Asymmetric price transmission between the urban and rural maize markets in Togo

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Abstract

The objective of this paper is to examine whether asymmetric price transmission between urban and rural markets exists in Togo. The evidence presented here, using the monthly retail maize price data over the period 2000-2015, strongly supports the asymmetric price responses hypothesis. The combination of ARDL and ECM provided clear evidence supporting asymmetric price adjustment between rural and urban markets. Results highlighted that maize price adjust downward faster in rural markets than in urban markets. Moreover, the study finds out that the maize price decreases in rural markets appear to be passed on more swiftly and fully to urban markets, while price increases in urban markets encounter some sluggishness in transmission to rural markets.

JEL classification: D40, O18, Q13, C32

Keys words: *Asymmetric price transmission, Urban markets, rural markets, ARDL/ECM*

1. Introduction

During last years, most governments of the Developing Countries reduced their level of intervention on the market of the agricultural products. Many economists saw in this deregulation's policy a means to improve the effectiveness of the markets whose mechanism was disturbed by the strong public intervention. It is for this purpose, the markets of cereals and specifically that of maize were liberalized in Togo in 1987. The policy of liberalization is based on the principle that coordination by the market without any direct control of the government is a more effective organization. This policy aims to remove the various dysfunctions to make competition more dynamic in order to ameliorate the efficiency of the markets by facilitating arbitrage. The arbitrage is defined as the process of exchange between actors between various segments of the market with the objective to draw an advantage of the price differences exceeding the costs of transaction. In other words in a market economy, the actors react when they observe opportunities to realize profits with buying in an area where the prices are low and selling in an area where prices are relatively high. If arbitrage is effective, the price differences reflect transaction costs. In this case the markets are integrated (Bassolet et Lutz, 1998). Thus, the success of trade liberalization policy depends on the force of the agricultural markets to transmit the signals of price from an area to another. This transmission is as fast as the markets are perfectly integrated.

When markets are integrated they provide the appropriate economic incentives to the producers by getting their prices right (Kherallah, et. al., 2000). Getting the producer prices right is expected to result from improvements in the efficiency of the domestic markets as a result of the removal of administrative controls and from a vibrant participation of the private sector.

Previous studies e.g., Alderman, 1993; Dercon, 1995; Badiane and Shively, 1998 and Yovo, 2015 have generally assumed symmetric price responses in the sense that a shock of a given magnitude to the central market would elicit the same response in the local markets, regardless of whether the shock reflected a

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price decrease or a price increase. However, as documented in the literature on price relationships, certain characteristics associated with imperfect competition e.g., market concentration, government intervention, etc.., menu costs in the case of perfectly competitive markets and inventory behaviour of traders can contribute to asymmetric price responses (Scherer and Ross, 1990; Roberts, et. al., 1994).

In specific case of Togo, many producers complain for the existence of price asymmetries, which is interpreted as evidence of monopolistic behaviour in the markets for agricultural products. The general concern raised is that the transmission of price changes between rural and urban markets may be different for price increases than for price decreases. This occurs in such a way that powerful actors in that particular market segment try to realize profits in excess of normal rates of return. In other words, Farmers often complain that decreases in farm prices are more fully and rapidly transmitted to the urban markets than equivalent increases in consumers' price. Therefore, it may be useful to test for the existence of price asymmetry between rural and urban Markets in Togo.

Previous studies conducted on the performance of the togolese grain markets (Koffi-Tessio, et. al., 2003; Yovo et Homevoh, 2006; Yovo, 2015) addressed the issues of market integration and the impact of liberalization and information service on markets integration. These studies offer useful information about the performance of the cereals markets in the post-liberalization period and indicate the presence of market integration. However, the degree of price transmission between rural and urban markets is largely unknown. This information gap should be addressed in order to fully understand the performance of the spatial marketing system.

More precisely, the article tries to answer the following question: did the rural markets and urban markets react in the same way for price increases or decreases in maize markets in Togo? Maize being the principal foodstuff among cereals marketed in Togo. To respond this query, the article begins with the literature review on the asymmetric price transmission (section 2). Section 3 describes the methodology and data used for the analysis. Section 4 presents and discusses the results. Finally the section 5 draws a conclusion and provides a direction for future research.

2. Literature review

Asymmetric price transmission (sometimes abbreviated as APT) refers to pricing phenomenon occurring when downstream prices react in a different manner to upstream price changes, depending on the characteristics of upstream prices or changes in those prices. The simplest example is when prices of ready products increase promptly whenever prices of inputs increase, but take time to decrease after input price decreases (Meyer and von Cramon-Taubadel, 2004; Peltzman, 2000). Meyer and von Cramon-Taubadel (2004) classified asymmetry in the context of price transmission according to three criteria. The first criterion refers to whether it is the speed or the magnitude of price transmission that is asymmetric. A second criterion allows APT to be classified as either positive or negative. The third criterion for classifying APT refers to whether it affects vertical or spatial price transmission.

According to the latter, the issue of Asymmetric Price Transmission received a considerable attention in economic literature because of two reasons: Firstly, its presence is not in line with predictions of the canonical economic theory (e.g. perfect competition and monopoly), which expect that under some regularity assumptions (such as non-kinked, convex/concave demand function) downstream responses to upstream changes should be symmetric in terms of absolute size and timing. Secondly, because of the size of some markets in which Asymmetric Price Transmission takes place (such as petroleum markets), global

dependence on some products (again oil) and the share of income spent by average household on some products (again petroleum products), Asymmetric Price Transmission is important from the welfare point of view. One must remember that APT implies a welfare redistribution from agents downstream to agents upstream; it has serious political and social consequences.
Peltzman (2000) in particular finds, in an extensive study of 282 products and product categories, including 120 agricultural and food products, asymmetric price transmission to be the rule rather than the exception. This leads him to the strong conclusion that the standard economic theory of markets is wrong, because it does not predict or explain the prevalence of asymmetric price adjustment.

Concerning the causes of APT, two main proposed causes dominate the literature: non-competitive markets , adjustment costs and asymmetric information. A commonly cited source of asymmetric price response is market power (Scherer and Ross, 1990). Oligopolistic middlemen in food markets may react collusively more quickly to shocks that squeeze their marketing margins than to shocks that raise them, resulting in asymmetric short-run transmission. In this case, price increases in the central market are transmitted more rapidly to the local market than price reductions. Similarly, asymmetric price transmission could result if traders in the local market believe that competitors will follow an increase in local market prices as prices in the central market rise, but that they will not respond to falling prices in the central market by granting an equivalent reduction. The role of inventories as a source of asymmetric price response is also well documented in the literature (Maccini, 1978; Blinder, 1982). Commodity price changes often send signals to inventory holders, leading to either accumulation or release of stocks. The anticipation of price increases in the central market in the next period creates an incentive for traders to increase their stock holdings by buying larger quantities of a given commodity at the present date. The increased supply from inventories in the local market puts downward pressure on prices so that they do not rise as much as they would in the absence of inventories. If on the other hand, central market prices are expected to decline, there is an incentive for traders to reduce their inventory holdings, which tends to moderate the initial downward pressure on local market prices in the next period. In either event, current local market price will not adjust fully to a change in the current central market price (Wohlgenant, 1985). Kovenock and Widdows (1998) point out that if input costs changes are perceived as temporary, then the menu costs which are likely to arise may serve as an incentive not to adjust prices when input costs decrease. These costs may result from the repricing of goods and informing sales people and customers, or may be generated by more sophisticated processes. For instance, firms may not be willing to signal their customers that market conditions have changed, since those customers could re-engage in search behaviour. Ball and Mankiw (1994) also present a model in which firms face menu costs and inflation. Under these conditions, shocks that increase a firm's desired price will trigger larger responses than shocks that reduce it. This is due to the fact that firms will take advantage of positive shocks to correct for accumulated and anticipated inflation, while inflation will already have affected some of the adjustment made by negative shocks. The presence of search costs in locally imperfect markets is also frequently cited as a reason for asymmetric price adjustment in commodity markets (Blinder, et. al., 1998). In many areas, firms may enjoy local market power due to the lack of similar firms in the neighbourhood. As a result of search costs, customers of these firms may not be able to acquire complete information about prices offered by other firms, although they face a finite number of choices. Even if customers observe a price increase at a particular outlet, they may be uncertain as to whether prices in other shops have increased. Under these conditions, firms can raise their prices quickly as prices in central markets increase and lower them slowly in response to price reductions in the central market (Abdulai, 2000).

Evidence of APT was found in the gasoline market where it was concluded that retail gasoline prices respond more quickly to increases in crude oil prices than to decreases (Borenstein, et. al. 1997). Several agricultural markets such as oranges, lemons, dairy products, pork, and beef have also been found to exhibit evidence of asymmetric price transmissions between the producer and retail levels in America and Europe (Karrenbrock, 1991).

London Economics (2003) analyses the mutual relationship between retailer and producer prices of a number of goods in Austria, Denmark, France, Germany, Ireland, Netherlands, Spain and UK. In this study the authors also employ a variation of the Von Cramon-Taubadel (1998) for the price series which turn out to be cointegrated. Empirical evidence supports the presence of asymmetric price transmission in the producer-retail relationship for the markets of Danish carrots and of UK bread, and in the retail-producer transmission mechanism for the UK lamb market.

In Africa some studies highlight APT in maize market. Goletti and Babu (1994) using Kinnucan and Forker (1987) model, showed that in Malawi, retail prices reflect price increases on the wholesale market-segment more rapidly than price decreases, indicating a rent for retailers. In Benin, Lutz (1994), did not find in maize market APT, except between two pair markets: Bohicon-Pobé and Azové and Kétou. He concluded that competition on the markets does not allow groups of traders to manipulate prices. In Ghana, Abdulai (2000) using both the threshold cointegration and asymmetric error correction models reveal that wholesale maize prices in local markets (Accra and Bolgatanga) respond more swiftly to increases than to decreases in central market (Techiman) prices. Accra prices are found to react faster than Bolgatanga prices to changes in Techiman market prices. The National Department of Agriculture in South Africa (2003) uses the model of Von Cramon- Taubadel (1998) to study the farm-retail transmission in the South African markets of maize meal, bread, fresh and long life milk, cheddar cheese and cooking oil. Monthly data over the period January 2000-July 2003 are used to obtain the impulse response functions for farm price increases and decreases, which suggests the presence of asymmetric transmission for all considered cases.

By reviewing the econometric models used in the different studies, Frey and Manera (2007) found that the most popular econometric models are: the autoregressive distributed lag (ARDL) model, the partial adjustment model (PAM), the error (or equilibrium) correction model (ECM), the regime witching model (RSM) and vector autoregressive models. The choice of a model depends on the author perception on the behaviour of actors and the nature of data. Among the 69 papers reviewed by Frey and Manera (2007), which provide a total of 83 estimated models, only 11 models show no evidence of asymmetries of any kind. Very often, models are chosen arbitrarily.

3. Methodology

3.1 The Model

In order to estimate the rate at which prices in rural and urban maize markets adjust relative to one another, a simple linear long-run relationship is estimated between the price series. The relationship takes the form of:

$$P_{i,t} = \beta + \alpha P_{j,t} + e_t \quad (1)$$

where $P_{i,t}$ and $P_{j,t}$ denote the prices of the markets i and j at time t and ε_t the error term.

The first step determines the order of integration of the variables analyzed. This step determines the number of times that a variable must be differentiated to become stationary. The test «Augmented Dickey Fuller" (ADF) is suitable for determining the order of integration.

The second step tests the hypothesis of cointegration between price series $P_{i,t}$ and $P_{j,t}$. The two-step procedure of Engle and Granger (1987) is generally recommended. However, in the presence of prices asymmetric, this procedure generates biased parameters. So we prefer the one-step method of Hendry in order to reduce bias risk (Banerjee, et.al., 1993). The model is specified as follows:

Let consider the Auto-Regressive (AR) process:

$$e_t = \rho e_{t-1} + \varepsilon_t \quad (2)$$

Substituting (2) in (1), it follows:

$$p_{i,t} = \beta + \alpha p_{j,t} + \rho e_{t-1} + \varepsilon_t \quad (3)$$

$$p_{i,t-1} = \beta + \alpha p_{j,t-1} + e_{t-1} \quad (4)$$

By taking $P_{i,t}$ and $P_{j,t}$ in difference,

$$\Delta p_t = \alpha \Delta p_{j,t} + (\rho - 1)e_{t-1} + \varepsilon_t \quad (5)$$

Substituting e_{t-1} by its expression, it follows

$$\Delta p_t = \alpha \Delta p_{j,t} + (\rho - 1)p_{t-1} - \alpha(\rho - 1)p_{j,t-1} + \varepsilon_t \quad (6)$$

$P_{i,t}$ and $P_{j,t}$ are cointegrated if and only if:

$$-1 < \rho < 1 \Leftrightarrow -2 < \rho - 1 < 0 \quad (7)$$

In the third step, Granger causality tests are conducted to determine if causal linkages between the rural and urban markets exist. This test is used to forecast future values of one variable based on past values on another. The null hypothesis in Granger Causality is that past price changes in market j, do not Granger cause future price changes in market i. The inverse equation is then subsequently tested with the null hypothesis that past price changes in market i, do not Granger cause future price changes in market j. In each test two lags of the dependent variable changes are included with two lags in the changes of another descriptive variable. The dependent variable lagged changes are included to account for its own history while causality is tested by determining if the coefficients on the lagged price changes on the descriptive variable are significantly different from zero (Wixson and Katchova, 2012).

The F-test is utilized to determine lag coefficients of price changes of the descriptive variable can jointly be a leading indicator of future changes in the price of the dependent variable. If the F-test is rejected, it can be interpreted as the past two months of price changes for market j, can together be a leading indicator of future price changes in market i. Even if individual test statistics are not significantly different from zero, performing a joint F-test may state otherwise (Verbeek 2008).

Finally, we combine ARDL and ECM to determine asymmetric price transmissions between variables using positive and negative price changes in conjunction with positive and negative values of the error correction term. The error correction terms were derived from the estimations of long run equilibrium between the markets prices series. From the asymmetric price transmission model, we determine if the prices of rural and urban adjust differently due to positive and negative deviations from long-run equilibrium.

In compliance with the theorem of Engle - Granger representation (1987), when two variables are cointegrated of order 1, the best representation of their short-term dynamics is the error correction model (ECM). The error correction term is interpreted as the actual value of the dependent variable less the predicted value of the dependent variable where $p_{i,t}$ is the actual value and $\hat{p}_{i,t}$ is the predicted value. We can then formulate that as following:

$$ECM_{i,j,t} = p_{i,t} - \hat{p}_{i,t} = p_{i,t} - \hat{a} - \hat{b}p_{i,t} \quad (8)$$

A combination of a distributed lagged adjustment model and an error correction model (Von Cramon-Taubadel, 2004) is estimated in the following form:

$$\Delta p_{i,t} = a + \sum_{m=1}^{M}(\beta_m^{+} D^{+} \Delta P_{j,t-m}) + \sum_{m=1}^{M}(\beta_m^{-} D^{-} \Delta P_{j,t-m}) + \theta ECT_{i,j,t-1} + e_t \quad (9)$$

where $\Delta P_{i,t} = P_{i,t} - P_{i,t-1}$ is prices variation in market i in month t and $P_{j,t}$ is the maize price in market j in month t , D^{+} and D^{-} are dummy variables with $D^{+} = 1\ if\ \Delta P_{j,t-m} > 0\ and\ D^{+} = 0$ otherwise; $D^{-} = 1\ if\ \Delta P_{j,t-m} < 0\ and\ D^{-} = 0$ otherwise. The $ECT_{i,j,t-1}$ is the one-period lagged residual from equation 1 and described in equation 2. However, this model assumes that price adjustments are symmetric between upward and downward price movements due to the term $\theta ECT_{i,j,t-1}$.

In order to examine the asymmetric price adjustment between variables, the residuals $\boldsymbol{ECT_{i,j,t}}$ from the cointegrating equations must be separated into $\boldsymbol{ECT_{i,j,t}^{+}}$and $\boldsymbol{ECT_{i,j,t}^{-}}$ (Scholnick, 1996). Therefore we segregate the error correction terms accordingly where,

$$ECT_{i,j,t}^{+} = \begin{cases} ECT_{i,j,t}\ if\ ECT_{i,j,t} > 0 \\ 0\ if\ ECT_{i,j,t} \leq 0 \end{cases} \quad (10)$$

and

$$ECT_{i,j,t}^{-} = \begin{cases} ECT_{i,j,t}\ if\ ECT_{i,j,t} < 0 \\ 0\ if\ ECT_{i,j,t} \geq 0 \end{cases} \quad (11)$$

The use of a distributed lag model allows for the testing of asymmetric price changes between variables. If a distributed lag structure is considered, the presence of asymmetry is only tested on the error correction term (Frey and Manera, 2007). The error correction term accounts for the long-run relationship between the variable of interest i and the descriptive variable j.Therefore, by testing the following model we can observe if price asymmetry exists based upon testing if the coefficients on the positive and negative values of the error correction terms are significantly different from zero. Lagged price differences are also separated into positive and negative values thus leading to the following specification.

$$\Delta p_{i,t} = a + \sum_{m=1}^{M}(\beta_m^+ D^+ \Delta P_{j,t-m}) + \sum_{m=1}^{M}(\beta_m^- D^- \Delta P_{j,t-m}) + \theta^+ ECT_{i,j,t-1}^+ + \theta^- ECT_{i,j,t-1}^- + e_t \quad \textbf{(12)}$$

The equilibrium relationship between the dependent and independent variable is defined simply as the mean of the residual series from the appropriate cointegrating equation and if their values are above (below) their mean they will eventually adjust downward (upward) toward equilibrium. Therefore, a positive value of the error correction term $ECT_{i,j,t}^+$ would be interpreted as the price of i being above its equilibrium price with respect to the price of j and if the coefficient θ^+ is negative we would expect the price of i to adjust downward in the following time period. A negative value of the error correction term would have the opposite meaning; the price of i is below its equilibrium price with respect to the price of j and would be expected to adjust upward toward long-run equilibrium in the subsequent time period (Scholnick, 1996; Martens, 2009). Therefore the $\theta^+$and θ^- coefficients are interpreted as price adjustments of the prices of one market with respect to another.

Two F-tests are performed to establish whether or not there are significant price adjustments, and if there are, whether they are asymmetric with respect to over-prediction and under-prediction in prices. The purpose of the first F-test is to determine if the coefficients of the $\theta^+$and θ^- are jointly significantly different than zero. A rejection of the null hypothesis that $\theta^+ = \theta^- = 0$ indicates that the price of variable i adjusts for changes in the price of variable$j$, i.e. there is a significant price adjustment. The second F-test is conducted to determine if the coefficients of $\theta^+$and θ^- are significantly different from one another. A rejection of the null hypothesis that $\theta^+ - \theta^- = 0$ means that adjustments that occur are not symmetric between positive and negative price changes.

3.2 Data

The data used are nominal[2], monthly retail maize prices for the periods from January 2000 to December 2015. These time series were extracted from the price database of DSID and ANSAT which are the two departments of agriculture's ministry in charge of prices statistics. Two urban markets, Lomé and Kara are selected according to geographical, economic criteria. Lomé the capital of Togo, has the most important and regular deficits in maize despite the convergence of maize produced in the others regions. This is due to the concentration of the population whose main staple food is maize. Most of rural markets have relationship with Lomé through wholesalers' activities. Kara can be seen as a big economic center in the North which records irregular deficit in maize. The Kara city is in relation with rural markets in savannas, central and Kara regions. The rural markets are markets in important production zones. They are selected on the basis of the importance of the maize volume transaction they established with urban markets as well as the availability of price series. Gando in the Savanna region, Kétao in Kara region, Tchamba in the central region, Anié in Plateau region and Gapé in coastal region.

[2] We use nominal instead of real prices because traders' arbitrage is not based on real but on nominal prices. Moreover, monthly inflation of cereals prices was not so important in Togo to affect significantly the efficiency of traders' arbitrage during the most period of study.

4. Results and discussion

The objective of this work is to analyze the asymmetric price transmission between the rural and urban maize markets selected. Results are analyzed in accordance with the methodology described above. We began by checking the correlation between the pairs urban-rural markets.

4.1 The correlation between the pairs of market prices

The table 1 shows that the coefficients of correlation between the pairs of markets vary from 0.45 to 0.93. Those coefficients highlight the fact that there is a linkage between urban and rural markets. However the results for some pairs like Kara-Kétao and Lomé-Anié are somewhat suprising. We expected a stronger linkage between those pairs because kétao is the most nearby kara and Anié is nearer than Tchamba, Kétao and Gando to Lomé. Those divergence can be explained by many factors: inflation and no stationarity of prices series. To avoid spurious correlation and have robust results we then perform the test of stationarity on the following step.

Table 1: Correlation between the pairs of markets prices

	Rural markets				
	Gapé	**Anié**	**Tchamba**	**Kétao**	**Gando**
Lomé	0.90	0.52	0.57	0.76	0.81
Kara	0.68	0.93	0.59	0.45	0.70

Source: Author's calculation based on data from DSID and ANSAT

4.2 Unit root test on the prices series

Table 2 shows the results of the unit root tests. Price series are not stationary. However, the ADF test for the price series in their first difference shows that the t-statistic is different from zero at the 1 %. Price series are stationary in their first differences where they are integrated in order1 (I1).

Table 2: Result of Unit root test

	Level: ADF statistics	**First difference : ADFstatistics**
Lome	-1.47 [2]	-11.30 [1]
Kara	-2.09 [4]	-10.02 [1]
Gapé	-1.20 [2]	-13.05 [1]
Anie	-2.24 [5]	-13.05 [1]
Tchamba	-1.70 [3]	-8.36 [1]
Ketao	-1.60 [4]	-6.92 [1]
Gando	-2.51 [1]	-21.26 [0]

Source: Author's calculation based on data from DSID and ANSAT; Values in brackets are the numbers of lags necessary to obtain a white noise (no autocorrelated residuals). The critical Mackinnon values of ADF test are: (-3. 52) for 1*%; (-2. 94) for 5%; (-2. 68) for 10%.*

4.3 Cointegration tests on the prices series

The price series all being integrated of order 1, the second step is to check the existence of a long-term process of integration the price series between urban and rural markets. To do this, the method of Hendry (Banerjee and al., 1993) yields the results shown in Table 3. We observe that all pairs of series between urban and rural markets are cointegrated. The result denotes the existence of a long term equilibrium between the urban and rural markets under study.

Tableau 3: Test for cointegration between prices series in urban and rural markets

	Rural markets				
	Gapé	**Anié**	**Tchamba**	**Kétao**	**Gando**
Lomé	-0.12**	-0.03***	-0.16**	-0.23**	-0.32**
Kara	-0.05*	-0.22***	-0.90**	-0.45**	-0.19*

Source: Author's calculation based on data from DSID and ANSAT. The values in cells are the cointegration's coefficients according to the estimation of equation (6). *** 1% significance level ** 5% significance level * 10% significance level*

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4.4 Test for Granger causality

In the third step, Granger causality tests are conducted to determine if causal linkages between the rural and urban markets exist. This test is used to forecast future values of one variable based on past values on another. The null hypothesis in Granger Causality is that past price changes in market j, do not Granger cause future price changes in market i. The inverse equation is then subsequently tested with the null hypothesis that past price changes in market i, do not Granger cause future price changes in market j. The results are reported in table 4.

Table 4: Statistics of Granger causality tests

	Lomé (i)	Kara (i)	Gapé (i)	Anié (i)	Tchamba (i)	Kétao (i)	Gando (i)
Lomé (j)			12.08***	10.27***	6.88**	9.75***	5.86**
Kara (j)			8.05**	11.15***	5.02**	4.54*	3.92*
Gapé (j)	10.52***	2.09					
Anié (j)	12.35***	10.57***					
Tchamba (j)	1.36	1.09					
Kétao (j)	2.02	1.24					
Gando (j)	2,07	0.83					

Source: Author 'calculation based on data from DSIS and ANSAT. The numbers in cells are F-test values.
**** 1% significance level ** 5% significance level * 10% significance level*

Results from the F-tests of Granger causality reported in Table 4 show that changes in the prices of Lomé market can be a leading indicator of changes in the price of all rural markets even the market of Gando in Savanna region. Conversely, when the reverse situation was subsequently tested, it was determined that changes in the price of rural markets namely Tchamba, Kétao and Gando were not a leading indicator of changes in the price of Lomé. In fact, we failed to reject the null hypothesis that a change in the price of each northern rural markets does not Granger cause changes in the price of Lomé. Only the changes in the prices in southern market of Gapé and Anié are leading indicators of changes in the price of Lomé. As regards the market of Kara, the results show that changes in the price of that northern city are leading indicators of changes in the prices of both all northern and southern rural maize markets. Contrarily, all rural markets prices are not leading indicators of changes of the price in Kara market except Anié market. It is important to notice that in the network of northern rural markets, Granger Causality tests using two lagged periods show that changes in the price of Anié can be used as strong indicator of future changes in the price of the two urban markets. These results provide the preliminary ideas of asymmetric price transmission. However, for deeper analysis we found appropriate to use the combination of two models, the ARDL and ECM. For convenience's reasons, the asymmetric price transmission analysis will be conducted only on the three bidirectional relationships: Lomé-Gapé, Lomé-Anié and Kara-Anié.

4.5 Test of asymmetric price transmission

We expect to observe asymmetric price relationships, especially in those variables that are strongly correlated with one another (Table 1) and in relationships where Granger causality results were significant (Table 4). The results of the price asymmetry model presented in equation (12) regarding changes in the price of urban or rural markets are reported in Table 5. Results indicate that the price in Lomé (column2) responds asymmetrically to deviations from long-run equilibrium as measured with respect to the prices of Anié. We also observe evidence of an asymmetric adjustment toward long-run equilibrium in changes in the price of Lomé with respect to changes in the prices of Anié due to the rejection of the hypothesis

$\theta^{+} - \theta^{-} = 0$. This result shows that the coefficients on the positive and negative values of the error correction term are significantly different from one another, thereby indicating that changes in the price of Lomé responds asymmetrically to changes in the prices of Anié. This result does not indicate in which direction the asymmetric adjustment occurs. In order to observe the direction and magnitude of the asymmetric price adjustment, the significance of the coefficients on the positive and negative values of the error correction term are examined individually. The asymmetric response to these variables occurs under opposite conditions. When the maize price in Lomé is above its predicted value with respect to the price of Anié, then the Lomé market price would then be expected to decrease in the subsequent month by respectively 11% of the value of the error correction term, which is the difference between the actual and predicted market price of Lomé.

Regarding the reverse relationship Anié-Lomé (column3), the asymmetric response occurs when Anié price deviates above long-run equilibrium with respect to the price of Lomé market. When this occurs the price of Anié is then expected to exhibit a downward adjustment by 34% of the value of error correction term the following month. By comparison we see that the downward adjustment of price in Anié is more than three times faster than the downward adjustment that Lomé exhibits due to its actual value which is higher than its predicted value.

In column 4 and 5 we consider the relationships Lomé-Gapé and Gapé-Lomé. In the Lomé-Gapé relationship (column 4) we fail to reject that the coefficients on the positive and negative values of the error correction term are significantly different from one another, however, we do observe that adjustments that do occur are significant. By examining the coefficients on the positive value of the error correction term in the Lomé-Gapé relationship we observe that the individual adjustment by itself is indeed significant. Therefore, it is concluded that changes in the price of Lomé respond asymmetrically to positive deviations from long-run equilibrium with respect to the prices of Gapé market. This means that the maize price in Lomé market adjusts downward when its actual value is higher than predicted with regards to the price in Gapé. This result is interpreted by saying that, when the price in Lomé is above its predicted value, they will likely experience a downward adjustment in the following month by 9% of the value of the error correction term. Regarding the reverse relationship Gapé-Lomé (column 5), a downward adjustment of 17% of the value of the error correction term in the following month is expected. By comparing the magnitude of the two adjustments it can be observed that prices in Gapé market adjust downward nearly twice faster than Lomé downward adjustment of price.

The results reported in columns (6) and (7) are similar to the previous findings. According to the results in column (6), the maize prices in Kara exhibit asymmetric price adjustments with regard to the prices of Anié market. It is concluded from the joint test of the coefficients on the positive and negative values of the error correction term that the null hypothesis is rejected. When testing to determine if the values of the coefficients of the positive and negative values of the error correction term are equal to one another, the test failed to reject also the null hypothesis. The column shows that when the actual price of maize market in Kara deviates above its long-run equilibrium with respect to the prices in Anié, then in the following month we would expect that prices would adjust downwards by 13% of the value of the error correction terms. The reverse relationship in column (7), shows that when the actual price of maize market in Gapé deviates above its long-run equilibrium with respect to the prices in Lomé, then in the following month we would expect that prices would adjust downward by 24% of the value of the error correction terms.

By comparison, we see that the downward adjustment of price in Anié is nearly twice faster than the downward adjustment that Kara exhibits due to higher than predicted prices.

The results in Table 5 also indicate that when prices in rural markets, Anié and Gapé decrease for 1%, respectively 57% and 43% of negatives variation are transmitted to Lomé (column 2 and 4) and 38% to Kara (column 6) on the following month. Conversely, when prices in urban markets increase for 1%, only 22% in Lomé (column 5) and 23% in Kara (column7) of positives variations are transmitted to Anié on the following month. We can conclude that urban markets respond more swiftly to prices decreases than to prices increases in rural markets whereas rural markets react less fast to prices increases than to prices decreases in urban markets. The finding confirms the hypothesis according to which the maize price decreases in rural markets appear to be passed on more swiftly and fully to urban markets, while price increases in urban markets encounter some sluggishness in price transmission to rural markets.

Table 5: Error Correction Model with Lagged Price Adjustment: Dependent Variable is change in the Price of market i ($\Delta p_{i,t}$)

1. Variables	2.Lomé (i) X Anié (j)	3.Anié (i) X Lomé (j)	4.Lomé (i) X Gapé (j)	5.Gapé (i) X Lomé (j)	6.Kara (i) X Anié (j)	7.Anié (i) X Kara (j)
$D^+ \Delta p_{j,t-1}$	0.03	0.22**	0.12	0.23**	0.01	0.23*
$D^+ \Delta p_{j,t-2}$	0.22	0.05	0.16	0.12	0.28	0.11
$D^- \Delta p_{j,t-1}$	0.57**	0.05	0.43**	0.03	0.38*	0.05
$D^- \Delta p_{j,t-2}$	0.25	0.16	0.16	0.09	0.12	0.20
$ECT^+_{i,j,t-1}$	-0.11***	-0.34**	-0.09**	-0.17*	-0.13**	-0.24*
$ECT^-_{i,j,t-1}$	0.11	0.13	-0.02	0.07	0.31**	-0.18
Constant	-0.54	0.45	0.06	-0.63	0.50	-0.33
N	152	152	152	152	152	152
R^2	0.37	0.31	0.21	0.25	0.40	0.19
Test $ECT^+_{i,j,t-1} = ECT^-_{i,j,t-1}=0$	3.88**	4.03**	1.45	4.07**	3.16*	5.95***
Test $ECT^+_{i,j,t-1}= ECT^-_{i,j,t-1}$	5.22***	3.27**	4.03**	4.65**	3.75**	6.05***

Source: *Author 'calculation based on data from DSID and ANSAT. .Values in the table are estimated parameters of equation (12) ***1% significance **5% significance *10% significance*

$D^+ \Delta P_{j,t-m}$ is the change in the market price j for lagged m periods if positive, zero if negative
$D^- \Delta Pj_{,t-m}$ is the change in the market price j for lagged m periods if negative, zero if positive
$ECT^+_{i,j,t-1}= ECT_{i,j,t-1}= 0$ F(2,192)
$ECT^+_{i,j,t-1}= ECT_{i,j,t-1}$ F(1,192)

Overall, these results indicate that price transmission asymmetries do exist between urban and rural in Togolese maize market. It is important to point out that this type of asymmetric price may have serious economic and social consequence from the welfare point of view because it implies a welfare redistribution from farmers to wholesalers.

Although some of the hypotheses mentioned in literature review do suggest that temporary market power could explain the asymmetry, the other explanations are consistent with competitive markets. As noted earlier, Yovo et Homevoh (2006) have shown that maize markets in Togo appear to be sufficiently competitive to prevent traders from enjoying excess margins, so the explanation for the asymmetric adjustment need to be sought elsewhere. Given that prices in Togolese markets are not posted and are generally determined by private negotiation between purchasers and traders, the observed asymmetries may not arise from menu costs associated with price changes. The response of prices is possibly due to asymmetries in the cost of inventory adjustment. The explanation for the underlying price transmission asymmetries is an issue worthy of further research.

5. Conclusion, policy implication and orientation for future research

The objective of this paper was to examine the asymmetric price transmission between urban and rural markets in order to determine whether results support the hypothesis according to which decreases in farm prices are more fully and rapidly transmitted to the urban markets than equivalent increases in consumers' price. Such a picture would pose a formidable challenge to applied economists who, in general, have been content to assume that spatial price transmission tends to be symmetric. The evidence presented here, using monthly retail maize price data over the 2000-2015 sample period, strongly supports the asymmetric price responses hypothesis. The combination of ARDL and ECM provided clear evidence supporting asymmetric price transmission between rural and urban markets. Results highlighted that maize price adjust downward faster in rural markets than in urban markets. Moreover, the study finds out that the maize price decreases in rural markets appear to be passed on more swiftly and fully to urban markets, while increases in urban markets encounter some sluggishness in price transmission to rural markets.

Although the asymmetric price transmission observed in this study may point to sub-optimal market structure, it may also be due to inventory adjustments and does not make a compelling case for government involvement in commodity markets. Government investments in roads and infrastructure will, however, help reduce transaction costs, and further promote market integration.

It would be interesting for future research to use Threshold Auto- Regressive (TAR) model which assumes that economic agents only act to move the system back to equilibrium when the deviation from equilibrium exceeds a critical threshold, whereby the benefits of this adjustment exceed the costs.

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