Price Transmission in Vertical Markets: An Empirical Analysis of Red Gram

Shivagangavva P. D. [a*] and C. P. Gracy [a]

[a] Department of Agriculture Economics, UAS Bengaluru, India.

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Original Research Article

ABSTRACT

Price transmission provides insight into vertical and horizontal integration of agricultural markets this will help in producer and consumer welfare. We have examined price transmission process between wholesale and retail markets by adopting Error correction model (ECM). This study has taken case of Red gram (*Cajanuscajan*) wholesale and retail markets in Bengaluru and Mumbai respectively It has used wholesale and retail prices data from secondary sources. The results revealed that retail price does not react completely to changes in producer price within one month. Dal price responds differently to seed price in its increasing and decreasing phases. Decreasing phase of seed price is associated with one lag, implying dal price to adjust slowly to seed price, say in a month's time period. The estimated results were 0.98 in Bengaluru and 0.97 in Mumbai in the rising phase (ECT+) and 0.58 and 0.64 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 Bengaluru. Both values are significant but ECT+ induces a greater change in the tur dal than ECT- in Bengaluru. Where as in Mumbai values of ECT+ and ECT- are also showing faster changes almost. This clearly explains the asymmetry in red gram seed to dal price transmission in Bengaluru and Mumbai.

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*Corresponding author: E-mail: spdoddamani3005@gmail.com;

1. INTRODUCTION

"Pulses have been cultivated since time immemorial in rain-fed conditions is characterized by poor soil fertility and moisture stress environments. These pulses improve soil health by enriching nitrogen status, long-term fertility and sustainability of the cropping systems. Pulses are the primary source of protein for the poor and the vegetarians. it contains 22 per cent of protein. Pulses turn out to be one of the most economical sources of protein for human consumption. The split grains of these pulses are called *dal* and are excellent source of high quality protein, essential amino and fatty acids, fibres, minerals and vitamins" [1].

India is the leading consumer, producer and importer of pulses in the world(PIB). But the worrisome story is India couldn't achieve the self-sufficiency in the production of pulses inspite of taking various measures. The market of pulses is very thin and fragmented. Hoarding and speculative practices are very common in marketing of pulses in India because of very weak pricing criteria. The prices of pulses in India are highly volatile and unstable. Agricultural prices are important economic variables in a market economy. Price relationships have a significant influence on decisions relating to the type and volume of agricultural production activity. The instability and higher fluctuations in commodity prices fail to serve as an adequate guide to production plans and, thus, cause inefficiency in allocation of resources and induce income uncertainty. These problems can be avoided through formation and implementation of a proper agricultural prices stabilization policy, which requires information on price movements, fluctuations over time and their impact on production.

"The magnitude 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). If price of one market gets transmit to another market faster that is Symmetric price transmission otherwise it is Asymmetric price transmission. While transmitting price some gaps will occurs this is due to monopolistic behaviour of trader, high storage, transaction and inventory holding costs and information gap.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" [2]. 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 paper attempt to estimate price transmission and test for asymmetry in a vertical marketsystem by taking the case of pulse seed and dal prices in two important markets in India. It builds on the hypothesis that There is symmetric price transmission in whole sale (Gulbarga market) and retail prices (Bengaluru market) of red gram seed and dal respectively. 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.

2. METHODOLOGY

In a survey on asymmetric price transmission Meyer and [3] states that, along with the explanation for the asymmetry, researchers' also face problems in empirically testing the asymmetric price transmission. Over the years the econometric methods that were used to test price transmission have been modified. Meyer and [3] suggest the following equation as the starting point for price transmission analysis, assuming symmetric and linear adjustment in two prices.

$$P_t^{out} = \alpha_0 + \beta_1 P_t^{in} + \mu_t \qquad (1)$$

Where P^{out} is the output price (retail price) and P^{in} is the input price (farm gate price) in period t. It is assumed that retail price is caused by the farm gate price. The asymmetric adjustment has been studied as a form of irreversible functions. Farrell (1952) was the first to investigate the irreversible demand functions for the data of tobacco, beer, and spirits. Tweeten and Quanve (1969) used dummy variable technique to

estimate supply elasticity for increasing and decreasing phases of prices in agriculture. Equation (2) is a translation of their original equations of supply analysis into price transmission context using the above-mentioned notations.

$$P_t^{out} = \alpha_0 + \beta_1^+ D_t^+ P_t^{in} + \beta_t^- D_t^- P_t^{in} + \varepsilon_t \quad (2)$$

Where

D_t^+ and D_t^- are dummy variables with;
$D_t^+ = 1$ if $P_t^{in} > P_{t-1}^{in}$; $D_t^+ = 0$ otherwise.
$D_t^- = 1$ if $P_t^{in} < P_{t-1}^{in}$; $D_t^- = 0$ otherwise.

Here the input price is split into two variables using dummy variables and hence two input price adjustment coefficients are estimated. Coefficient β_1^+ for increasing input price phases and β_t^- for decreasing input price phases. Price transmission is asymmetric if β_1^+ is significantly different from β_t^- which is tested by using a standard F-test.

As a reaction to the work by Tweeten and Quanve (1969), Wolffram (1971) proposed another variable splitting technique which includes sums of first differences of the positive and negative changes in the explanatory variables to be estimated. Wolffram (1971) states that the solution given by Tweeten and Quanve (1969) is mathematically incorrect for the estimation of β_1^+ and β_1^- and in differentiating the partial influence of an independent variable at a period of investigation. The Wolffram's specification of the irreversible function is represented in equation (3).

$$P_t^{out} = \alpha_0 + \beta_1^+ \left(P_0^{in} + \sum_{t=1}^{T} D^+ \Delta P_t^{in} \right) + \beta_1^- \left(P_0^{in} + \sum_{t=1}^{T} D^- P_t^{in} \right) + \varepsilon_t \quad (3)$$

Later Houck [4] suggested a simple alternative approach for specifying linear irreversibility. He did not take the first observation into account as in Wolffram (1971) specification because these first observations will not have explanatory power and the differential effects to be measured hinge on changes from the previous position. Unlike Wolffram's specification, he provided an operationally clearer specification which includes only the first differences of increasing and decreasing phases of input price variable. Wolffram-Houck specification for irreversible response functions is given by equation (4).

$$\Delta P_t^{out} = \alpha_0 + \beta_1^+ D_t^+ \Delta P_t^{in} + \beta_1^- D_t^- \Delta P_t^{in} + \varepsilon_t \quad (4)$$

Asymmetry is determined by testing whether $\beta^+ = \beta^-$ using a standard F-test. Further, [5] extended Wolffram-Houck specification by introducing lags to the explanatory variables and it is given by the following equation (5).

$$\Delta P_t^{out} = \alpha_0 + \sum_{j=1}^{K} (\beta_j^+ D_t^+ \Delta P_{t-j+1}^{in}) + \sum_{j=1}^{L} (\beta_j^- D_t^- \Delta P_{t-j+1}^{in}) + \varepsilon_t \quad (5)$$

The lag lengths K and L can differ, because there is no a priori reason to expect equal lag lengths for increasing and decreasing phases of input price change (Mayer and von Cramon-Taubadel 2004, Rajendran 2015). Many studies on price transmission have used lags to differentiate between the magnitude (long-run symmetry) and speed (short-run symmetry) of price transmission (Boyd and Brorsen 1988, Hahn 1990). vonCramon-Taubadel (1998) states that long-run symmetry is tested by determining whether the sums of the coefficients of these polynomials are equal, while a testable condition for short-run symmetry is that these polynomials are identical. Empirical works on price transmission by Boyd and Brorsen (1988), Kinnucan and Forker (1987), and Ward (1982) have demonstrated asymmetric price transmission using Wolffram-Houck specification.

Myers (1992) mentions that commodity price series show some distinct characteristics which should be considered in building an adequate framework for price analysis. Two of them which are relevant to price transmission analysis include the presence of stochastic trends (unit roots) and common stochastic trend driving multiple time series (cointegration). vonCramon-Taubadel and Loy (1996) and von Cramon-Taubadel (1998) pointed out that Wolffram-Houck specification does not consider the time series nature of the data being analyzed. They also mention that the following empirical studies (Appel, 1992; Kinnucan and Forker, 1987; Pick et al., 1990; Zhang et al., [6] are characterized by the first-order autocorrelation, which is a symptom of spurious regression in the analysis of non-stationary time series. Spurious regression can be avoided if the time series are cointegrated, but the Wolffram-Houck specification is incompatible with cointegration. If P_t^{out} and P_t^{in} are co-integrated, then analysis asymmetric hypothesis tested using Wolffram-Houck specification should be rejected. On the other hand, if the results indicate asymmetric price transmission, it precludes the cointegration between P_t^{out} and P_t^{in} alone. Hence, Wolffram-

Houck specification is popularly called as pre-cointegration methods of price transmission in the literature.

As an alternative, [7] and von Cramon-Taubadel (1998) suggested an Error Correction Model to test transmission of co-integrated price series which explains their behavior over time. In this Error Correction Model, initially, the two price series of I(1) are tested for the presence of cointegration (long-run equilibrium relationship) using equation (1). In that case, $P_t^{out} = \alpha_0 + \beta_1 P_t^{in} + \mu_t$ is referred to as cointegration equation. Where P_t^{out} and P_t^{in} are prices at different market levels and μ_t is the error correction term. [8] summarizes from Engle and [9,10,11] that the cointegration between two price series depends on the nature of the following autoregressive process: $\Delta\mu_t = \gamma\mu_{t-1} + v_t$, where Δ is the first difference operator and $\gamma \neq 0$ implies that deviations from the equilibrium are stationary and that the price series are cointegrated. If P_t^{out} and P_t^{in} are in long-run equilibrium relationship (co-integrated), their Error Correction Representation (ECR) takes the standard notation form as in equation (6).

$$\Delta P_t^{out} = \beta_0 + \beta_1 \Delta P_t^{in} + \beta_2 ECT_{t-1} + \beta_3(L)\Delta P_{t-1}^{out} + \beta_4(L)\Delta P_{t-1}^{in} + \varepsilon_t \qquad (6)$$

Where $ECT_{t-1} = P_{t-1}^{out} - \alpha_0 - \alpha_1 P_{t-1}^{in}$ is the Error Correction Term and $\beta_3(L), \beta_4(L)$ are polynomial lags.

Granger and Lee (1989) modified equation (6) by splitting ECT_{t-1} into ECT_{t-1}^+ and ECT_{t-1}^- to add the asymmetric component into the error correction model of the co-integrated price series. If the prices at different levels of markets for the same product are analyzed, then the ECT_{t-1}^+ indicates that the marketing margin is above its long-run equilibrium price and ECT_{t-1}^- indicates that the marketing margin is below its long-run equilibrium price. These error terms move downwards and upwards to correct the positive and negative deviations deviation from long-run equilibrium price level respectively.

$$\Delta P_t^{out} = \beta_0 + \beta_1 \Delta P_t^{in} + +\beta_2^+ ECT_{t-1}^+ + \beta_2^- ECT_{t-1}^- + \beta_3(L)\Delta P_{t-1}^{out} + \beta_4(L)\Delta P_{t-1}^{in} + \varepsilon_t \qquad (7)$$

Standard F-test can be used to determine whether the price transmission is symmetric or asymmetric. The null hypothesis of symmetry is rejected if $\beta_2^+ \neq \beta_2^-$.

3. RESULTS AND DISCUSSION

This Table 1 showing that Granger –Causality test were performed in order to verify the direction of the causality. A unidirectional causal relationship running from both prices. The empirical test of APT has to start with Granger Causality test to find a lead lag relationship between seed and dal prices. Studies done on this subject are based on the assumption that input price (seed price) cause output price (dal price) and not vice versa. Granger causality test indicates that red gram seed price "cause" red gram dal price with lag length 2 in Bengaluru and Mumbai, i.e., causality runs one way from seed to dal and not the other way in these states.
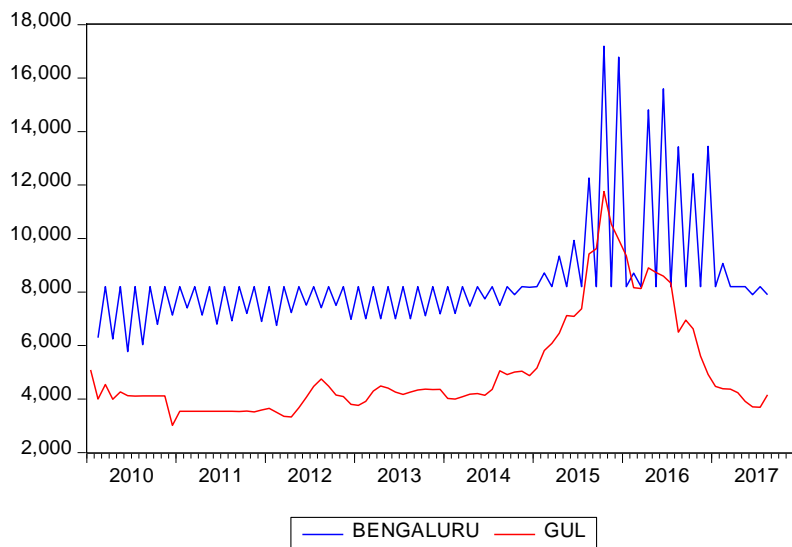

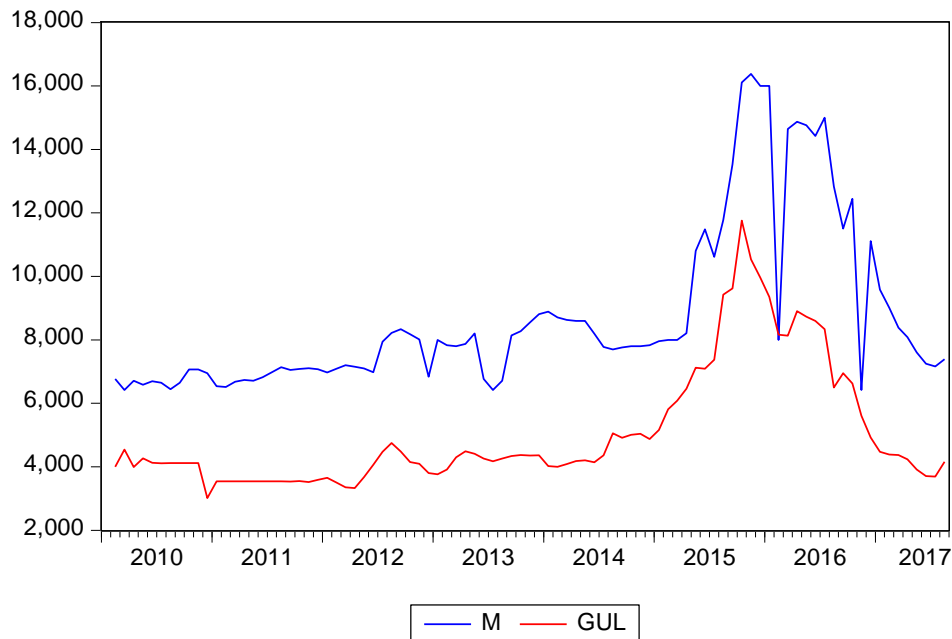**Fig. 1. Relationship between whole sale(Gulbarga) and retail price(Bengaluru)**

Fig. 2. Relationship between whole sale(Gulbarga) and retail price(Mumbai)

Table 1. Causality Test of pulses in Bengaluru(B), Gulbarga(G) and Mumabai(M) markets

Effect	Hypothesized cause	t statistics	P value
whole sale price (G)	Retail price (B)	9.974	1.00E-05
whole sale price (G)	Retail price (M)	19.682	1.00E-07

Table 2 shows the ADF test results applied for red gram and red gram dal prices in levels and in first differences. The results from the ADF test fails to reject the null hypothesis of a unit root for all the four red gram price series in levels, which shows that the price series are non-stationary. The P-values of the ADF test applied to the first differenced red gram prices signifies that the null hypothesis of a unit root can be rejected less than 1% significance level. Therefore, we can say that the red gram prices are integrated of order one i.e., I (1).

Table 4 suggests that the null hypothesis of zero cointegrating vectors can be rejected at less than 5% significance level for both cities. The test fails to reject the alternative hypothesis that here is two and one cointegrating relationship between whole sale price and retail prices for the red gram and dal. Johansen test method has better sample properties than other methods of cointegration. Johansen (1988) states that the reason for expecting the estimators to behave better than the regression estimators is that they take into account the error structure of the underlying process, which regression estimators do not. In data analysis, Johansen tests conclude

that thewhole sale and retail prices of red gram seed and red gram dal long-run equilibrium price relationship.

The coefficient for the variable of whole sale price is 0.94 and 0.68 for Bengaluru retail market and Mumbai retail market respectively. These values indicate that the elasticity of price transmission is less than one in both markets . This also shows that the retail price does not react completely to changes in producer price within one month . That is 1 per cent increase in the bengaluru retail price for Redgram leads to 0.94 per cent increase in its whole sale price and also 1 per cent increase in the Mumbai retail price for Redgram leads to 0.68 per cent increase in its whole sale price price .The results show that 1 per cent increase in retail price in bengaluru market   induces 0.94 per cent increase the whole sale prices of of red gram in Gulbarga market and1 per cent increase in retail price in Mumbai market induces 0.68 per cent increase the whole sale prices of of red gram in gulbarga within one month. The estimated respective values of D+ and D- are 0.94 and 0.84 in Bengaluru, 0.68 and 0.42 in Mumbai.These values in the rising and falling phases bear

positive signs and are significant at 1 and 5 per cent level of significance.The number of lags found to be statistically significant with the rising price is one in Bengaluru and Mumbai. In case of falling price, the estimated value with lags is not significant in Bengaluru. But it is significant in the case of Mumbai at one lag. This clearly shows that dal price responds differently to seed price in its increasing and decreasing phases.Decreasing phase of seed price is associated with one lag, implying dal price to adjust slowly to seed price, say in a month's time period.

To what extent is the response of price of dal 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-. It is estimated to be 0.98 in Bengaluru and 0.97 in Mumbai in the rising phase (ECT+) and 0.58 and 0.64 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 Bengaluru. A negative and significant coefficient of error term indicates that the previous period's disequilibrium in prices may be corrected in within month time period. It also signifies large diversions in the long-run adjustment path of two price series in each market from January 2010 to august 2017. In other words, both values are statistically significant but ECT+ induces a greater change in the tur dal than ECT- in Bengaluru. Where as in Mumbai values of ECT+ and ECT- are also showing faster changes almost. The hypothesis of symmetry in red gram seed to dal price transmission in Bengaluru and Mumbai is rejected.

Table 2. Augmented-Dicky-Fuller (ADF) test for unit-root

City	Level(t value)	P-Value	First differenc(t value)	P-Value
Bengaluru	2.791	0.204	-39.580	0.000*
Mumbai	-1.918	0.636	-14.260	0.000*
Gulbarga	-1.091	0.924	-8.667	0.000*

Table 3. Johansen test for cointegration

City	Hypothezied No. of cointegrated equation	Trace statistics	P-Value	Maximised Eigen Value	P-Value
Bengaluru	At most 1	12.425	0.013	9.071	0.028
Mumbai	At most 1	24.872	0.016	16.850	0.019

Table 4. Asymmetric price transmission test

Dependent variable: prices of Dal	Bengaluru	Mumbai
Constant	0.024	0.016
D+ Seed (SR +)	0.94 (7.9*)	0.68 (17.8*)
D+ lag 1	0.85 (4..4*)	0.58 (3.2*)
Cumulative (+)	1.79	1.26
D - Seed (SR -)	0.84(5.3*)	0.42(8.2***)
D-lag 1	0.63(0.4)	0.36(1.6**)
Cumulative (-)	1.47	0.45
Lagged ECT +	- 0.98*	-0.97*
Lagged ECT -	-0.58*	-0.64*
Number of observations	85	85
Prob	0	0
R-squared	0.97	0.98
Adj R-squared 0	0.96	0.98
Durbin-Watson stat	1.94	2.43
Test for asymmetry(F statistics)	7.122(p value -0.000)	4.162(p value -0.000)

4. CONCLUSION

This study analyse the behaviour price by using ECM approach for retail and whole sale market in India the result suggested that retail and whole sale price transmission for pulse was asymmetric. The economic interpretation is that the adjustment of retail price to whole sale price is faster when there is an increase in whole sale price than decrease.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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