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Spatial integration of Vegetable Markets in West Africa: Case of Tomato *(Lycopersicum esculentum)* between Benin and Burkina Faso

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ABSTRACT

The instability of world prices of traditional cash crops led to the promotion of nontraditional crops. Among the latter, vegetable farming is positioned as strategic cropping for meeting urban and periurban food consumption in most West African countries. Seasonality differences between coastal and sahelian countries, coupled with, the logic of vegetable producers, and the requirements of crops and the prices variability resulted in the development of production and marketing strategies favorable to market integration in West African countries. This study aims at providing preliminary information on tomato market integration between Benin and Burkina Faso. Data from fields surveys and on monthly prices, extracted from ONASA and DGSA databases are used to analyze the regional market integration. Cointegration models based on Johansen approach and Autoregressive Distributed Lag approach of Pesaran are used for analysis. The hypothesis on the existence of a potential weak integration of tomato markets was confirmed and corroborated in this study. Established chains of integration were identified between the Cotonou market and the main tomato-producing areas of Burkina Faso and Benin production areas with the markets of Boulkiemdé, Kénédougou, Oubritenga Sanguié respectively. The integration chain of Cotonou was found to be more established than the Bohicon and the Malanville chains and constitute a reference market for tomato wholesalers. However, there is need to conduct further in-depth analysis on integration to tap existing opportunities for enhanced vegetable producer's income and poverty reduction.

Key words: West Africa, tomato, complementarity, market integration

JEL Classification:

INTRODUCTION

Most of West Africa countries are under the similar agro-climatic conditions and therefore produce the same agricultural commodities. Benin and Burkina Faso are two countries of the zone whose economies are based on agriculture. According to the Ministry of Agriculture (MAEP 2006) in Benin, the agricultural sector employs about 70% of the labor force, contributes for 39% of GDP and provides 80% of export earnings of the country. While in Burkina Faso, the same sector which represents on average 40% of GDP at constant prices, occupies more than 80% of the active population and nearly 80% of export earnings.

The performance of the agricultural sector in the two countries results from a series of policy measures at national and regional levels. These reforms aim at improving the competitiveness of the sector through the diversifications of sub-sectors. Then, vegetables become important in increasing producers' incomes, playing an important role in the diet and reducing food insecurity in rural communities. Governments put efforts in this sub-sector (MAEP, 2006; Tapsoba, 2007).

Unfortunately, analysis reveals that domestic production is low and cannot meet the demand along the year in both countries Benin and Burkina Faso. Therefore, this situation increases the prices of tomato. Seasonality differences between coastal and sahelian countries, coupled with, the logic of vegetable producers, and the requirements of crops and the prices variability resulted in the development of production and marketing strategies favorable to market integration in West African countries.

Tomato exports from Burkina Faso to Benin are effective. However, Tapsoba (2007) wrote, "There is a lack of coherence between the production and the processing and marketing. This inconsistency particularly affected farmers and their families who are deprived of income to honor prescriptions and to ensure the education of their children, are the producers". In 2007, when tomato prices continue to burn in the markets of Benin, Burkina Faso producers are crying slump. Also, the period of scarcity of tomato in Benin extends from November to July (DPP / MAEP, 2009), period which coincides with production period in Burkina Faso.

Previous researches have been made on the complementarity and integration of agricultural markets in general in the sub-region on cereals (Koffi-Tessio et al., 2007; Abiassi and Klevor 2007; Lutz et al., 2006; Koffi-Tessio 1999). Very little scientific information is available on conventional agricultural products, such as tomato market between countries in West Africa. Unfortunately, that information is not capitalized. Also, integration issues are often based on macroeconomic information, including prices of export and import, inflation, VAT, etc. (Goletti and Christina-Tsigas, 1995; CEDEAO, 2004; Njinkeu and Posso, 2006; UEMOA, 2008). Previous economic integration analyses based on agricultural products excluded microeconomic dimensions, important for enabling effective markets. Given these deficits, the fundamental question arises: What is the level of tomato market integration between Benin and Burkina Faso?

In tropical Africa, the rapid growth of the urban population raises the question of urban food supply (Olanrewaju et al., 2004). Therefore, the urban and perurban agriculture (UPA) is an option that attempts to address the problem of improving urban food insecurity, despite the low performance of farming production systems. Gardening appears today in the cities of Benin as a major component of UPA (Mougeot, 2006). Vegetable crops occupy particularly vulnerable segments of the population (Adorgloh-Hessou, 2006; Tokannou and Quenum, 2007). Tiamiyou and Sodjinou (2003) revealed irregular supply and insufficient consumption areas in Benin. Studies carried out by LARES (2001, 2004) have showed that the supply of horticultural products in Benin in general and in particular in the major cities is far below the demand. According to LARES (2001), the annual domestic demand of tomatoes, in Benin, is around 105,000 tons, while supply is estimated at 84,000 tons. This situation causes the sudden dependency of Benin, during certain periods of the year. The complement comes from other countries in the sub-region including Burkina Faso, Ghana, Niger and Nigeria (Tiamiyou and Sodjinou, 2003).

In Burkina Faso, the UPA plays an important role in the economy. However, it is threatened by climatic factors, particularly rainfall generally quite low, very irregular, poorly distributed and short-lived. Tomato cropping is settled during the off-season October- April (Judicome / Jexco, 2004; Traoré-Gué and Dao, 2007). Before this period, Burkina Faso is deficient in fresh tomatoes. The complement comes mainly from Ghana, Mali and Côte d'Ivoire (DGPSA, 2008). Marketing of tomato has generated 37 % of total vegetable incomes (Easypol, 2007).

In other hand, fresh tomato exports towards the EU are became difficult nowadays because of phytosanitary standards set regarding pesticide residues. Face to these economic challenges for West Africa countries, it is very important to develop and strengthen the regional integration of agricultural products including tomatoes.

This study aims at providing preliminary information on tomato market integration between Benin and Burkina Faso.

MATERIALS AND METHODS

Based on the hypothesis on the existence of a potential weak integration of tomato markets, the study has selected important agricultural markets in main production zones of both countries Benin and Burkina Faso.

Empirical analysis of market integration used in this study is based on the approach used by Lutz and *al*., (2006) on maize in Benin. Benin and Burkina Faso are neighbors and share a number of general physical and human food productions and organization of the business. Market integration can be seen from the point of view of the volume of goods traded (Henner, 2001a; Egg and Igué, 1993). According to Adégbidi (2003), the integration of two or more markets is a multidimensional concept that involves both the integration of pricing, standardization of measures and trade patterns. Thus, the integration of price is a necessary condition for market integration. In a competitive market, the integration of prices results from arbitrage activities including exchanges between actors from different markets actors who seek to take advantage of price differences that exceed the cost of marketing.

Sexton, Kling and Carman (1991) showed that the lack of market integration is the result of one of the following three factors. The first factor is related to the markets in autarky where no arbitrage is possible because the marketing costs are very high compared to the price differences, or because markets are publicly protected. The second factor concerns trade barriers, imperfect information on the market or aversions to risk which contrast the effectiveness of arbitrage. The last factor is related to imperfect competition, e.g. due to collusion or preferential access to scarce resources (transport, credit), which leads to a large excess unjustified price differences on marketing costs. In the other hand, Goletti and Christina-Tsigas, (1995) reported that the importance of the analysis of market integration enables governments to make suitable interventions. Market integration brings up areas of deficit and surplus food from countries or regions and regions producing non-food cash crops.

Tomek and Robinson (1981) listed the conditions under which spatial price integration must take place: (i) price differences between regions (or markets) that exchange, are equal to marketing costs; (ii) price differences between regions (or markets) that do not exchange, are less than or equal to marketing costs. The price differences are more important than marketing costs; this fact is assumed to be due to imperfections in the market system.

However, this work focuses only on prices to assess the level of integration. According to economic theory, the market price is the result of all transactions.

The analysis uses monthly prices of tomato extracted from ONASA (Benin) and DGSA (Burkina Faso) databases. Cointegration models based on Johansen approach and ARDL (Autoregressive Distributed Lag) approach of Pesaran (1995) are used for analysis. Some field data are also used to explain the functioning of agricultural product markets.

Data

The data used in this study to measure market integration focuses on retail prices of tomato, large consumption product in both countries. Data cover the period 2006 to 2008. These prices are monthly. A total of nine (9) major tomato markets are selected in each country base on the data availability on tomato prices. Among markets, there are the most important producer markets and the most important consumer markets. Retail prices play an important role in explaining the functioning of markets (Pede and Mckenzie, 2005). But these prices are low frequency and fail to capture the whole dynamic process of price arbitrage (price changes that may occur weekly or daily basis between two markets) (Amikusuno, 2010). Since we are in UEMOA zone, the prices are measured in FCFA per kg of fresh tomato.

Other types of data i.e. imports, exports, production was used to analyze the functioning of product markets gardeners in the two countries

Once the price data collected, we proceeded to their first log-linearization, then stationarity tests were performed on all variables price and finally the cointegration analysis performed. Statistics of normality of Jarque-Bera, Skewness and Kurtosis were used (Jarque & Bera, 1987; Brys et al. 2004; Jalt, 1997). The Bayesian information criterion (BIC) was used to determine the optimal number of lags or optimum offset. The number of delay is not only useful for testing stationarity but also lets you know if the price formation in a current period also depends on the previous period (Wang, 2009).

Analysis model of market integration

Several approaches are used for the quantitative analysis of market economic integration (Balassa, 1987). Among them, there are models of cointegration.

The analysis of cointegration by Granger (1983) and Engle and Granger (1987), is regarded today as the most widely technique used for time series analysis. The most common method used is the multiple cointegration of Johansen (Full Information Maximun likelihood of Johansen). These models have solved the problem of non-stationarity of the variables in reformulating to their difference. Also, the use of cointegration model has reduced the presence of multi co linearity in the estimations.

Caupin and Laporte (1998) have reported that the study of the spatial integration of markets starts with the precursor work of Ravallion (1986). Some advances have been made in designing test procedures that take account of common trends and the nonstationarity of food prices series. Many progresses to a large literature have continued during many years to renew according to the works of Palaska and Harris-White (1993), Dercon (1995). Cointegrated prices are thus now interpreted as indicating market integration. The basic concept for testing spatial market integration is as follows: Two or more markets may be said to be integrated if the variation of prices in a market is transmitted partially or completely to other markets. But these tests ignore transfer costs and assume a linear relationship between market prices, which is inconsistent with the discontinuities in trade implied by the spatial arbitrage conditions

As shown Baulch (1997), the methods used in these articles are imperfect, partly because integration tests carried out from the econometric estimation of a model that is constructed without reference to a more structural formation and interaction of prices on and between markets. However, we will take this type of approach because, although imperfect, they appear sufficiently robust to answer raised questions. In fact, they do not aim to "discover" all the determinants of prices in a market, but are primarily intended to see if prices evolve jointly in different markets. Prices are assumed to contain all the information that characterizes the markets. The evolution of prices of agricultural products is often seasonal and / or trends. In addition, the frequent lags are produced in the price response between markets. It is impossible to apply traditional methods of econometric estimation. The correlations between the series can be artificial, that is to say only due to the presence of the same seasonal cycle and or to similar trends in the different series. A series that has neither trend nor seasonality is said to be stationary. Cointegration analyzes of statistical series have a dual interest practical and theoretical. From a practical point of view, those analyses allow to perform econometric analyzes from non-stationary series. Thus, two or more non-stationary series are cointegrated if there exist a stationary linear combination of these series. From a theoretical point of view, when two or more series are cointegrated, there is long term equilibrium relationship that binds these series. Any deviation from equilibrium is corrected in time. This second aspect of cointegration of series is particularly interesting for the study of market integration. Once a long-term equilibrium relationship is established between the prices of different markets, these markets are integrated in long term. Any price shock on one or several markets is corrected in time and different prices regain their equilibrium level. The error correction models allowed modeling the dynamics of short-term, taking into account the long-term equilibrium.

In total, there have been significant recent improvements in methods for analyzing market efficiency taking into account some of the problems of previous methods. The most notable developments were extensions of cointegration methods by taking into account the existence of "neutral band" created by the existence of transaction costs. This includes methods of "Threshold Autoregression" and "Threshold Cointegration". The important contribution of these models was that the existence of "neutral band" due to transaction costs reduced the probability of rejecting the hypothesis of market efficiency. The biggest advantage of these methods is that they do not require the collection of information on transaction costs and solve the problem of endogeneity bias. Thus, when price data are only available, these methods appeared to be the most appropriated (Pesaran, 1995; Barrett, 2001). However, they were highly parameterized and considered that transaction costs were constant and the flow of goods traded were ongoing during the analysis period. In other words, these methods do not take into account the flow and transaction costs, nor their variability.

The fundamental weakness of these methods is that they are only interested in a particular case of market integration, perfect integration of markets occurs when markets are both integrated and efficient spatially (Barrett and Li, 2002).

Overall, after the first attempts original of Engle and Granger (1987), it can be considered, in general there are two main approaches of cointegration before ARDL approach of Pesaran, (1995) including approach of Johansen (1988) and Johansen and Juselius (1991) and approach of FMOLS (Fully Modified OLS) of Philipps and Hansen (1990).

The model of Engle and Granger (1987) proceeds in two steps: (1) Test the order of integration of variables. Indeed, a necessary condition for cointegration is that the series must be integrated in the same order. If this is not the case, they cannot be cointegrated. The method to check this is the test of Dicker-Fuller simple or Augmented (DF or DFA) and (2) Estimate the long-term relationship by Ordinary Least Squares (OLS) and by a stationarity test on the residue. Stationarity of the residue can then write an error correction model using the representation theorem of Granger.

Thus, Engle and Granger propose using OLS to estimate the model parameters and to test the stationarity of the residuals. The equation (1) is followed:

$$Y_{1t} = \mu_t + \beta_2 Y_{2t} + \beta_3 Y_{3t} + \cdots . + \beta_n Y_{nt} + \varepsilon_t \qquad (1)$$

where μ_t is the deterministic trend and ε_t the residual of regression (1). The objective is to test the stationarity or not of ε_t . In this case we test the hypothesis $Ho: \rho = 0$ (no cointegration) against $H1: \rho \neq 0$ (cointegration) in the following model (2)

$$\Delta\varepsilon_t = \rho\,\varepsilon_{t-1} + \sum_{i=1}^{k} \gamma_i \Delta\varepsilon_{t-i} + e_t \qquad (2)$$

However the main limitation of this approach is that it first proceeds by tests I (1) on the variables. Or for example, we no longer need to do these tests with Johansen.

The model of Johansen (1988) and Johansen and Juselius (1991) is based on an estimation procedure based on the maximum likelihood model which is funded on a Vector Autoregressive model order P (VAR).

Suppose one VAR (P) defined by:

$$Y_t = \mu + \sum_{i=1}^{P} \emptyset_i Y_{t-i} + \varepsilon_t \qquad (3)$$

where $\emptyset_i$ is a matrix $n \times n$, ε_t is a vector of n perturbations with a matrix variance-covariance. According to Johansen (1988, 1991), these errors are all independent and identically distributed according to a normal distribution.

The Granger representation theorem allows us to write equation (3) in a form of error correction model

$$\Delta Y_t = \mu + \pi Y_{t-1} + \sum_{j=1}^{k} \tau_j \Delta Y_{t-j} + \varepsilon_t \qquad (4)$$

With

$\tau_j = -(I - \pi_1 - \pi_2 - \dots \dots - \pi_j)$

$\pi = -(I - \pi_1 - \dots \dots - \pi_{k+1})$

Equation can be rewritten

$$\Delta Y_t = \mu + \alpha Z_{t-1} + \sum_{j=1}^{k} \tau_j \Delta Y_{t-j} + \varepsilon_t \qquad (5)$$

Where $Z_t = \beta' Y_t$ is the balance error of the system. Integration Zt in (5), we obtain;

$$\Delta Y_t = \mu + \alpha\beta Y_{t-1} + \sum_{j=1}^{k} \tau_j \Delta Y_{t-j} + \varepsilon_t \qquad (6)$$

The cointegration test is based on a test rank π

- If rank (π) = 0, there is no cointegrating relationships between the variables Y_{it} et Y_{jt}. The model has no long-term ownership. All variables are I (1). What we can do in this case is to write the model as a first difference.

- If rank (π) = n, there is a lack of unit root, so it is an I (0). Hence there is a need to write the model in level.

- If rank (π) = r, then we have (n- r) unit roots in the system and r cointegrating relationships in the model. In this case, π can be decomposed as $\pi = \alpha\beta'$, where α and β are two distinct matrix $(n \times r)$ The matrix α is interpreted as the matrix of adjustment coefficients and β the cointegrating vector which verifies the assumption $\beta' Y_t$ is stationary even when Y_t is non-stationary.

The Fully Modified OLS approach of Phillips and Hansen (1990) and Phillips (1995) is used in estimating the parameters. Equation (1) can be rewritten as:

$$\begin{cases} Y_{1t} = \beta' Y_{2t} + \varepsilon_{1t} \\ \Delta Y_{2t} = \varepsilon_{2t} \\ \varepsilon_t = \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix} \end{cases} \qquad (7)$$

One might be tempted to make the unit root tests on the parameters. This joins Engle and Granger (1987). However, there is a problem: all variables are I(1). Which no longer allows test parameters β_i due to a bias problem called the regressor endogeneity bias Y_{2t}. Indeed, in the matrix of variances-covariances, ε_{1t} and $et\ \varepsilon_{2t}$ are correlated. This will mean that the first differences of the variables ε_{1t} are correlated. The FMOLS therefore aim to correct this bias using all the information available up to change the starting OLS (Y_{1t}) .

The ARDL approach has a number of advantages over other techniques of cointegration. The results of this approach are consistent even when you have a small sample size. Also, the ARDL approach can be used regardless of the order of integration of variables. This will mean that the ARDL approach can be applied if the model variables are I(1) and / or I(0). Also, very often macroeconomic series such as prices are integrated of different orders but have for the most unit root. The ARDL approach is based on the Schwarz information criterion (SC) to determine the optimal delays and optimal models, or SC is now seen as the best criterion.

According to Pesaran (1995) model, ARDL approach can be represented as follow:

$$\emptyset(L,P)Y_t = \sum_{i=1}^{k} \beta_i(L,q_i)X_{it} + \delta' W_i + \mu_t \qquad (8)$$

where, $\emptyset(L,P) = 1 - \emptyset_1 L - \emptyset_2 L^2 - \ \ldots . -\emptyset_p L^P$

and

$$\beta_i(L,q_i) = 1 - \beta_{i1}L - \beta_{i2}L^2 - \ \ldots . -\beta_{iqi}L^{qi}\ ; \ \ i = 1,2,3, \ldots \ldots ., k$$

Y_t represents the dependent variables of the model, X_{it} the independent variables of the model, L is the lag operator, W_t is $(S \times 1)$ deterministic vectors representing the variables used, including error terms, dummies, trends and other exogenous variables. The optimal lag is determined by the information criteria such as AIC or SBC.

Rearranging equation (8), we obtain:

$$\Delta Y_t = -\emptyset\left(1,\hat{P}\right)EC_{t-1} + \sum_{i=1}^{k} \beta_{i0}\Delta X_{1t} + \delta' \Delta W_t - \sum_{j=1}^{\hat{p}-1} \varphi * Y_{t-j} - \sum_{i=1}^{k}\sum_{j=1}^{\hat{q}_{i-1}} \beta_{ij} * \Delta X_{ij=j} + \mu_t \qquad (9)$$

Finally, we can define the error correction model as follows:

$$EC_t = Y_t - \sum_{i=1}^{k} \hat{\theta}_i X_{it} - \varphi' W_t \qquad (10)$$

Where $\varphi *$, δ', β^{*}_{ij} are the coefficients of short-term dynamics and $\emptyset\ (1, \hat{P})$ represents the speed of adjustment.

Specification of the model

The ARDL approach is used to estimate the error correction model and to better define the degree of spatial integration of markets for agricultural food products in time.

Considering a given market, a series of tomato prices P_{1t}, and n markets a series of tomato price P_{nt} in time (equation 11). Cointegration of tomato prices between one market and other markets is represented by the equation 12 (see equation 9).

$$\begin{cases} P_{1t} = \alpha_0 + \sum_{i=1}^{k_1} \beta_i P_{1t-i} + \sum_{j=0}^{k_2} \gamma_j P_{2t-j} + \cdots \sum_{w=0}^{k_n} \tau_w P_{nt-w} + \varepsilon_{1t} \\ \ldots\ldots\ldots\ldots\ldots \\ P_{nt} = \alpha_0 + \sum_{i=1}^{k_n} \beta_i P_{nt-i} + \sum_{j=0}^{k_{n+1}} \gamma_j P_{(n+1)t-j} + \cdots \sum_{w=0}^{k_{2n}} \tau_w P_{(n+1)t-w} + \varepsilon_{nt} \end{cases} \qquad (11)$$

$$\Delta P_{1t} = \alpha_0 + \pi_1 P_{t-1} \sum_{i=1}^{k_1} \beta_i \Delta P_{1t-i} + \sum_{j=0}^{k_2} \gamma_j \Delta P_{2t-j} + \cdots \sum_{w=0}^{k_n} \tau_w \Delta P_{nt-w} + \varepsilon_{1t} \quad (12)$$

π_1 represents the return force, following a shock that deviates from its equilibrium path. He returns to equilibrium. Its value is always negative and significant.

k_1 is the number of delay optimal price P_1 on the market 1, k_2 is the number of delay optimal P_2 price on the market 2, kn is the number of optimal delay of Pn on market n.

In the context of this study, 10 markets are considered throughout the analysis period. On the market 1, the price of tomatoes in period t is P_{1t}; on the market 2, the price is P_{2t} and so on until market 10 where the market price of tomatoes is noted P_{10t}. All current prices and delayed on the markets is given by the system of equation:

$$\begin{cases} P_t = \{P_{1t}, P_{2t}, P_{3t}, \dots \dots \dots, P_{10t}\} \\ P_{t-1} = \{P_{1t-1}, P_{2t-1}, P_{3t-1}, \dots \dots \dots, P_{10t-1}\} \\ P_{t-k} = \{P_{1t-k}, P_{2t-k}, P_{3t-k}, \dots \dots \dots, P_{10t-k}\} \end{cases}$$

Where k is the optimal number of delayed. Equation (11) becomes then assuming that this number of delays was 2 on all the markets:

$$\begin{cases} \boldsymbol{P_{1t} = \alpha_0 + \beta_1 P_{1t-1} + \beta_2 P_{1t-2} + \gamma_0 P_{2t} + \gamma_1 P_{2t-1} + \cdots + \tau_0 P_{10t} + \tau_1 P_{10t-1} + \tau_2 P_{10t-2} + \varepsilon_{1t}} \\ \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \\ \boldsymbol{P_{9t} = \alpha_0 + \beta_1 P_{9t-1} + \beta_2 P_{9t-2} + \gamma_0 P_{10t} + \gamma_1 P_{10t-1} + \cdots + \tau_0 P_{1t} + \tau_1 P_{1t-1} + \tau_2 P_{1t-2} + \varepsilon_{9t}} \end{cases} \quad (14)$$

P_{1t} is the price of tomato on the market 1 during period t; P_{1t-1} is the price of tomato on the market 1 during period t-1; P_{1t-2} is the price of tomato on the market 1 during the period t-2; P2t is the price of tomato on the market 2 in period t; P_{2t-1} is the price of tomato on market 2 during period t-1; P2t-2 is the price of tomatoes on the market 2 in period t-2, and so on to the market where the price is P_{9t} on tomato market 9 during period t; P_{9t-1} is the prices on the market 9 during the period t-1; P_{9t-2} is the price of tomato on the market 9 during the nine period t-2; P_{10t} is the price of tomato on the market 10 during period t; P_{10t-1} is the price on market 10 during the period t-1; P_{10t-2} is tomato prices on the market 10 during the period t-2.

The market 1 is Dantokpa; market 2 is Bohicon, the market3 is Malanville, 4 is Glazoué, the market 5 is Azovè, 6 is Boulkiemdé, the market 7 is Houet, 8 is Kénédougou, the market 9 is Oubritenga, the market 10 is Sanguié.

EMPIRICAL RESULTS AND DISCUSSIONS

Description of markets

Markets included in the study animated every five (5) or seven (7) days for 10-14 hours. Exchanges on tomato are often held along a path to market, near the fleet. The site devoted to the sale of tomato is often not protected, but you can see the hangars used to keep the product until the arrival of vehicles for loads to other markets.

This place is dominated by traders, wholesalers, in front which are exposed baskets of tomatoes 5-10 baskets per vendor. Baskets coming directly from producers weigh about 25kg. Retailers are scattered on the market but concentrated in a placeholder for the sale of foodstuffs details. Some retailers are sheltered under umbrellas, others in makeshift sheds or exposed to open air. Displays are on the ground or on small tables. Tomatoes are arranged in piles or in small bowls.

The weight loads vary from 200g to 1kg at different times. The period of abundance is indicated by lots of 1kg costing on average 100 CFA. During the period of scarcity, it is rather that lots of 200g dominate stalls and cost on average 100 – 200 FCFA.

In Benin, markets of Azovè, Comè, Ouando and Bohicon supply Dantokpa. Bohicon receives tomato production from Glazoué market while supplies Dantokpa itself. Dantokpa is a large consumption market. All productions of the country come to Cotonou in one way or another during the year.

Regarding Burkina Faso, most markets are areas of consumption and collection of tomatoes. Yatenga, Oubritenga, Sanguié, Boulkiemdé, and Boulgou refuel the market Kadiogo (Ouagadougou). These are all consumption and collection markets.

Trade activity of tomato is dominated by women whatever the country. We distinguish wholesalers, semi-wholesalers and retailers, sometimes intermediaries between producers and consumers.

In marketing of tomato, there are national and international traders. It should be noted that this is a free market regulated by the law of supply and demand. Nowadays, tomato traders of Benin at international level will look for tomato in Burkina Faso.

At the national level, during January-February, the off season production of southwestern regions of Benin is marketed, relayed from February to May by the production of the lower valley of the river Ouémé. The rainy season tomato production of the northern of Benin is marketed during the period August-December. Production coming from the South and Central regions during the rainy season (August–November) flooded markets. Therefore prices of fresh tomato drop considerably during this period. This confirms the results of the previous study reporting a surplus of 72,000 tons of tomatoes in Benin during the season of abundance, 2008-2009 crop years Soulé (2008). Because of lack of processing facilities, much of this surplus is lost and the rest is dumped in Nigeria. This surplus could not be exported to Burkina Faso because of the quality; varieties usually cropped are local and cannot resist more than 2 days against rot, (Adeoti, 2012). Tomato starts by getting scarce from November because the northern production cannot meet the needs of consumers. Sub-regional imports of tomato are set in motion and reach the critical point from March to July, period when the tomato from Burkina dominates the major consumer markets such as Cotonou and Bohicon.

The opposite phenomenon occurs in Burkina Faso. The abundant production is carried out throughout the country in the period of November–June. Almost all of the production of certain provinces such Boulgou and Houet is marketed within these provinces. Other provinces sell their tomato production in various areas neighboring provinces as well. Kadiogo market (Ouagadougou) is the main center of consumption and thus receives a share of the productions of the provinces. During this period, traders of Burkina convey the product to Togo, Ghana, Benin and Côte d'Ivoire. From April to July, the Burkinabe national merchants flock to irrigated tomato of Bam, Houet, Passoré and Yatenga and tomato from Ghana. This is the time of fresh tomato imports from Ghana and Togo. Previous works of DGPSA (2008) reported that Burkina Faso has imported between 2003-2005 more than 437 tons of fresh tomatoes.

Whatever the country, the distribution channels are very short in the domestic market and concern mainly suburban and urban productions. This is explained by the fact that the tomato constitutes an important part in the consumption of the population. Exchanges of tomato are not observed from Benin to Burkina Faso.

Traders, although scattered, are better informed about the market of vegetables including tomatoes. In total, it appears that the operation on tomato markets is in the form of traditional marketing channels. This result confirms the work of Koffi-Tessio et *al*., (2001) according to which the functioning of the food products is made through traditional marketing channels.

Study of stationnarity of the tomato prices

Results relating to the optimal delays on the tomato markets of the two countries are reported in table1.

It is allowed that predictions can be made on the markets admitting for number of delay 4 which are the markets of Burkina Faso besides, the markets admitting for number of delay 3. 2, and to a lesser extent the markets having for delay 1 which are for most markets of Benin (Tanguiéta, Azovè, Glazoué, Ouando and Parakou). On the market of Bohicon, one can suspect that the actors base themselves on the prices observed during the past month and exceeded to determine the price level of the present month. No forecast of price is probably done on the markets of Dantokpa, Malanville, Comè, of Boulgou and Houet (delay 0). These are distribution markets on several small markets inside the country; due to the perishable nature of the product, the wholesalers seek to get rid of the product.

Table1. Determination of number of delay by the BIC on tomato markets

Markets	VAR (p)				
	0	**1**	**2**	**3**	**4**
Dantokpa	**-2,04032***	-1,98175	-1,86006	-1,86945	-1,89797
Bohicon	-1,07681	-1,81224	**-1,9204***	-1,86249	-1,76019
Malanville	**-1,02166***	-,934712	-,863416	-,844507	-,776342
Glazoué	-,14364	**-,326784***	-,217771	-,196563	-,083286
Azovè	,117014	**-,310278***	-,188277	-,226188	-,22515
Comè	**,380933***	,394571	,51345	,576226	,679948
Ouando	-,414841	**-,557218***	-,484933	-,370479	-,378308
Parakou	-,657454	**-.912592***	-,791676	-,676555	-,554557
Tanguiéta	,188623	**-,120918***	-,004193	,100861	,206208
Boulgou	**-5.21521***	-5,14224	-5,04065	-4,93988	-5,06515
Boulkiemde	-4,35323	-4,81163	-5,02952	-5,10093	**-5,29278***
Gnagna	-2,59917	-3,23767	-4,36177	-4,56289	**-4,67889***
Houet	**-4,97474***	-4,89091	-4,77924	-4,65978	-4,79497
Kénédougou	-5,58637	-5,92704	-5,8216	-5,71007	**-6,46131***
Oubritenga	-3,31032	-3,18859	-3,07365	-3,06947	**-3,832***
Sanguié	-4,26731	-4,14532	-4,02503	-4,3399	**-4,54025***
Sanmatenga	-3,15192	-3,03336	**-4,73294***	-4,66015	-4,53837
Yatenga	-2,0261	-1,90408	-1,81281	-1,86176	**-2,16326***

Numbers in bold and with * are significant

The tests of stationnarity of the tomato prices in Benin and Burkina Faso show that the prices of tomato are nonstationary on all the markets of Benin (table2). On the other hand, in Burkina Faso, except for Boulgou, Boulkiemdé and Sanmatenga, the prices are stationary. This shows that if in Burkina Faso, it is possible to envisage the trend of the prices of tomato and to make sound policy decisions in terms of price; the exercise seems a bit more difficult in Benin even if in Dantokpa, Malanville and Tanguiéta, one can suspect the existence of the deterministic trends. We can envisage a balance of the long-term evolution.

Table2. Stationnarity study of tomato prices on the markets of Benin and Burkina Faso-Faso

Variables	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value	Tendance Coefficient.	T student
Dantokpa	-4,177	-4,3771	-3,596	-3,238	0,006	1,30
Bohicon	-2,001	-4,371	-3,596	-3,238	-0,005	-0,90
Malanville	-4,229	-4,371	-3,596	-3,238	-0,02	-2,31
Glazoué	-2,753	-4,371	-3,596	-3,238	0,005	0,49
Azovè	-3,100	-4,371	-3,596	--3,238	-0,01	-1,32-
Comè	-2,495	-4,371	-3,596	-3,238	-0,001	-0,10
Ouando	-2,962	-4,371	-3.596	-3,238	0,009	0,94
Parakou	-0,928	-4,371	-3,596	-3,238	-0,004	-0,32
Tanguiéta	-3,030	-4,371	-3,596	-3,238	0,05	2,86
Boulgou	-3,934	-4,371	-3,596	-3,238	0,000	0,15
Boulkiemde	-3,175	-4,371	-3,596	-3,238	0,001	1,40
Gnagna	-9,042	-4,371	-3,596	-3,238	0,000	1,03
Houet	-4,876	-4,371	-3,596	--3,238	0,000	0,64
Kénédougou	-4,024	-4,371	-3,596	-3,238	0,000	0,70
Oubritenga	-6,207	-4,371	-3,596	-3,238	0,003	1,98
Sanguiél	-9,133	-4,371	-3,596	-3,238	0,001	1,11
Sanmatenga	-2,487	-4,371	-3,596	-3,238	0,000	0,11
Yatenga	-7,647	-4,371	-3,596	-3,238	0,01	4,33

Integration of tomato markets of Benin and Burkina Faso

On the whole of the tomato markets of both countries Benin and Burkina Faso, we note the existence of at least 5 relations of Cointegration at 5% of degree of significance.

According to table3, the chains of integration between the markets of tomato are presented as follow (See figure below for the various markets):

Dantokpa, Boulkiemdé, Houet, Kénédougou, Oubritenga, Sanguié ;

Bohicon, Boulkiemdé, Kénédougou, Oubritenga, Sanguié ;

Malanville, Boulkiemdé, Kénédougou, Oubritenga, Sanguié ;

Azovè, Houet, Oubritenga ;

Boulkiemdé, Houet, Kénédougou ;

Kénédougou, Bohicon, Malanville, Glazoué ;

Oubritenga, Houet, Kénédougou, Sanguié ;

Sanguié, Bohicon, Boulkiemdé, Kénédougou.

It comes out from these chains that the markets Boulkiemdé, Houet, Kénédougou, Oubritenga, Sanguié in Burkina Faso and the markets Azovè and Malanville in Benin constitute principal production zones and points of regrouping of the area productions. They receive productions of tomato all the year (rain production and off-season) and convey them towards the other markets in particular Dantokpa.

One could estimate the prices of tomato on certain markets of Burkina Faso starting from Azovè and Malanville. In other words, the supply of the main markets results from the complementarities of the production periods. The relatively permanent production periods in these zones can also reinforce these chains of integration. It also arises that integration between the markets of different countries is much stronger than when it is the markets of the same country.

The markets of Benin such as Dantokpa and Bohicon are great consumption markets supplying the overdrawn zones. This Cointegration shows also clearly that Cotonou town constitutes the destination or the common point of result of the majority of flows of tomato of Burkina Faso in the direction of Benin.

Table3. Cointegration of tomato prices on markets of both countries

Estimated Cointegrated Vectors in Johansen Estimation (Normalized in Brackets)
Cointegration with no intercepts or trends in the VAR
30 observations from 2 to 31.

	Dantokpa	**Bohicon**	**Malanville**	**Glazoué**	**Azovè**	**Boulkiemdé**	**Houet**	**Kénédougou**	**Oubritenga**	**Sanguié**
Dantokpa	,0037541	-,024088	,23704	2,3985	-,62026	-,45785	-1,3278	,063340	-,53289	-,28473
	(-1,0000)	(-1,0000)	(-1,0000)	(-1,0000)	(-1,0000)	(-1,0000)	(-1,0000)	(-1,0000)	(-1,0000)	(-1,0000)
Bohicon	-,0086918	,028994	-,047910	,15525	-,35889	,30583	,0068149	1,3012	-,37961	1,1249
	(2,3153)	(1,2037)	(,20212)	(-,064726)	(-,57861)	(,66798)	(,0051327)	**(-20,5438)**	(-,71237)	(3,9507)
Malanville	.0023435	-,011801	,051043	,50865	,88666	-,085632	1,0702	-,72782	-,54361	,057661
	(-,62425)	(-,48991)	(-,21533)	(-,21207)	(1,4295)	(-,18703)	(,80601)	**(11,4908)**	(-1,0201)	(,20251)
Glazoué	,0035769	-,019185	-,0065979	-,017453	,53048	,89699	,42842	,81953	,65648	-,29859
	(-,95281)	(-,79643)	(,027834)	(,0072765)	(,85525)	(1,9591)	(,32267)	**(-12,9386)**	(1,2319)	(-1,0487)
Azovè	,0013939	-,0052485	,012345	-,2581E-3	-,012705	-,45556	-,28214	-1,0995	,18582	,38492
	(-,37130)	(-,21789)	(-,052077)	(,1076E-3)	(-,020484)	(-,99499)	(-,21250)	**(17,3585)**	(,34871)	(1,3519)
Boulkiemdé	1,7414	4,2531	-8,0575	1,1884	-3,8884	3,1010	-,61055	-,32937	1,2413	1,2413
	(-463,8633)	**(176,5608)**	**(33,9916)**	(-,49546)	**(-6,2690)**	**(6,7729)**	**(4,4314)**	**(9,6393)**	(-,61809)	(4,3597)
Houet	,034917	10,4273	-4,0577	1,7262	-1,3482	1,6700	-8,2550	3,9680	1,1215	,064545
	(-9,3012)	**(432,8800)**	**(17,1179)**	(-,71972)	**(-2,1735)**	**(3,6475)**	**(-6,2173)**	**(-62,6461)**	**(2,1046)**	(,22669)
Kénédougou	-,76773	-1,8863	7,2434	-4,6296	,047360	-13,0821	-10,5704	3,8954	4,3121	-2,2597
	(204,5042)	**(-78,3059)**	**(-30,5572)**	(1,9302)	(,076356)	**(-28,5728)**	**(-7,9611)**	**(-61,4998)**	**(8,0919)**	**(-7,9361)**
Oubritenga	,71874	-6,0104	1,7443	,69409	3,5227	2,2784	1,6197	-1,7105	-1,5494	-,098557
	(-191,4550)	**(-249,5172)**	**(-7,3584)**	(-,28939)	**(5,6795)**	**(4,9764)**	(1,2199)	**(27,0052)**	**(-2,9076)**	(-,34614)
Sanguié	-3,9397	3,9198	-1,4076	4,2116	-,059245	3,0376	-1,2356	,84910	-2,0600	,78376
	(1049,5)	**(162,7271)**	**(5,9380)**	(-1,7559)	(-,095516)	**(6,6345)**	(-,93058)	**(-13,4054)**	**(-3,8657)**	**(2,7526)**

Number in bracket are the T student

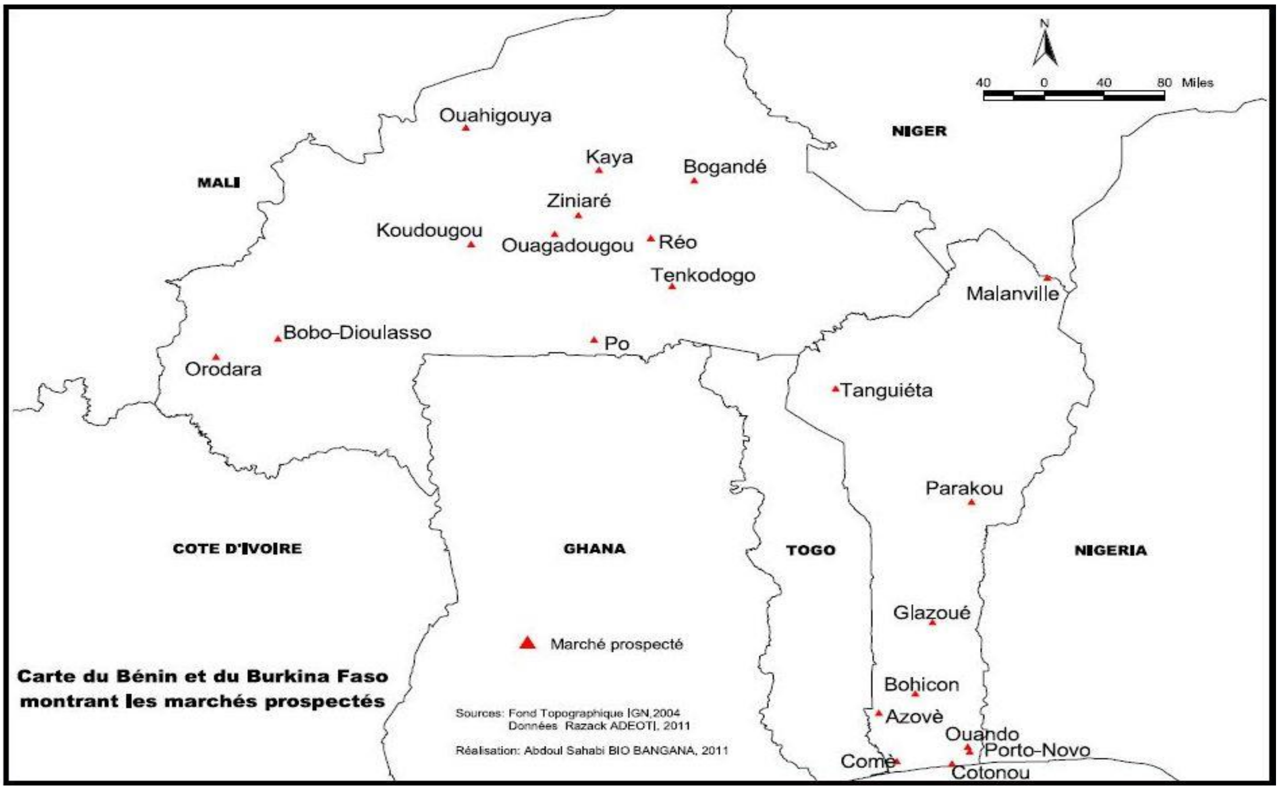

Figure. Integrated tomato markets between Benin and Burkina Faso by ARDL approach

The juxtaposition of growing seasons and overlap in Benin and Burkina Faso engender periods of abundance and scarcity of tomato. Better, the tomato is produced in all regions of the two countries. The period of high production in Benin (August-December) is equivalent to the small-scale production in Burkina Faso. However, large-scale production in Burkina Faso takes place between February-May; period corresponding to high tomato prices period in Benin. Exchanges in tomato are from Burkina Faso to Benin, March to July. Conversely, some of rainfall production of Benin (August-November) is discharged in Nigeria, specifically the Lagos market, near Dantokpa. This, because of the quality of tomato produced which cannot resist rotting. These results confirm the work of WABI (2006) on cross-border trade.

The zone of great consumption, the Southern of Benin in general, and in particular Cotonou (Dantokpa), is supplied during the dry season by tomato coming from Burkina Faso via Togo, the valley of Ouémé through the market of Ouando and Azovè in South-western. This confirms the findings of LARES (2004). Between, 2006-2008 more than 425 tons of tomatoes (20% of reality) were officially recorded at the border of Hilacondji (Adéoti, 2012). The supply of Cotonou, Bohicon and Parakou in tomato results from the complementarity of production periods all the year.

CONCLUSION

In a general way, the results of this work show that there is well space integration of the markets of Benin and Burkina Faso thus confirming the results of several former works in the field. The average costs of the kg of tomato of temporal series in the two countries make it possible to conclude a potentiality from export of Burkina Faso. Traditionally, the 2 areas maintain the relations of exchange of the food agricultural products; particularly between direct and immediate adjoining countries in a formal or informal way. Results show the existence of the chains of integration between the Beninese and Burkinabe markets. Zones with food surpluses can trough the market game provide foodstuffs to those with very strong deficits.

We can also conclude by saying that the integration of tomato market is horizontal and low. But actions should be continued for a perfect integration to ensure real income growth for vegetable growers for poverty reduction by strengthening the organizational structures of actors, namely vegetable producers on the possibilities increase tomato production because the market exists, and examine contractual agreements between economic agents to make them more professional

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