Original Research Article

Asymmetric Price Transmission in Agricultural Markets: A Case of Chick Pea's in South India

Abstract

Emergence of food crisis due to price increases of key food commodities resulting from the events of the last two years calls for policy attention. Supply restrictions form COVID-19 and the Russian-Ukraine war, along with the persistent low productivity of the legume crops threatens the food and nutrition security of millions of people in the developing worlds. Understanding price transmission mechanisms of key food commodities can help in evidence-based policy making. In this paper we empirically assess the vertical price transmission mechanism between producer and consumer prices of chickpeas in Karnataka for the period from January 2016 to January 2019 using monthly wholesale and retail price data. Threshold cointegration models are employed to analyze whether the retail and wholesale markets are cointegrated or not and to check the asymmetric adjustment towards a long-run equilibrium relationship. Both the threshold autoregressive (TAR) and momentum-threshold autoregressive (M-TAR) models reveal that the retail and wholesale prices of Bengal gram are integrated. M-TAR model provided the clear evidence of asymmetric price transmission in the major Bengal gram Markets in south India. This implies that retail prices (downstream prices) respond differently to wholesale (upstream prices) based on whether the upstream prices (wholesale prices) are increasing or decreasing price transmission with special reference to Bengal Gram. It is clearly evident that the presence of asymmetry in price transmission along the Bengal gram markets in India.

Keywords: Asymmetry, India, Price, Transmission, Bengal gram, Cointegration.

Introduction

Low productivity of pulse crops, COVID restrictions and Russian war are the ingredients of a perfect storm that is emerging to affect the food security and protein availability in the Indian context. The case of Bengal gram, a legume crop that is in high demand in India, is typical. In this paper we study the price transmission mechanisms of the chickpeas a key crop of food an nutrition security for millions of Indian household, to guide the policy makers on how to device evidence based policies to smoothen the impact of the emerging food crisis. Price transmission between agricultural markets and between two vertically integrated levels has received a huge attention in the agricultural economics research. Price transmission in general means how the price changes at one market affects the price at another market. The price transmission could be either spatial or vertical. Price transmission helps to understand the relationship between prices of different related commodities as well. Price transmission serves the interest of both producers and consumers as both the group of consumers one or the other time believe that they are exploited and not getting the correct price.

Pricing efficiency is part of a larger marketing efficiency framework. Free movement of goods and information over form, space, and time is required to achieve vertical and spatial efficiency in the marketing system (Barrett, 1996). This is also critical for the most efficient use of resources in the manufacturing process. In a market-oriented economy, it is maintained that efficient price generation is necessary for efficient resource allocation. The process of asymmetric price transmission is well researched in many agricultural and non-agricultural commodities in the developed countries. However, in developing countries like India particularly in agricultural commodities received less focused barring few studies. In Agriculture, Prices are said to asymmetrically transmit as we witness very less producer share in consumer rupee. Asymmetric price transmission is nothing but the price at one market level reacts differently to price changes at another market level depending on whether the price is increasing or decreasing. It is the price which connects different markets which are geographically long and also many vertically integrated levels of the marketing channel (Luoma *et al.*, 2004). Vertical price transmission may be imperfect if price changes at one level are not fully transmitted to another level; if there is a time lag between price adjustments at different levels or if there is an asymmetry in reaction between positive and negative price shocks (Bunte, 2006). In agricultural markets we often observe that an increase of producer prices is transmitted more fully and faster to consumer prices while producer price decrease is passed-through the supply chain to consumer prices incompletely and at a lower speed (Vavra and Goodwin, 2005). The term "asymmetric" reaction of the price at one level of the marketing chain to a price change at another level, depending on whether the initial change is positive or negative," (Von Cramon-Taubadel, 1998). Negative asymmetry, on the other hand, "denotes a situation in which the retail price reacts more fully or quickly to a reduction in farm price than to an increase in farm price. Empirical studies show that asymmetric price transmission is a rule rather than exception (Peltzman, 2000). For example, retail price of a particular commodity reacts differently when there is increase and decrease in producer price.

Crux of Asymmetric Price Transmission Studies

- Understanding the root causes of changes in prices or asymmetry in price transmission.
- Forecasting of prices based on the trends in prices of related commodity

For example, if the prices of groundnut are transmitted to sunflower, based on the future prices of the groundnut one can predict the prices of sunflower as these two commodities are oilseed crops and they are perfect substitutes.

It helps in identifying the constrains in agricultural marketing system

For example, if two markets are close enough and there is a less price transmission between those two markets, we can suspect there is transportation problem between two markets.

Types of Asymmetric price transmission

First Criterion

1) Asymmetric price transmission in magnitude

2) Asymmetric price transmission in speed

3) Asymmetric price transmission in both magnitude and speed

Second Criterion (Peltzman Criteria)

1) Positive Asymmetric price transmission

2) Negative Asymmetric price transmission

Third criterion

1) Vertical Asymmetric price transmission

2) Spatial Asymmetric price transmission

Causes of Asymmetric Price transmission (Meyer, J. & Von Cramon Taubadel, S., 2004)

1. **Market Power/ Imperfect Market Condition**

Most of the literature on asymmetric price transmission mentioned the existence of imperfect market condition in agricultural markets is the major cause of asymmetry. For example, in case of collusive oligopolistic market condition, oligopolist increases the prices whenever there is increase in input price/ produce price but whenever there is a decrease in producer price, they do not decrease the price without consulting with other firms and with a fear of getting punished for breaking the agreement.

2. **Inventory Management**

Retailers don't decrease their price whenever there is a low demand instead, they try to maintain the inventory with aim of getting good price in future.

3. Menu Cost

It is the cost involved in changing the prices and disseminating the information related to changes in prices. Therefore, when there is an increase in producer price, retailer has to change the prices and disseminate information. Nonetheless, when there is decrease in producer price, retailer does not bother as it involves menu cost.

4. Government Intervention

The Government or political intervention in the form of administered prices is quite common in agriculture. In such cases the price decreases are considered as temporary phenomenon by the retailer and they do not respond to decrease in producer prices but they respond quickly to increase in producer prices.

5. Asymmetric Information

Asymmetric information about prices at different market levels among different stake holders in marketing leads to asymmetric price transmission.

6. Search Costs

It is the cost involved in searching for lower prices. If the search costs are more than the profit from the lower prices of a particular commodity leads to asymmetry.

Table 1. Empirical studies on asymmetric price transmission

Author	**Year**	**Study Area**	**Major findings**
Kinnucan *et. al.*	1987	Investigating price transmission in the Finnish dairy sector	Retail prices in the dairy market adjust faster to increases in dairy farm prices than to their decrease.
Abdulai	2002	Using threshold cointegration to estimate asymmetric price transmission in the Swiss pork market	Price transmission between the producer and retail levels is asymmetric.
Jaffery, S.	2004	Asymmetric Price Transmission: A Case Study of the French Hake Value Chain.	Retailers immediately respond to positive changes in auction prices by adjusting their prices upward, but they do not react as quickly to falling auction prices.

Bor *et al.*	2014	Asymmetry in Farm-Retail Price transmission in Turkish fluid milk Market	Positive price asymmetry in the farm-retail price transmission in the Turkish milk market. That is, the retail prices tend to adjust more quickly to the input price increases than to their decreases which yield welfare losses to the consumers
Srinivasulu Rajendran	2015	Price Transmission Process in Vertical Markets- an Empirical Analysis of Onion Markets in Tamil Nadu State, India	The findings reveal that high margin at the retail and wholesale price levels indicate the probability of price distortion, which could result in an asymmetric process in the vertical market. The presence of both positive and negative asymmetry has been identified in the vertical market system based on the speed and amount of price fluctuations and the type of asymmetry. In terms of speed, there is evidence that retail prices respond significantly faster to decreases in wholesale prices than to increases in wholesale prices, where markets have displayed negative asymmetry.
Alam, M. and Jha, R.	2016	Asymmetric Threshold Vertical Price Transmission in Wheat and Flour Markets in Dhaka, Bangladesh	Short-run price asymmetries implying that downstream price responds faster when upstream price increases than when the latter falls.
Ahmed, O.	2018	Vertical price transmission in the Egyptian tomato sector after the Arab Spring	Price increases to be transferred more completely along the supply chain than price declines.
William J. Burke and Robert J. Myers	2014	Spatial equilibrium and price transmission between Southern African maize markets connected by informal trade	We find that, contrary to some current evidence on the performance of SA grain markets linked by formal trade, informally traded markets work rather effectively. Long-run price equilibrium is consistent with competitive trade, price transmission is quick, and prospective trade restraints have little effect on long-term relationships. Nonetheless, we uncover evidence of substantial transfer costs on occasion, which may stymie informal trade flows. The conclusion is that policies that encourage informal trade and minimize informal trade expenses will improve market performance

Aditya Shrinivas and Miguel I. G´omez	2016	Price transmission, asymmetric adjustment and threshold effects in the cotton supply chain: a case study for Vidarbha, India	This study looks at price transmission asymmetries in the cotton supply chain in Vidarbha, India. The first stage's findings suggest that the Indian and worldwide cotton markets are well-connected. The second stage, on the other hand, exhibits strong threshold-type nonlinearities as well as price asymmetries between home and farm gate prices. The short-run dynamics show that when domestic prices fall, the pass-through to farm gate prices is greater than when they rise. The implication is that price variations benefit traders at the expense of farmers. According to evidence from fieldwork in Vidarbha, the inequalities identified in this study may be linked to trader market power and a lack of market information.
Surabhi Mittal, Vinod K Hariharan, Subash S P	2018	Price volatility trends and price transmission for major staples in India	The study examined the patterns, trends and volatility in domestic and international prices of rice and wheat, and found that although both the international and domestic prices are volatile, the degree of volatility is higher in the international prices. The volatility in domestic prices is mainly due to internal production shocks and is not influenced much by the international prices. This disconnect is attributed to domestic policy measures, such as market support to farmers and public stockholding of food grains for public distribution and price stabilization.

Materials and Methods

Data Description

To analyze the vertical asymmetric price transmission in major Bengal gram markets in Karnataka, India the average weekly wholesale prices were calculated based on the daily wholesale prices collected from Agmarknet for the period from January 2006 to November 2019 and the weekly retail prices were collected from retail price information system of Directorate of Economics and statistics, Government of India. The missing values in both the price series were interpolated using cubic spline interpolation.

Model Specification

Before testing the symmetry hypothesis for the Indian Pulse market, the cointegrated properties of the data should be examined. Particularly, the existence of cointegration between consumer and producer prices must be verified. The hypothesis is based on the assumption that price transmission in a vertical market system is symmetric which indicates that market is highly efficient.

Step1: Long–run relationship among the Retail and Wholesale Prices is estimated using the following equation

$$RPt = \beta 0 + \beta 1\ WP_t + \varepsilon$$

Where,

RPt is weekly retail price at time t

WPt is weekly wholesale price at time t

After estimating the long run relationship between the retail and wholesale markets

Step 2: Optimum lag and threshold selection

Optimum lag length is selected based on the Akaike's Information Criteria and Bayesian Information Criteria.

Optimum threshold is selected using Chan approach (1993) which involves grid search over all possible thresholds and optimum threshold is selected based on the lowest sum of squared errors.

The adjustment process given by Enders and Siklos is represented as

$$\Delta \mathcal{E}_{\mathrm{t}} = \sum_{k}^{n} \binom{n}{k} x^k a^{n-k}$$

$$\Delta \hat{\varepsilon}_t = I_t \rho_1 \hat{\varepsilon}_{t-1} + (1 - I_t) \rho_2 \hat{\varepsilon}_{t-1} + \sum_{i=1}^{p-1} \delta_i \Delta \hat{\varepsilon}_{t-1} + \omega_t \qquad (1)$$

where, I_t is the Heaviside indicator function such that:

$$I_t = \begin{cases} 1 & if \quad \Delta \hat{\varepsilon}_{t-1} \geq \tau \\ 0 & if \quad \Delta \hat{\varepsilon}_{t-1} < \tau \end{cases} \qquad (2)$$

Where,

T- Threshold value

Step 3: Testing the null hypothesis of no cointegration

i.e., ρ1 = ρ2 =0

Where,

ρ1= Adjustment coefficient for positive discrepancies

ρ2 = Adjustment coefficient for negative discrepancies

Step 4: Testing the null hypothesis of no asymmetric adjustment

i.e., ρ1 = ρ2

Step 5: Fitting Asymmetric Error Correction Model

Asymmetric Error Correction Model (AECMs) with (M–TAR) adjustment is fitted using the Equation below:

$$\Delta RP_t = \sum_{s=1}^{k} \alpha_s \Delta RP_{t-s} + \sum_{s=0}^{k} \beta_s \Delta PP_{t-s} + \gamma_1 Z\_plus_{t-1} + \gamma_2 Z\_\min us_{t-1}$$

Where, k is lag-length, Z plus t-1 and Z minus t-1 are the error correction terms from the threshold cointegration regressions, representing adjustments to positive and negative shocks to marketing margin (Abdulai, 2002)

Empirical Results

Cointegration analysis

Non-stationary time series can lead to statistically significant results due to purely spurious correlation. Therefore, we tested for the stationarity of the price series using Augmented Dickey Fuller (ADF) and Phillips Perron (PP) tests. The Augmented Dickey-Fuller and Phillips-Perron tests confirmed that all our time series are non-stationary and stationarized them by taking first differences. The tests indicated that all variables were stationary in first differences. The lags of the dependent variable in the tests were determined by Akaike Information Criterion (AIC). The stationarity tests showed that the original time series are non-stationary, which could be used for cointegration analysis.

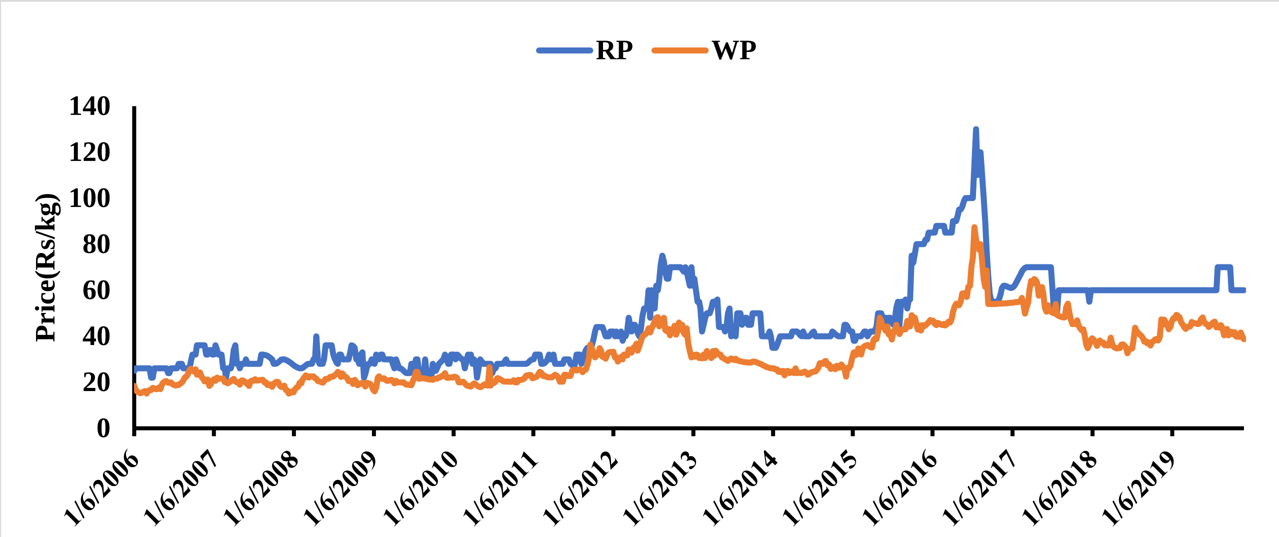

Figure 1: Trends in Wholesale and Retail Prices of Bengal gram in Karnataka

Figure 1 shows the time plot of weekly wholesale prices and weekly retail prices expressed in terms of Rupees per Kg. It depicts the fluctuations in prices of Bengal gram in the state of Karnataka at two market levels i.e., at wholesale level and at retail level. It is clear that the increase in wholesale prices is always followed by higher increase in retail prices. In contrast, the decrease in wholesale price not always followed by the decrease in retail price. This implies that the retail price is not responsive to wholesale prices during corresponding period in the selected markets of Bengal gram in the state of Karnataka.

Table 2: Descriptive Statistics of the Price data

Particulars	Wholesale Price	Retail Price
Mean	46.04	32.37
Median	41.00	28.83
Mode	60.00	32.00
Range	108.00	72.33
Minimum	22.00	15.07
Maximum	130.00	87.40

Source: Authors estimation using secondary data

Table 3: Augmented Dicky fuller Test

Markets	Price	At level	At First difference
Gadag	Wholesale Price	-2.60 (0.32)	-9.10*** <(0.01)
Hubli	Retail Price	-3.35 (0.06)	-12.91*** <(0.01)

Note: 1. Figures in parentheses represent the p value, 2. Signif. Codes: '***' 0.01 '**' 0.05

Table 3 shows the Augmented Dickey Fuller unit root test results. The null hypotheses of non-stationarity are tested both at level and at first difference for both wholesale and retail price series. The results revealed that both wholesale prices and retail prices are non-stationary at level and stationary at first difference.

Table 4: Long Run Relation

Variable	Estimate
Intercept	3.13*** (0.00)
Wholesale Price	1.32*** (0.00)

Note: 1. Figures in parentheses represent the p value, 2. Signif. codes: '***' 0.01 '**' 0.05

Table 4 provides the estimates of long-run relation between retail and wholesale prices of Bengal gram when retail price is regressed based on wholesale prices. It is clear from the results that for every one rupee increase in wholesale prices the retail prices increase by 1.32 rupees from the mean level in the long run.

Table 5: Threshold Cointegration Estimates

Estimates	TAR	MTAR
Lag value	**1**	**1**
Threshold value	-5.72	2.01
$\rho 1$	-0.06*** (0.00)	-0.14*** (0.00)
$\rho 2$	-0.09*** (0.00)	-0.05*** (0.00)
$\rho 1= \rho 2=0$	**12.67*****	**15.06*****

	(0.00)	**(0.00)**
$\rho 1 = \rho 2$	**1.09** **(0.29)**	**5.72**** **(0.01)**

Note: 1. Figures in parentheses represent the p value, 2. Signif. Codes: '***' 0.01 '**' 0.05

Table 5 shows the threshold cointegration estimates using TAR and MTAR methodologies. The optimum lag length selected by both Akaike's Information Criteria and Bayesian Information Criteria is one. The optimum threshold value in case of TAR model is -5.72 while it is 2.01 in case of MTAR model. The null hypotheses of no cointegration is tested using both TAR and MTAR methodologies and failed to accept the null hypotheses no cointegration ($\rho 1 = \rho 2 = 0$) using the F test at the 1% level of significance and hence the two-price series (wholesale and retail prices) are said to be cointegrated. The null hypotheses of symmetric adjustment ($\rho 1 = \rho 2$) in the long run is tested using both TAR and M-TAR methodologies. We failed to reject the null of symmetry ($\rho 1 = \rho 2$) using TAR methodology, however the same is rejected using MTAR methodology at the 5% level of significance. The MTAR model confirms that there is asymmetric adjustment in long run. Hence, the asymmetric error correction model is fitted to know the short run and long run dynamics of wholesale and retail prices in Bengal gram.

Table 6: AECM (Asymmetric Error Correction Model) estimates of Gadag Market in Karnataka

	ΔRP		**ΔWP**	
	Coefficient value	**t value**	**Coefficient value**	**t value**
Z plus $_{t-1}$	-0.04**	-1.99	0.02	1.83
Z minus $_{t-1}$	-0.07***	-3.80	0.01	0.83
LB (8)	(0.13)		(0.12)	
DW	2.02 (0.79)		1.97 (0.67)	

Note: 1. Figures in parentheses represents the p-value

2. Signif. Codes: '***' 0.01 '**' 0.05

3. LB (8) is the significance level of the Ljung-Box statistic that the first 8 of the residual autocorrelations are jointly equal to zero

4. Z_plus(t-1) and Z_minus(t-1) are error correction terms showing adjustments to positive and negative shocks to marketing margin in the long-run, respectively

Table 6 depicts the results of Asymmetric Error Correction Model (AECM). The estimates for the asymmetric speed adjustment are represented by Z_plus (t-1) and Z_minus (t-1). The t-statistics for Z_plus (t-1) and Z_minus (t-1) for retail prices of Bengal gram revealed that the retail prices of Bengal gram respond strongly/quickly to negative shocks which squeeze the market margin. But positive shocks which expand the marketing margin are also persisting. However, the t-statistics for Z_plus (t-1) and Z_minus (t-1) for wholesale prices of Bengal gram revealed that the producer prices do not respond to either positive or negative shocks to the marketing margin. Thus, it is clearly evident that the retail prices adjust to correct long-run disequilibria in retail and wholesale prices, while wholesale prices do not significantly respond to long run disequilibria. LB (8) is the significance level of the Ljung-Box statistic that the first 8 of the residual autocorrelations are jointly equal to zero and it is clear from the p values that there is no residual auto correlation and Durbin Watson statistic also shows that there is no autocorrelation.

Table 7: Granger Causality Test

Null Hypothesis	F-Statistics	Rejection of Null hypothesis	Direction
Wholesale Price does not granger cause Retail Price	15.65*** (0.00)	Yes	Unidirectional
Retail Price does not granger cause Wholesale Price	3.30 (0.06)	No	

Note: 1. Figures in parentheses represent the *p value*

2. Signif. Codes: '***' 0.01 '**' 0.05

Table 7 shows the results of granger causality test. Granger causality test was carried out to know whether there is a unidirectional causation or bidirectional causation. The null hypotheses of wholesale price does not granger cause retail price is rejected at 1% level of significance. However, the null hypotheses of retail price does not granger cause wholesale price is not rejected. Therefore, it is clearly indicated that there is a unidirectional causation from wholesale to retail price of Bengal gram.

Conclusion

Price volatility in agricultural commodities could result in higher instability in prices in both domestic and international prices, which may increase the incidences of food insecurity. Moreover, consumers often complain that retail prices increase more when input prices are rising and thereafter, decrease when costs are falling. In response to this emotion, a wide range of empirical works have tried to clarify whether or not asymmetries occur, proposing various definitions of asymmetries and using different econometric models. This investigation explores the price transmission mechanism between producers and consumers in the Indian pulse sector. This paper analyzed vertical price transmission along food supply chain for Bengal gram in India. It is clearly evident from the econometric that wholesale and retail markets are cointegrated and there is asymmetry in price transmission between retail and wholesale markets of Bengal gram. This clearly implies that the vertical asymmetry in the Bengal gram market representing in market inefficiency and welfare loss to both consumers as well as producers which needs to be addressed. In order to assess the existence and degree of market power in the Greek agri-food sector, one would also have to take into account the role of additional variables such as government intervention through price support, marketing costs (Kinnucan & Forker, 1987) and exogenous shocks (Lloyd, McCorriston, Morgan, & Rayner, 2006) in the determination of agri-food product retail demand and farm supply. Thus, a possible direction for future research is the study of the issue of market power in the Indian pulse sector, taking into account the role of such variables.

References

1 Abdulai, A. (2002). Using threshold cointegration to estimate asymmetric price transmission in the Swiss pork market. *Applied Economics*, *34*(6), 679-687.

2 Acharya, S. S., Chand, R., Birthal, P. S., Kumar, S., & Negi, D. S. (2012). Market integration and price transmission in India: A case of rice and wheat with special reference to the world food crisis of 2007/08. *Rome: Food and Agriculture Organization*.

3 Ahmed, O. (2018). Vertical price transmission in the Egyptian tomato sector after the Arab Spring. *Applied Economics*, *50*(47), 5094-5109.

4 Alam, M. J., & Jha, R. (2016). *Asymmetric threshold vertical price transmission in wheat and flour markets in Dhaka (Bangladesh): seemingly unrelated regression analysis*. The Australian National University, Australia South Asia Research Centre.

5 Barrett C (1996). Market Analysis Methods: Are Our Enriched Toolkits Well Suited to Enlivened Markets?, American Journal of Agricultural Economics, 78: 825–9

6 Bor, Ö, Ismihan, M., & Bayaner, A. (2014). Asymmetry in farm-retail price transmission in the Turkish fluid milk market. *New Medit*, *13*(2), 2-8.

7 Jeffry, S. (2004). Asymmetric Price Transmission: A Case Study of the French Hake Value Chain, *Marine Resource Economics*, 19,511-523.

8 Kharin, S. (2015). Vertical price transmission along the diary supply chain in Russia. *Studies in Agricultural Economics, 117*(2), 80-85.

9 Kinnucan, H. W., & Forker, O. D. (1987). Asymmetry in farm-retail price transmission for major dairy products. *American journal of agricultural economics*, 69(2), 285-292.

10 Listorti, G., & Esposti, R. (2012). Horizontal price transmission in agricultural markets: fundamental concepts and open empirical issues. *Bio-based and Applied Economics*, *1*(1), 81-108.

11 Luoma, A., Luoto, J., & Taipale, M. (2004). *Threshold cointegration and asymmetric price transmission in Finnish beef and pork markets*. Helsinki: Pellervo Economic Research Institute.

12 Meyer, J. & Von Cramon-Taubadel, S. (2004). Asymmetric price transmission: a survey. *Journal of agricultural economics*, *55*(3), 581-611.

13 Otoo, E. A. (2012). Asymmetric Price Transmission between Local and Imported Rice Prices in Burkina Faso. *Journal of Economics and Behavioral Studies*, *4*(9), 523-531.

14 Sephton, P. S. (2003). Spatial market arbitrage and threshold cointegration. *American Journal of Agricultural Economics*, *85*(4), 1041-1046.

15 Vavra, P. and B. Goodwin. (2005). "Analysis of Price Transmission along the Food Chain", OECD Food, Agriculture and Fisheries Papers, No. 3, OECD Publishing, Paris.

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