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ABSTRACT

This article aims to analyze the integration level of corn markets in collines in Benin. To achieve this, the methodology is to study the order of price integration, then to verify the co-integration of series and finally to test the asymmetry in the transmission of price shocks in the corn market thanks to a threshold autoregressive model (TAR). The results indicate that Glazoue regional market prices are co-integrated with local market maize prices in the collines department. Also, there is an asymmetrical co-integration relationship between the Glazoue market and other markets, confirming the existence of transaction costs which hinder the long-term relationship between the price series of these markets. In view of the results obtained, it is necessary for the authorities to improve road infrastructures, and to establish an efficient information system on the markets.

Introduction

Food security is one of the biggest challenges for developing countries in recent decades. Urban households in developing countries are finding it increasingly difficult to access food. Civil unrest and the so-called hunger riots of 2008 have highlighted the vulnerability of urban households to the surge in food prices. Thus, the market integration question has been debated in connection with the liberalization of food markets in developing countries (Badolo, 2011). The challenges of integrating agricultural markets are important for food security and agricultural growth. Indeed, different studies (Fackler and Godwin 2001,Araujo-Bonjean and Combes 2010) show that market integration increases producer incomes through better exploitation of economies of scale and comparative advantages and it stabilizes agricultural prices, thus protecting domestic markets from shocks. Market integration is a necessary condition for effective reform of agricultural markets. In the absence of a spatial integration of markets, price signals are not transmitted from food-surplus regions to food deficit regions, prices are more volatile and producers have difficulty specializing according to the theory of comparative advantage in the long run and trade gains are difficult to achieve (Badolo, 2011). The absence of market integration or full repercussions of price changes from one market to another has a considerable influence on economic well-being (Barrett and Li, 2002). Indeed, an incomplete transmission of prices due either to commercial and other policies or to transaction costs linked, for example, to poor transport or communication infrastructure, leads to a reduction in the quality of available information; regarding price, for economic agents and thus risk leading to decisions contributing to ineffective results.

The rise in commodity prices in international markets in the period 2006-2008 has renewed the debate on price transmission. This price spike began in 2006 and affected food prices over the 2007-2008 period. It has led to increased food insecurity. The United Nations Food and Agriculture Organization (FAO) showed in a study that the food price index increased by 7% in 2006 and by 27% in 2007. This rise is accelerated in the first half of 2008 to reach 61%. Between January 2007 and March 2008 maize prices increased by 42%.

Benin does not seem to escape this observation. The price of maize, the main staple food produced and consumed in the country, has risen by 220% from \$ 300 to \$ 950 per tonne in 2007-2008 (ONASA, 2009). In fact, to combat food insecurity, the Beninese government, decision-makers must have a good knowledge of how the market works, good understanding of how regional market price signals are transmitted to their local markets (or conversely) to make the functioning of the markets more efficient.

The purpose of this article is to analyze the integration of maize markets in the collines in Benin. In other words, measure the degree of price transmission of corn in the collines. The article is organized as follows: section 1 makes a brief review of the literature. The Section 2 explains the methodology used, introduce the descriptive analysis of the data. The last part presents and discusses the results obtained.

2. Literature Review

Market integration and price transmission

The analysis of market integration is of growing interest in recent years. The definition of market integration is relatively unclear in the economic literature. Its definition differs according to the authors; integrated markets would correspond to locations with highly correlated prices (Harris, 1979), to geographically connected positions through trade flows (Ravallion, 1986) or to regions whose prices are related to one another, or the smooth transmission of price and information signals between spatially separated markets (Barett, 1996). Two markets engaged in trade relations are said to be integrated into space when the price difference between these two markets equals the cost of transfer (Baulch, 1997). Barett and Li (2002) draw on all of these definitions to define market integration as the process by which demand, supply and transaction costs in spatially separated markets jointly determine prices and trade flows, as well as then the transmission of price shocks from one market to another.

The market integration question and price transmission is key to understanding how agricultural markets are integrated. The terms "market integration" and "transmission of price shocks" are widely used in price analysis. However, in the literature, the distinction between market integration and price transmission is difficult since market integration is a consequence of price transmission. In other words, it is according to the degree of price transmission that we can conclude whether the agricultural markets are integrated or not. The integration of markets and the transfer of prices are based on the law of the single price which postulates that the price difference between two markets governed by commercial links is equal to the transaction costs. The satisfaction of this law leads to the conclusion that the markets are integrated; in other words, the transmission of prices between them is perfect.

Evolution of the measurement of integration

The first analyzes of market integration have used correlation coefficients (Harris, 1979), which have the disadvantage of not taking into account the influence of common factors that affect all markets. In contrast to dynamic models have been developed to test the integration of markets. These include Granger's causality tests, the analysis of automatic responses of structural or non-structural autoregressive vector (VAR) models and cointegration analyzes (Engle and Granger, 1987, Johansen

1988). Among all the integration tests, those based on the cointegration technique (Engle and Granger 1987, Johansen 1988) are the most widely used in the literature. However, these classical cointegration models (Engle and Granger, 1987 and Johansen, 1988) assume asymmetric fit, ie the price response is the same regardless of the nature of the shock. But, several factors can induce an asymmetric price response such as government intervention, transport costs linked to the quality of transport and communication infrastructure and the market power of commercial intermediaries can be sources of asymmetry (for example Abdulai 2000, Subervie 2008). The latest developments in market integration techniques focus on two broad categories of models.

It is, on the one hand, a regime change models (Spiller and Wood, 1988, Sexton et al., 1991, Baulch, 1997 and Araujo et al., 2005), which take into account commercial discontinuities and transactional costs that is complex and time-varying(Sanogo, 2008). On the other hand, we have Threshold autoregressive models (TAR) or error-correction models in which the rate of adjustment varies according to the level of price imbalance -TVECM- (Balke and Fomby, 1997, Hansen 1997, 1999, 2000, Goodwin and Holt 1999, Enders and Granger 1998, Enders and Siklos 2001, Obstfeld and Taylor 1997). The estimation of these TAR or TVECM models comes up against the difficulties of statistical inference when the nuisance parameters are not identified under the null hypothesis of linearity (Hansen, 1996 cited by Aurojo and Combes 2010).

Empirical review

Abdulai (2000) analyzes price transmission in major maize markets in Ghana using a TAR model. The author shows that commercial intermediaries significantly influence the transmission of price shocks from the central market and that wholesale prices in secondary markets adjust more rapidly to increases than to declines in the primary market. Badolo (2011) evaluated the relationship between the amount of imported rice in Burkina Faso and the international price from linear and non-linear cointegration tests (TAR). The empirical analysis uses monthly price series for two markets in Burkina Faso, the Sankaryare market in Ouagadougou and the Dori market in the north of the country. The results show that the price of imported rice on the markets in Burkina Faso is integrated into the international price. The elasticity of long-term transmission appears relatively high. The TAR model reveals an asymmetric transmission whose magnitude differs according to the nature of the shocks. Mundlak and Larson (1992) use the static regression technique to estimate the transmission of international food prices to national prices in 58 countries with annual price data provided by FAO. The authors highlight an almost perfect price transmission. They find a median transmission elasticity of 0.95, which means that 95% of world price changes are passed on to national markets. Using a dynamic econometric model, Quiroz and Soto (1995) used the same data from Mundlak and Larson (1992). The authors conclude that there is no long-term relationship between domestic and international prices for 30 of the 78 countries in the sample, and in countries where there is a relationship, convergence is very low in many cases. Baffes and Gardner (2003) use an error-correction model to analyze price transmission with a sample of 31 country-product pairs over the period 1970-1990. The authors find that only a small part of the world price changes are passed on to national prices. By introducing structural breaks in their model, the authors show that the reforms have contributed to considerably limiting price transmission. Conforti (2004) analyzed the transmission of prices with a sample of 16 countries, including three from Sub-Saharan Africa for 7 types of agricultural products using an error-correction model. The results obtained for African countries differ according to the state and the kind of product. In Ethiopia, the authors highlight the existence of a long-term relationship between world prices and national prices for wheat, sorghum and maize. In Ghana, there is a relationship between the international price and the domestic price for wheat but no connection for maize and sorghum. In Senegal, the authors find a long-term relationship for rice but not for maize.

Empirical studies have tried to highlight some factors that have led to asymmetric price transmission at the national or international level. In return, few studies have examined the relationship between local price shocks and the price response in a regional market within Benin country, given the problems related to the availability of data in the context of developing countries. The degree of transmission may differ depending on the market. To do this, we test the maize price response in the Glazoue market following the impact of corn price shocks on local markets in the Collines department of Benin.

3. Methodology

3.1 Specification of the model

To analyse the integration of agricultural markets, we first determined the properties of the price series of our sample using unit root tests. After, we test co-integration according to the approaches of Engle Granger (1987) and Enders and Granger (1988). Finally, in case of co-integration of the series, standard and asymmetric error correction models are specified.

3.1.1 Standard stationarity and co-integration test

In this study, the order of series integration is determined by the Dickey-Fuller augmented tests (ADF-test = Augmented Dickey Fuller test) and Philips-Perron (PP).

We have tested the hypothesis of non-co-integration of price series using the Engle-Granger technique (1987).To test the hypothesis of co-integration of the series from the Engle-Granger method, we start from the long-run equilibrium relationship between the price of corn in local markets and the price of the regional maize market of Glazoué in the department of the collines in Benin;

$$P_t^d = ß_o + ß_1 P_t^e + \mu_t (1)$$

Where P_t^d and P_t^e respectively are the corn price of Glazoué regional market and prices of local markets.μ_t is the random error term of constant variance and captures the effect of unobservable variables such as transaction costs (all costs related to transportation, storage and trade margins). If μ_t is stationary, the two prices $P_t^d$and$P_t^e$are co-integrated, which implies that a stable long-term equilibrium relationship links them.

The coefficient $ß_1$ represents the elasticity of long-term transmission. It measures the proportion of P_t^e variations transmitted to P_t^d. The Engle-Granger technique for testing the co-integration hypothesis applies to the residue of equation (1) as follows:

$$\Delta\mu_t = \rho\mu_{t-1} + \varepsilon_t \ (2)$$

Where ρ is the speed of convergence $\varepsilon_t$is a white noise. The standard integration order tests namely the Augmented Dickey-Fuller test and the Phillips-Perron test are performed on equation (2). The non-co-integration hypothesis can be rejected if the μt residues are stationary and of zero average. If the tests invalidate the non-co-integration hypothesis, an error correction model is estimated to examine the short-run dynamics. This model is in the following form:

$$\Delta P_t^d = \alpha + \gamma\mu_{t-1} + \sum_{k=0} \theta_k \Delta P^e_{t-k} + \sum_{k=1} \rho_k \Delta P^d_{t-k} + \varepsilon_t \quad (3)$$

Where γ is the adjustment speed of P_t^d andθ_k represents the short-term transmission elasticities (short-term dynamics).

3.1.2 Asymmetric transmission modeling

The hypothesis that there is an asymmetry in the transmission of price shocks in the corn market in the hill department is tested using an autoregressive threshold model (TAR).

- The autoregressive model with threshold

The relation (2) supposes that there exists a symmetric adjustment. However, most economic variables are subject to asymmetrical adjustments. Enders and Granger (1998) propose to take these adjustments into account by integrating positive (ρ1) and negative (ρ2) values of the residual. Thus, the asymmetric co-integration test equation is as follows:

$$\Delta\mu_t = I_t\rho_1\mu_{t-1} + (1-I_t)\,\rho_2\mu_{t-1} + \varepsilon_t \quad (4)$$

Where μ_t is the residue of relation (1), such that μ_t is independent of ε_t. I is an indicator function defined as follows:

$$I_t = \begin{cases} 1\, si\, \mu_{t-1} \geq 0 \\ 0\, si\, \mu_{t-1} < 0 \end{cases} \quad (5)$$

The long-term equilibrium is given by $\mu_{t-1}=0$. If $\mu_{t-1}<0$ this means that a decrease in the price of the local market in question leads to a positive deviation from the long-run equilibrium, in this case the adjustment speed is equal to $\rho_1\mu_{t-1}$. Si $\mu_{t-1}<0$ a rise in the price of the local corn market in question leads to a negative deviation from the equilibrium, in which case the adjustment speed is equal to $\rho_2\mu_{t-1}$. Moreover, if ρ1 less than ρ2 then the positive deviations are more quickly absorbed than the negative differences.

To account for dynamic adjustment effects, Enders and Granger (1998) show that equation (4) can be modified by adding lags of μ_t. Indeed, equation (4) is not enough to capture the dynamic adjustment of $\Delta\mu t$ at its long-term equilibrium value. The modified equation (4) is as follows:

$$\Delta\mu_t = I_t\rho_1\mu_{t-1} + (1-I_t)\,\rho_2\mu_{t-1} + \sum \alpha_k \Delta P_{t-k}^{e} + \sum_{i=1}^{p-1} \gamma \Delta\mu_{t-1} + \varepsilon_t \quad (6)$$

Before estimating equation (6), it is important to ensure that there is no autocorrelation of residuals and the choice of the appropriate number of lags. The autocorrelation of the residue is tested using Breush-Godfrey tests. There are several methods for determining the number of delays of variables in a model. However, in our, to determine the offsets of the variables we will use the Akaike Information Criteria (AIC) and the Schwartz Bayesian Criterion (SC).

For this, we will choose any number of shifts p that will vary from 1 to 10 while observing each time the values of the statistics of Akaike and Schwartz. The number of optimal lags (p*) that will be taken into account is the number corresponding to the smallest values of the AIC and SC statistics. However, there are cases where the results of the two criteria differ. In such cases, we will choose the smallest number of shifts.

The co-integration test in the TAR model is based on the coefficients ρ_1 and $\rho_2$if the price co-integration hypothesis is verified, the coefficients ρ_1 and $\rho_2$are negative. Enders and Siklos (2001) use two tests: the t-Max (the largest of the two individual statistics) and the t-Min (the smallest) to test the hypothesis that the coefficients are significantly negative and an F-test. To test the hypothesis that they are jointly different from zero. The critical values of this test are given by Enders and Siklos (2001). According to Enders and Siklos (2001), the co-integration of variables makes it possible to write the error correction model as follows:

$$\Delta P_t^{d} = \omega + I_t\rho_{1.1}\mu_{t-1} + (1-I_t)\,\rho_{2.1}\mu_{t-1} + \sum \alpha_k \Delta P_{t-k}^{e} + \sum \beta_k \Delta P_{t-k}^{d} + \dot{\eta}_t \quad (7)$$

Where ρ_1 and ρ_2 are respectively the adjustment coefficients for positive shocks (decrease in the price of maize on the local market) and negative shocks (rise in the price of maize on the local market).

3.2 Source and data collection

The analysis uses monthly data of the price of maize collected on the various maize markets in the collines department by specialized services in the group and dissemination of statistics: MAEP, CeRPA, ONASA. These maize price series were deflated using the consumer price index in Benin. The period chosen for the study of the integration of agricultural markets in the department of the collines is that which goes from 2004 to 2010. The peculiarity of this period is that it constitutes a period during which the flight of the prices of the There has been a remarkable increase in foodstuffs at the international and national levels, particularly in 2007 and 2008.

4. Results and Analysis of Estimates

4.1. Results of stationarity tests

The three models are estimated and the results are presented in Table 1:

Table 1: Unit root test on level price series

Markets	Bante	Dassa-Zoume	Glazoue	Ousse	Savalou	Save
Model 1	-2,729	-1,981	-1,107	-2,296	-0,469	-3,06
Model 2	-2,762	-2,147	-2,354	-2,280	-1,056	-3,269
Model 3	-0,448	-0,184	-0,574	-0,333	-0,959	-1,247

Source: Based on ONASA's price series

The Dickey-Fuller Augmented test performed on all the price series shows that we cannot reject the existence of unit root in these series and this for the three possible specifications: without trend but with a constant term, with trend and the constant term, without trend and without constant term.

The results of this test are shown in Table 1. The critical values are: -3,4556, -3,9946, -2,5730 respectively for models 1,2 and 3. It is easy to see that whatever the model or series, the calculated values are higher than the critical values. As a result, it can be concluded that no series is level stationary or that all series of prices are non-stationary.

The results of the test, in the first difference, are presented in Table 3. Here again, all three models were estimated. The results showed that model 3 without constant or trend is the best specification of all series. The result shows the rejection of unit root in the first difference series. Indeed, all the calculated t-statistics are below the critical values, at the 1% threshold. The white noise is obtained with the lags number equal to 1, as confirmed by the Q tests of Ljung Box and Brusch-Godfrey. Then, all price series are integratedin order 1. In other words, the price series of all markets are stationary in first difference.

Table n ° 2: Unit root test on first difference price series (p = 1)

Markets	Bante	Dassa-Zoume	Glazoue	Ousse	Savalou	Save
ADF	-12,5984*	-11,6259*	-12,7763*	-15,6325*	-13,8182*	-12,9239*
Q-stat[1]	1,000	0,988	0,891	0,951	0,979	0,912
LM test[2]	0,6272	0,7178	0,3044	0,6054	0,4882	0,4161

Source: Based on ONASA's price series

*Note: * significant test at 1%.*

1 These are the probabilities of the Ljung-Box Q statistics autocorrelation test

2 These are the probabilities of the Breusch-Godfrey Lagrange multiple self correlation tests.

The critical values at 1% are: -3.45, -3.99, -2.57 respectively for the models 1,2 and 3. It is noted that the values resulting from the ADF test are lower than the values critical for all markets on first difference price series (p = 1). It can be concluded that prices are stationary only in first difference at the 1% threshold.

The results of Phillips-Perron (PP) without constant and trend are as follows:

Table 3: Unit root test on monthly data

Series	Bante	Dassa-Zoume	Glazoue	Ousse	Savalou	Save
I(0)	-0,158	-0,143	-0,012	-0,217	-0,164	-0,174
I(1)	-65,712**	-22,503**	-26,203**	63,712**	-28,516**	-21,899

Source: Based on ONASA's price series

*Note: The values recorded in the table above are the estimated values of τ of PP, compared to the critical values of Mackinon according to the degree of significance: - 4.12 for 1%; - 3.46 for 5% and -3.13 for 10%; ** (significance at 5%)*

It can be seen from this table that none of the price series is stationary in level but they are in first difference, which confirms the result of the ADF test.

The results of the previous tests show that the variables are all integrated of order one (1); a variable is integrated of order p if it is necessary to differentiate it p times so that it is stationary. Thus these variables are combined of order 1 because they must be separated once they are stationary.

4.2. Results of estimates and economic interpretations

4.2.1 Co-integration tests of price series

The estimation of the long-term relationship (equation (1)) provides a transmission elasticity of 0.400 for the Bante market, 0.259 for the Dassa-Zoume market, 0.481 for the Ouesse market, 0.334 for the Savalou market and 0.281 for the Save market. The co-integration test of Engle and Granger (1987) is then applied to the residue of the long-term relationship. The test statistic is less than the critical value for all market pairs, so the null hypothesis of non-co-integration is rejected (Table 5). This means that Glazoue corn market prices are co-integrated with corn prices of local markets in the collines department. For example, according to Table 4, a 1% increase in Save's maize price will be hit by 28% in the Glazoue corn market.

Table 4 presents the result of the estimation of the Engle-Granger long-term relationship between Glazoue corn prices and the price of other markets in the collines department.

Table n ° 4: Estimation of Engle-Granger's long-term relationship between Glazoue corn prices and the price of other markets

Pair of markets	β0	β1
Glazoue-Bante	2,810***	0,400**
Glazoue-DassaZoume	3,567***	0,259**
Glazoue-Ouesse	2,548***	4,481**

Glazoue-Savalou	3,296***	0,334**
Glazoue-Save	3,457***	0,281**

Source: Based on ONASA's price series

*Note: ***, ** (1% significance, 5%)*

Table 5: Co-integration test results according to Engle and Granger (1987)

Pair of markets	ADF test statistic	Co-integration hypothesis
Glazoue/Bante	-6,11 (0,00)	
Glazoue/Dassa-Zoume	-5,25 (0,00)	
Glazoue/Ouesse	-7,2 (0,00)	Accepted
Glazoue/Savalou	-5,35 (0,00)	
Glazoue/Save	-5,10 (0,00)	

Source: Based on ONASA's price series

Note: The values without parentheses are the ADF estimates to compare with the critical values of Mackinon according to the degree of significance: -4.12 for 1%; -3.46 for 5%; -3.13 for 10%. Values in parentheses are P Values.

The tests being confirmed the co-integration hypothesis, the estimation of the error correction model to examine the short-term dynamics is presented in the following table:

Table 6: Model with standard error correction

	Bante	Dassa-Zoume	Ouesse	Savalou	Save
γ	-0,170	-0,068	-0,159	-0,122	-0,079
	(0,041)	(0,068)	(0,038)	(0,039)	(0,021)
θ_0	0,302**	0,261**	0,316**	0,285**	0,279**
	(0,030)	(0,037)	(0,035)	(0,039)	(0,032)
Prob(*t-Breusch-Godfrey)*	0,35	0,63	0,42	0,55	0,61

Source: Based on ONASA's price series

*Note: Numbers in parentheses represent standard deviations. The Breusch-Godfrey test confirms the absence of autocorrelation of residues (probability greater than 0.05 at the 5% threshold). ** (significance at the 5% threshold)*

The analysis of this table shows us that the error correction coefficients (γ) are very negative and significantly different from zero and also they are less than unity in absolute value for all markets. This allows us to accept the validity of the Error Correction Model (ECM) because there is an error correction mechanism.

The short-term transmission elasticity $\theta_0$appears relatively low (0,261 for Dassa-zoumé, 0,285 for Savalou, etc.).

3.2.2 Asymmetric co-integration tests of price series

Table 7 presents the values of the Akaike (AIC) and Schwarz (SC) information criteria according to ten successive values of p (number of lags).

Table n ° 7: Choice of the p number of admissible lag(s)

P	1	2	3	4	5	6	7	8	9	10
AIC	44,4	44 ,32	44,08	43,90	43,93	43,86	43,98	44,08	44,02	44,06
SC	45,12	45,68	46,08	46,55	47,22	47,80	48,58	49,35	49,94	50,65

Source: Based on ONASA's price series

It can be seen that with the Akaike information criterion, the lag p = 6 would be selected while the delay p = 1 is chosen by the Schwarz information criterion. The Schwarz information criterion appears best in the selection exercise of the number of allowable delays of a model. Moreover, for the delay p = 1, the error is white noise. As a result, we will proceed to the co-integration test with p = 1.

4.2.2.1 TAR model for different market pairs

Table n ° 8: Economic results of the TAR model for the different pairs of markets:

Market Pairs	Glazoue-Bante	Glazoue-DassaZoume	Glazoue-Ousse	Glazoue-Savalou	Glazoue-Save
P_1	-0,197	-0,241	-0,185	-0,212	-0,273
P_2	-0,704	-0,638	-0,721	-0,653	-0,542
$F(p_1=p_2=0)$	14,260	13,015	12,690	13,781	11,422
$Wald(p_1=p_2)$	4,853	6,075	5,902	7,013	6,980

Source: Based on ONASA's price series

Note: the value of F read on the table of Enders and Siklos (2001) at the 5% threshold is 5.87; the Wald test is the test of equality of the coefficients p.

The results of the asymmetric co-integration test with one lag and for a threshold equal to zero (Table 8) show that the coefficients p1 and p2 are negative for all market pairs. It can thus be concluded that all the models converge and the hypothesis of non-co-integration of the TAR model is rejected because the calculated value of F is higher than the value read on the table of Enders and Siklos (2001) at the threshold of 5. % is 5.87.

We then test the symmetric fit assumption. This assumption assumes the equality of the coefficients (p1 = p2) and is tested from the standard test file or Wald test. The results of the test give values: 4,853; 6.075; 5,902; 7,013 and 6,980 for Glazoue-Bante, Glazoue-Dassazoume, Glazoue-Ousse, Glazoue-Savalou, and Glazoue-Save respectively. The symmetric adjustment assumption is therefore rejected for the five markets for a zero threshold. We can thus conclude that there is an asymmetrical co-integration relationship between these market pairs. This result confirms that there are factors such as transaction costs, market power that hinder the long-term relationship between the price series of these markets.

The estimated coefficients of p1 and p2 are -0.197 and -0.704 for Bante. The p1 value indicates that about 19% of the positive deviations (lowering of the maize price at Bante) compared to the long-term equilibrium are absorbed over a month. On the other hand, that of p2 indicates that 70% of the negative deviations (increase in the price of maize at Bante) compared to the long-term equilibrium are absorbed throughout a month.

In the case of Dassa-zoume (respectively from Ouesse), the estimated coefficients of p1 and p2 are -0.241 and -0.638 (respectively -0.185 and -0.721). The p1 value indicates that about 24% (respectively 18%) of the positive deviations, the fall in the price of maize at Dassa-zoume (respectively of Ouesse), compared to the long-term equilibrium are absorbed during a month. On the other hand, that of p2 indicates that 63% (respectively of 72%) of the negative deviations, lowering of the price of corn at Dassa-zoume (respectively of Ouesse), compared to the long-term equilibrium are absorbed during a month.

In the Savalou (respectively Save) case, the estimated coefficients of p1 and p2 are -0.212 and -0.653 (respectively -0.273 and -0.542). The p1 value indicates that about 21% (respectively 27%) of the positive deviations, the fall in the price of maize at Savalou (respectively Save), compared to the long-term equilibrium are absorbed over a month. On the other hand, that of p2 indicates that 65% (respectively 54%) of the negative deviations, increase in the price of maize at Savalou (or Save respectively), compared to the long-term equilibrium are absorbed throughout a month.

Table 9: Results of the error correction model with an asymmetric price adjustment

	Glazoue-Bante	Glazoue-Dassa-Zoume	Glazoue-Ouesse	Glazoue-Savalou	Glazoue-Save
P_{1-1}	-0,202	-0,170	-0,225	-0,184	-0,163
	(0,073)	(0,043)	(0,081)	(0,059)	(0,032)
P_{1-2}	-0,425	-0,382	-0,452	-0,401	-0,351
	(0,087)	(0,045)	(0,095)	(0,082)	(0,032)
	0,153	0,124	0,161	0,146	0,116
	(0,042)	(0,033)	(0,051)	(0,039)	(0,030)
	0,063	0,055	0,075	0,060	0,050
	(0,015)	(0,011)	(0,017)	(0,013)	(0,010)
Observations	72	72	72	72	72
Wald	7,603	6,798	7,861	7,058	6,551

Source: Based on ONASA's price series

Note: Numbers in parentheses represent standard deviations. The null hypothesis of the Wald test is H0: p1-1 = p1-2 = 0.

These results mean that shocks at the origin of positive deviations are more persistent than those at the origin of negative differences in the Bante, Dassa-zoume, Ouesse, Savalou and Save markets. In other words, maize prices on the Glazoue market respond more quickly to shocks driving price increases in the five markets than to those resulting in declines in these five markets.

The analysis of the short-term dynamics from the asymmetric error correction model shows that a 1% increase in the price of corn in Bante leads to an increase of about 15% in the price of maize at Glazoue; a 1% increase in the price of maize in Dassa-zoume brings about a 12% increase in the price of corn in Glazoue, a 1% increase in the price of maize in Ouesse leads to an increase of about 16% in the price of maize corn at Glazoue, a 1% increase in the price of maize at Savalou brings about 15% of the corn price to Glazoue, a 1% increase in the price of Save leads to a rise of about 12% in the price of corn at Glazoue.

Moreover, the prices on the Glazoue market respond significantly to positive deviations and negative to equilibrium. Indeed the estimated coefficients are - 0.202 and -0.425 for Bante. The p1.1 value indicates that about 20% of the positive deviations (lowering of the maize price at Bante) compared to the long-term equilibrium are absorbed over a month. On the other hand, that p2.1 indicates that 42% of the negative deviations (increase in the price of maize at Bante) compared to the long-term equilibrium are absorbed over a month.

In the case of Dassa-zoume (respectively from Ouesse), the estimated coefficients of p1.1 and p2.1 are -0.170 and -0.352 (respectively -0.225 and -0.452). The value p1.1 indicates that about 17% (respectively 22%) of the positive deviations, lowering the price of maize at Dassa-zoume (respectively of Ouesse) compared to the long-term equilibrium are absorbed during the a month. On the other hand, that of p2.1 indicates that 35% (respectively 45%) of the negative deviations, an increase of the price of maize at Dassa-zoume (respectively of Ouesse), compared to the long-term equilibrium are absorbed during the month.

In the case of Savalou (respectively Save), the estimated coefficients of p1.1 and p2.1 are -0.184 and -0.401 (respectively -0.163 and -0.351). The value p1.1 indicates that about 18% (respectively 16%), positive deviations, lowering the price of maize at Savalou (respectively Savè), compared to the long-term equilibrium are absorbed during the month. On the other hand, that of p2.1 indicates that 40% (respectively 35%), negative deviations, increase in maize prices at Savalou (Savè) respectively, compared to the long-term equilibrium are absorbed during the course of a month.

5. Conclusion

This article aims to analyze the level of integration of corn markets in the collines in Benin. In other words, measure the degree of transmission of maize prices in the Bante, Dassa-zoume, Ouesse, Savalou and Save markets on the one hand and the Glazoue regional market on the other. To achieve this, the methodology consists in studying initially the order of integration of the maize price series by the Dickey-Fuller augmented tests and Philips-Perron (PP). Next, co-integration of the price series is tested using the Engle-Granger technique (1987). Finally, the asymmetry in the transmission of price shocks of the corn market in the collines department is examined thanks to a threshold autoregressive model (TAR).

The results of the integration level tests show that the price series of all the markets are stationary in first difference. Also, the co-integration test of Engle and Granger (1987) indicates that Glazoué corn market prices are co-integrated with the corn prices of local markets in the collines department. The results of the asymmetric co-integration test suggest that all models converge and the non-co-integration assumption of the TAR model is rejected; in other words, there is an asymmetrical co-integration relationship between these market pairs. This result confirms that there are factors such as transaction costs, market power that hinder the long-term relationship between the price series of these markets.

Given the results obtained, it is necessary for the authorities to improve the road infrastructure, as the poor state of rural feeder roads is an obstacle to access to village markets for maize collection, especially for non-resident wholesalers; to establish an effective market information system.

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