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Full Length Research Paper

An application of the von Cramon-Taubadel and Loy error correction models in analyzing asymmetric adjustment between retail and wholesale maize prices in Ghana

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Previous studies analyzing asymmetric price transmission have been based on an econometric specification that is shown to be inconsistent with cointegration. This study draws on the concept of cointegration to implement the von Cramon-Taubadel and Loy error correction approach in analyzing retail-wholesale maize price transmission in Ghana. Asymmetries are modeled to affect the direct impact of price increases and decreases as well as adjustments to the equilibrium level. The analysis demonstrates that transmission between retail and wholesale maize prices in Ghanaian maize market is asymmetric. In accordance with common belief, retailers react more quickly to increasing wholesale prices than decreasing wholesale prices.

Key words: Asymmetric adjustments, cointegration, error correction model.

INTRODUCTION

Recent empirical studies analyzing whether prices rise faster than they fall, have categorised the price dynamics into symmetric and asymmetric[1] processes. Those processes for which the transmission differs accordingly to whether the prices are increasing or decreasing (i.e. asymmetric price transmission) are of keen interest. This asymmetric behavior of prices has been the focus of numerous studies in agricultural economics. Mohanty et al. (1995) provide empirical evidence for this asymmetrical price behavior in the international wheat market using variants of model specification. All these studies use various forms of an econometric specification introduced by Wolffram (1971) and refined by Houck (1977). However, this specification is not consistent with cointegration between the prices being studied. Funda-mentally, if the prices at different levels of the market are are cointegrated, then the Wolffram-Houck specification is an inappropriate means of testing for asymmetric transmission between these levels.

In this article, tests for asymmetric price transmission that is consistent with cointegration is invoked and applied to the transmission of maize prices from the retail to the wholesale level in Kumasi in the Ashanti region of Ghana.

RATIONAL FOR ASYMMETRIC PRICE TRANSMISSION

Several factors which culminate in asymmetric price transmission have been proposed in the literature. First, a commonly cited source of asymmetric price transmission is market power (Kinnucan and Forker, 1987; Miller and Hayenga, 2001; McCorrisston, 2002; and Lloyd et al., 2003). Oligopolistic processors, for example, might react collusively more quickly to shocks that squeeze their margin than to shocks that stretch it, resorting in asym-metric short run transmission in an attempt to hide the exercise of market power behind the 'confusion' created by major shocks, processors could also react less completely to the shocks that stretch their margins leading to asymmetric long run transmission.

Similarly, asymmetric price transmission could result if

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[1] By definition, asymmetry is an unreciprocal relationship between rises and falls in prices. e.g. Farm and retail prices

traders in the local market believe that competitors will follow an increase in the local market prices as price in the central market rise, but that they will not respond to falling prices in the central market by granting an equivalent reduction. It is however important to mention that concentration is probably a necessary but certainly not a sufficient condition for the exercise of market power, as the theoretical and empirical evidence on the relationship between these two phenomena is inconclusive (Weaver et al., 1989; Goodwin, 1994). Within the oligopoly context, both positive and negative asymmetries are conceivable depending on the market structure and conduct. In this regard, several studies of market power and asymmetry that focus on specific markets deserve to be mentioned. Borenstein et al. (1997) analysed vertical price transmission for crude oil to gasoline prices, and concluded that downward stickiness of retail prices for gasoline in an oligopolistic environment will lead to positive asymmetry. Alter-natively, Ward (1982) suggested that market power can lead to negative asymmetry if oligopolists are reluctant to risk losing market share by increasing output prices. Similarly Bailey and Brorsen (1989) considered firms facing a kinked demand curve that is either convex or concave to the origin. If a firm believes that no competitor will match a price increase but all will match a price cut (concave), negative asymmetry will result. Alternatively, if the firm conjectures that all firms will match an increase but none will match a price cut (convex), positive asymmetry will result. Hence, it is not clear a priori whether market power will lead to positive or negative asymmetry (Bailey and Brorsen, 1989).

Secondly, price asymmetry can be partly attributed to adjustment cost that arises when firms change their quantities and prices of inputs and outputs. Consequently, positive or negative asymmetric price transmission results if these costs are symmetric with respect to increase or decrease in quantities or prices. In an analysis of the US beef market, Bailey and Brorsen (1989) argued that firms may face different adjustment cost depending on whether prices are rising or falling. Subsequently, they noted that the competition between meat packers faced with a high fixed cost and excess capacity, for example, might result in farm prices that are bid up rapidly, in response to increased demand for meat products, but fall more slowly as demand weakens. Ward (1982) suggested that retailers of perishable products may be hesitant to raise prices for fear that they could end up holding spoiled stocks, leading to negative asy-mmetry. Heien (1980) disputes this assertion and notes that changing prices is less of a problem for perishable products than it is for those with a long shelf life, because for the latter, changing prices incur higher time cost and loss of good will. Thus, echoing the so called menu cost hypothesis proposed by Barro (1972), (that is a change in nominal price induces cost for example, the reprinting of price list or catalogues and the cost of informing market partners). Ball and Mankiw (1994) developed a model based on menu cost (the cost involved in changing nominal prices such as the cost of reprinting catalogues etc) in combination with inflation that leads to asymmetry. In this model, positive nominal input price shocks are more likely to lead to output price adjustment than negative price shocks. This is because in the presence of inflation, some of the adjustment made necessary by an input price reduction is automatically carried out by inflation, which reduces the real value of the margin. Thus in situations where firms face menu cost and inflation, shocks that bring upward price adjustment are rapidly responded to than those that reduce it, as inflation in this respect would have automatically affected some of the adjustment made necessary by the downward adjustment shocks (Kuran, 1983; Buckle and Carlson, 2000). In contrast to Bailey and Brorsen (1989), Peltzman (2000) makes a case for positive asymmetry affirming that it is easier for firm to disemploy inputs in the case of an output reduction than it is to recruit new inputs to increase output. This recruitment will lead to search cost and price premier increasing phases. Additional explanation for price asymmetry which has been proposed cannot be considered directly under market power or adjustment cost. Kinnucan and Forker (1987) suggested that asymmetry could result from government intervention, indicating that such political intervention can lead to asymmetric price transmission if it leads wholesalers or retailers to believe that a reduction in farm prices will only be temporary because it will only trigger government intervention, while an increase in farm prices is more likely to be permanent.

MATERIALS AND METHODS

Econometric models of asymmetric price transmission

The modeling of asymmetric price transmission can be grouped into pre-cointegration and cointegration approaches (Meyer and von Cramon, 2004). The pre-cointegration and the cointegration approaches draw heavily from Houck (1977) and von Cramon (1998) respectively.

Within the context of the pre-cointegration approaches, numerous authors have developed a test for asymmetric price transmission which is based on the Houck's segmentation of prices into increasing and decreasing phases (Kinnucan and Forker, 1987; Bailey and Brorsen, 1989; Zhang et al., 1995; Mohanty et al., 1995; Boyd and Brorsen, 1998). These different applications are considered as variants of the Houck's model and denoted by Houck's approaches. These pre-cointegration approaches require the data to be stationary in order to avoid spurious regression. The cointegration approaches are motivated by the fact that the Houck's approaches are not consistent with cointegration between the price series involved. The cointegration approaches draws heavily from (Granger and Lee, 1989; von Cramon-Taubadel, 1998; von Cramon - Taubadel and Loy, 1999).

Houck's specification

Asymmetric Price Transmission has been tested in a wide variety of agricultural markets. Appel (1992) finds that both speed and degree of price transmission from the producer to the retail level for broilers in Germany is asymmetric. Boyed and Brorsen (1988) studied the US pork market and find no evidence of asymmetric price transmission. However, this result was challenged by Hahn (1990) who finds that prices at all levels of the US pork and beef marketing chains are more sensitive to price increasing shocks than to price decreasing shocks. Hansmire and Willett's (1992) indicated that farm-retail price transmission for New York state apples is asymmetric and Kinnucan and Forker (1987) came to the same conclusion regarding dairy product transmission in the United States. Pick et al. (1990) finds evidence that short-run but not long-run vertical price transmission on the US citrus market is asymmetric. Finally, Ward (1982) points to both short and long run asymmetries in vertical price transmission for fresh vegetable in the United States, while Zhang et al. (1995) noted that price transmission for pea nut to peanut butter prices in the US is asymmetric in the short-run, but symmetric in the long-run.

Each of these studies implements some variant of an econometric technique for estimating irreversibility that was introduced by Wolfram (1971) in response to work on irreversible supply reaction by Tweeten and Quance (1969). In investigating the relationship between an output price P_A and input price P_B, Tweeten and Quance (1969) used an indicator variable to split the input price into two parts: one variable includes only increasing input prices P_B^+ and another includes only decreasing input prices P_B^-. From this, two input price adjustments coefficients (that is β_1^+ and β_1^-) can be estimated as specified below.

$$P_{A,T} = \beta_o + \beta_1^+ P_{1B,T}^+ + \beta_1^- P_{1B,T}^- + \varepsilon_T \quad (1)$$

Symmetric price transmission is rejected if the coefficients β_1^+ and β_1^- are significantly different from one another. Based on Tweeten and Quance (1969), Wolffram (1971) proposes a variable splitting technique that explicitly includes first difference of prices in the equation to be estimated which was later modified by Houck (1977). Within the context of the Wolfram-Houck (W-H) method, the response of price P_A to another price P_B is estimated with the following equation.

$$\sum_{T=1}^{T} \Delta P_{A,T} = \beta_0 + \beta_1 \sum_{T=1}^{T} \Delta P_{B,T}^+ + \beta_2 \sum_{T=1}^{T} \Delta P_{B,T}^- + \varepsilon_T \quad (2)$$

Where ΔP^+ and ΔP^- are the positive and negative changes in P_B respectively, β_O, β_1^+, β_1^- are coefficients and T is the current period.

Numerous studies estimate a dynamic variant of the Houck's static model. Some analyst distinguish between short-run and long-asymmetries by introducing lagged terms in $\Delta P_{B,T}^+$ and $\Delta P_{B,T}^-$ into Equation (1), in which case β^+ and β^- become lag polynomials. Long-run symmetry is tested by determining whether the sums of the coefficients in these polynomials are identical.

Estimation of the above equation has generally taken place without adequate regard to the time series nature of the data used. Many of the empirical applications cited above (Appel, 1992; Kinnucan and Forker, 1987; Pick et al., 1990; Zhang et al., 1995) are characterised by first-order autocorrelation, which is often symptomatic of spurious regression in the analysis of non-stationary time series (Granger and Newbold, 1974). Spurious regression is avoided if the analysed variables are cointegrated (Banerjee et al., 1993). However, it can be shown that the W-H specification in (2) is fundamentally incompatible with cointegration between P_A and P_B. To see this, reparametrise (2) using the identity:

$$\sum \Delta P_T = \sum \Delta P_{B,T}^+ + \sum \Delta P_{B,T}^- \equiv P_{B,T} - P_{B,0} \quad (3)$$

And be rearranged to yield (Ward 1982):

$$P_{A,T} = (P_{A,0} + \beta_o + \beta_1^- P_{B,0}) + \beta_1^- P_{B,T} + (\beta_1^+ - \beta_1^-) \sum \Delta P_{B,T}^+ + \varepsilon_T \quad (4)$$

This reparametrization of Equation (2) was proposed by Ward (1982) who tests whether the coefficient $(\beta_1^+ - \beta_1^-)$ differs from 0 in order to test whether price transmission is asymmetric. Von Cramon-Taubadel (1998) asserts that the estimation of equation 4 can lead to four basic results depending on the significance of the term $(\beta_1^+ - \beta_1^-)$ and the stationarity of the error term ε_T: These are (i) $\beta_1^+ - \beta_1^- \neq 0$ (asymmetry) and ε_T is I(0), (ii) $\beta_1^+ - \beta_1^- = 0$ (symmetry) and ε_T is I(1), (iii) $\beta_1^+ - \beta_1^- \neq 0$ (asymmetry) and ε_T is I(1), (iv) $\beta_1^+ - \beta_1^- = 0$ (symmetry) and ε_T is I(0). (i) implies that P_A, P_B and $\sum \Delta P_{B,T}^+$ are cointegrated, which precludes cointegration between P_A and P_B alone. (ii) and (iii) are spurious regressions involving non stationary variables (Granger and Newbold, 1974), while (iv) implies that P_A and P_B are cointegrated. Notably, if the Houck method points to asymmetry, then either the results reflect spurious regression (iii), or the prices in question are not cointegrated (i).

The asymmetric error correction representation

Fundamentally, the asymmetric error correction model (ECM) approach is motivated by the fact that all the variants of the aforementioned Houck approach discussed above are not consistent with cointegration between the price series. If the prices P_A and P_B are cointegrated, then an error correction representation exists (Engle and Granger, 1987). Granger and Lee (1989) propose a modification to the error correction representation that makes it possible to test for asymmetric price transmission between cointegrated variables. This involves a Wolffram–type segmentation of the error correction term into positive and negative components. The asymmetric ECM takes the form:

$$\Delta P_{A,T} = \beta_o + \beta_1 P_{B,T} + \beta_2^+ ECT_{T-1}^+ + \beta_2^- ECT_{T-1}^- + \beta_3 \Delta P_{B,T-1} + \beta_4 \Delta P_{A,T-1} + \quad (5)$$

The error correction model (ECM) then relates changes in P_A to changes P_B as well as the so called error correction term (ECT = $P_{A,t} - ß_o - ß_1 P_{B,t}$), the Lagged residuals derived from estimation of their long run relationship. The ECT measures the deviation from the long-run equilibrium between the P_A and P_B, and including it in the ECM allows P_A not only to respond to changes in P_B but also to correct any deviations from the long-run equilibrium that may be left over from previous periods. Splitting the ECT into positive and negative component (that is positive and negative deviation from the long-run equilibrium (ECT^+ and ECT^-) makes it possible to test for asymmetric price transmission.

Von Cramon-Taubadel and Loy (1996) also segmented the contemporaneous response term in equation (5). This leads to the following specification in which contemporaneous and short–run response to departures from the cointegrating relation are asymmetric if $\beta_1^+ \neq \beta_1^-$ and $\beta_2^+ \neq \beta_2^-$ respectively:

$$\Delta P_{A,T} = \beta_0 + \beta_1^+ \Delta P_{B,T}^+ + \beta_1^- \Delta P_{B,T}^- + \beta_2^+ ECT_{T-1}^+ + \beta_2^- ECT_{T-1}^- + \beta_3 \Delta P_{B,T-1} + \beta_4 \Delta P_{A,T-1} + \varepsilon \quad (6)$$

Noticeably, Equation 6 is equivalent to the Houck approach given by equation 2, except that equation 6 also contains $\beta_2^+ ECT_{T-1}^+$, $\beta_2^- ECT_{T-1}^-$, $\beta_3 \Delta P_{B,T-1}$, $\beta_4 \Delta P_{A,T-1}$. Thus in effect the asymmetric ECM with complex dynamics nests the Houck's model in first difference or has the structures of the Houck's model.

DATA ANALYSIS AND RESULTS

The application of the von Cramon Taubadel and Loy ECM is based on 520 weekly observations of undeflated (norminal) retail and whole sale prices for maize from January 1994 to December, 2003 from Kumasi in the Ashanti Region of Ghana were used in this analysis. The weekly data for all prices are cedi per 100 kg and given the high level of inflation in the period covered, prices are deflated using consumer price index (CPI) deflator. The source of the data is the ministry of agriculture in Ghana,

The price transmission analysis proceeded with a granger causality test aimed to establish the direction of price linkage. The Granger causality test reveals in Table 1 that the wholesale prices Granger causes the retail prices and the reverse is not valid. This necessitates the use of the single equation.

According to the Augumented Dickey Fuller method (Dickey and Fuller, 1979) and Philip Peron (PP), the time series of the variables under consideration are non stationary integrated of the order one (Tables 2 and 3) and subsequently, a linear combination will result to a stationary series. This result has to be tested with the cointegration technique. The two step residual-based test by Engle and Granger (1987) was applied to confirm this assertion. The first step is the cointegrating regression of non stationary price series between the retail as dependent against the wholesale as independent.

$$P_R = \beta_0 + \beta_1 P_W + \varepsilon_T$$

Where:

P_R = the retail price

PW = the wholesale price,

ε_T = error term

The second step involves testing whether the residuals from the cointegrating regression are non stationary by using ADF test and PP test.

$$\varepsilon_T = P_R - \beta_0 - \beta_1 P_W + U_T$$

Where U_T is the error term.

The co integrating results for the first step is shown in the upper part of Table 4 with it resultant unit root test of the residuals in the lower part of Table 4. With the results of the Engle Granger cointegration technique below, it can be confirmed that the retail and wholesale prices are cointegrated.

Information criteria such as the Akaike Information Criterion, (Akaike, 1973) and the Bayesian Information Criterion (Schwarz, 1978) are applied to determine the number of lags to be included in all models. This study finds significant asymmetries in the adjustment of retail prices in response to wholesale prices when the price transmission process is analyzed using the von Cramon-Taubadel and Loy asymmetric error correction model. The result of the test for asymmetry is presented in the analysis of variance displayed in Table 5 in which the symmetric model specified in equation 7 is compared with the asymmetric model specified in equation 8.

$$\Delta P_{A,T} = \beta_0 + \beta_1 \Delta P_{B,T} + \beta_2 ECT_{T-1} + \beta_3 \Delta P_{B,T-1} + \beta_4 \Delta P_{A,T-1} + \varepsilon \quad (7)$$

$$\Delta P_{A,T} = \beta_0 + \beta_1^+ \Delta P_{B,T}^+ + \beta_1^- \Delta P_{B,T}^- + \beta_2^+ ECT_{T-1}^+ + \beta_2^- ECT_{T-1}^- + \beta_3 \Delta P_{B,T-1} + \beta_4 \Delta P_{A,T-1} + \varepsilon \quad (8)$$

The results of the model estimations are displayed in Table 6 in appendix and the asymmetric adjustments coefficients of interest are (9.031e-^{01}, 6.964e-^{01}) and (-3.156e-^{02},-1.938e-^{01}) for the short run and long run adjustment parameters respectively.

The obvious difference between the values of the coefficients for the positive and negative partitions in the model culminates in rejection of the null hypothesis of symmetric transmission via a conventional F test.

It can be concluded that that asymmetry existed under the von Cramon-Taubadel and Loy ECM. The formal test of the asymmetry hypothesis using Equation (8) is:

$$H_0: \beta_1^+ = \beta_1^- \text{ and } \beta_2^+ = {}_2^-$$

In effect asymmetric behavior is detected by a joint F-test. We hypothesis the effect of increase and decrease in wholesale price on the retail price was the same on the

Table 1. Granger causality test.

Market	Effect	Hypothesized cause	F statistic	p-value
Kumasi	Retail price	Wholesale price	3.659	0.03
	Wholesale price	Retail price	0.462	0.63

Table 2. Results of unit root test in levels of maize prices in Kumasi market.

Market/Test	None	P- value	Intercept	P-value	Intercept and trend	P-value
Kumasi wholesale price						
ADF test	-1.3	0.1709	-4.4	0.0004	-4.4	0.0021
PP test	-1.3	0.1923	-4.4	0.0003	-4.5	0.0016
Kumasi retail price						
ADF test	-1.3	0.1839	-4.4	0.0043	-4.3	0.0021
PP test	-1.3	0.2269	-4.4	0.0004	-4.4	0.0025

Table 3. Results of unit root test in differences of maize prices in Kumasi market.

Market /test	None	P- value	Intercept	P-value	Intercept and trend	P-value
Kumasi wholesale price						
ADF test	-24.1	0.000	-24.0	0.000	-24.0	0.000
PP test	-24.1	0.000	-24.0	0.000	-23.8	0.000
Kumasi retail price						
ADF test	-24.2	0.000	-24.2	0.000	-24.2	0.000
PP test	-24.5	0.000	-24.5	0.000	-24.5	0.000

Table 4. Engle Granger test for maize.

Results of 1st stage test for maize				
Market pair name	**Constant**	**Coefficient**	**P-value for**	
Kumasi retail -wholesale	63218.68	0.905705	0.0000	
Results of 2nd stage test for residuals				
Market name	**ADF Test**	**P-value**	**PP test**	**P- value**
Kumasi	-6.0515	0.0000	-5.7440	0.0000

Table 5. Testing for asymmetry using an analysis of variance.

Model	Res. DF	RSS	DF	Sum of Sq	F	Pr(>F)
Symmetric	498	1.0521e + 11				
Asymmetric	496	1.0330e + 11	2	1.9130e + 09	4.5926	+ 0.01056 *

Significance codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1.

retail price was the same. The F-test indicates that the null hypothesis of symmetric transmission is rejected at 5% level or lower. The p-value of 0.01056 indicates that the null can be rejected here, suggesting the existence of significant asymmetry. Intituitively, this implies that the positive and negative components of the error correction term and the increasing and decreasing components of the wholesale price can be treated separately in the model. This asymmetric result suggests that the retailers react more quickly to increasing wholesale prices than to decreasing wholesale prices. This finding is derived on the basis of the von Cramon-Taubadel and Loy error correction model.

Conclusion

This research analyzed the behavior of tests of asymmetric price transmission according to the von Cramon-Taubadel and Loy ECM approach for retail and wholesale prices in the Ghanaian maize market. The findings suggested that the retail-wholesale price transmission process for maize in Kumasi was asymmetric. In accordance with common belief, the adjustment of retail price to the wholesale price is faster when there is an increase in the wholesale price than when there is a decrease. Further research will be necessary to establish whether this asymmetric behavior exist in other agricultural markets.

REFERENCES

Akaike H (1973). Information Theory and an Extension of the Maximum Likelihood Principle. B.N. Petrov and F. Csaki (eds.) 2nd International Symposium on Information Theory: Budapest: Akademiai Kiado. pp. 267-281.

Appel V (1992). Asymmetrie in der Preistransmission. Agrarwirtschaft Sonderheft 135: 178-213.

Bailey D, Brorsen BW (1989). Price Asymmetry in Spatial Fed Cattle Market. West J. Agric Econ 14 (2): 246-252.

Ball L, Mankim NG (1994). Asymmetric Price Adjustments and Economic Fluctuations. The Econ J. 104: 247-261

Banerjee A, Dolado JJ, Galbraith JW, Hendry DF (1993). Co-Integration, Error Correction, and the Econometric Analysis of Non-Stationary Data. Oxford: Oxford University Press.

Barro RJ (1972). A Theory of Monopolistic Price Adjustment. Rev Econ Stud 39: 17- 26.

Borenstein S, Cameron AC, Gilbert R (1997). DO Gasoline Prices Respond Asymmetrically to Crude Oil Price Changes? Q. J. Econ .112: 305- 339.

Boyd MS, Brorsen BW (1988). Price asymmetry in the U.S. pork marketing channel. North Central J. Agric Econ 10: 103-109.

Buckle RA, Carlson JA (2000). Inflation and Asymmetric Price Adjustment. Rev Econ Stat 82(1): 157- 160.

Dickey DA, Fuller WA (1979). "Distribution of the Estimators for Autoregressive Time Series with Unit Root. J. Ame Stat Assoc, 74: 427-431

Engle RF, Granger CWJ (1987). Co-integration and Error Correction: Representation, Estimation and Testing. Econ 55: 251-276.

Goodwin BK (1994). Oligopsony power: A Forgotten Dimension of Food Marketing? Ame J. Agric Econ 76: 1163-1165.

Goodwin BK (1994). Oligopsony power: A Forgotten Dimension of Food Marketing? Ame J. Agric Econ 76: 1163-1165.

Granger CWJ, Newbold P (1974). Spurious Regressions in Econometrics. J. Econ. 2: 111-120.

Granger CWJ, Lee TH (1989). Investigation of Production, Sales and Inventory Relationships using Multicointegration and non-symmetric Error Correction Models. J. Applied Econ. 4: 135-159.

Hahn WF (1990). Price Transmission Asymmetry in Pork and Beef Markets. J. Agric. Econ. Res. 42(4): 21-30.

Hansmire MR, Schertz Willet L (1992). Price Transmission Processes: A Study of Price Lags and Asymmetric Price Response Behaviour for New York Red Delicious and McIntosh Apples. Cornell University

Heien DM (1980). Markup Pricing in a Dynamic Model of Food Industry. Am. J. Agric. Econ. 62: 10-18.

Houck JP (1977). An Approach to Specifying and Estimating Nonreversible Functions. Am. J. Agric. Econ. 59: 570-572.

Kinnucan HW and Forker OD (1987). Asymmetry in Farm-Retail Price Transmission for major Dairy Products. Am. J. Agric. Econ. 69: 285-292.

Kuran T (1983). Asymmetric Price Rigidity and Inflationary Bias. Am. Econ. Rev. 73(3): 373-382.

Lloyd T, McCorriston S, Morgan CW, Rayner AJ (2003). The Impact of Food Scares on Price Transmission in Inter-Related Markets. Paper presented to the XXVth IAAE Conference in Durban/South Africa.

McCorriston S (2002). Why Should Imperfect Competition Matter to Agricultural economists? Eur. Rev. Agric. Econ. 29(3): 349-371.

Meyer J, von Cramon-Taubadel S (2004). Asymmetric Price Transmission: A survey. J. Agric. Econ. 55 (3): 581-611.

Miller DJ, Hayenga ML (2001). Price Cycles and Asymmetric Price Transmission in the U.S. Pork Market. Am. J. Agric. Econ. 83: 551-562.

Mohanty S, Peterson EWF, Kruse NC (1995). Price Asymmetry in the International Wheat Market. Can. J. Agricultural Econ. 43: 355-366.

Peltzman S (2000). Prices Rise Faster Than They Fall. J. Pol. Econ. 108(3): 466-502.

Pick DH, Karrenbrock JD, Carman HF (1990). Price Asymmetry and Marketing Margin Behavior: an Example for California - Arizona Citrus. Agribusiness 6(1): 75-84.

Schwarz G (1978) "Estimating the Dimension of a Model." Annals Stat. 6: 461–464.

Tweenten LG Quance CL (1969). Positivistic Measures of Aggregate Supply Elasticities: Some new Approaches. Am. J. Agric. Econ. 51: 342-352.

Von Cramon-Taubadel S (1998). Estimating Asymmetric Price Transmission with the Error Correction Representation: An Application to the German Pork Market", Euro. Rev. Agric. Econ. 25: 1-18.

Von Cramon-Taubadel S, Loy JP (1996). Price Asymmetry in the International Wheat Market: Comment. Can. J. Agric. Econ. 44: 311-317.

Von Cramon-Taubadel S, Loy JP (1999). The Identification of Asymmetric Price Transmission Processes with Integrated Time Series. Jahrbücher für Nationalökonomie und Statistik 218(1-2): 85-106.

Ward RW (1982). Asymmetry in Retail, Wholesale and Shipping Point Pricing for Fresh Vegetables. Am. J. Agric. Econ. 62: 205-212.

Weaver RD, Chattin P, Banerjee A (1989). Market structure and the Dynamics of Retail Food prices. Northeastern J. Agric. Resource Econ. 18: 160-170.

Wolffram R (1971). Positivistic Measures of Aggregate Supply Elasticities - Some New Approaches –Some Critical Notes. Am. J. Agric. Econ. 53: 356-356.

Zhang P, Fletcher S, Carley D (1995). Peanut Price Transmission Asymmetry in Peanut Butter. Agribusiness 11(1): 13-20.

APPENDIX

Table 6. The results of the model estimations.

	Coefficients	Standard error
Intercept	$-2.901e^{+03}$	$-1.295e^{+03}$
$\Delta P^{+}_{W,T}$	$9.031e^{-01}$	$6.655e^{-02}$
$\Delta P^{-}_{W,T}$	$6.964e^{-01}$	$4.807e^{-02}$
$\Delta P_{W,T-1}$	$1.213e^{-01}$	$5.292e^{-02}$
$\Delta P_{W,T-2}$	$9.052e^{-03}$	$5.170e^{-02}$
$\Delta P_{W,T-3}$	$1.542e^{-01}$	$5.018e^{-02}$
$\Delta P_{W,T-4}$	$2.221e^{-01}$	$5.009e^{-02}$
$\Delta P_{W,T-5}$	$4.160e^{-02}$	$5.099e^{-02}$
$\Delta P_{W,T-6}$	$1.016e^{-01}$	$5.013e^{-02}$
$\Delta P_{R,T-1}$	$-1.154e^{-01}$	$4.649e^{-02}$
$\Delta P_{R,T-2}$	$4.835e^{-02}$	$4.568e^{-02}$
$\Delta P_{R,T-3}$	$-1.492e^{-01}$	$4.448e^{-02}$
$\Delta P_{R,T-4}$	$-1.430e^{-01}$	$4.350e^{-02}$
$\Delta P_{R,T-5}$	$-3.070e^{-02}$	$4.381e^{-02}$
$\Delta P_{R,T-6}$	$-1.258e^{-02}$	$4.309e^{-02}$
ECT^{+}_{T-1}	$-3.156e^{-02}$	$3.578e^{-02}$
ECT^{-}_{T-1}	$-1.938e^{-01}$	$6.139e^{-02}$
Multiple R^2	0.5084	
Adjusted R^2	0.4926	
	11300.72	
BIC	11376.2	
Durbin Watson stat.	2.0211	