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**Article**

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# Food market integration in the West African Economic and Monetary Union (WAEMU): a dynamic panel approach

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## ABSTRACT

Our study examines the integration of food markets in West African Economic and Monetary Union (WAEMU) and assesses the role of bilateral trade. In this study, we hypothesize that each country has a market. We adopted the framework borrowed from Ravallion using a dynamic panel model. The theoretical approach used is the law of one price. The main conclusion is that food markets are segmented in the short term and there is a possibility that they will be integrated in the long term. Furthermore, even if trade development tends to reduce the gap in food prices between countries, this reduction is not significant.

## IMPACT STATEMENT

In this study, we ask a fundamental question: is there a co-movement of food prices in the West African Economic and Monetary Union (UEMOA)? The appropriate theoretical framework to answer such a question is the law of one price. We therefore analyze the integration of food markets in West Africa by highlighting the role that bilateral trade can play. The importance of our study lies on three levels. First, we draw the attention of state and non-state actors to the need to put in place policies to facilitate better integration of food markets in the short term. This could include improving transport and communications infrastructure, and reducing non-tariff barriers. Second, by showing that long-term integration possibilities exist, we encourage the pursuit of cooperation and food market development strategies. Third, we reveal that the bilateral trade necessary to equalize food prices between countries is not yet achieved in the WAEMU.

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## 1. Introduction

The price of food products has increased by more than 100% in the West African Economic and Monetary Union (WAEMU) countries between January 2000 and September 2023, and this varies from one country to another. This situation leads us to ask a fundamental question: Is there a co-movement of food prices at WAEMU? This study focuses on the integration of food markets in West Africa. The theoretical approach used was the Law of One Price (LOP). The LOP is an analytical framework widely used in macroeconomics to study the convergence of prices across geographical areas (Borraz & Zipitria, 2022; Isard, 1977; Kaplan et al., 2019; Rogoff, 1996). According to the LOP, market mechanisms, while ensuring the reduction of differences in the prices of goods, contribute to equalizing the prices of production factors between countries. Price convergence results from market integration (Gonzales et al., 2022). In a competitive market, the integration of prices results from arbitrage activities, including exchanges between actors from different markets seeking to take advantage of price differences that exceed marketing costs. Clements et al. (2023) applied the LOP to food markets. These authors have

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started from a fundamental question: Are food prices more or less equalized across countries? For them, market wedges appear to be insufficiently important to prevent food prices from equalizing over the longer term. Following this important work, we examine the state of food market integration in West Africa by answering an important question: Are food markets in West Africa segmented or integrated in the short and long term?

In this study, we adopted the following three assumptions: First, economic integration through grouping countries into a community has the advantage *among other things* expanding the market, promoting the possibility of obtaining economies of scale and reducing costs. Thus, countries must improve their external competitiveness. Given their static and dynamic effects, integration can be a source of improvement in collective well-being through an increase in the volume of trade between partner countries (Balassa, 1987; Esty, 2023; Gonzales et al., 2022; Viner, 1950). Second, economic integration refers to the integration of markets. Each country in the integration zone is considered as a market. Third, price integration results in market integration. According to Tomek and Robinson (1981), spatial price integration can take place under two conditions: price differences between regions (or markets) that exchange is equal to marketing costs, and price differences between regions (or markets) that do not exchange are less than or equal to marketing costs. Indeed, the LOP considers that the economic integration of an area should have, consequently, a convergence movement of consumer prices within that area. Within a single market, a reduction in transaction costs made possible by economic integration potentially promotes price convergence. Indeed, in accordance with the law of single price, in a perfectly integrated economic area, under the assumption of a competitive market and perfect substitutability of goods, the presence of differences between countries' price levels would induce consumers to seize arbitrage opportunities in favor of the lowest prices. As this threat encourages suppliers to limit tariff differentials within the economic zone, a nominal convergence trend is expected. Balassa (1964) and Samuelson (1994) agree by assuming that the prices of goods converge within an integrated economic zone: the prices of tradable goods first, and then those of non-tradable goods. From this perspective, the price of goods can be considered a key indicator in the analysis of any integration process.

Africa has undertaken several integration efforts to increase both intra-community and external trade. This is the case for Central African Customs and Economic Union (CACE) in Central Africa, WAEMU and Economic Community of West African States (ECOWAS) in West Africa, Southern African Development Community (SADC) in Southern Africa, and Arab Maghreb Union (AMU) in North Africa. Regional integration, at least outwardly, is based on the promotion of regional integration schemes (Kayizzi-Mugerwa et al., 2014). Even in several African regions, economic integration has successfully reduced tariff protection by freezing the opportunity to raise applied tariffs against fellow integration partners above those promised (Stender & Vogel, 2023), however, despite the high level of regional integration within Africa, it does not necessarily stimulate intra-Africa trade to expected levels, as proposed by Jordan (Jordaan, 2014). In West Africa, particularly within the ECOWAS, several reforms are underway, including the creation of a monetary zone, a customs union, and increased trade between countries. This ambition was reaffirmed in 2011 in the Regional Integration Strategy Paper for West Africa from 2011–2015. This document aims to have ECOWAS as a borderless zone for people and goods, with the intra-community exchange of goods at the heart of the strategy. ECOWAS is a pledge for promoting trade (Gbetnkom, 2006). These different integration processes have been analyzed in relation to trade development (Agbodji, 2007; Békolo-Ebé, 2001; Bibow, 2022; Elbadawi, 1997; Foroutan & Pritchett, 1993). In the case of WAEMU, Agbodji (2007) concludes that the area continues to be characterized by low intra-regional trade with a strong expansion of unregistered trade. According to Békolo-Ebé (2001), harmonized tariff policies and taxation have neither developed trade nor captured investment. There is no trade diversion because traditional polarizations towards developed countries remain, nor is there any creation of new trade flows because intra-community trade remains marginal, despite the multiplicity of regional organizations. Bibow (2022) shows that market integration must go hand-in-hand with policy integration while avoiding persistent divergences in competitiveness among member countries.

Regarding the integration of food markets, several recent studies have been carried out in West Africa (Abdulia, 2000; Amare et al., 2024; Antwiago Amarchey & Adjei Kwakwa, 2024; Kwasi & Kobina, 2014; Yenibehit, 2023). When analyzing those work, the general observation that emerges is that they focus on one country and one or two food products. Our contribution goes beyond this for two reasons:

first, our article uses aggregate food price indices of several food products; second, rather than considering a single country, we work on several West African countries. Thus, this study analyzes the integration of the food market in West Africa and assesses the role of bilateral trade. The analysis of food market integration is relevant for two reasons. Firstly, the integration of food markets makes an essential contribution to strengthening food security in West Africa. Integrated food markets, by facilitating the circulation of food products, make it possible to respond more quickly and efficiently to the changing needs of populations, thus reducing the risks of food shortages. Second, the analysis of food market integration highlights the importance of food price stability. Excessive price fluctuations can have harmful consequences for producers and consumers, directly impacting the economic security of communities. Understanding the mechanisms allows the development of policies aimed at mitigating these variations, thus promoting predictability and long-term planning.

In addition to the introduction and conclusion, the article is organized as follows: [Section 2](#) presents a literature review with the theoretical framework of market integration, an empirical review, and a review of market integration analysis models. The model, data, and methodology are presented in [Section 3](#). The empirical results are presented in [Section 4](#). Discussions are made in [Section 5](#).

## 2. Literature review

### 2.1. Theoretical approach of market integration

The analysis of market integration concerns several divergences in economic literature. For some authors, an integration analysis should make it possible to identify integrated market groups. On the one hand, this form of analysis avoids duplication of interventions. On the other hand, it helps to determine which price level has been set to ensure the effectiveness of the effects of trade creation in the integrated area and the diversion of trade flows to the detriment of the rest of the world. This is the view of Goletti and Christina-Tsigas (1995) and Borraz and Zipitría (2022), who consider that integration refers to co-moving prices and, more specifically, to the transmission of price signals through separate markets in a given area. If markets are well integrated, a government pricing policy can be concentrated in any one market with effects on the prices of others. In a context in which we advocate the coordination of agricultural and food policies in the UEMOA, integrated food markets will offer a guarantee for the optimal allocation of resources (Abdulia, 2000). The presence of a cointegration relationship between two chronological series of prices indicates an interdependent relationship, and its absence indicates market segmentation. According to Delgado (1986), a market integration study ensures that regional balance occurs between markets with deficits and surpluses. This assessment is supported and supplemented by Ravallion (1986). According to him, if price transmission does not occur, abundant and localized shortages can lead to excessive pressure on populations, leading to sources of tension and instability in the regimes. The identification of the structural factors responsible for market integration can contribute to improving market development-oriented policies. The market integration study also attempts to characterize the degree of co-moving prices in separate markets in a given space.

According to Wyeth (1994), market integration is limited to the interdependence of price changes through spatially separated markets. Previous research has identified various measures of market integration, including correlation coefficients (Blyn, 1973; Farruk, 1970). Unfortunately, a comparison of the various measures and an analysis of the structural factors affecting these market integration measures have been overlooked by these authors (Goodwin & Schroeder, 1991) and Faminow and Benson (1990). Engle et al. (1986) address the issue of market integration, arguing that two markets are integrated when they communicate or trade different products with each other.

In conclusion, the analysis of market integration gives rise to divergences in the economic literature, with different perspectives on how this integration should be understood. Some authors emphasize the identification of groups of integrated markets, emphasizing the importance of minimizing redundant interventions and determining price levels that promote efficient trade. In the context of the coordination of agricultural and food policies within the UEMOA, integrated food markets are seen as a guarantee of optimal allocation of resources, thus contributing to the regional balance between deficit and surplus markets.

## 2.2. Empirical review

Several studies have examined the complementarity of markets and integration in Africa. These studies have focused more on the integration of agricultural markets (Koffi-Tessio, 1999; SADAOC (Sustainable Food in West Central Africa) Foundation, 2002; Lutz et al., 2006; Koffi-Tessio et al., 2007). Other studies have addressed integration issues from a macroeconomic perspective with information on the export, import, and inflation prices of goods (Agbodji, 2007; Békolo-Ebé, 2001; Bibow, 2022; Elbadawi, 1997; Foroutan & Pritchett, 1993; Goletti & Christina-Tsigas, 1995; Njinkeu & Powo-Fosso, 2006). However, these studies generally overlook microeconomic dimensions, and those that have addressed the macroeconomic aspect have not considered each country taken individually as a market.

Studies of market integration have approached this concept from several perspectives. First, Market integration can be perceived in terms of the volume of products traded (Egg & Igué, 1993; Grégoire & Labazée, 1993). Second, the integration of two or more markets is considered a multidimensional concept that involves both price integration and the standardization of measures and commercial habits (Abay et al., 2023; Abdulai, 2000; Kidane, 2022). Thus, price integration is necessary for market integration. In a competitive market, price integration is the result of arbitrage activities—exchanges between players in different markets who seek to benefit from the advantages of price differences that exceed marketing costs. Third, market integration is analyzed in terms of its determinants. Sexton et al. show that the lack of market integration results from one of the following three factors: The first factor is related to self-sufficient markets; that is, no arbitrage is possible because marketing costs are very high compared to price differences, or because markets are publicly protected. The second factor concerns barriers that impede the effectiveness of arbitration activities, such as trade barriers, imperfect market information, and risk aversion. The last factor is related to imperfect competition, such as collusion or preferential access to scarce resources (transport and credit), which leads to a significant unjustified excess of price differences over marketing costs. Kidane (2022) argues that there is insufficient evidence to support the claim that the market structure contributes to the price increase in Ethiopian grain markets. The fourth group of studies considers the integration of markets as resulting from the integration of prices on the markets (Lutz, 1994; Tomek & Robinson, 1981). The analysis of market integration is often limited to the study of price integration in different markets. However, studies on the structure and conduct of market players are necessary (Lutz, 1994). Indeed, the similarity in price movements between markets could be the result of arbitrage or collusion between wholesalers. When barriers to entry for traders are absent, the degree of arbitrage between markets depends on both the price differences and marketing costs. The level of marketing costs depends, among other things, on physical quality and access to infrastructure and market information. If the marketing costs are zero, arbitrage will always be possible as long as prices differ in the markets. Marketing costs are the main factors limiting trade, and their reduction can always improve trade opportunities.

In this study, we favor those who view market integration as a result of price integration. From this perspective, the integration of food markets boils down to that of food prices. Unlike various works that have studied several markets within the same country, we consider each WAEMU country as a specific market.

## 2.3. Theoretical and empirical review of market integration analysis models

Since the seminal work of Ravallion (1986), the study of spatial market integration has been the subject of a large body of literature that has been constantly renewed in recent years (Alexander & Wyeth, 1994; Caupin & Laporte, 1998; Dercon, 1995). The concept used as a basis for spatial market integration tests is one in which two or more markets are considered integrated. If the price change in one of the markets is transmitted partially or completely (degree of integration) to other markets.

Several approaches have been used in the economic literature to address the question of market integration. Cointegration analysis, presented by Engle and Granger (1987), is currently considered the most widely used technique in time-series analysis. The most commonly used method is the Johansen multiple cointegration model (Full Information Maximum likelihood of Johansen). The co-integration test and analysis in a VAR (autoregressive vector (VAR) model is often appreciated as superior to Engle-



Granger's unique equation methods. The statistical properties of Johansen's model are generally better and the power of the cointegration test is high (Charemza & Deadman, 1997).

According to Baulch (1997), the methods used in these articles are imperfect, particularly because integration tests are conducted based on the econometric estimation of a reduced model, which is constructed without reference to a more structural model of price formation and interaction on and between different markets. However, we use this type of method because, although imperfect, they appear robust enough to answer the questions. Indeed, their objective is not to "discover" all the determinants of a price on a market, but mainly to see whether prices move together in different markets. Prices should contain all the information that characterizes markets. The evolution of agricultural commodity prices is often seasonal and/or trend-oriented. Trend reversals (breaks) are frequent. Therefore, it is impossible to apply traditional econometric estimation methods. Correlations between series can be artificial, that is, only due to the presence of the same seasonal cycle and/or trend in the different series. A series with no trends or seasonality is called a stationary series. Co-integration analyses of statistical series have dual practical and theoretical interests. From a practical point of view, they allow econometric analyses to be carried out using non-stationary series. Thus, two (or more) non-stationary series are co-integrated if there is a linear combination of these series that are stationary. From a theoretical point of view, when two (or more) series are co-integrated, a long-term equilibrium relationship links these series. Any deviation from equilibrium was corrected over time. This second aspect of the cointegration of series is particularly interesting for the study of market integration. As soon as a long-term equilibrium relationship is established between the prices of various markets, these markets are integrated in the long term. Any price shock in one or more markets is corrected over time, and the various prices return to their equilibrium levels. Error-correction models then make it possible to model short-term dynamics by considering long-term equilibrium.

In our study, even if we start from a framework borrowed from Ravallion (1986), we use a dynamic panel model with an estimation procedure based on the Generalized Moment Method (GMM) developed by Arellano and Bond (1991). This methodological choice is justified by the fact that the dynamic panel approach best minimizes the biases of simultaneity, reverse causality, and omitted variables.

### 3. Methodology

#### 3.1. Data

##### 3.1.1. Dependent variables

Consumer Prices, Food Indices constitute the dependent variables. They are calculated by the FAO from the prices of the following food products: cereals (wheat, rice, corn, etc.), vegetable oils (palm oil, soybean oil, etc.), dairy products (milk in powder, cheese, butter, etc.), meats (beef, pork, poultry, etc.), sugar, fish and seafood, vegetables, fruits, coffee, tea, cocoa, spices and condiments. The descriptive statistics of these Consumer Prices, Food Indices are presented in Table 1. We use prices as dependent variables for two main reasons. On the one hand, the LOP considers that the economic integration of a zone must result in a movement of convergence of consumer prices within this zone. On the other hand, price integration leads to market integration (Tomek & Robinson, 1981). For us, price is a better indicator for analyzing market integration.

**Table 1.** Descriptive statistics on food consumer price indices in WAEMU between 2000 and 2022.

Description des variables	PBEN Benin food consumer price indices	PBFA Burkina-Faso food consumer price indices	PCIV Cote d'Ivoire food consumer price indices	PMLI Mali food consumer price indices	PNER Niger food consumer price indices	PSEN Senegal food consumer price indices	PTGO Togo food consumer price indices
Mean	87.05	88.58	88.92	86.90	86.23	91.90	88.74
Median	100	100	100	100	100	100	100
Maximum	117.33	146.67	132.32	123.96	122.12	141.70	132.63
Minimum	59.27	56.63	56.26	59.52	54.78	63.13	54.22
Std. Dev.	16.20	19.28	19.11	14.79	18.13	16.32	18.36
Coef.var	0.18	0.21	0.21	0.17	0.21	0.17	0.20
Skewness	0.06	0.37	0.86	0.16	0.07	0.37	0.70

Source: Author based on FAOSTAT, 2023.

### 3.1.2. Variable of interest

In order to analyze the effect of bilateral trade on the integration of food markets in the WAEMU, we introduced the variable “bilateral trade” into Eq. (3). Several studies have in fact shown that trade can play a role a key role in market integration. This is the case of the work of Djuric et al. (2017) which showed that physical trade flows between countries and bilateral or multilateral trade agreements play a key role in the integration of the markets of the Commonwealth of Independent States countries. Also, Sekhar (2012) indicated that commodity markets that do not face interstate or interregional movement restrictions, such as essential oils and edible oils, appear to be well integrated.

### 3.1.3. Control variables

The determination of prices in economic systems is a multifaceted process influenced by various factors. The factors generally identified by the economic literature are supply and demand (Smith, 1937), monetary factors (Friedman, 1952), government policies (Keynes, 1937), market structure and market-specific variables (Robinson, 1969; Sadoulet & De Janvry, 1995). The markets here being countries, we consider two categories of variables: supply variables (the Gross domestic product (GDP) of each country) and demand variables (the populations of each country). Regarding GDP, a period of economic growth combined with low government intervention is a favorable factor for market integration (Ismet et al., 1998). The level of development was strongly associated with the degree of rice market integration (González-Rivera & Helfand, 2001). Bekaert et al. (2007) for their part conclude that in integrated markets, (risk-adjusted) differences between local and exogenous growth opportunities should contain no information about future excess growth. Turning to the population variable, González-Rivera and Helfand (2001) show that higher levels of human capital should increase the productivity of agents responsible for the flow of goods at all levels of the market, and should increase the speed and accuracy of the flow of information. Our empirical analysis supported this point of view.

## 3.2. Basic model, specification and estimation method

Several methods have been used to analyze market integration (Blyn, 1973; Delgado, 1986; Hays & McCoy, 1977). The method described by Ravallion (1986) was adopted. The model adapted for WAEMU is

$$p_{it} = (\alpha_i - 1)(p_{i,t-1} - p_{j,t-1}) + \beta_{i0}p_{jt} + (\alpha_i + \beta_{i0} + \beta_{i1} - 1)p_{j,t-1} + \gamma_i x_{it} + \varepsilon_{it} \quad (1)$$

With  $x_{it}$  representing specific effects of country  $i$  and other exogenous variables,  $p_{it}$  consumer prices of country  $i$  in period  $t$ ,  $p_{jt}$  consumer prices of country  $j$  in period  $t$ ,  $p_{i,t-1} - p_{j,t-1}$  represents the consumer price gap between countries  $i$  and  $j$  in period  $t - 1$ ,  $\varepsilon_{it}$  is a random disturbance.

The market is segmented or unintegrated if  $\beta_{i0} = \beta_{i1} = 0$ . If  $\beta_{i0} = 1$ , and  $\beta_{i1} = \alpha_i = 0$ , then the market is integrated in the short term. The market will be integrated only in the long term if  $\alpha_i + \beta_{i0} + \beta_{i1} - 1 = 0$ .

We can specify Eq. (1) by the following one:

$$dprice_{it} = \delta_0 + \delta_1 \Delta price_{ij,t-1} + \delta_2 dprice_{jt} + \delta_3 price_{j,t-1} + \delta_4 \ln GDP_{it} + \delta_5 \ln Pop_{it} + \delta_6 \ln GDP_{jt} + \delta_7 \ln Pop_{jt} + \varepsilon_{it} \quad (2)$$

With  $price_{it}$  consumer price of country  $i$  in period  $t$ ,  $price_{jt}$  consumer prices of country  $j$  in period  $t$ ,  $\Delta price_{ij,t-1}$  consumer price gap between countries  $i$  and  $j$  in period  $t - 1$ ,  $-\ln GDP_{it-1}$  : Natural logarithm of Real GDP of country  $i$  in period  $t$ ,  $\ln GDP_{jt-1}$  : Natural logarithm of Real GDP of country  $j$  in period  $t$ ,  $-\ln Pop_{it-1}$  : Natural logarithm of Population of country  $i$  in period  $t$ ,  $-\ln Pop_{jt-1}$  : Natural logarithm of Population of country  $j$  at period  $t$ .  $-\delta_1 = \alpha_i - 1$ ,  $-\delta_2 = \beta_{i0}$ ,  $-\delta_3 = \alpha_i + \beta_{i0} + \beta_{i1} - 1$ , and  $\varepsilon_{it}$  is a random disturbance.

The estimation is performed in two steps: the first step consists of estimating Eq. (2) to calculate the integration parameters and to highlight the effect of trade on integration. The second estimated Eq. (3) is Eq. (2) with the trade variable added. Equation (3) is expressed as follows:

$$dprice_{it} = \delta_0 + \delta_1 \Delta price_{ij,t-1} + \delta_2 dprice_{jt} + \delta_3 price_{j,t-1} + \delta_4 \ln GDP_{it} + \delta_5 \ln Pop_{it} + \delta_6 \ln GDP_{jt} + \delta_7 \ln Pop_{jt} + \delta_8 \ln Com_{ijt} + \varepsilon_{it} \quad (3)$$



With  $\ln Com_{ijt}$  is the natural logarithm of the value of bilateral trade between country  $i$  and country  $j$  in period  $t$ .

The estimation method is a dynamic panel model using the Generalized Moment Method (GMM) developed by Arellano and Bond (1991). This estimation method is the most appropriate for a dynamic panel. Indeed, the dynamic model causes a correlation problem between the error term and the delayed explained variable. Arellano and Bond (1991) method (GMM in difference) is an estimation method that aims to eliminate the possible bias of omitted variables related to specific effects.

## 4. Results

### 4.1. Food consumer price dispersion in WAEMU

Figure 1 shows the evolution of the average monthly consumer food price indices in WAEMU from 2000 to 2022. The analysis in Figure 1 shows a uniform movement of food price indices in the seven (7) WAEMU countries considered. This could reveal a priori convergence of the price–time gaps within the space. Over the entire period of 2000–2022, the highest average food price indices were observed in Senegal (91.90), Cote d'Ivoire (88.92), and Togo (88.74). The lowest indices were observed in Niger (86.23) and Mali (86.90). When we analyze the evolution curves of the average food price indices over the entire study period, Figure 1 shows a general narrowing of price differentials. In total, there are several episodes of strong food price dispersion: 2000–2002 (between 8 and 10%), 2003–2004 (10%), 2005–2007 (12%), 2008–2010 (15%), 2011–2022 (10%).

To deepen the analysis on the dispersion of food consumer prices, we calculated on the one hand, some dispersion statistics (Table 1) and on the other hand, carried out mean-comparison tests of food prices between WAEMU countries (Table 2).

As shown in Table 1, Mali and Senegal displayed the lowest coefficient of variation (0.17). This indicates low dispersion in food prices in these two countries. The weakness of dispersion measures (Coef.var, Skewness) leads us to say that price indices are poorly dispersed and, therefore, well concentrated. However, prices are widely dispersed in Burkina Faso, Cote d'Ivoire, and Niger because of the high value of their coefficients of variation (0.21). Mean-comparison tests of food prices between the WAEMU countries are presented in Table 2.

The analysis of variance carried out in Table 2 shows a significant difference between food prices in WAEMU countries ( $\text{Prob} > F = 0.0042$ ). This reveals a lack of convergence in food prices within WAEMU. Therefore, the law of one price was violated in this area. Indeed, WAEMU is still characterized by a low level of adjustment in food prices between countries. Kaplan et al. (2019) find three fundamental causes for these results: persistent differences in the average price of goods at different stores, and persistent differences in the relative price of a good relative to the price of other goods at different stores. The fundamental question is which countries can be the basis of this result? By performing a two-by-two analysis, we noticed the absence of food price convergence in the WAEMU coming from Senegal, Benin, Mali, and Niger. As Borraz and Zipitria (2022) conclude in their work, store characteristics can explain this divergence in food prices. Indeed, within-store decisions on variety selection can have a large impact on price volatility. In addition, food products present in WAEMU countries are non-tradable goods for which the law of one price does not apply, as predicted by the Balassa (1964) and Samuelson (1994) effects.

Figure 2 shows the position of the monthly consumer food price indices between 2000 and 2022 for different WAEMU countries. This makes it possible to group countries with similar price characteristics over the period under study.

As shown in Figure 2, the seven countries under study can be categorized into two relatively homogeneous groups in terms of consumer price movements: countries with positive coordinates above the origin of factor axis 2 (Benin, Senegal, Côte d'Ivoire), and countries with at least one negative coordinate below the origin (Burkina-Faso, Niger, Togo, Mali). It should be noted that the countries in the first group are coastal, while those in the second group are non-coastal, with the exception of Togo. In addition, countries such as Senegal, Niger, Benin, Burkina Faso, and Togo are very close to the first axis, containing 98.92% of the information. In contrast, Côte d'Ivoire and Mali are close to the second axis.



**Figure 1.** Average monthly consumer food price indices in the WAEMU from 2000:1 to 2022:09 (273 months).  
Source: Author based on FAOSTAT, 2023.

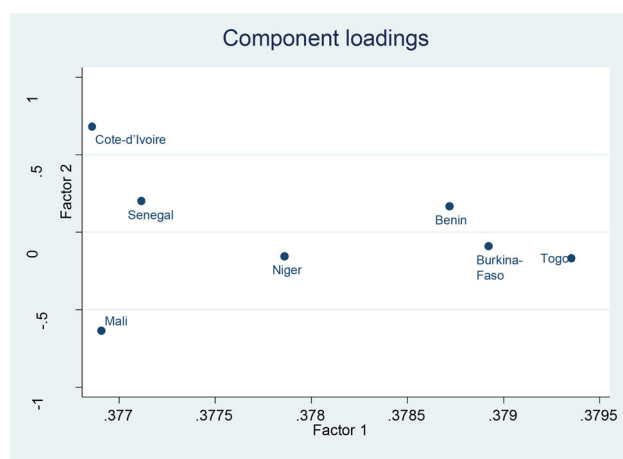
#### 4.2. Food market integration in WAEMU

Table 3 presents the determinants of food consumer prices in the WAEMU. In general, it appears from the results that the variables in most cases have the expected signs, although with varying statistical significance.

**Table 2.** Mean-comparison tests of food prices in WAEMU.

Analysis of variance						
Source	SS	df	MS	F	Prob > F	
Between groups	5850.89	6	975.14	3.17	0.0042	
Within groups	585107.74	1904	307.30			
Total	590958.64	1910	309.40			
Bartlett's test for equal variances: chi2(6) = 31.3028 Prob > chi2 = 0.000						
Comparison of food price by country (Bonferroni)						
	Benin	Burkina-Faso	Cote d'Ivoire	Mali	Niger	Senegal
Burkina-Faso	1.53 (1.000)	–	–	–	–	–
Cote d'Ivoire	1.87 (1.000)	0.33 (1.000)	–	–	–	–
Mali	–0.14 (1.000)	–1.68 (1.000)	–2.02 (1.000)	–	–	–
Niger	–0.82 (1.000)	–2.35 (1.000)	–2.69 (1.000)	–0.67 (1.000)	–	–
Senegal	4.84 (0.026)	3.31 (0.574)	2.97 (0.999)	4.99 (0.018)	5.67 (0.003)	–
Togo	1.68 (1.000)	0.15 (1.000)	–0.18 (1.000)	1.83 (1.000)	2.51 (1.000)	–3.15 (0.742)

Source: Author based on FAOSTAT, 2023.

**Figure 2.** Position of consumer price indices in WAEMU countries.

Source: Author based on FAOSTAT, 2023.

**Table 3.** The determinants of food consumer prices in WAEMU.

	Coef	Std. Err	z	P > z	[95% Conf Interval]
Price <sub>it-1</sub>	–0.14	0.02	–7.30	0.00	–0.18 –0.10
$\Delta \text{price}_{ijt-1}$	0.69	0.02	28.30	0.00	0.64 0.74
price <sub>jt</sub>	0.76	0.02	34.68	0.00	0.72 0.81
price <sub>jt-1</sub>	–0.003	0.006	–0.52	0.60	–0.01 0.009
lnGDP <sub>it-1</sub>	0.08	0.05	1.55	0.12	–0.02 0.19
lnGDP <sub>jt-1</sub>	–0.20	0.07	–2.77	0.006	–0.34 –0.05
lnpop <sub>jt-1</sub>	–0.15	0.07	–2.06	0.04	–0.30 –0.007
lnpop <sub>it-1</sub>	0.28	0.07	3.59	0.00	0.12 0.43
_cons	–1.18	0.33	–3.48	0.00	–1.84 –0.51

Number of instruments = 127  
Wald  $\chi^2(8) = 1889.12$   
Prob >  $\chi^2 = 0.00$

Source: Author, 2023.

The current level of food prices is negatively and significantly affected by the previous level. Indeed, the coefficient of lagged price is 0.14. This result can be explained by the sawtooth evolution of food prices in WAEMU. Any increase in the price gap between countries *i* and *j* during a period leads to a significant increase in the prices in country *i* during the following period. It is as if market forces were working to increase the price gaps between WAEMU countries whenever a phenomenon tends to widen

**Table 4.** Level of food market integration in WAEMU.

Parameters	Values
$\delta_1$	0.69
$\delta_2$	0.76
$\delta_3$	-0.003
$\alpha_i = \delta_1 + 1$	1.69
$\beta_{i0} = \delta_2$	0.76
$\beta_{i1} = \delta_3 - \alpha_i - \beta_{i0} + 1$	-0.22
The market is segmented or non-integrated if $\beta_{i0} = \beta_{i1} = 0$	Non-segmented market because $\beta_{i0} \neq \beta_{i1} \neq 0$
If $\beta_{i0} = 1$ , and $\beta_{i1} = \alpha_i = 0$ , the market is integrated in the short run	Market not integrated into short run because $\beta_{i0} \cong 1$ , and $\beta_{i1} \neq \alpha_i \neq 0$
The market is integrated in the long-term if $\alpha_i + \beta_{i0} + \beta_{i1} - 1 = 0$	Market can be integrated into long-term because $\alpha_i + \beta_{i0} + \beta_{i1} - 1 = -0.003 \cong 0$

Source: Author, 2023.

them. On the other hand, an increase in current consumer prices in country  $j$  contributes to higher prices in country  $i$ .

The increase in GDP per capita in countries  $i$  and  $j$  contributes positively and significantly to raising the price level in country  $i$ . Faced with this result, a number of questions can be asked: Can it be argued that the increase in income by inducing additional purchasing power is not followed by an increase in demand that can influence the level of consumer prices? Can we conclude that supply variables are not responsible for price movements in WAEMU?

With regard to demand variables such as population size, it can be seen that an increase in population in country  $i$  significantly increases prices in country  $i$ . Indeed, an increase in population generates additional demand for goods that are included in the calculation of food consumer price indices and are essentially domestic products. However, an increase in the population in country  $j$  results in a decrease in the consumer price in country  $i$ . This result appears paradoxical.

The results of market integration analyses in WAEMU are presented in [Table 4](#).

Because the parameters  $\beta_{i0}$  and  $\beta_{i1}$  are different and both differ from 0, it is concluded that the markets in WAEMU are not segmented. This means that if the price differences between the two WAEMU markets are strictly higher than the transfer costs, exchanges occur between the two markets. The phenomenon of market segmentation is generally observed when there are price differences between the two markets, and these differences are lower than transaction costs; the price ratio in the two markets, in this case, is different from 1. In the case of the WAEMU countries, we conclude that there is no price uniqueness. The factors generally cited as determining factors for market segmentation have not yet been applied to WAEMU. These factors include transport costs, customs duties, differences in indirect taxes between countries, and differences in production costs. Indeed, customs duties are nonexistent in the WAEMU. Transport costs, which cannot fail to exist, can constitute only a tiny part of the cost of the product returned in this case, which would only justify small price differences. The Value Added Tax (VAT) rates are almost identical between countries.

WAEMU markets are not integrated in the short term ( $\beta_{i0} \cong 1$ , and  $\beta_{i1} \neq \alpha_i \neq 0$ ). This means that the speed at which a product is transferred from one market to another is still low in WAEMU. In other words, the speed at which a price shock spreads from one country to another in the WAEMU remains slow.

In [Table 5](#) and the last row, it should be noted that in the long term, the WAEMU markets can be integrated ( $\alpha_i + \beta_{i0} + \beta_{i1} - 1 = -0.003 \cong 0$ ). This is possible only when appropriate reforms are implemented. These reforms have the advantage of creating trade and exchange opportunities between WAEMU member countries.

### 4.3. Role of trade in food market integration in WAEMU

The One Price Law, assuming that the economic integration of an area should have as its repercussion a convergence movement of consumer prices within that area, the analysis made here aims to see if, with the development of trade, we could witness a convergence movement of prices between WAEMU member countries and, therefore, their price integration, which we call market integration. The results of this analysis are listed in [Table 5](#). The main result is that the development of trade contributes to reducing the spatial increase in prices, but in a non-significant manner. At its current level, the volume of intra-

**Table 5.** Price determinants in country  $i$  with introduction of the trade variable.

	Coef	Std. Err	z	P > z	[95% Conf	Interval]
Price <sub>it-1</sub>	-0.16	0.02	-8.01	0.00	-0.20	-0.12
$\Delta$ price <sub>ijt-1</sub>	0.70	0.02	28.70	0.00	0.66	0.75
price <sub>it</sub>	0.79	0.02	34.87	0.00	0.74	0.83
price <sub>jt-1</sub>	0.007	0.008	0.92	0.35	-0.008	0.02
lnpib <sub>it</sub>	0.20	0.06	3.34	0.00	0.08	0.32
lnpib <sub>jt</sub>	-0.23	0.07	-2.93	0.00	-0.38	-0.07
lnpop <sub>jt</sub>	-0.02	0.08	-0.24	0.80	-0.19	0.15
lnpop <sub>it</sub>	0.33	0.08	3.99	0.00	0.16	0.49
Incom <sub>ijt</sub>	-0.05	0.01	-4.00	0.00	-0.07	-0.02
_cons	-4.43	0.92	-4.77	0.00	-6.25	-2.61

Number of instruments = 124  
Wald chi2(9) = 1906.55  
Prob > chi2 = 0.00

Source: Author.

**Table 6.** Level of food market integration in WAEMU with the introduction of the trade variable.

Parameters	Values
$\delta_1$	0.7
$\delta_2$	0.79
$\delta_3$	0.007
$\alpha_i = \delta_1 + 1$	1.7
$\beta_{i0} = \delta_2$	0.79
$\beta_{i1} = \delta_3 - \alpha_i - \beta_{i0} + 1$	-1.483
The market is segmented or non-integrated if $\beta_{i0} = \beta_{i1} = 0$	Non-segmented market because $\beta_{i0} \neq \beta_{i1} \neq 0$
If $\beta_{i0} = 1$ , et $\beta_{i1} = \alpha_i = 0$ , the market is integrated in the short run	Market not integrated in the short run because $\beta_{i0} \cong 1$ , and $\beta_{i1} \neq \alpha_i \neq 0$
The market is integrated in the long run if $\alpha_i + \beta_{i0} + \beta_{i1} - 1 = 0$	Market can be integrated in the long run because $\alpha_i + \beta_{i0} + \beta_{i1} - 1 = 0.007 \cong 0$

Source: Author.

WAEMU trade is not sufficient to influence the prices in member countries. Therefore, we admit that a low level of trade between the two countries in WAEMU is associated with an increase in the gap in food prices between these two countries. This is corroborated by Oglend et al. (2023), who concluded that the probability of relationship breakup increases in the deviation of the relationship-specific price from a reference price.

The results in Table 6 show that the current levels of bilateral trade do not support short-term market integration into the WAEMU. However, if efforts are made, they can be made over the long term. Indeed, we note that  $\alpha_i + \beta_{i0} + \beta_{i1} - 1 = 0.007$  compared to the initial situation where there was no trade ( $\alpha_i + \beta_{i0} + \beta_{i1} - 1 = -0.003$ ). The current levels of trade in WAEMU do not yet help equalize consumer prices and thus ensure market integration, anything that does not benefit consumers.

## 5. Discussions and policy recommendations

Several lessons can be drawn from the results of this study. These lessons are structured around two main points: the dispersion of food prices in the WAEMU and the integration of food markets in the WAEMU with an emphasis on the role of trade. Based on these lessons, several economic policy recommendations are made.

Three achievements deserve to be highlighted in view of our results. Firstly, the results of our investigations reveal that the food price indices in the seven (7) WAEMU countries follow a uniform evolution and are characterized by low dispersion in Mali and Senegal and high dispersion in Burkina Faso, in Ivory Coast and Niger. This disparity in the dispersion of food prices offers crucial avenues for reflection to understand the factors underlying these variations and to guide appropriate economic and food policies. In Mali and Senegal, the low dispersion of food prices suggests a certain stability in local markets. On the other hand, the strong price dispersion observed in Burkina Faso, Ivory Coast and Niger could be explained by the state of market infrastructures, supply chains and regulatory policies. Some empirical work carried out in other contexts emphasizes the following reasons: a high concentration of sellers and a strong difference in consumer income (Anania & Nisticò, 2014), the persistent heterogeneity of prices of sales chains retail (Berardi et al., 2017) and supply and demand shocks (Byrne et al., 2013). Secondly,

there is a lack of convergence of food prices in the WAEMU. The countries which are at the origin of this situation are Senegal, Benin, Mali and Niger. This result can be explained by several factors: store characteristics (Borraz & Zipitría, 2022); the non-tradable nature of food products presents in the WAEMU for which the law of single price does not apply, as predicted by the Balassa (1964) and Samuelson (1994) effects; government policies with the various distortions they introduce into markets (Anderson & Masters, 2009). To alleviate this situation, it is important that WAEMU countries work to establish greater coordination of economic policies at the regional level, effective harmonization of agricultural policies, the establishment of price regulation mechanisms, and strengthened collaboration between member countries. Third, the result that "WAEMU food markets are not integrated in the short term but with the possibility of integration in the long term" raises essential questions about regional economic dynamics and the factors that can influence them. This result is consistent with that found in another West African country by Antwiago Amarchey and Adjei Kwakwa (2024) according to which plantain markets are weakly spatially integrated in Ghana with an overall degree of integration of 17 percent. In the short term, several elements can explain the non-integration of food markets within the WAEMU. Trade barriers, structural differences in national economies, divergent agricultural policies, and logistical constraints can contribute to this non-integration of food markets. However, optimism lies in the possibility of long-term integration. To understand this perspective, it is crucial to explore regional initiatives, common economic policies, and infrastructure projects that promote greater convergence of food markets over time. WAEMU, as an economic union, has an institutional framework conducive to the coordination of economic policies and the reduction of obstacles hindering integration.

In light of these lessons, five policy recommendations can be formulated: (i) implement price instruments differentiated according to countries or groups of countries, (ii) focus on demand and price variables to promote market integration, (iii) continue the process of integration into the WAEMU by putting in place policies to fight market segmentation, (iv) develop an information system on the WAEMU markets and a policy to reduce the costs of transferring products between markets, and (v) implement an adequate trade policy to allow market operators to seize opportunities for developing intra-zone trade and reducing the spatial increase in prices.

## 6. Conclusion

The results of this research revealed several lessons on the integration of markets in the WAEMU zone in West Africa. Thus, we observed that food consumer price movements in the WAEMU alternate periods of tightening and dispersion; food consumer prices in the WAEMU are poorly dispersed, reflecting the normal distribution of these prices; demand variables have a significant effect on food consumer prices, unlike supply variables; the WAEMU markets are not segmented in the long term; WAEMU markets are not integrated in the short term, but can be so in the long term. It should also be noted that even if the development of trade contributes to reducing the spatial increase in prices, the volume of this intra-WAEMU trade is not yet sufficient to equalize food consumer prices and, therefore, guarantee market integration.

Although the results of this study are relevant, some limitations remain and offer opportunities for future research. Article, by integrating food products as a whole, can obscure a certain number of considerations specific to each product. For example, one of the results of the study is that food prices evolve uniformly in WAEMU countries. This result does not allow us to perceive the realities linked to the price of each food product. Future research could address issues of distribution, barriers to trade, and equitable access by consumers. Also, the article showed that demand variables have a significant effect on consumer prices of food products, unlike supply variables. Future research can be carried out to understand, on the one hand, the effect of external factors not included in the analysis and on the other hand, the interaction of the dynamics of supply with demand.

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## Data availability statement

The data that support the findings of this study are available on request from the corresponding author.

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