistical inference of the residual based ADF test (for rejection of hypothesis of a unit root) is based on Mackinnon Critical values, which are -2.58, -1.94 and -1.62 at 1, 5 and 10 per cent respectively.