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RESULTS & DISCUSSION

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RECOMMENDATIONS/SUGGESTIONS

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THE ANALYSIS OF SPATIAL PRICE DYNAMICS OF PLANTAIN MARKETS IN CAMEROON

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ABSTRACT

The concept of food security implies regular and adequate market supply of foodstuffs. This regularity, which results in an equilibrium between supply and demand on the various markets, is more effective when there is a spatial integration between them. The absence of such integration can constitute a signal of food insecurity because the technique of arbitrage, which makes possible for the surplus areas to supply the deficit areas, would be difficult to realize. To facilitate the spatial integration of main foodstuffs markets (plantain, cassava, onion, rice) in Cameroon the authorities set up a market information system on to support the flow of information on prices, as well as the correction of market dysfunctions. In the particular case of the banana plantain, the issue is ever-increasing urban consumer prices. Is this the result of a lack of arbitrage or bad information circulation between the markets of consumption and the markets of production? This work tries to answer these questions by means of the econometric time series models. Results show a weak integration of the production and consumption markets resulting from the poor information circulation between the various markets. The concentration of information in the hands of certain traders, particularly the wholesalers, is preventing other wholesalers from penetrating the plantain marketing chain. The situation results in a weak supply to cities and consequently high consumer prices for plantain. To maintain urban food security in plantain, actions must be taken to reduce the asymmetry of information on the prices between consumption and production areas.

KEYWORDS
market integration, plantain markets, time series models, cameroon.

1. INTRODUCTION

Bananas in general and plantains in particular are cultivated throughout the tropics and play a key role in the economy of many developing countries. In terms of gross production, bananas represent the world's fourth most important food crop after rice, wheat and corn.
They are both a staple food and an export crop. As a basic food product, bananas (including plantains and other types of cooking bananas) contribute to the food security of millions of people in most of the developing world, and when they are sold on the local markets, they constitute a source of employment and income for local populations.
As exports, they contribute to the economy of many low income food deficit countries including Ecuador, Honduras, Guatemala, Cameroon, Côte-d'Ivoire and the Philippines. In terms of volume and value, bananas are also the world's most exported fresh fruit (FAO, 2004).
In Cameroon, in particular in the two biggest cities, Douala and Yaoundé, plantain plays a significant role[1] in the food security of the populations. This role can be related to the macroeconomic context of structural adjustment policies (liberalization of the agricultural sector) and to the urbanization.
The population forecasts on the growth of the cities raise questions about their food Security through the regular supplies of foodstuffs in general and plantain in particular.
In a document on the sectoral orientation of the agricultural policy on the plantain in Cameroon, a diagnosis of the MINAGRI (Temple and Tentchou, 2000) stresses the importance of the questions of food security in years to come. The document reports the:

- Degradation of food self-subsistence, which is highlighted by increasing food imports.
- Appearance of chronic food insecurity areas in the country.
- Continued increases of urban consumer real prices.

This report defined several objectives to support the realization of food security via the plantain subsector in Cameroon, specifically the need to increase the per capita production of the crop and especially to reduce the real prices to the urban consumers. Indeed, the data on prices (DSCN, SNAR Project) confirm that prices[2] of plantain have increased faster than inflation since 1994. In addition, the prices of plantain in certain rural zones are sometimes higher than those of the urban markets. This is the case for Ebolowa prices, which are higher than Yaounde's because of the attraction of the Libreville (Gabon) market for the marketable surplus of the South province (Temple and Engola, 1998).
Increased plantain prices in cities can be explained by several reasons, of which one of the most significant is the poor circulation of information on the various plantain markets, an issue that is more or less related to the lack of spatial integration of the various plantain markets in the country. A good spatial integration is a mark of good information circulation between the actors of the marketing network, which in turn makes it possible to accurately reflect the demand near the traders who can then carry out arbitrage[3] to guarantee food security by transferring the plantain from the surplus areas towards the deficit areas.
In a competitive economy, the actors react when they note that they can make profits buying in areas where the prices are low and selling in those where they are high. If the arbitrage is effective, the difference of the prices will equal the transaction costs and in this case, the markets are integrated (Lutz, 1994; Sexton et al., 1991).
This objective of developing a competitive market was at the origin of the government's setting up a food markets information system (FMIS) in 1993 to work with the emergence of conditions supporting the effective articulation between food supply and demand with an aim of stimulating the intervention of private operators. By reinforcing information circulation, the FMIS intends to remove
The various market dysfunctions so that competition is more dynamic and to promote the market's effectiveness by supporting the development of arbitrage (Shahidur Rashid, 2004).
The transmission of price information from the reference market towards the peripheral markets is faster when the markets are perfectly integrated. Among the strategies for guaranteeing food security in Cameroon, the spatial integration of the plantain markets is crucial because of the agro-food characteristics of the areas that supply the two biggest cities of the country. Indeed, the plantain market in Cameroon is structured mainly around these two urban poles, Yaoundé and Douala (Temple et al., 1996). These two poles of consumption are relatively independent of one another in their supply zones. Yaoundé (with approximately 1.5 million inhabitants), the policy and administrative capital of the country, is located at the heart of the principal cocoa plantation zone of Cameroon, whereas Douala constitutes the centre of industrial and commercial activity of the country. Its population is estimated at approximately 2 million inhabitants.

[1] Plantain contributes 10–16% of monetary incomes (Temple et al., 1996) and approximately 11% to the calorie food (Varlet, 1993). In 1997, plantain contributed about 3% OF GDP. More than 500,000 producers and a huge number of the people are employed in the marketing chain of this product (Temple and Tentchou, 2000).
[2] That raising of prices causes an increase the food bills and a reduction of the monetary availability that the households devote to the health expenditure, or to the acquisition of manufactured consumer goods.
[3] Arbitrage is defined as the process of exchange between actors and the various segments of the market with the objective to draw an advantage from the differences in price exceeding the transaction costs (packing, storage, transformation, handling, costs of transport, etc.).

The success of a policy to reinforce food security in these two big cities depends on the force of the markets to transmit direction of price signals in the zones that supply them. Part of the food supply of Yaoundé is organized from the West (corn, tomato, bean, potato), but plantain, cassava and yam come mainly from Centre, South and East provinces. Douala is mainly supplied in food by the South-West, Littoral and West provinces.

RESEARCH ISSUES

Our aim in this work is to look into the objective of achieving food security – the reduction of the prices to the urban consumers – by analysing the spatial integration of plantain markets in Cameroon.

More especially, the study tries to answer the following questions: Are rising urban prices related to the fact that the markets are not integrated spatially? Is the transmission of price information faster between the urban markets and those of the rural markets? Or between the markets of the urban zones, in particular between Douala and Yaoundé? In other words, is the spatial integration of the plantain markets in Cameroon a reality? The remainder of the document is organized as follows: After this introduction, the paper presents the objectives and hypothesis of the research. The third section is devoted to a review of literature on the plantain subsector in Cameroon and the theory of the transmission of the prices and the market integration. Section 4 examines the methodological framework of the market integration tests and the price transmissions for an empirical work and presents the data used. Section 5 has the results and Section 6 concludes the paper.

OBJECTIVES AND HYPOTHESES OF THE RESEARCH

The general objective of this research is to analyse the spatial integration of plantain markets in Cameroon and to evaluate the extent of the transmission of the prices on these markets, in particular of the urban markets, towards the peripheral markets located in the rural zones. The aim is to understand why urban prices are high. More specifically, the study seeks:

- To analyse the long-run and short-run integration of plantain markets using tests of causality and cointegration.
- To evaluate the degree and the speed of adjustment of the prices to the long-run equilibrium.
- To evaluate if the transmission of the prices on the markets is symmetrical or asymmetrical.
- To achieve these goals, we formulate a certain number of hypotheses:
- H1: The central market of Douala or Yaoundé is cointegrated with each peripheral market that supplies it.
- H2: The price of each peripheral market is caused by that of the central market of Douala or Yaoundé.
- H3: The transmission of the prices of the central market of Douala or Yaoundé is asymmetrical.
- H4: The speed of adjustment of the prices to the long-run equilibrium is weak

2. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

Considerable analytical work has been done on food security and related issues in general and plantain price aspects in particular. Similarly, theoretical frameworks on market integration regarding price dynamics abound in the literature. This section traces some of the developments in these areas that are especially relevant to this study.

LITERATURE REVIEW

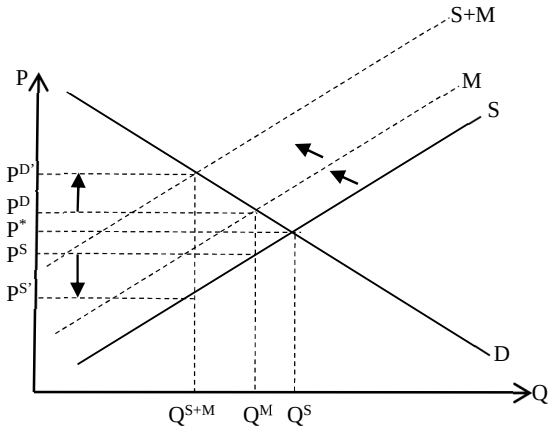
Food security includes three components (FAO, 1996; FAO, 2006): availability, accessibility and affordability. That is, sufficient food supplies must exist, the supply must be stable in time and in space, and adequate food must be within the material and economic reach of everyone.

For Temple et al. (1998), the first component includes the food supply concept and supposes increases in production. The second component stresses the importance of the stability of the food supply, which can be threatened by various factors such as the instability of production, deficiencies of storage infrastructure and marketing systems, the inter annual and interregional price fluctuations, and cyclical fluctuations of supply and demand on the international markets. The third component recalls that the access to food is dependent on the availability of an income.

Considering the question of prices, which is the subject of the second component, several studies carried out in the plantain subsector in Cameroon analyse the impact of instability of plantain prices on urban food security (Bikoï and Yomi, 1998; Temple et al., 1998; Dury et al., 1998). The concept of instability relates to random shocks and other events to which the actors cannot allocate probabilities.

For Cameroon, the raw data on plantain prices give an account of a strong instability of prices per kilogramme (Temple et al., 1999). This instability is, by hypothesis, a source of food insecurity because of high trading margins: Consumers cannot envisage the quantity of plantain they will be able to acquire with their income from one day to another. Figure 1 illustrates the theoretical impact of the trading margin on the prices. The equilibrium price between supply *(S)* and demand *(D)* is at *P**. The increase in the trading margin *(M)* results in a reduction in the price on the production market (*PS* drops to *PS'*) and an increase in the price on the consumers' market (*PD* increases to *PD'*). These significant margins suggest the possibility that arbitrage between the consumption (Douala and Yaoundé) and production markets does not exist.

FIGURE 1: GRAPHICAL ILLUSTRATION OF IMPACT OF TRADING MARGIN ON PRICES



Source: By the author

Conscious of the impact of the prices on the food security of the urban populations in Cameroon, Bikoï and Yomi (1998) have analysed the food supply and distribution systems in the plantain marketing chain in order to identify the sources of instability and the strategies the economic agents adopt to manage this instability. To nourish the cities, the systems must forward to urban consumers the increasing quantities of plantain coming from ever more distant production areas. Between the moments these plantains are harvested and the point where they arrive in the shopping basket of the urban consumer, various actors are involved in a whole series of operations (collection, handling, transport, storage, wholesaler and retailer markets, transformation) that are reflected on the final price paid by the consumer. If these operations are not effective, the supply costs and the final price will be higher and the food security of urban consumers will be threatened. This implies that the improvement of the plantain supply and distribution system is needed.

To lead to this improvement, authors have analyses the supply networks of Yaoundé and Douala (Temple et al., 1998; Bikoï and Yomi, 1998) the price determinants and their instability (Temple et al., 1998; Nkendah and Akyeampong, 2002). Other research has looked into plantain consumption and quality standards (Dury et al., 1998; Temple et al., 1997) and the spatial integration between the production and consumption areas (Temple et al., 1997).

Concerning the supply markets, Temple et al. (1998) analyse the network serving Yaoundé and Bikoï and Yomi (1998) investigate the one for Douala. Both studies generally find two categories of markets: production markets generally located in rural areas and consumption markets generally located in urban areas. The reality of this distinction is not always obvious; however, because the majority of the markets have these two functions and the importance of one compared with the other varies according to the period of the year. For the Yaoundé supply network, three markets (Mfoundi, Essos, and Mvog-Mbi) have a wholesale function that supplies the consumption markets of Elig Ejoa, Etoudi and Nkoleton. The Mokolo market plays both roles and is supplied by Okola and Nyong and Kéllé. For the Douala supply network, 70% of plantain comes from the South-West province starting from the production markets of Mile 20, Owe and Bole. New Deido, Bonassama and Dakar are the consumption markets. It is significant that marginal quantities of plantain sometimes come from the province markets of the South (Ebolowa), West (Bafoussam) with regard to Yaoundé and largely West for Douala.

Concerning the tendencies of price and the determinants of their instability, the studies stress that the prices are sometimes higher in the peripheral markets than on the central market. For example, the prices of plantain in Ebolowa are higher than those in Yaoundé because of the attraction exerted by the Gabonese demand in this area. The plantain production zone located between Ebolowa and the border supplies the Gabonese market more than that of Yaoundé.

The increased price gap between the two cities shows that the supply from South province is not able to satisfy simultaneously the sub regional demand and the local one. The price series analysed for the Yaoundé and Douala markets reveal an upward trend, w hich by hypothesis would translate into a quantitative supply deficit compared with the urban market demand. The instability of markets is expressed in the absence of a guarantee of purchase (or sale), an irregular supply and a relatively unstable price, thus increasing economic taking risk and disadvantaging investment.

The instability of the supply depends on several variables that concern at the same time the production and distribution systems and the socioeconomic situation of the operators. It is initially related to the concentration of planting dates between March and June. Planted at this period, to benefit from the first rains, the bananas will flower in March–April, which coincides with the season that tornados cause high falls of banana plants, as well as strong parasitic pressure of nematodes and disease. The repercussions of the falls of the banana plants will be felt between May and July, the period when the banana should have been harvested. The instability of the markets is also reinforced by deficiencies of equipment and infrastructure adapted to wholesale marketing (absence of equipment, storage, conservation, problems of hygiene and safety).

Studies on the consumption of plantain underline a drop in the availability of plantain per capital since 1970 because of the change of diet accompanying urbanization. Although plantain consumption has declined more strongly in the cities than in the rural areas, findings do not make it possible to check the law of Bennett[4]. Plantain remains a good with income elasticity near to 1. On the other hand, the modification of food preferences results in the need to increase quality and prospects for process and value added.

Research on the integration of plantain markets in Cameroon (Temple et al., 1996, 1998) is based on the price correlations of the production and consumption markets in the Yaoundé supply network with those of Douala. By taking reference from the market of Mokolo (Yaoundé) and the markets of Obala (40 km from Yaoundé) and Sa'a (70 km from Yaoundé), the authors show that the price differential is weak in periods of abundance but increases in a significant way in periods of shortage with regard to the Yaoundé supply network. The economic information circulation and the transaction costs would be thus by hypothesis be more significant for the period of abundance. With regard to the Douala supply network, the prices do not reveal any significant correlation between the various physical production markets, or between the producer prices and the consumer prices.

The authors note that there are no significant correlations between the prices of the wholesale production markets. This finding is in contradiction with the qualitative data on the spatial organization of the markets, which would validate the existence of good information circulation and strong competition. Indeed, the way in which the production markets follow one another in time shows how the calendar constitutes a means to circulate information between the various areas of production that supply Douala. Thus, the market takes place on Monday in Miles 20 (120 km from Douala); Tuesday in Bole (140 km from Douala); Wednesday in Owe (80 km Douala); Thursday in the crossroads Penda-Mboko (50 km from Douala) and Friday in Muyuka (45 km from Douala). The market day is thus moved through the week from Monday to Friday.

This rotation allows producers to plan for the passage of the purchasers and thus ensures an economic information circulation on the wholesale consumption markets. In conclusion, when the correlations of price are considered, the production markets are not integrated into the market of reference, which is Douala, but their spatial organization allows a good information circulation.

THEORETICAL FRAMEWORK

At the theoretical level, two markets engaged in the trade are said to be integrated in space when the difference in price between them is equal to the cost of transfer (Baulch, 1997). Many studies have been carried out to test the spatial integration of agricultural markets. These integration tests are often seen as a way of testing the effectiveness and competitiveness of the markets. However, spatial integration is not sufficient to conclude either Paretian effectiveness of a competing equilibrium or a perfect competitiveness of markets (Lutz, 1994; Sexton et al., 1991).

In general, two approaches are used to test the integration of the markets: an approach based on the calculation of the correlation coefficients and one involving the estimation of a regression model.

The first approach is largely used in the literature (Farruk, 1970; Lele, 1971). The limit of this approach is that it is founded on strong hypotheses: the permanence of commercial flows between the markets, the fixity of the costs of transfer, and the fact that on a market, the prices are supposed to be given in an exogenic way (Mohammad and al. 1998). Another limit of this approach is that the coefficient can be high and even equal to 1, even when no trade exists between the two markets. This can be the case if the prices in the two markets are affected by the same factors – inflation and seasonal movements (Timmer, 1974; Golleti and Babu, 1994; Dimitris, 1995).

In contrast, the approach based on the estimation of a regression model is founded on less strong hypotheses: the hypothesis of linearity between the prices of the various markets, the fact of being unaware of the transfer costs and the inability of regression models to insulate as for the first approach, and the effects of the synchronous factors on the markets, in particular inflation and seasonality. In spite of these limits, the regression method is more appropriate to the analysis of spatial integration of the markets than the correlation coefficients (Mohammad and al. 1998).

The regression method comprises a static approach and a dynamic approach. The dynamic approach has the advantage of allowing the distinction between the concepts of short-run integration (instantaneous integration) and long-run integration. This distinction is significant insofar as it is less probable that the trade between markets adjusts in an instantaneous way to a spatial difference of the prices. One would be a little reticent to accept the idea of short-run integration of as a concept of equilibrium. With time, however, short-run adjustments can converge towards such equilibrium. It is according to this framework that Ravallion (1986) studied the spatial integration of the markets in Bangladesh.

Today, the majority of the studies use the econometric techniques of time series to test the integration of the markets. The development of these techniques, which include the co integration and ferror correction models, became the standard tools for analysing spatial relations of the markets, thus replacing the old empirical tools such as regression and correlation coefficients. Time series analysis has also been criticized as being not very reliable (Blauch, 1997; Barrett and Li, 2002).

The debate on methodology to test market integration and the transmission of prices has a relatively long history that starts with Harriss (1979). Blauch (1997) examines the discussion and the statistical performance of the econometric tests for market integration. Primarily, the linear tests for market integration and price transmission are described as rough and inadequate (Blauch, 1997; McNew, 1996; McNew and Fackler, 1997; Fackler and Goodwin, 2002; Barrett and Li, 2002).

[4] "The law of Bennett describes exchanges in various basic calorie foods depending on income growth: the basic Component calorie is partially replaced by other food calories and the share of food calories in the total budget decreases (Grossens, 1998).

Factors making the linear models non useful and vague are: the non linearity in the relations of the market which result from the conditions of arbitrage, the non synchronized price cycles, the discontinuous trade and the non stationary transfer costs.

Although time series models for analysing market integration are criticized, it is significant to note that they provide excellent results concerning the question of integration and the transmission of the prices if a methodological framework of suitable tests is used and results are interpreted correctly.

Moreover, the time series models require fewer data than other econometric models, an advantage considering the availability of price series date in the developing countries (Rapsomanikis et al., 2003).

These models found a rather vast field of application in the world in general and in Africa in Particular. All in all, the models were used to study the impact of trade liberalization on the spatial integration of markets for agricultural produce like corn in Malawi (Goletti and Babu, 1994) and in Togo (Yovo, 2004), teff in Ethiopia (Dercon, 1995), sorghum in Burkina Faso (Bassolet and Lutz, 1998) and rice in Indonesia (Mohammad et al., 1998). The conclusions of these studies are mixed: positive results for commercial liberalization on market integration (Goletti and Babu), negative results (Bassolet and Lutz, 1198; Mohammad et al., 1998) or mitigated results (Yovo, 2004).

3. METHODOLOGY (MODELS AND DATA)

A lot of this section was drawn from Rapsomanikis et al. (2003). Given prices for a commodity in two spatially separated markets, p1t and p2t, the Law of One Price (Protopapadakis and Stoll, 1986; Ardeni, 1989; Baffes, 1991) postulates that at all points of time, allowing for transfer costs c, for transporting the commodity from market 1 to market 2, the relationship between the prices is as follows:

$$p1t = p2t + c \quad (1)$$

If a relationship between two prices, such as (1), holds, the markets can be said to be integrated. In general, spatial arbitrage is expected to ensure that prices of a commodity will differ by an amount that is at most equal to the transfer costs, with the relationship between the prices being identified as the following inequality:

$$p2t - p1t - c \quad (2)$$

Which is the condition of the space arbitrage (Fackler and Goodwin, 2002)? More recently, two newer methods that focus directly on spatial market efficiency have been employed. The first is threshold auto-regression, which recognizes possible "thresholds" in how spatial prices respond to shocks, depending on whether the shock is large enough to raise spatial price differentials above transfer cost (Goodwin and Piggott, 2001). The second newer method is the parity bounds model (PBM), which estimates the probability of being in spatial price regimes that are consistent with the equilibrium notion that all spatial arbitrage opportunities are being exploited (Enke, 1951; Samuelson, 1964; Takayama and Judge, 1971). The PMB has been extended (Negassa and Myers, 2007) to allow gradual probability changes over time in different trade regimes. Three mutually exclusive regimes can be identified on the basis of the relative sizes of spatial price differentials and transfer costs: in regime 1, the spatial price differential is equal to transfer cost; in regime 2, the spatial price differential is less than the transfer cost; and in regime 3 the spatial price differential is greater than the transfer cost. These two new methods focus on spatial market efficiency, while our objective is to investigate price transmission related to market integration.

The concept of price transmission can be thought of as being based on three notions, or components (Prakash, 1998; Balcombe and Morisson, 2002). These are:

- Co-movement and completeness of adjustment, which implies that changes in prices in one market are fully transmitted to the other at all points of time;
- Dynamics and speed of adjustment, which implies the process by, and rate at which,
- Changes in prices in one market are filtered to the other market or levels; and,
- Asymmetry of response, which implies that upward and downward movements in the price in one market are symmetrically or asymmetrically transmitted to the other. Both the extent of completeness and the speed of the adjustment can be asymmetric.

In this context, complete price transmission between two spatially separated markets is defined as a situation in which changes in one price are completely and instantaneously transmitted to the other price, as postulated by the Law of One Price represented by relationship (1). In this case, spatially separated markets are integrated. In addition, this definition implies that if price changes are not passed through instantaneously, but after some time, price transmission is incomplete in the short run, but complete in the long run, as implied by the spatial arbitrage condition. The distinction between short-run and long-run price transmission is important and the speed by which prices adjust to their long-run relationship is essential in understanding the extent to which markets are integrated in the short run. Changes in the price at one market may need some time to be transmitted to other markets for various reasons, such as policies, the number of stages in marketing and the corresponding contractual arrangements between economic agents, storage and inventory holding, delays caused in transportation or processing, and so on.

Many researchers have worked on the issue of asymmetric price responses utilizing the asymmetric error correction model developed by Granger and Lee (1989) or threshold co integration models proposed by Enders and Granger (1998). Abdulai (2000) provides a comprehensive discussion on the rationale behind spatial asymmetric price response. In addition to policies, market power is often cited as a source of asymmetries (Scherer and Ross, 1990).

Industry concentration and imperfectly competitive behaviour beyond the farm gate implies that wholesalers, or middlemen with power over price, may exercise pricing strategies that result in a slow and incomplete transmission of the price changes at the peripheral markets.

A certain number of time series techniques can be used to examine each component of the transmission of the prices and, thus, to evaluate its importance finally. These various techniques are:

- Co integration
- Causality
- Error correction mechanism
- Symmetry

The concept of co integration (Granger, 1981) and methods to estimate a relation of co integration or a system (Engle and Granger, 1987; Johansen, 1988, 1991, 1995) provide a framework for estimating and testing the relations of long-run equilibrium among the variables. The co integration was largely discussed and applied in literature examined by Maddala and Kim (1998). If two prices in spatially separated markets (or different levels of the supply chain), *1t* and *p2t,* contain stochastic trends and are integrated of the same order, say I(*d*), the prices are said to be co integrated if:

$$p_{1t} - \beta p_{2t} = u_t \quad (3)$$

is I (0).

Where is the vector of co integration (in the case of two variables is a scalar), while Equation 3 is known as regression of co integration. The co integration parameter _ measures the long-run equilibrium relationship between the two prices. This parameter was sometimes interpreted as "the elasticity of the transmission of the prices", when the series of price are converted into logarithms.

The relation can be estimated using ordinary least squares (OLS) (Engle and Granger, 1987) or the maximum likelihood method with complete information developed by Johansen (1988, 1991) and generally met in the literature. More specifically, *p1t* and *p2t* are co integrated if there is a linear combination between them. The co integration implies that the two series of price move narrowly together in the long run, although in the short run, they can diverge, and thus conforms with the concept of market integration. Engle and Granger test the null of no co integration by applying unit root tests on *ût*. Johansen derived the distribution of two test statistics for the null of no cointegration referred to as the trace and the eigenvalue tests.

In addition to formally testing market integration, the concept of co integration has an important implication, represented by the Granger representation theorem (Engle and Granger, 1987). According to this theorem, if two trending, say I (1), variables are co integrated, their relationship may be validly described by an error correction model (ECM), and vice versa (see also brief description in Appendix A). In the case that prices from two spatial separated markets, *p1t* and *p2t*, are co integrated, the vector error correction (or VECM) representation is:

$$\begin{pmatrix}\Delta P_{1t}\\ \Delta P_{2t}\end{pmatrix} = \begin{pmatrix}\mu_1\\ \mu_2\end{pmatrix} + \begin{pmatrix}\alpha_1\\ \alpha_2\end{pmatrix}(P_{1t-l} - \beta P_{2t-1} + A_2\begin{pmatrix}\Delta P_{u-1}\\ \Delta P_{2i-1t}\end{pmatrix} + \dots + A_i\begin{pmatrix}\Delta P_{u-i}\\ \Delta P_{2t-i}\end{pmatrix} + \begin{pmatrix}\nu_{1t}\\ \nu_{2t}\end{pmatrix} \quad (4)$$

Where *v1t* and *v2t* are *iid* disturbances with zero mean constant and finite variance, while the operator denotes that the I(1) variables have been differenced in order to achieve stationarity.

The inclusion of the levels of the variables, *p1t* and *p2t* alongside their differenced terms *_p1t* and *_p2t* is central to the concept of the ECM. Parameters contained in matrixes *A2...Ak*, measure the short run effects, while _ is the co integrating parameter that characterizes the long-run equilibrium relationship between the two prices. The levels of the variables enter the ECM combined as the single entity *(p1t-1 – _p2t-1),* which reflects the errors or any divergence from this equilibrium, and corresponds to the lagged error term of Equation 3. The vector (α1/α2) contains parameters, usually, *0*< | α *1* |< *1*, *i*=1,2, commonly called error correction coefficients, that measure the extent of Corrections of the errors that the market initiates by adjusting *p1t* and *p2t* towards restoring the long-run equilibrium relationship.

The speed with which the market returns to its equilibrium depends on the proximity of *_i* to one. In this context, short-run adjustments are directed by, and consistent with, the long-run equilibrium relationship, allowing the researcher to assess the speed of adjustment that shapes the relationship between the two prices. Sharma (2002), in a paper aiming to assess market integration between several Asian wheat markets and the world market, estimated ECMs and conducted an extensive policy review.

His findings suggest that in countries such as Pakistan, India, Sri Lanka and Indonesia, where government intervenes in the domestic market through various policy instruments, the error correction coefficients) estimated to lie between -0.01 and -0.07) indicate a slow adjustment to the long-run relationship.

Another important implication of co integration and the error correction representation is that co integration between two variables implies the existence of causality (in the Granger sense) between them in at least one direction (Granger, 1988; Kouassi et al., 2004, 2006). The definition of causality and its relevance in the context of market integration and price transmission warrants some discussion. Co integration itself cannot be used to make inferences about the direction of causation between the variables, and thus causality tests are necessary. Granger (1969) proposed an empirical definition of causality based only on its forecasting content: if *x*t causes *y*t then *y*t+1 is better forecast if the information in *x*t is used, since there will be a smaller variance of forecast error. This definition has caused considerable controversy in the literature (see for example Pagan, 1989) as it really indicates precedence, rather than the instantaneous causality that most economists profess.

Nevertheless, if two markets are integrated, the price in one market, *p1*, would commonly be found to Granger-cause the price in the other market, *p2* and vice versa. Therefore, Granger causality10 provides additional evidence as to whether, and in which direction, price transmission is occurring between two series.

The hypothesis that *p*1 Granger-causes *p*2 and vice versa can be assessed within a vector auto regression (VAR) framework (see Appendix A) by testing the null that the coefficients of a subset of these jointly determined variables, the lagged *p*1 terms, are equal to zero. In addition, Granger (1988) proposed a test for long-run Granger causality within the context of the error correction representation of a co integrated system of variables. The presence and direction of Granger causality in the long run can be assessed by testing the null that the error correction coefficients *_1* and *_2* in the VECM presented by (3) are equal to zero, a test that also reveals weak exogeneity in the econometric sense. In more detail, under *_1 = 0, _2 _ 0, p2* Granger-causes *p*1 in the long run; under *_2 = 0, _1 _ 0, p1* Granger-causes *p*2 in the long run; and under *_1 _ 0, _2 _ 0*, both series Granger-cause each other in the long run.

The error correction representation also provides a framework for testing for asymmetric and non linear adjustment to long-run equilibrium. Granger and Lee (1989) proposed an asymmetric ECM (AECM) where the speed of the adjustment of the endogenous variable depends on whether the Deviation from the long-run equilibrium is positive or negative. The single asymmetric ECM is specified as follows:

$$\Delta P_{it} = \mu_i + \alpha_i^{+}(P_{2t-1} + \beta p_{2t-1})^{+} + \alpha_i^{+}(P_{2t-1} + \beta p_{2t-1})^{-} + \sum_{i=0}^{t} \delta_i \Delta p_{2t-i} + \sum_{i=0}^{t} \gamma_i \Delta p_{2t-i} + \nu_{it} \quad (5)$$

1*t* 1 2*t* 1 *p* β*p* reflecting positive and negative disequilibrium, respectively. Within this context,

Asymmetry occurs in the event that positive and negative divergences from the long-run equilibrium between *p1t* and *p2t* result in changes in *p1t* that have different magnitudes. Therefore, asymmetric transmission implies that *_1+* is not equal to *_1*

The null of symmetry against the alternative Hypothesis that adjustment is asymmetric is tested by imposing the equality restriction *_1+ = _1-*. In addition, short-run asymmetric transmission can also be tested by decomposing *P2t* into two parts reflecting price rises and price falls, and testing for equality of the corresponding short-run coefficients. Asymmetric adjustment can be also tested by following Prakash et al. (2001).

This method involves the assignment of a dummy variable, *d*=0, to all the parameters of the underlying autoregressive distributed lag (ADL) if there is positive disequilibrium and *d*=1 if there is negative disequilibrium. Asymmetric adjustment to the long-run equilibrium is then tested by imposing and testing zero restrictions on the dummies' parameters.

EMPIRICAL STEPS

In view of the foregoing discussion on the empirical tools that can be used to assess the notional Components of market integration and price transmission, we proceed to apply the proposed time series techniques on ten plantain markets in Cameroon according to the sequence represented in Figure2 (Rapsomanikis et al., 2003). The way in which the tests on the components of the transmission have been ordered is not neutral and is to some extent ad hoc. The sequences of the tests are as follows:

1) For each pair of prices, in particular between the central market (Douala or Yaoundé) and each peripheral market that supplies it, we start by testing for the order of integration for each price series utilizing the augmented Dickey-Fuller test (Dickey and Fuller, 1979) and the Phillips– Perron tests (Phillips and Perron, 1988). In the event that the series have a different order of integration, we conclude that the markets are not integrated. In the case that the series are found to be I(0), we resort to assessing the dynamics of the relationship by means of the autoregressive distributed lag (ADL) models. We test for Granger causality within a vector auto regression (VAR) framework to assess price transmission between the markets or along the supply chain.11
2) In the event that the tests indicate that the series are integrated of the same order (say I(1)), we proceed by testing the null of non co integration against the alternative hypothesis of one co integrating vector using the Johansen procedure (Johansen 1988, 1991), or we test for the null of non co integration following Engle and Granger (1987). Evidence against the null of no co integration is taken to indicate that prices co-move and that markets are integrated. In the event that the null of non co integration is not rejected, we conclude that the markets are not integrated, and/or that we are unable to conclude that price transmission along the supply chain is complete.
3) In the event that tests indicate that the price series are co integrated, we proceed by focusing on the error correction representation, in the form of a vector error correction model (VECM) and examining the short run dynamics, the speed of adjustment and the direction of Granger causality in the short or the long run following Granger (1969, 1988).
4) At the next stage, based on our results on the direction of causality, we specify AECMs and test for the null of symmetry following Granger and Lee (1989) or Prakash et al. (2001).
5) Finally, we discuss the results and comment on the nature of price transmission and market Integration.

THE DATA USED

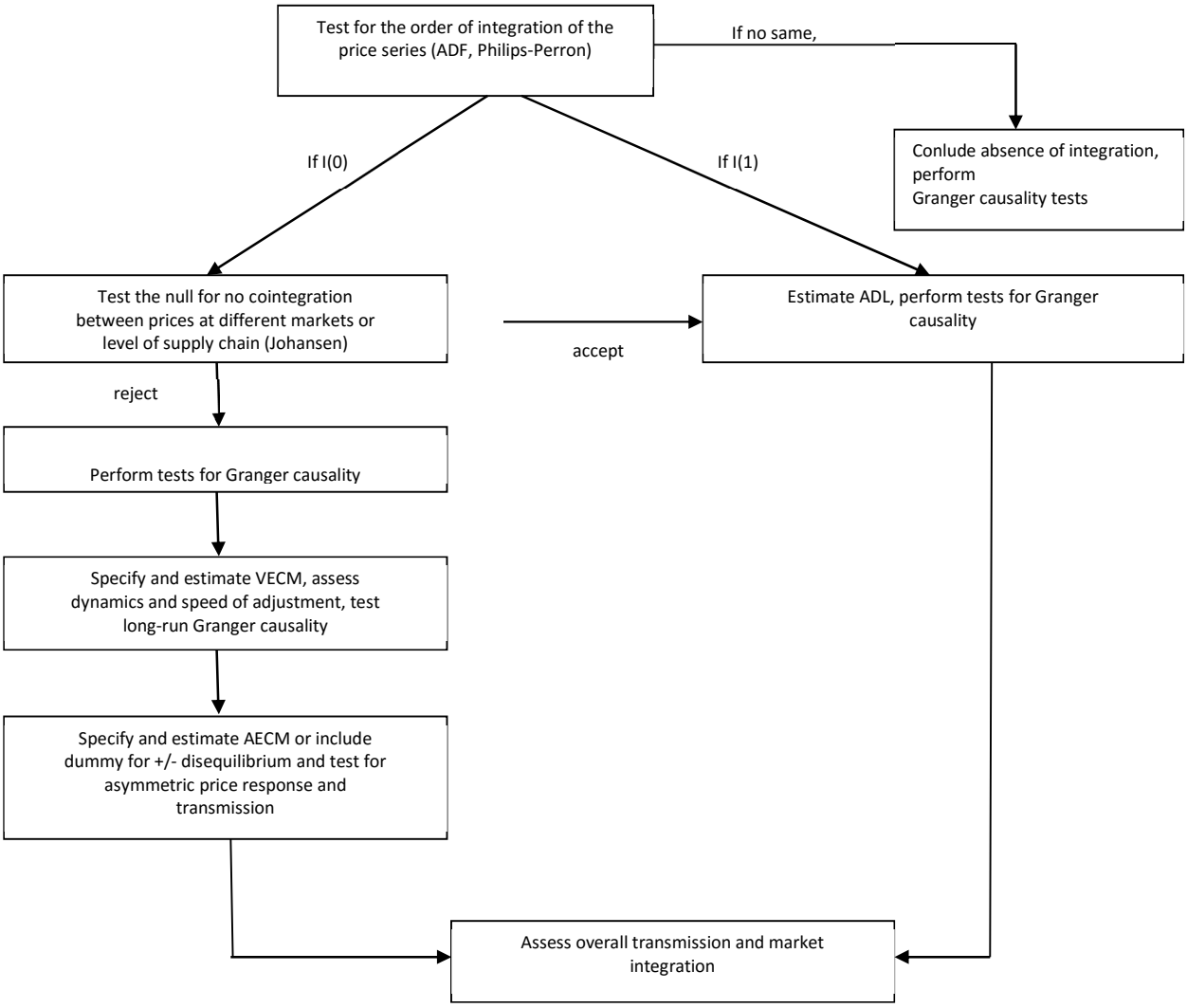
The data used in this study are the monthly nominal plantain prices in kilograms (CFAF/kg) from April 1993 to December 2000. That is to say there were 77 observations for each price series. These data were collected by MINAGRI within the framework of the food market information system project (FMIS) and were supplemented by observations of the markets by CARBAP (African Research Centre on Banana and Plantain) as well as the Direction of Statistics and National Accounting (DSCN). These three data sources are comparable: they were observed over the same period and the price series are based on the same measuring unit (CFAF/kg).

As we have seen, existing studies (Temple et al., 1996) find the plantain marketing chain in Cameroon to be structured around the two large cities: Yaoundé, the political capital, and Douala, the economic capital, which will be identified as the urban markets in this analysis. Yaoundé is supplied starting from the rural markets located in Centre province (Bafia, Obala), South (Ebolowa), West (Bafoussam) and North-West (Bamenda). Douala is supplied starting from the rural markets of the provinces of South-West (Miles 20, Muyuka), Littoral (Penda-Mboko), West (Bafoussam) and North- West (Bamenda). Consequently, Douala and Yaoundé and the rural markets of the Centre, South- West and Littoral provinces are retained as the markets studied; that is to say on the whole ten of which a geographical description and of their operation is given by Temple et al. (1996; 1998). See Appendix B for graphs of the price series.

The markets of Douala and Yaoundé are the consumption markets and will be regarded as the reference markets. The other markets are the production markets and are considered in the analysis as the peripheral markets.

The choice of these markets is based on the availability of the data on plantain prices and the existence of relationships of real exchange of plantain between these "rural" markets and the urban markets of Yaoundé and Douala. 12

FIGURE 2: METHODOLOGY SEQUENCES OF TEST OF PLANTAIN MARKET INTEGRATION IN CAMEROON



Source : Rapsomanikis et al., 2003.

4. RESULTS

Our objective in this work is to analyse the process of integration of the plantain markets in Cameroon in order to understand why consumer prices are high in the urban areas and endanger the food security of the townspeople. A descriptive analysis of the data aiming at characterizing the seasonality of prices and the strategies of the actors, the structure of the markets, and the pricing is presented below, followed by the econometric analysis.

DESCRIPTIVE ANALYSIS

How are prices formed on the plantain markets in Cameroon? According to the market observatory data of CARBAP (Bikoï and Yomi, 1998), the more highlighted characteristic of plantain market in Cameroon is undoubtedly the great number of sellers and purchasers, particularly at retail level. The operations of purchase and sale proceed on open spaces. The market infrastructure of (roads, hangars, storerooms) is generally poor and inadequate. The transparency of the market is often blocked by the heterogeneity of the measuring instruments, and by an information system based on personal relationships between people. The principal actors in the marketing chain include producers, traders and consumers. One of the characteristics of the plantain marketing chain is the great diversity of traders– wholesalers, semi-wholesalers, commission agents (collectors and conveyors) and retailers.

The plantain market also includes associations and wholesalers with strong financial and material capacities to mobilize large volumes of the product and a signif-icant labour force on the collection areas.

Prices are seldom formed in a free way by bargaining between sellers and buyers. Rather, the prices that result from purchase and sale operations are based on personalized relationships, in particular on the production markets located in the rural areas. In their negotiation, the purchasers are generally guided by the former price and the level of market demand, gauged by the number of purchasers present. In conclusion, one can say that the structure of the plantain markets in Cameroon is at the same time competitive (consumption markets in Douala and Yaoundé) where prices are generally close to those of the competition and oligopolistic (markets of production located in the rural areas) where prices are strongly based on personal relationships, on the practices of purchase and credit sale, and on the barriers aimed at preventing the entry of new traders.

To understand the raising of prices to the urban consumers during the year in the two reference markets (Douala and Yaoundé), we analyse the seasonality and inter-annual tendency of prices.

With some exceptions, there is a seasonal increase in the prices from April (Yaoundé) and March (Douala) that reached a climax in September and August before returning to the normal in October, November and December. The principal reason for this price variation is the variation observed in the level of supply. The

prices are higher in periods of insufficiency of the supply on the markets (May, June, July, August and September) and low in periods of abundance (remainder of the year).

Over the period considered, the Douala price of plantain in nominal value rose from 83 CFAF/kg in 1993 to 124 CFAF/kg in 2000, an increase of 49% in seven years. In real value, this increase is 35.4%. In Yaoundé, the price per kilogram increased from 61 to 98 CFAF in seven years – an increase of 60% in nominal value and 27.6% in real value (Table 1). In addition, plantain prices increased more quickly than those of other foods (Temple et al., 2002). According to same authors, the difference of the prices between the consumption and production markets noted that the trading margins increased by 40% in five years in Cameroon. The explanation for these increases relates to the increase in the costs of transport and the dysfunctions of market.

TABLE 1: VARIATION OF THE PRICES OVER THE PERIOD OF STUDY (1993 TO 2000)

Towns	Nominal prices		Variations in percentage	
	Price of 1993	Price of 2000	Nominal value	Real value
Douala	83 CFAF / kg	124 CFAF / kg	49%	35.4 %
Yaoundé	61 CFAF / kg	98 CFAF / kg	60%	27.6 %

** The selected rates of inflation are those of the DSCN and are 1.7 and 5.4, respectively, in Douala and Yaoundé in 1999. We have supposed that these rates remained constant during the period considered.*

Source: Calculations by the authors.

In terms of transport, the devaluation of the CFAF in 1994 and the multiple rises of fuel prices have increased the transport cost, which is reflected in the current prices of the plantain to the urban consumers. Works on transport in Cameroon (Ongolo Zogo, 2002 and Ongolo Zogo and Fosah, 2005) underline its important role in the process of spatial mobility of the resources in the whole country.

This important role of the transport sector calls for the attention of government to make it more Competitive through privatization. The search for an optimal price of transport bearable by the economic agents remains a challenge to be surmounted and is the subject of research now under way (Ongolo Zogo and Fosah, 2005).

As for the dysfunction of markets, the information flow between the consumption and production are as if it's done badly because some production areas are locked and gone off into the distance. It follows that some wholesalers may benefit from this situation to collect significant margins and block the arbitrage process. The role of arbitrage (or the lack thereof) is discussed in the following section.15

ECONOMETRIC ANALYSIS

We apply our methodological framework of the tests to Cameroon's plantain markets. The integration of the production and consumption markets of Douala and Yaoundé are analysed to understand why plantain prices in urban markets continues to increase.

First, we test the order of integration by performing the augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1979) and the test of Phillips and Perron (1988). The ADF is most generally used, but sometimes it presents limits, particularly in the presence of autocorrelation. Dickey and Fuller correct the temporal correlation by including the lagged differences in the regression; even so, the size and the power of ADF proved to be sensitive to the number of these terms of difference. The Phillips– Perron tests are nonparametric tests of the null assumption for the unit root and are considered more powerful, because they use the consistent estimators of the variance.

Table 2: presents the statistics of the unit root test. The ADF test is carried out while including up to 12 lagged terms of difference in the regression; we use the Akaike information criterion (AIC) to choose the suitable number of lags. The ADF statistics presented in Table 2 correspond to the regression that minimized the AIC. On the basis of the ADF and Phillips–Perron tests, we accept the null assumption of non stationary for all the series of price except Bamenda and Ebolowa. Once applied, the first difference test on the non stationary series in level, the two tests lead to the rejection of the null assumption, indicating that all the price series are integrated of order one or I(1).

TABLE 2: UNIT ROOT TESTS OF THE PRICE SERIES (SEE EQUATIONS IN APPENDIX A)

Series	ADF (trend)		ADF (without trend)		Phillips-Perron	
	Level	Differences	Level	Differences	Level	Differences
Douala	-1.181[6]	-8.120[1]	-1.134[6]	-9.181[1]	-2.886[6]	-10.152[1]
Bamenda	-10.4[5]	---	-7.541[5]	---	-5.025[5]	---
Obala	-2.885[5]	-7.352[1]	-1.786[5]	-11.971[1]	-2.885[5]	-13.766[1]
Bafoussam	-1.852[5]	-8.521[1]	-1.005[5]	-8.052[1]	-1.652[5]	-11.063[1]
Bafia	-1.751[5]	-9.762[1]	-1.772[5]	-10.210[1]	-1.02[5]	-9.226[1]
Yaoundé	-2.035[6]	-12.455[1]	-2.145[6]	-11.554[1]	-1.352[6]	-14.881[1]
Ebolowa	-8.521[5]	---	-5.458[5]	---	-4.858[5]	---
Miles 20	-2.027[3]	-10.595[1]	-1.395[3]	-13.765[1]	-1.321[3]	-12.762[1]
Penda-Mboko	-1.520[5]	-8.025[1]	-2.761[5]	-9.502[1]	-2.681[5]	-12.493[1]
Muyuka	-2.102[4]	-10.112[1]	-1.052[4]	-7.512[1]	-1.235[4]	-10.594[1]

The values in brackets represent the number of necessary delays to get a white noise. The critic values of Mackinnon test for ADF are (-3.52) to 1%; (-2.9) to 5% and (-2,58) to 10%. The critical values of Perron are (- 4.48) to 1% and (-4.17) to 5%. One tests H0: the series is non stationary. If the ADF statistic is higher than the critic value, one accepts H0 for the existence of a unit root.

Source: Calculation by the authors.

According to the methodology summarized in Figure 2, for each integrated rural market in order one or I (1), we test the co integration with the market of reference (Douala or Yaoundé), which are also I (1), by using the Johansen approach; then we test the Granger causality and estimate an error correction model (ECM) in order to evaluate the dynamics and the speed of the adjustment. The asymmetrical adjustment is then tested following the approach of Granger and Lee (1989). On all the markets we choose the number of lags for VAR and ECM models by means of the AIC.

The results of the Johansen co integration tests are presented in Table 3. There is a strong indication that the price of plantain in Douala and the prices on its peripheral supply markets of Miles 20, Muyuka and Penda Mboko are co integrated. The market price of Yaoundé is also co integrated with each market of production that supplies it (Bafia and Obala). For all the co integrated markets, the coefficients of the vector of co integration are significant. The Johansen test makes it possible to reject the null hypothesis of non co integration of the Douala or Yaoundé market with those of the markets of Bafoussam and Ebolowa, respectively. In addition, the two reference markets of Douala and Yaoundé are not co integrated. This result confirms the direct observations of exchange between these two big towns of consumption. The two cities, only 260 km apart by a highway, do not exchange plantain with each other. The co integration indicates that the peripheral markets are integrated to the market of Douala or Yaoundé and that there is a Granger causality in at least one direction.

TABLE 3: TESTS OF CO INTEGRATION OF JOHANSEN BETWEEN THE MARKET OF REFERENCE (DOUALA OR YAOUNDÉ) AND EACH PERIPHERAL MARKET THAT SUPPLIES IT

Markets	r	Trace statistic λtrace	Critical value of Osterwald-Lenun (1992) 5%	Co integration vector	
				Price	Parameters
Douala and Miles 20	0	21.211**	15.41		1
	1	1.796	3.76		-0.76**
Douala and Muyuka	0	29.830**	15.41		1
	1	2.672	3.76		-0.842**
Douala and Mpenda Mboko	0	25.840**	15.41		1
	1	2.268	3.76		-1.298*
Douala and Bafoussam	0	13.452	15.41		1
	1	1.752	3.76		-0.856
Douala and Yaoundé	0	12.875	15.41		1
	1	2.024	3.76		-1.024
Yaoundé and Obala	0	28.312**	15.41		1
	1	1.875	3.76		-0.978**
Yaoundé and Bafia	0	24.234**	15.41		1
	1	1.772	3.76		-1.143*
Yaoundé and Bafoussam	0	14.211	15.41		1
	1	3.045	3.76		-0.852

r = a number of vectors of co integration, which is maximum equal to 1 because one tests the couple of 2 markets.
If λtrace > critic value, one rejects H0.

P^{M20} = plantain price on Miles 20 market	P^{B} = plantain price on Bafoussam market
P^{D} = plantain price on Douala market	P^{Y} = plantain price on Yaoundé market
P^{M} = plantain price on Muyuka market	P^{O} = plantain price on Obala market
P^{PB} = plantain price on Penda Mboko market	P^{BF} = plantain price on Bafia market

Source: Calculations by the authors.

The estimated symmetrical error correction models (ECM) and asymmetrical (AECM) are presented in tables 4 and 5, respectively. For the markets that supply Douala, the ECM results suggest that the process of adjustment of prices to the long-run relation is relatively weak with approximately 27% and 25% of divergences from long-run equilibrium corrected each month for Penda Mboko and Muyuka, respectively. The Miles 20 market has a low coefficient of adjustment, 7%, representing a weak integration at the reference market. With regard to Obala and Bafia markets, which supply Yaoundé, their speeds of adjustment of 22% and 21%, respectively, are relatively weak compared with the threshold of the perfect adjustment of 100%. The short-run dynamics indicate that the price variations on the Douala and Yaoundé markets are transmitted partially to the peripheral markets. This indicates that the markets are weakly integrated in the short run, thus variations of the urban prices are partly transmitted to the domestic markets. Moreover, the estimated parameters of $P1t$ are, respectively, 0.47, 0.27 and 0.07 for Penda Mboko, Muyuka and Miles 20, and 0.47 and 0.36, respectively, for Bafia and Obala, also suggesting that the shocks of the Douala and Yaoundé markets instantaneously and partially affect the peripheral markets that supply them. The lagged difference terms are sometimes negative and sometimes positive, however, reflecting the complexities of the short-run dynamics.

TABLE 4: ESTIMATION OF ERROR CORRECTION MODEL (ECM)

Pair of markets	Constants	$\hat{u}_{t-1}$	ΔP_{1t}	ΔP_{2t-1}	ΔP_{1t-1}	ΔP_{2t-2}	ΔP_{1t-2}	ΔP_{2t-3}	ΔP_{1t-3}
Douala – Miles 20	0.17	-0.07**	0.07**	0.13	-0.01	0.19	-0.43**	-0.16	0.22
	(-0.28)	(-3.52)	(5.56)	(0.36)	(-0.04)	(1.14)	(-2.89)	(-1.75)	(1.46)
Douala – Muyuka	0.05	-0.25**	0.27**	0.03	-0.01	0.19**	-0.43**	-0.16	0.22
	(-0.19)	(-3.52)	(5.56)	(0.26)	(-0.04)	(2.14)	(-2.89)	(-1.75)	(1.46)
Douala – Penda Mboko	0.21	-0.27**	0.47**	0.03	-0.01	0.19**	-0.43**	-0.16	0.22
	(-0.29)	(-3.52)	(5.56)	(0.36)	(-0.04)	(2.14)	(-2.89)	(-1.75)	(1.46)
Yaoundé – Obala	1.13	-0.22**	0.36**	0.03	-0.01	0.19**	0.43	-0.16	0.24
	(-0.37)	(-3.32)	(3.46)	(0.36)	(-0.04)	(2.14)	(1.89)	(-1.75)	(1.46)
Yaoundé – Bafia	0.02	-0.21**	0.47**	0.03	-0.01	0.19**	-0.43*	-0.16	0.22
	(-0.21)	(-3.12)	(4.56)	(0.36)	(-0.04)	(2.14)	(-2.89)	(-1.75)	(1.46)

The numbers in parentheses are Student's statistics.
P_1 = reference price in Douala or Yaoundé and P_2 is the peripheral market price.
$(\hat{u}_{t-1})^+ = (P_{1t-1} - \beta P_{2t-1})^+$ et $(\hat{u}_{t-1})^- = (P_{1t-1} - \beta P_{2t-1})^-$ in accordance with equation (5).

Source: Calculations by the authors.

TABLE 5: ESTIMATION OF ASYMMETRICAL ERROR CORRECTION MODEL (AECM)

Pair of markets		Constants	$(\hat{u}t\text{-}1)^+$	$(\hat{u}t\text{-}1)^-$	ΔP_{1t}	ΔP_{2t-1}	ΔP_{1t-1}	ΔP_{2t-2}	ΔP_{1t-2}	ΔP_{2t-3}	ΔP_{1t-3}
Douala – Miles 20	Parameter (a^+)	-0.01	-0.09**	-	- 0.08**	0.10	-0.21	0.24	-0.49**	-0.05	0.51**
		(-0.33)	(-2.11)	-	- (4.96)	(0.03)	(-1.00)	(1.02)	(-2.45)	(-0.40)	(2.57)
	Parameter (a^-)	0.12	-	- 0.03	0.05**	0.04	0.10	0.15	-0.50**	-0.28**	-0.14
		(0.02)	-	(-1.90)	(3.17)	(0.22)	(0.35)	(1.02)	(-2.18)	(-2.22)	(-0.69)
Douala - Muyuka	Parameter (a^+)	-0.11	-0.25**	-	0.38**	0.00	-0.21	0.24**	-0.49**	-0.05	0.51**
		(-0.35)	(-2.11)	-	(4.96)	(0.13)	(-1.00)	(2.02)	(-2.45)	(-0.40)	(2.47)
	Parameter (a^-)	-0.09	-	-0.22	0.45**	0.04	0.10	0.15	-0.40**	-0.28**	-0.23
		(-0.25)	-	(-1.88)	(3.18)	(0.27)	(0.45)	(1.02)	(-2.15)	(-2.12)	(-0.59)
Douala – Penda Mboko	Parameter (a^+)	-0.12	-0.29**	-	0.48**	0.20	-0.21	0.24**	-0.49**	-0.05	0.51**
		(-0.26)	(-2.11)	-	(4.96)	(0.13)	(-1.00)	(2.02)	(-2.45)	(-0.40)	(2.57)
	Parameter (a^-)	-0.14	-	-0.23	0.45**	0.04	0.10	0.15	-0.50**	-0.28**	-0.13
		(-0.42)	-	(-1.90)	(3.18)	(0.29)	(0.45)	(1.02)	(-2.15)	(-2.12)	(-0.59)
Yaoundé - Obala	Parameter (a^+)	-0.16	-0.23**	-	0.48**	0.00	-0.21	0.24**	-0.49*	-0.05	-0.51*
		(-0.44)	(-2.22)	-	(4.86)	(0.03)	(-1.00)	(2.02)	(-2.45)	(-0.40)	(-2.57)
	Parameter (a^-)	-0.08	-	-0.20	0.35**	0.04	0.10	0.15	-0.51*	-0.28*	-0.13
		(-0.42)	-	(-1.81)	(3.20)	(0.29)	(0.45)	(1.02)	(-2.25)	(-2.02)	(-0.69)
Yaoundé - Bafia	Parameter (a^+)	-0.61	-0.21**	-	0.48**	0.00	-0.21	0.24**	-0.49*	-0.05**	-0.51*
		(-0.47)	(-2.02)	-	(4.85)	(0.03)	(-1.00)	(2.02)	(-2.45)	(-2.40)	(-2.57)
	Parameter (a^-)	-0.25	-	-0.24	0.45**	0.04	0.10	0.15	0.50*	-0.28**	-0.13
		(-0.54)	-	(-1.40)	(3.28)	(0.29)	(0.45)	(1.02)	(2.15)	(-2.12)	(-0.59)

The numbers in parentheses are Student's statistics. P_1 = reference price in Douala or Yaoundé and P_2 is the peripheral market price.
$(\hat{u}_{t-1})^+ = (P_{1t-1} - \beta P_{2t-1})^+$ et $(\hat{u}_{t-1})^- = (P_{1t-1} - \beta P_{2t-1})^-$ in accordance with equation (5).
(a^+) = asymmetrical error correction model with positive residues of the long-run relation.
(a^-) = asymmetrical error correction model with negative residues of the long-run relation.

Source: Calculations by the authors.

The AECM results correspond to some realities and the test (Table 6) shows that the transmission of the prices from the urban markets towards the peripheral markets is asymmetrical for the majority of the markets except those of Penda Mboko for Douala and Obala for Yaoundé, where transmission is symmetrical translating the fact that the price changes on the urban market are not transmitted in the same way towards the production markets. The proximity of Penda Mboko to Douala and Obala to Yaoundé could constitute an explanation for the fact that the transmission of the prices of the reference market towards each of them is rather symmetrical.

TABLE 6: SYMMETRICAL OR ASYMMETRICAL TEST OF PRICE TRANSMISSION

Pair of markets	Wald test	
	W-stat.	Probability
Douala – Miles 20	0.079**	0.042
Douala – Muyuka	0.182**	0.021
Douala – Penda Mboko	0.047	0.241
Douala – Bafoussam	0.172**	0.001
Douala – Yaoundé	0.162**	0.005
Yaoundé – Obala	0.172	0.131
Yaoundé – Bafia	0.152**	0.023
Yaoundé – Bafoussam	0.152**	0.041

After estimation of Equation 4, one makes the restriction test H0: $\propto_1^+ = \propto_{1+}$

Source: Calculations by the authors.

According to Rapsomanikis et al. (2003), an asymmetrical adjustment of prices can be due to a floor price policy that entails fixing a minimum price to the producers and consumers, a price that may smooth out the rise and fall variations of the reference price of urban market. In Cameroon, no policy of this kind is in force and the asymmetrical adjustment could be explained by other reasons like the market power exerted by certain traders at different levels of the marketing chain or high fixed costs in the distribution chain.

The long-run Granger causality tests (Table 7) indicate that the urban price of Douala or Yaoundé causes the price of the plantain on the peripheral markets, but not conversely.

TABLE 7: LONG-RUN GRANGER CAUSALITY TEST

Pair of markets	$\propto_1$	$\propto_2$	Result
Douala – Miles 20	-0.27**	0.043	Douala price causes Miles 20 market price.
	(-3.52)	(0.79)	
Douala – Muyuka	-0.22**	0.073	Douala price causes Muyuka market price.
	(-2.62)	(0.59)	
Douala – Penda Mboko	-0.15**	0.078	Douala price causes de Penda Mboko market price.
	(-2.22)	(0.99)	
Yaoundé – Obala	-0.35**	0.024	Yaoundé price causes Obala market price.
	(-3.40)	(0.69)	
Yaoundé – Bafia	-0.44**	0.038	Yaoundé causes Bafia market price.
	(-2.51)	(0.69)	

The figures in parentheses are Student's statistics.

After estimate of the equation (4), one tests: H_0: $\propto_1 = 0$ and $\propto_2 = 0$ then p_2 causes p_1 *H0:* $\propto_1 \neq 0$ and $\propto_2 = 0$ then p_1 causes p_2 *H0 :* $\propto_1 \neq 0$ and $\propto_2 \neq 0$ then p_1 causes p_2 and p_2 causes p_1.

Source: Calculations by the authors.

In a general way, there are sufficient reasons to conclude that the urban market of Douala is slightly integrated with the markets of Penda Mboko and Muyuka. The markets of Douala and Miles 20 are less integrated than others; however, The Yaoundé market is also slightly integrated with those of Obala and Bafia. The price signals on the urban markets are transmitted to these markets in the short and the long run. The results show that in a general way, the marketing chain from the producer to the urban consumer functions at a weak degree. This result is moderate, however, because the markets that are close to Douala or Yaoundé – and connected there by the bituminized roads – have coefficients close to the average. The distance and the good transport infrastructure would be the determining factors of market integration and price transmission. It is noted, however, that the Bamenda, Bafoussam and Ebolowa markets, which are also connected

in Douala and Yaoundé by bituminized roads, are not cointegrated. This shows that variables other than the distance and the good infrastructures exist to explain spatial integration and price transmission on the plantain markets in Cameroon.

In addition, the Johansen test presented in Table 3 shows an absence of co integration of prices of the urban market and those of the peripheral markets (Bamenda, Bafoussam, Ebolowa), suggesting the non integration of the latter at the urban markets. Since the peripheral and urban prices are not co integrated, we carry out the estimate of an autoregressive distributed lag model (ADL) for each one of these markets. The estimated coefficients (Table 8) are significant and indicate that, in a general way, the price on each one of these markets can be modeled by an autoregressive model (ADL). The lagged terms of the urban price also seem to influence the variations of peripheral prices to a certain extent. However, it is difficult to evaluate the relationship to the lagged terms of the urban price because lagged one, this price positively explains the peripheral prices and lagged twice, it explains them negatively.

TABLE 8: ESTIMATION OF AUTOREGRESSIVE DISTRIBUTED LAG MODEL FOR THE LEVEL STATIONARY MARKETS AND FOR NON CO INTEGRATED MARKETS

Markets	Constants	P_{2t-1}	P_{2t-2}	P_{1t}	P_{1t-1}	P_{1t-2}
Bamenda	-0.156	0.750**	0.137**	0.055**	0.193	-0.104**
	(-0.152)	(9.849)	(1.663)	(0.692)	(1.536)	(-2.523)
Ebolowa	-0.132	0.815**	0.137*	0.055	-0.152	-0.228**
	(-0.149)	(9.849)	(1.663)	(0.692)	(-1.516)	(-2.563)
Bafoussam	0.115*	0.615*	-0.237*	0.055	0.262	-0.102*
	(0.218)	(8.849)	(-1.763)	(0.542)	(1.523)	(-2.423)
Douala	-0.130	0.815**	0.137*	0.155	0.191	-0.214**
	(-0.139)	(9.849)	(1.663)	(0.792)	(1.546)	(-2.513)
Yaoundé	0.126*	0.815*	-0.137*	0.155	0.162	-0.204*
	(0.239)	(9.849)	(-1.663)	(0.642)	(1.526)	(-2.533)

Numbers are estimated parameters of variables. Those in brackets are Student's statistics.

Source: Calculations by the authors.

The result proves that there is no transmission of price from the urban markets (Douala, Yaoundé) towards these markets (Bamenda, Bafoussam, Ebolowa). The prices on these markets are explained by their current prices and lagged ones.

5. CONCLUSION AND IMPLICATIONS FOR POLICY

The objective of this study was to understand why plantain prices continue to increase in the cities of Douala and Yaoundé, thus endangering the food security of the townspeople. The answer to this principal question required the application of econometric techniques of time series to the spatial integration tests of the markets. The methodological framework used was a co integration–error correction model on a sample of ten plantain markets in Cameroon whose Douala and Yaoundé constitute consumption or reference markets.

Globally, it transpires from the results that the transmission of Douala or Yaoundé prices towards the production markets (the peripheral markets) that supply them is not immediate and total. In other words, the price variations in Douala and Yaoundé are transmitted to the peripheral markets with a certain delay. However, the markets react to the changes of the urban prices in different degrees.

Although the short-run integration is weak, certain markets are more integrated than others. The speed of adjustment, which is defined as the number of days, weeks or months that the prices take to complete their adjustment, remains low in general, indicating insufficient arbitrage between reference and peripheral markets.

Is the insufficiency of the arbitrage process between the reference and peripheral markets explained mainly by the concentration of information in hands of certain traders? The availability and the accessibility of information for the whole range of actors of the food market are thus instrumental in stimulating the exchanges. It was to improve this availability and accessibility of information that the Cameroonian government in 1993 set up a food marketing information system (FMIS). The data used are mainly from this FMIS, indicating that the target aims are not yet achieved even though the results of our research do not enable us to say if the FMIS has improved the availability and accessibility of information on the food markets. We do think that the FMIS is to be encouraged because it makes it possible for the various actors of the distribution chain (producers, sellers and consumers) to rationalize their decisions of purchase and sale, which is a condition of food security of the urban populations.

In addition, there is an asymmetrical price transmission from the reference market towards the peripheral markets, indicating an asymmetry of information between traders and rural producers. One20 of the lessons of the economy of information is that in an environment where information is incomplete and asymmetrical, the agents manage risky situations, which contributes to obstructing the operation of the markets. For food markets, the existence of asymmetrical information flows between traders and producers can involve problems of anti selection and modify the nature of their transactions and, more generally, the process of supplying cities. The asymmetrical information on the prices, which constitutes a risk for the producers, traders and consumers, is a barrier to the exchanges between production zones and consumption areas. To maintain urban food security in plantain, actions must be taken to remove the asymmetry of information on the prices between urban and production areas.

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