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Full Length Research Paper

Static versus dynamic model for estimating asymmetric price transmission in the Ghanaian maize market

Henry De-Graft Acquah[1]* and Edward Ebo Onumah[2]

[1]Department of Agricultural Economics and Extension University of Cape Coast, Cape Coast, Ghana.
[2]Department of Agricultural Economics and Agribusiness University of Ghana, Accra, Ghana.

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A conventional approach to analyzing asymmetric price transmission involves the use of the Houck's static model. This paper compares this time invariant approach to a dynamic variant of the model. The static model is a standard regression type model where parameters are assumed fixed over time, whereas the more flexible dynamic Houck's model allows parameters to vary over time. The flexibility of the dynamic modeling revealed the existence of price asymmetry in the Ghanaian maize market. This result was not supported by the Houck's static model. The results suggest that within the price transmission modeling framework, static and dynamic variants of the same approach may lead to differences in conclusion.

Key words: Asymmetry, model choice, static, dynamic.

INTRODUCTION

Estimating asymmetric price transmission using Houck's static model is common in the asymmetric price transmission literature. Numerous researchers have applied static variants of the Houck's model. A criticism of these models is that, their estimated dynamics of price transmission do not vary with time or they do not account for price changes that take longer than one period. Ward (1982) modified the static models to allow for price changes over more than one time period and his dynamic model has been extensively used to test for asymmetry in price adjustments. This paper compared the results from both the static and dynamic models in an attempt to ascertain whether the choice of model impacts on the results derived from price transmission analysis. In particular, this study focused on the ability of each model to capture asymmetric behavior. The information theoretic selection criterion was adopted as the basis for comparison since it provides a simple framework for choosing between competing models.

*Corresponding author. E-mail: henrydegraftacquah@yahoo.com. Tel: 00233245543956.

MATERIALS AND METHODS

The Houck approach

Houck (1977) developed a test for asymmetric price transmission based on the segmentation of price variables into increasing and decreasing phases. Other analysts notably includes: Boyd and Brorsen (1988), Kinnucan and Forker (1987), Bailey and Brorsen (1989), Zhang et al. (1995), Mohanty et al. (1995), Bernard and Willett (1966), Willett et al. (1997), Peltzman (2000) and Aguiar (2002), followed suit. Drawing from Houck (1977), the response of price P_A to another price P_B was estimated under the Houck's static model as follows:

$$\Delta P_{A,t} = \beta_o + \beta_1^{+} \Delta P_{B,t}^{+} + \beta_1^{-} \Delta P_{B,t}^{-} + \varepsilon_t \tag{1}$$

Where, ΔP^{+} and ΔP^{-} are the positive and negative changes in P_B respectively, β_o, β_1^{+}, and β_1^{-} are coefficients and t is the current period. Numerous studies estimated 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 the Equation 1, in which case, β^{+} and β^{-}

become lag polynomials. Long-run symmetry was tested by determining whether the sums of the coefficients in these polynomials were identical. Ward (1982) provided an analytical extension of the Houck's specification by including lags. While Brorsen (1988) was the first to use lags to differentiate between magnitude and speed of transmission. A simple variant of the Houck's dynamic models can be specified as follows:

$$\Delta P_{r,t} = \beta_o + \beta_1^+ \Delta P_{w,t}^+ + \beta_1^- \Delta P_{w,t}^- + \beta_2^+ \Delta P_{w,t-1}^+ + \beta_2^- \Delta P_{w,t-1}^- + \varepsilon_t \quad (2)$$

Other authors, for example, Mohanty et al. (1995) take the sum of both sides of equation 1 to derive the following equation:

$$\sum_{t=1}^{T} \Delta P_{A,t} = \alpha_o + \alpha_1 \sum_{t=1}^{T} \Delta P_{B,t}^+ + \alpha_2 \sum_{t=1}^{T} \Delta P_{B,t}^- + \varepsilon_t \quad (3)$$

This can be rearranged as follows:

$$P_{A,t} - P_{A,0} = \alpha_o + \alpha_1 P_{B,t}^{UP} + \alpha_2 P_{B,t}^{DOWN} + \varepsilon_t \quad (4)$$

$$P_{A,t} = P_{A,0} + \alpha_o + \alpha_1 P_{B,t}^{UP} + \alpha_2 P_{B,t}^{DOWN} + \varepsilon_t \quad (5)$$

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. Incorporating lags into equation 4 to allow for dynamic price response leads to the following equation:

$$P_{A,t} = \alpha_0^* + \sum_{l=1}^{k} \alpha_{1l} P_{B,t}^{UP} + \sum_{l=1}^{k} \alpha_{2l} P_{B,t}^{DOWN} + \varepsilon_t \quad (6)$$

In which short-run and long-run symmetry are rejected when individual α_{1l} and α_{2l} terms are unequal and when $\sum^{k} \alpha_{1l}$ and $\sum^{k} \alpha_{2l}$ are unequal, respectively. The Houck estimation technique has methodological questions when the data is co integrated. von Cramon-Taubadel (1998) demonstrated that the Houck's approach to measuring asymmetry is incompatible with co-integration. In order to demonstrate this point, von Cramon-Taubadel (1998) considered two processes, P_A and P_B, and the model below as previously defined in Equations 2 and 3:

$$\sum \Delta P_{A,t} = \beta_o + \beta_1^+ \sum \Delta P_{B,t}^+ + \beta_1^- \sum \Delta P_{B,t}^- + \varepsilon_t \quad (7)$$

Which can be reparametrized using the identity:

$$\sum \Delta P_{B,t}^+ + \sum \Delta P_{B,t}^- \equiv P_{B,t} - P_{B,0} \quad (8)$$

to yield:

$$P_{A,t} - P_{A,0} = \beta_o + \beta_1^+ \sum \Delta P_{B,t}^+ + \beta_1^- (P_{B,t} - P_{B,0} - \sum \Delta P_{B,t}^+) + \varepsilon_t \quad (9)$$

or

$$P_{A,t} = (P_{A,0} + \beta_o + \beta_1^- P_{B,0}) + \beta_1^- P_{B,t} + (\beta_1^+ - \beta_1^-) \sum \Delta P_{B,t}^+ + \varepsilon_t \quad (10)$$

This reparametrization of equation 7 was proposed by Ward (1982) who tested whether the coefficient $(\beta_1^+ - \beta_1^-)$ differs from 0 in order to test whether price transmission was asymmetric.

von Cramon-Taubadel (1998) asserted that the estimation of equation 10 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.

Case 1: $\beta_1^+ - \beta_1^- \neq 0$ (asymmetry) and ε_t is I (0)

Case 2: $\beta_1^+ - \beta_1^- = 0$ (symmetry) and ε_t is I (1)

Case 3: $\beta_1^+ - \beta_1^- \neq 0$ (asymmetry) and ε_t is I (1)

Case 4: $\beta_1^+ - \beta_1^- = 0$ (symmetry) and ε_t is I (0)

Case 1 implied that P_A, P_B and $\sum \Delta P_{B,t}^+$ are co-integrated, which precludes co-integration between P_A and P_B alone. Cases 2 and 3 were spurious regressions (Granger and Newbold, 1974), while case 4 implied that, P_A and P_B are co-integrated. Notably, if the Houck method pointed to asymmetry, then either of the results reflects the spurious regression (Case 3), or the prices in question are not co-integrated (Case 1). von Cramon-Taubadel (1999) asserted that, although the Houck approach to measuring asymmetry was not compatible with co-integration as previously demonstrated, it does not mean, however, that, the asymmetric price transmission between co-integrated prices using the Houck's technique cannot be test for.

Model selection

Akaike's information criteria (AIC)

One of the most commonly used information criteria is the Akaike's information criteria (AIC). The idea of AIC (Akaike, 1973) was to select the model that minimizes the negative likelihood penalized by the number of parameters as specified in the Equation 11:

Table 1. 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 ***
Multiple R^2	0.4033	
Adjusted R^2	0.4010	
Akaike's Information Criterion (AIC)	11500.06	
Bayesian information criteria (BIC)	11517.07	
Durbin Watson Stat	2.2	

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

$$AIC = -2 \log p(L) + 2p \quad (11)$$

Where, L refers to the likelihood under the fitted model and p is the number of parameters in the model. Specifically, AIC was aimed at finding the best approximating model to the unknown true data generating process and its applications drawn from Akaike (1973), Bozdogan (1987) and Zucchini (2000).

Bayesian information criteria (BIC)

One of the most commonly used information criteria is the Bayesian information criteria (BIC). BIC was derived within a Bayesian framework as an estimate of the Bayes factor for two competing models (Schwarz, 1978; Kass and Rafftery, 1995). BIC is defined:

$$BIC = -2 \log(L) + p \log(n) \quad (12)$$

Where, L refers to the likelihood under the fitted model, p is the number of parameters in the model and n is the sample size. Models that minimize the BIC were selected. From a Bayesian perspective, BIC was designed to find the most probable model given the data.

Data

The data was obtained from the Ministry of Agriculture in Ghana and consist of weekly undeflated (nominal) retail and whole sale prices for maize from January 1994 to December 2003 from Kumasi in the Ashanti Region of Ghana. The weekly data for all prices were cedi per 100 kg and given the high level of inflation in the period covered, prices were deflated using consumer price index (CPI) deflator.

RESULTS AND DISCUSSION

The Houck's static and dynamic models estimated were specified in equations 13 and 14 and the information criteria provided the basis for the selection of the number of lags included in the dynamic model. The results of the model estimations are displayed in Tables 1 and 2:

$$\Delta P_{A,t} = \beta_0 + \beta_1^{+} \Delta P^{+}_{B,t} + \beta_1^{-} \Delta P^{-}_{B,t} + \varepsilon \quad (13)$$

$$\Delta P_{r,t} = \beta_o + \beta_1^{+} \Delta P^{+}_{w,t} + \beta_1^{-} \Delta P^{-}_{w,t} + \beta_2^{+} \Delta P^{+}_{w,t-1} + \beta_2^{-} \Delta P^{-}_{w,t-1} + \varepsilon_t \quad (14)$$

The asymmetry hypothesis in static model was tested by determining whether the coefficients (β_1^{+} and β_1^{-}) were identical (That is, $H_0 : \beta_1^{+} = \beta_1^{-}$) in the static model (Equation 13). The results for the test for asymmetry based on the Houck's static model are displayed in Table 3. The p-value of 0.1828 indicated that, the hypothesis that these coefficients were equal was not rejected at the 10% or lower significance levels. Fundamentally, the Houck's static model points to the symmetric price transmission.

The formal test of the asymmetry hypothesis using the Houck's dynamic model (Equation 14) includes:

$$H_0 : \beta_1^{+} = \beta_1^{-} \quad (15)$$

$$\beta_2^{+} = \beta_2^{-} \quad (16)$$

The results for the test for asymmetry based on the Houck's dynamic model are displayed in Table 4. The p-value of 0.02196 indicated that, the hypothesis that these coefficients are equal was rejected at the 5% or lower significance levels. Fundamentally, the Houck's dynamic model found significant asymmetry in the price transmission process whilst the static model failed to confirm the existence of asymmetries. Asymmetric behavior was assessed by a joint F-test. Essentially, it was hypothesized that the effect t of increase and

Table 2. Parameter estimates of the Houck's dynamic model.

Parameter	Estimate	P- value
Intercept	780.224	0.42396
$\Delta P^{+}_{w,t}$	0.89848	<2e-16 ***
$\Delta P^{+}_{w,t-1}$	0.01557	0.82609
$\Delta P^{+}_{w,t-2}$	0.12271	0.07415 .
$\Delta P^{+}_{w,t-3}$	-0.07808	0.25220
$\Delta P^{+}_{w,t-4}$	0.01889	0.79208
$\Delta P^{+}_{w,t-5}$	-0.01826	0.80002
$\Delta P^{+}_{w,t-6}$	-0.05760	0.42656
$\Delta P^{-}_{w,t}$	0.69219	<2e-16 ***
$\Delta P^{-}_{w,t-1}$	0.07530	0.14657
$\Delta P^{-}_{w,t-2}$	0.00861	0.86849
$\Delta P^{-}_{w,t-3}$	0.11477	0.02202*
$\Delta P^{-}_{w,t-4}$	0.14893	0.00298**
$\Delta P^{-}_{w,t-5}$	-0.02580	0.60519
$\Delta P^{-}_{w,t-6}$	0.14771	0.00322**
Multiple R^2	0.4566	
Adjusted R^2	0.4413	
Akaike's Information Criterion (AIC)	11348.16	
Bayesian information criteria (BIC)	11416.22	
Durbin Watson Stat	2.15	

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

Table 3. Testing for asymmetry in Houck's static model using 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

Significant codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1; Res. DF, RSS, DF, Sum of Sq, F, Pr (>F).

Table 4. Testing for asymmetry in Houck's dynamic model using analysis of variance.

Model	Res. DF	RSS	DF	Sum of Sq	F	Pr (>F)
Symmetric	505	1.1799e+11				
Asymmetric	498	1.1420e+11	7	3.7964e+09	2.3652	0.02196 *

Significant codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1; Res. DF, RSS, DF, Sum of Sq, F, Pr (>F).

decrease in wholesale price on the retail price was the same. It therefore can be concluded that asymmetry existed under the Houck's dynamic model. This asymmetric result implied that, retailers react more quickly to increasing wholesale prices than to decreasing wholesale prices. This conclusion was derived on the basis of the Houck's dynamic model and was not supported by the Houck's static model.

In summary, the findings indicated that the Houck's dynamic model found significant asymmetry whilst the

Houck's static model failed to support this empirical evidence in the same market with the same data. The F-test associated with the null hypothesis that, the retail prices responded symmetrically to increases and decreases in the whole sale prices was not rejected in the case of Houck's static model for the maize market. In contrast, the hypothesis of symmetry was rejected in the Houck dynamic approach. In testing for asymmetry, static and dynamic variants of the same model or approach may lead to different conclusions. Houck's static model should be used together with its dynamic variant in analyzing asymmetric adjustments. It was concluded that, retailers react more quickly to increasing wholesale prices than decreasing wholesale prices in the Kumasi Market.

Conclusions

This study analyzed the behavior of tests of asymmetric price transmission according to the Houck's static and dynamic 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 was asymmetric. With the Houck's dynamic model, the retailers reacted more quickly to increasing wholesale prices than to decreasing wholesale prices in the Kumasi Market. This conclusion was not supported by the Houck's static approach. The results suggested that different variants of the same method of testing for asymmetry may lead to the differences in conclusion given the same market data. It remains imperative that the Houck's static model was used in conjunction with the Houck's dynamic model.

REFERENCES

Aguiar DRD, Santana JA (2002). Asymmetry in Farm to Retail Price Transmission: Evidence from Brazil. Agribusiness, 18(1): 37-48.

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, pp. 267-281. Budapest: Akademiai Kiado.

Bacon RW (1991). Rockets and Feathers: The Asymmetric Speed of Adjustment of UK Retail Gasoline Prices to Cost Changes. Energy Econ., 13: 211-218.

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

Bernard JC, Schertz Willet L (1996). Asymmetric Price Relationships in the U.S. Broiler Industry. J. Agric. Appl. Econ., 28(2): 279-289.

Boyd MS, Brorsen BW (1998). Price Asymmetry in the US Pork Marketing Channel. North Central J. Agric. Econ., 10: 103-109

Bozdogan H (1987). Model Selection and Akaike's Information Criterion (AIC): The General Theory and Its Analytical Extensions. Psychometrika, 52(3): 345-370.

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

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

Kass RE, Raftery A (1995). Bayes Factors. J. Am. Stat. Assoc., 90: 773-795.

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

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

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

Schwarz G (1978) "Estimating the Dimension of a Model." Ann. Stat., 6: 461-464.

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

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

Willett LS, Hansmire MR, Bernard JC (1997). Asymmetric price response behavior of red delicious apples. Agribusiness, 13: 649-658.

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

Zucchini W (2000). An Introduction to Model Selection. J. Math. Psychol., 44: 41-61.