American-Eurasian Journal of Scientific Research 5 (1): 60-66, 2010
ISSN 1818-6785

A Comparison of the Different Approaches to Detecting Asymmetry in Retail-Wholesale Price Transmission

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Abstract: The purpose of the study is to investigate whether the price transmission between the retail and wholesale maize prices is asymmetric in Ghana. Houck's static model and the von Cramon-Taubadel and Loy Error Correction Model (ECM) were applied to test for asymmetry and the results compared. The finding indicates that the von Cramon-Taubadel and Loy Error Correction Model find significant asymmetry whilst the Houck's static model fails to support this conclusion in the same market with the same data. The F- test associated with the null hypothesis that retail prices respond symmetrically to increases and decreases in wholesale prices is not rejected in the case of Houck's static model. In contrast, the hypothesis of symmetry is rejected in the ECM approach. These results suggest that different models may lead to different conclusions in asymmetric price transmission modeling.

Key words: Maize price · Asymmetric adjustments · Cointegration · Houcks model · ECM

INTRODUCTION

The analysis of price transmission and asymmetric adjustment has matured over the years with many developments in model specification, estimation and testing. Among these developments are the construction and application of various econometric models of asymmetric price transmission.

These models include an econometric model specification introduced by Wolffram [1] and later refined by Houck [2], the error correction model von Cramon-Taubadel [3]; [4] and models with a threshold Tsay [5]; Balke and Fomby [6]; Enders and Granger [7]; Goodwin and Holt, [8]; Goodwin and Harper [9]; Goodwin and Piggott [10]; Abudulai [11]; Cook and Holly [12]; Goodwin and Serra [13]; Cook [14]. Different kinds of these models have been extensively used in analysing price transmission and testing for asymmetric adjustment. Meyer and von Cramon, [15] categorize these models of asymmetric price transmission into pre-cointegration and cointegration approaches. Within the pre-cointegration setting, the variant of the Houck's model (HK) includes specification in first differences and recursive sum of first differences. In the post -cointegration setting, variants of the Error Correction Models (ECM) specified includes the standard error correction representation Granger and Lee [16]; von Cramon-Taubadel [3] and an error correction model with complex dynamics von Cramon-Taubadel and Loy [17]. Additionally, variants of the threshold model have been specified by various authors Godwin and Piggott [10]; Abdulai [10]; Hansen and Seo [19]; Cook [14]; Meyer [20].

Although the alternative methods or models are continually used in analysing price dynamics and testing for asymmetric adjustments to derive policy conclusions, they remain incompatible with one another and may result to differences in inference and conclusions. In support of the fact that different methods employed to detect asymmetric price transmission may lead to different conclusions, Capps and Sherwell [21] find that the inference and conclusions derive from the von Cramon-Taubadel and Loy ECM approach was not supported by the dynamic variant of the conventional Houck approach in an empirical application. The purpose of this paper is therefore to support this claim and in so doing demonstrate that the differences in conclusions and inference are possible when a static variant of the Houck's model is compared to the von Cramon-Taubadel and Loy ECM approach. Fundamentally, this study investigates the differences in conclusion when

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competing time invariant models are used to analyse asymmetric data. The current study brings the pre-cointegration and cointegration approaches together to detected asymmetries using the same market data. In spirit of von Cramon-Taubadel and Houck, the different approaches, Houck's static model and the ECM are applied to test for retail-wholesale asymmetry in the Kumasi maize market. The current study differs from previous studies (Capps and Sherwell [21]) in two ways. First, like much of earlier literature, they considered fully dynamic models, whilst this paper emphasizes static variants of these models. Second they employ monthly data from a developed country whilst the current study employs weekly data sets from a developing country.

In the subsequent sections, the paper describes the von Cramon-Taubadel and Loy ECM and its relationship with the Houck's model that will be employed in testing for asymmetry within the context of the pre cointegration and co integration approach. This section also describes the data used in testing for asymmetry and presents the results of the test of cointegration between the variables. This is followed by the results of the test of asymmetry and the conclusion drawn from the study.

MATERIALS AND METHODS

Pre-cointegration and Cointegration Approaches to Testing for Asymmetry: Houck [21] proposes a simple static model in which asymmetries specified affects the direct impact of price increases and decreases and does not take into account adjustments to the equilibrium level. The Houck approach can be specified as follows:

$$\Delta P_{A,t} = \beta_1^{+}\Delta P_{B,t}^{+} + \beta_1^{-}\Delta P_{B,t}^{-} + v_t \qquad v_t \sim N(0,\sigma_v^2) \qquad (1)$$

Where $\Delta P_{B,t}^{+}$ and $\Delta P_{B,t}^{-}$ are the positive and negative changes in $P_{B,t}$. Symmetry is tested by determining whether the coefficients (β_1^{+} and β_1^{-}) are identical (i.e. $H_0: \beta_1^{+} = \beta_1^{-}$). Ward [22] extended the Houck's specification by including lags. While, Boyd and Brorsen [23] was the first to use lags to differentiate between magnitude and speed of transmission. Hahn [24] attempts to generalize the methods discuss so far, referring to them as the pre-cointegration methods.

Other authors e.g. Mohanty, Peterson and Kruse, [25] take the sum of both sides of equation (1) to derive the following equation.

$$\sum_{t=1}^{T}\Delta P_{A,t} = \alpha_o + \alpha_1\sum_{t=1}^{T}\Delta P_{B,t}^{+} + \alpha_2\sum_{t=1}^{T}\Delta P_{B,t}^{-} + \varepsilon_t \qquad (2)$$

which can be rearranged as follows:

$$P_{A,t} - P_{A,0} = \alpha_o + \alpha_1 P_{B,t}^{UP} + \alpha_2 P_{B,t}^{DOWN} + \varepsilon_t \qquad (3)$$

Where $P_{B,t}^{UP}$ is the sum of all positive changes in price B and $P_{B,t}^{DOWN}$ is the sum of all negative changes in price B. A formal test for symmetry using an F test or t -statistic is rejected when the coefficients α_1 and α_2 are unequal.

The Houck model is sometimes used without adequate regards to time series properties of the data. Von Cramon-Taubadel [3] has demonstrated that the model is fundamentally incompatible with cointegration between two price series. 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.

The Granger and Lee asymmetric Error Correction Model data generating process (DGP) can be specified as follows:

$$\Delta P_{A,t} = \beta_1\Delta P_{B,t} + \beta_2^{+}ECT^{+}_{t-1} + \beta_2^{-}ECT^{-}_{t-1} + \varepsilon \qquad \varepsilon \sim N(0,\sigma_\varepsilon^2) \qquad (4)$$

P_A and P_B are generated as I (1) non stationary variables that are cointegrated. An equilibrium relationship exist between P_A and P_B which produces I (0) stationary series. This equilibrium equation is estimated by least squares and the lagged deviation from this regression denoted by the Error Correction Term (ECT_{t-1}). The ECT is decomposed into positive and negative deviations using Wolffram segmentation (Granger and Lee, [16]) and plugged into the asymmetric error correction model specified in equation (4).

Where $ECT = P_{At} - \beta_1 P_{Bt}$ and

$ECT^{+}_{t-1} = ECT_{t-1}$ if $ECT_{t-1} > 0$ and 0 otherwise and

$ECT^{-}_{t-1} = ECT_{t-1}$ if $ECT_{t-1} < 0$ and 0 otherwise

Asymmetry is incorporated by allowing the speed of adjustment to differ for the positive and negative components of the Error Correction Term (ECT) since the long run relationship captured by the ECT was implicitly symmetric (see Cook *et al.* [26], Cook *et al.* [14], Cook *et al.* [27]). Symmetry in equation (4) is tested by determining whether the coefficients (β_2^{+} and β_2^{-}) are identical (i.e. $H_0: \beta_2^{+} = \beta_2^{-}$).

An alternative approach to model asymmetry within the error correction framework is provided by von Cramon-Taubadel and Loy [28]. They suggested that the $\Delta P_{B,t}$ in equation (4) can also be split into positive and negative components to allow for more complex dynamics effects.

$$\Delta P_{A,t} = \beta_1^+ \Delta P_{B,t}^+ + \beta_1^- \Delta P_{B,t}^- + \beta_2^+ ECT^+_{t-1} + \beta_2^- ECT^-_{t-1} + e \quad e \sim N(0, \sigma_e^2) \tag{5}$$

Where $\Delta P_{B,t}^+$ and $\Delta P_{B,t}^-$ are the positive and negative changes in $P_{B,t}$ and the remaining variables are defined as in equation (4).

Von Cramon-Taubadel and Loy [28] applied equation (5) to study spatial asymmetric price transmission on world wheat markets. The remaining model variables were defined as in equation (4) and formal test of the asymmetry hypothesis using equation (5) is: $H_0 : \beta_1^+ = \beta_1^-$ and $\beta_2^+ = \beta_2^-$. Noticeably, since equation (5) involves a linear combination of coefficients, a joint F-test can be used to determine symmetry or asymmetry of the price transmission process.

Noticeably, equation 5 is equivalent to the Houck approach given by equation 1, except that equation 5 also contains $\beta_2^+ECT^+_{t-1}$, $\beta_2^-ECT_{t-1}$. 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.

Thus the asymmetric ECM nests the Houck's model when the lag lengths of $\Delta P_{B,t}^+$ and $\Delta P_{B,t}^-$ are the same. Under these conditions, if any of the coefficients β_2^+, β_2^-, are statistically different from zero, the asymmetric ECM statistically is superior to the Houck model. In emphasizing the estimation of the static models for which the respective lag lengths are the same for the price series, the Akaike Information Criteria and the Bayesian Information Criteria may not be necessary in choosing between the Houck and ECM specifications.

Data Analysis and Empirical Results: Weekly 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 were deflated using consumer price index (CPI) deflator. The data was obtained from the ministry of agriculture in Ghana.

Prior to estimating the asymmetric price transmission equation, it is important to test for the direction of causality so as to ensure that the asymmetric price transmission model is not miss-specified. The Granger causality test was therefore carried out to determine the direction of causality between the retail and wholesale maize prices.

The hypothesis that wholesale prices Granger cause (precede) retail prices and vice versa Granger, [28] must be tested. Empirically, this hypothesis rests on a regression of retail price as a function of lagged retail and wholesale prices as well as a regression of wholesale price as a function of lagged retail and wholesale prices.

If wholesale prices Granger cause retail prices, then in the case where retail price is the dependent variable, the F-test corresponding to all coefficients associated with lagged wholesale prices should be statistically significant. If retail prices fail to Granger cause wholesale prices, then, in the case where wholesale price is the dependent variable, the F-test corresponding to all coefficients associated with lagged retail prices should not be statistically significant. According to the results of the Granger causality test in Table 1, it can be concluded that the wholesale prices Granger causes the retail prices. The next step was to consider the cointegration between the respective wholesale and retail price series. The Augmented Dickey-Fuller (ADF) and Philip Peron (PP) test were used to check on the stationarity of the retail and wholesale price series.

The application of the Augumented Dickey Fuller-ADF method Dickey and Fuller, [10] and Philip Peron (PP) test confirmed that the time series of the variables under consideration are I (1) and consequent they might give a linear combination that is I(0). The two step residual-based test by Engle and Granger [12] was used to check for cointegration when the price series were found to be integrated of the same order as illustrated in table 2 and 3.

The first step is the co integrating regression of I (1) price series between the retail as dependent against the wholesale as independent. The second step involves testing whether the residuals from the cointegrating regression are non stationary by using ADF test.

With the results of the Engle Granger cointegration technique [30] indicated in Table 4 it was confirmed that the retail and wholesale prices are cointegrated. In order to examine the existence of possible asymmetric adjustments the Houck's static model and the von Cramon-Taubadel and Loy ECM are estimated as follows:

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 andTrend	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				
	ADF Test	P-value	PP test	P-value
Mkt Name	-6.0515	0.0000	-5.7440	0.0000

Table 5: Parameter Estimates of the Houck's Static Model

	Parameter Estimate	P value
Intercept	-514.34927	0.49
$\Delta P^{+}_{B,t}$	0.80572	<2e-16 ***
$\Delta P^{-}_{B,t}$	0.6873	<2e-16 ***
Adjusted R^2	0.401	
DW	2.1	

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Table 6: Parameter Estimates of the Error Correction Model

	Parameter Estimate	P value
Intercept	-2.58E+03	0.052085.
$\Delta P^{+}_{B,t}$	8.13E-01	< 2e-16 ***
$\Delta P^{-}_{B,t}$	6.79E-01	< 2e-16 ***
$ECT^{+}{}_{t-1}$	-7.65E-02	0.029081 *
$ECT^{-}{}_{t-1}$	-2.32E-01	0.000136 ***
Adjusted R^2	4.40E-01	
DW	2.14	

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Table 7: Testing for asymmetry in Houck's static model using an analysis of variance

Model	Res. DF	RSS	DF	Sum of Sq	F	Pr(>F)
Symmetric	517	1.2608e+11				
Asymmetric	516	1.2564e+11	1	4.3322e+08	1.7792	0.1828

Significance Codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Table 8: Testing for asymmetry in Error Correction model using an analysis of variance

Model	Res. DF	RSS	DF	Sum of Sq	F	Pr(>F)
Symmetric	516	1.1738e+11				
Asymmetric	514	1.1613e+11	2	1.2540e+09	2.7752	0.06327

Significance Codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$$\Delta P_{A,t} = \beta_o + \beta_1^+ \Delta P_{B,t}^+ + \beta_1^- \Delta P_{B,t}^- + \varepsilon \quad (6)$$

$$\Delta P_{A,t} = \beta_o + \beta_1^+ \Delta P_{B,t}^+ + \beta_1^- \Delta P_{B,t}^- + \beta_2^+ ECT^+_{t-1} + \beta_2^- ECT^-_{t-1} + \varepsilon \quad (7)$$

The results of the model estimations are displayed in Tables 5 and 6. The asymmetric adjustments coefficients of interest are (0.80572, 0.6873) for the Houck's model and (-7.65E-02,-2.32E-01) for the Error Correction Model. Despite this apparent difference between the values of the coefficients for the positive and negative partitions in the Houck's model, this study found the null hypothesis of symmetry could not be rejected using a conventional F test.

The asymmetry hypothesis is tested by determining whether the coefficients (β_1^+ and β_1^-) are identical (i.e. $H_0 : \beta_1^+ = \beta_1^-$) in the Houck's model (equation 6). The p-value of 0.1828 indicates that the hypothesis that these coefficients are equal is not rejected at the 10% or lower significance levels. Conversely, the values of the positive and negative components of the von Cramon-Taubadel and Loy ECM was found to be statistically different with $H_0 : \beta_1^+ = \beta_1^-$, $\beta_2^+ = \beta_2^-$. The formal test of the asymmetry hypothesis using the ECM (equation 7) is: $H_0 : \beta_1^+ = \beta_1^-$ and $\beta_2^+ = \beta_2^-$. In effect asymmetric behavior is assessed by a joint F-test. Essentially, it is hypothesized that the effect of increase and decrease in wholesale price on the retail price was the same. The p-value of 0.06327 indicates that the null hypothesis of symmetric transmission is rejected at 10 % level or lower. It therefore can be concluded that that asymmetry existed under the von Cramon-Taubadel and Loy ECM.

What this asymmetric results suggest is that retailers react more quickly to increasing wholesale prices than to decreasing wholesale prices. This conclusion is derived on the basis of the von Cramon-Taubadel and Loy ECM and not supported by the Houck's model.

In summary the finding indicates that the von Cramon-Taubadel and Loy Error Correction Model find significant asymmetry whilst the Houck's model fails to support this empirical evidence in the same market with the same data. The F- test associated with the null hypothesis that retail prices respond symmetrically to increases and decreases in whole sale prices is not rejected in the case of Houck's model for above maize markets. In contrast, the hypothesis of symmetry is rejected in the ECM approach.

In testing for asymmetry, different models or approaches may lead to different conclusions. Houck's static model should be used together with the von Cramon-Taubadel and Loy Error Correction Model in analyzing asymmetric adjustments. It is concluded that retailers react more quickly to increasing wholesale prices than decreasing wholesale prices in the Kumasi Market.

CONCLUSIONS

The current study analysed the behavior of tests of asymmetric price transmission according to the conventional Houck and von Cramon-Taubadel and Loy ECM approach for weekly retail and wholesale prices in the Ghanaian maize market. Empirical results suggested that the retail-wholesale price transmission process for maize in Kumasi clearly was asymmetric. With the von Cramon-Taubadel and Loy Error Correction Model the retailers react more quickly to increasing wholesale prices than to decreasing wholesale prices in the Kumasi Market. This conclusion is not supported by the Houck's static approach. The results suggest that different methods of testing for asymmetry may lead to different conclusion given the same market data. It remains imperative that the Houck's model is used in conjunction with the error correction model. In effect the different approaches should complement each other. What will be of interest is to see whether this asymmetric behavior exists in other agricultural markets.

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