Title
Food Price Volatility implications for Trade and Monetary Policy between Nigeria and CEMAC: a Bayesian DSGE model approach

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Acknowledgements

We acknowledge the Centre of Studies and Research in Economics and Management (CEREG) of University of Yaoundé II, the Centre for the Study of African Economies (CSAE) of Oxford University, and the Laboratory for Analysis and Research in International Finance and Economics (LAREFI) of the University of Montesquieu-Bordeaux IV. We are also grateful to the United Nations Economic Conference for Africa (UNECA) to have sponsoring the presentation of this research at the 2014 GTAP Conference.
Abstract

Food price volatility has become a major challenge for trade in many commodity-oriented developing countries. In Africa, the growing concern is the suitable exchange rate regime to tackle the effect of volatility for trade intensification. According to the theory of international trade, exchange rate stability, by the reduction of transaction costs, stimulates investments and therefore intensify cross-border trade. The proposed research aims thus to emphasize food price volatility implications on the bilateral trade between Nigeria and CEMAC in presence of fixed exchange regime relatively to floating exchange regime. We develop a two-country Dynamic Stochastic General Equilibrium (DSGE) model with different monetary policy regimes. The model departures of the canonical model via some keys extensions, such as, net food importer, vulnerability to supply shock, large spending allocated to food consumption, the money preference and Engel’s Law in the food market. The calibration and estimations of the DSGE model would be obtain using Bayesian method by means of Monte-Carlo simulations and metropolis-hasting algorithm. The following findings could be suggested: the designed DSGE model provides a good point of departure for the examination of the effect of food prices volatility on trade between food-oriented economies in Africa facing different exchange rate regimes. Moreover, results reveal that Nigeria encompasses a huge degree of vulnerability to food prices shock than CEMAC region. Furthermore, result suggests that food prices volatility accentuate the low level of bilateral trade between Nigeria and CEMAC. In addition, results show an incomplete pass-through of exchange rate to domestic inflation in both economies. More importantly, results reveal that in the presence of adverse foreign food prices shocks, floating exchange rate regime is dominant than fixed exchange rates regime for each economy to tackle the shocks. Through welfare analysis, results confirm that, facing external food price shocks, the floating exchange rate regime is best for bilateral trade intensification between Nigeria and CEMAC. As policy implication, to enhance trade, monetary policymakers in both economies should cooperate by establishing mechanism able to offset the impact of food price volatility.

Key Words: Food price volatility, Trade, Monetary Policy, DSGE model, Bayesian method, Nigeria, CEMAC

JEL Codes: F1, F4, Q18, E52, C11, C51
1. Introduction

Food price volatility effect on trade is a main concern in both advanced economies and developing economies. Variability in prices is problematic when variations are large and unpredictable, as they complicate the achievement of bilateral exchange between partners. In many commodity-oriented developing countries, food prices cycles seem to be asymmetric, and shocks to food prices may take several years to dissipate (Collier 2012; Cashin et al. 2012; Geiregat 2012). Hence, it becomes challenging to a monetary authority to analyze inflation process and to forecast prices with a reasonable degree of confidence with a huge implications on trade.

Basically, trade is the fundamental driver of economic development worldwide. Nowhere is this more relevant nowadays than in Central Africa, where trade volumes are at low-levels and lagging behind the median indicators for sub-Saharan Africa and many low-income countries. Nigeria and the Central African Economic and Monetary Commission (CEMAC) share a common border (namely, Cameroon, Chad, Equatorial Guinea), as well as strong historical and cultural ties. This suggests a considerable potential for cross-border trade, with benefits for communities on both sides of the border. Because of weak trade strategies, the CEMAC member countries had not been able to take full advantage of opportunities offered by the growing economic landscape of Nigeria\(^2\) (Ben Barka 2012). As Nigeria is becoming the African lead economy, it is obvious that something must be done to rethink the cross-border trade policy between the CEMAC and Nigeria. However, in presence of different monetary policy regimes, food price volatility may be an impediment of intra-trade between both economies.

While Nigeria, with its improving monetary policy performance, and the CEMAC, with a functioning monetary union, have the institutional framework for sound cross border trade, in reality the framework is fraught with numerous inefficiencies that impede trade. A substantial part of inflation volatility in Nigeria and CEMAC clearly reflects the sharp rise in global food prices in 2008 and in 2011\(^3\). This can be explaining by their economic structure in which a large share of consumed food is imported, nowstanding their huge endowment of natural resources (Dia et al. 2010). World food price increases raised domestic food prices, which

\(^2\) The Central African Economic and Monetary Commission (CEMAC) consists of six countries (Cameroon, Central African Republic, Republic of Congo, Equatorial Guinea, Gabon and Chad) which have a common central bank (Bank of Central African States, BEAC) and a common convertible currency pegged to the Euro (Franc CFA).

\(^3\) The FAOs (2011) report that world food prices were generally stable between 1970 and 2000, but increased significantly from 2006 onwards and peaked between February and July 2008, declined thereafter and soared again between June 2010 and February 2011.
could then led to devaluations and feedback effects on overall consumer prices, with a threat to trade and good economic performance (Easterly and Fisher 2000; Durevall et al. 2010; Abbott and de Battisti 2011). Also, exogenous shocks, such as food price volatility, might set off expectations and create persistent inflation due to a missing monetary anchor that ties prices down (Mishra et al. 2010; Durevall et Sjö 2012).

In presence of food price volatility, the choice of exchange rates regimes may also affects trade. In principle, floating rates make it possible for the Central Bank to choose an inflation target independently of the rest of the world as well as to isolate or dampen foreign price shocks. A fixed exchange rate, on the other hand, can only work if domestic monetary policy is consistent with inflation rates in the country’s trading partners. A fixed regime will also make the country more exposed to foreign price shocks. Both the Central Bank of Nigeria (CBN) and the Central Bank of Central African States (BEAC) are classified as pursuing price stability. The difference between the two Central Banks is that the BEAC ran a fixed exchange rate regime. Hence, throughout the past decades the nominal exchange rate was very stable, unless the 50 percent devaluation in 1994, the CFAF is currently pegged to the Euro at 655.96 CFAF per euro (Caceres et al. 2011). The CBN, on the other hand, has a much more flexible regime which comes close to a floating exchange rate. However, the CBN has recently used auctions to stabilize the naira. Despite periodic increase in demand for foreign currency, the exchange rate of the naira against the dollar of the United States, with the Dutch Auction System, ranged between 152 NGN to the dollar in January 2011 and 156 NGN to the dollar in December 2011. The relatively low depreciation of the naira in the fourth quarter of 2011 was due to the adjustment of target official exchange rate, which rose from 150 to 155 NGN per dollar (CBN 2012).

The CBN and the BEAC policy responses during recent years illustrate well the challenges facing monetary authorities to manage food prices volatility. In response to changes in world food prices, the Central Bank of Nigeria has introduced measures to curb inflationary pressures. She has opted in 2011 for a tight monetary policy. The monetary policy rate, which stood at 6.25% in September 2010, was raised six times in 2011, reaching 12.0% in December. The cash ratio has also been raised steadily from 1.0% in March to 8% in December 2011. This contraction policy compressed inflation which rose from 13.7% in 2010 to 12.2% in 2012 (Adebiyi and Mordi 2014). In BEAC issuing Zone, following the world food prices crisis in 2008, inflation increased by 4.4% in 2009, and after the 2011 world food
prices crisis, inflation rose by 4.4% in 2012. In response, since 2010, the BEAC has changed five times its intervention rate to ease inflationary pressures.

Against this background, in this paper, we emphasize the food price volatility implications on the bilateral trade between Nigeria and CEMAC in presence of fixed exchange regime relatively to floating exchange regime. We empirically assess this important issue by developing a two-country Dynamic Stochastic General Equilibrium (DSGE) model with different monetary policy regimes. Our model departures of the now canonical model of Gali and Monacelli (2005) via some keys extensions coming from features of both economies, such as, net food importer feature, vulnerability to supply shock, large spending allocated to food consumption, the money preference and Engel’s Law in the food market. The model disentangle food sector from non food sector, both in consumption function and production function, given the size of the food sector and the highly divergent behavior of prices in the two sectors in those economies. In fact, CEMAC and Nigeria are chosen as case study because, first, they share a common border, most consumption habit and are potentially expose to an intense cross-border trade. Secondly, both economies are net food importer and larger proportion of their household expenditure goes to food. Thirdly, many foods products are intermediate inputs in those economies. Finally, food prices are very important in their consumer basket, so they may also have significant effects on wage pressures, which also impinge on their overall price level and in turn in trade.

To move towards this outcome, after the introduction, monetary policy framework are presented, next related literature are reviewed, then DSGE model are specified, after that, data sources and model calibration are examined, then estimations results are presented, also impulse response function and welfare analysis are analyzed, finally conclusion and policy implications are articulated.

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4 The statistics used in this sub-section are extracted from the African Data Base of International Monetary Fund (Latest Published Data, AFR EO, September 2013).

5 Diao et al (2010) state that in Africa, 50-70% of household budgets are spent on food.
2. *Monetary policy framework of CBN and BEAC*

The CBN targets single-digit inflation while keeping the naira-US$ exchange rate within a narrow band and supporting financial sector stability. To attain its objectives the CBN uses a policy interest rate corridor, open market operations, monetary targeting, foreign exchange sales, and regulatory requirements. However, high economic volatility, partly caused by food price volatility, has meant that at times it has struggled to attain its multiple objectives. Hence, throughout the past two decades, the objectives of Nigerian monetary policy have been the attainment of internal and external balance. This was reaffirmed by the CBN Monetary Policy Circular No. 33, 2002, stating that one of the CBN’s major objectives is the “sustenance of price and exchange rate stability.”

The combination of liquidity surprises with the ability of the federal government to finance large budget deficits by borrowing freely from the CBN at below market-clearing interest rates has severely impaired the CBN in its conduct of short-run and long-run strategy during the past two decades. In addition, theoretical evidence suggest that, it is not possible for a country open to international capital flows like Nigeria to have both a stable exchange rate and monetary policy directed at domestic goals like price stability, the so called “impossible trinity” (Fischer 2001). Sooner or later conflicts between the two goals arise, jeopardizing the attainment of one or even both objectives. One particular aspect of the debate is that trying too hard to keep exchange rates stable when the economy is open and subject to short-term capital flows can be risky\(^6\). As a result, a consensus emerged that adjustable peg and other soft pegs, can be dangerous arrangements for open economies subject to international capital flows (Khan 2003).

Nigeria’s exchange rate arrangement is therefore a managed float (IMF 2010). More specifically, in July 2002, Nigeria reintroduced a bi-weekly Dutch Auction System (DAS) as an operational system for its foreign exchange market to replace the Interbank Foreign Exchange Market (IFEM). The DAS is a method of exchange rate determination through auction where bidders pay according to their bid rates and where the ruling rate is arrived at

\(^6\) Each of the major international capital market-related crises, namely, Mexico in 1994; Thailand, Indonesia, and Korea in 1997; Brazil and Russia in 1998; and Argentina and Turkey in 2000; involved some sort of fixity of the exchange rate.
with the last bid rate that clears the market. In short, contrary to the old IFEM system, where supply of currency was elastic at some given rate, take or leave some allowance for depreciation when demand was perceived to be too large, under the DAS the exchange rate is mainly determined by the bids made by commercial banks on behalf of their clients. So, the move back to a DAS indicates that Nigeria seems to be wishing for more, rather than less, flexibility in the exchange rate and Nigeria appears to be opting for the last monetary regime solution: stable prices and a freely floating exchange rate.

On December 11, 2006, the Bank adopted a new monetary policy framework that sought to shift from a ‘quantity’ target to a ‘price’ target. Consequently, an interest rate corridor regime was introduced with a standing/deposit facility rate around the monetary policy rate which replaced the minimum rediscount rate as the Bank’s nominal anchor for interest rate. A major objective of the new framework was to eliminate the large volatility in the interbank call rate as well as engender efficiency in liquidity management and encourage interbank trading. Thus, the CBN, through its monetary operations, steers the overnight rate to be within the corridor band. Before the introduction of the interest rate corridor, the interbank rate exhibited high volatility which has been relatively subdued under the current monetary policy implementation framework. Pockets of volatility observed during the period of the interest rate corridor regime are associated with shocks due to the global food prices and CBN guarantee of interbank lending (Adebiyi and Mordi 2014).

Regarding CEMAC region, the monetary policy is conducted by the BEAC. Four basic agreements define the institutional framework of monetary policy, such as; the convention of CEMAC, the convention of UMAC (Monetary Union of Central Africa), the status of BEAC, revised in 2010, and the convention with French. The CEMAC was established in March 1994 by Cameroon, the Central African Republic (CAR), Chad, the Republic of Congo, Equatorial Guinea, and Gabon to promote economic integration among members of the currency union. Historically, in June 1959, the Equatorial Customs Union (UDE) was created by the Central African Republic, the Congo, Gabon, and Chad, but joined by Cameroon in 1961. On December 8, 1964, the five countries created in Brazzaville (Congo) the Customs and Economic Union of Central Africa (UDEAC), and joined by Equatorial Guinea in 1983. On March 16, 1994, in N'Djamena (Chad), the UDEAC was transformed into the CEMAC, with end of an integral economic union (UEAC) in one hand, and currency union (UMAC) in other hand.
The BEAC operates in close cooperation with the French Treasury as part of the CFA franc zone arrangement. In fact, the five countries cited above signed with French, in November, 22th, 1972, a Monetary Cooperation Convention. Equatorial Guinea, joined the Monetary Cooperation Convention, on August, 24th, 1984, and since January, 1st, 1985, became CEMAC member. Main objectives of BEAC’s monetary policy are to maintain price stability and an appropriate level of foreign reserves in the pooled foreign exchange reserves of the members. The French Treasury holds 50% of CEMAC countries’ foreign reserves and guarantees the convertibility of the CFAF into Euros at a fixed exchange rate (Baldini and Poplawski-Ribeiro 2011).

Moreover, to facilitate the conduct of the monetary policy, two monetary policy rules are incorporated in its statues: (i) the BEAC limits the stock of total advances to governments to 20% of the previous year’s fiscal revenues; (ii) the BEAC is designed to keep gross foreign reserves for each Central Bank above 20% of sight liabilities. In addition to those rules, the BEAC has made use of quantitative limits on credit to governments and private sector to limit monetization of their deficits. However, although national treasuries are allowed to issue treasury bills and bonds through weekly and monthly auctions, government securities markets have yet to take off. Besides monetary rules, the governments of member countries tend to contain inflation through controlling prices of a wide range of products, including food items (Caceres et al. 2011; Ranganathan et al. 2012). This confirms our intuition that global food prices may have an impact on the inflation dynamics in CEMAC.

In fact, countries within the region are very heterogeneous in terms of size, economic structure, and price controls. Cameroon dominates the region accounting for almost 50% of the population and 31.5% of its GDP. Equatorial Guinea is the smallest, but also the richest, member of the currency union owing to its large reserves of oil and natural gas. The sectoral composition of currency union’s economy is rather skewed, and the micro structure of the food basket varies among countries, with the poorest having usually the largest share of the food. This combination of unfavorable economic structure and high levels of poverty make CEMAC particularly vulnerable to the recent surge in food prices. Global food prices became thus one of important drivers of noncore inflation in the region (Caceres et al. 2011; David et al. 2011).

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7 The Congo and Equatorial Guinea are highly reliant on oil exports whereas Cameroon and Gabon have a more diversified economic base.
3. Related literature

Whereas in the macroeconomic literature it has been recognized that oil prices play a role in real economic, the possible impact of food prices has been taken up by the literature only recently (Blanchard and Gali 2007; Gomez-Lopez and Puch 2008; Bodenstein et al. 2008; Batini and Tereanu 2009; Kilian 2009). The importance of food prices volatility to monetary policy has, however, long been recognized in the DSGE literature. In addition to the attention on the role of food inflation brought by the global food crisis, the introduction of the distinction between headline, core inflation and non-core inflation, reinforce the concerns that food prices volatility have substantial effect on inflation dynamic and trade in developing countries (Gouveia 2007; Catao and Chang 2010; Anan and Prasard 2010; Walsh 2010; Adam et al. 2012; andrle et al. 2012).

Thus, Gouveia (2007) use a DSGE model to show that food has low price elasticity of substitution with other goods. This, together with the average high share in spending, implies that food price shocks should have a nontrivial impact on marginal rates of substitution and labor supply. In addition, food is a highly competitive industry, displaying fast pass-through from cost shocks to prices, as well as high price volatility. This makes food very different from the typical composite good variety in models featuring staggered sectoral prices.

Catao and Chang (2010) address the issue of large fluctuations in world food prices by focusing in the question of how monetary policy in small open economies should react to imported price shocks. They develop a small open economy DSGE model in which all food is imported and where food represents a sizeable share of household spending. A key novelty of their model is that the real exchange rate and the terms of trade can move in opposite directions in response to food price shocks. Results reveal that under a variety of model calibrations, broad CPI targeting emerges as welfare-superior to alternative policy rules once the variance of food price shocks is as large as in real world data.

Anand and Prasad (2010), with a particular focus on emerging market economies has shown that food is a significant component of their consumer baskets, much more than in industrialized countries. In a model where there are credit market frictions, namely that a fraction of consumers have no access to credit, Anand and Prassad (2010) show that the
Central Bank should target headline rather than core inflation because of the distributional effects and the spillover from commodity prices to aggregate demand and trade.

Indeed, Walsh (2011) argues that the justification for focusing on core inflation relies on the idea that headline and core inflation have the same long-run mean, and non-core inflation has no long-run effects on core inflation. And this is the key assumption that is not warranted by theory and evidence, in particular in emerging market economies where food accounts for a large fraction of the consumer basket.

Pourroy et al (2012) develop a new-Keynesian small open-economy model that distinguishes three price indexes: an overall consumer prices index, the exact index of core inflation based on sticky prices, and a proxy for the core inflation index based on non-food prices. They show that nonfood inflation is a good proxy for core inflation in high-income countries, but not for middle-income and low-income countries. Although, in these countries they find that associating non-food inflation and core inflation may be promoting badly-designed policies, and consequently central banks should target headline inflation rather than non-food inflation. This result holds because non-tradable food goods represent a significant share in total consumption. Indeed, the poorer the country, the higher the share of purely domestic food goods in consumption and the more detrimental lack of attention to the evolution in food.

In Africa, there are few empirical studies on food prices volatility, namely those related to trade and DSGE model. A couple of studies, drawing mainly on logical deductions and descriptive analysis, emerged in the light of rapid food price increases after 2005 (O’Conell and Lang 2010; Durevall et al. 2010; Caceres an al. 2011; Misati et al. 2012; Portillo and Zanna 2013).

O’Connel and Lang (2009) develop a DSGE model in which food supply shocks play a key role in inflation dynamics. The authors show that private storage can generate serial correlation of food price inflation when food price shocks are serially.

Durevall et al. (2010), using monthly data from 2000-2009, model inflation in Ethiopia by including error correction mechanisms for food and non-food prices. In contrast to other studies, they specify separate long-run relationships for the monetary, domestic food, and external food and non-food sectors, though they ignore long-run effects of energy prices.
Their findings are that, domestic food prices adjust to changes in world food prices, and non-food prices adjust to changes in world producer prices. Domestic food supply shocks also have a strong effect on inflation but it is a short-run effect. The evolution of money supply does not affect food prices directly, though money supply growth significantly affects non-food price inflation in the short run.

Abbott and Borot de Battisti (2011) investigate price transmission patterns for a number of African countries. They find great that in Africa, countries like Nigeria and Ethiopia appear to be closely linked to the world markets, whereas most of the other countries show limited and/or lagged responses, suggesting that world market pressures are resisted by domestic market institutions. The authors also identify certain patterns, such as much greater price transmission for highly traded commodities compared to non-tradable ones, and higher price transmission rates for import dependent countries. Such findings are supported by other studies on countries in Africa (Benson et al. 2008; Cudjoe et al. 2010; Minot 2011).

Caceres an al. (2011) analyses inflation dynamics in the CEMAC using a panel cointegrated vector autoregressive (VAR) models. Results reveal that imported commodity price shocks are significant in explaining inflation in the region. In addition, in most CEMAC countries, the largest effect of global food and fuel prices occurs after four or five quarters in noncore inflation and then decays substantially over time. Second-round effects are significant only in Cameroon and to a lesser extent in the Republic of Congo.

Portillo and Zanna (2013), disaggregate food and non food sectors in a DSGE model to quantify the implications of structural transformation for inflation and Monetary policy in low-income countries. Their study reveals that structural features amplify the effects of food shocks on food inflation and on headline inflation at earlier stages of economic development. Also, they find that, the larger the food sector share sector, the more costly it is to target headline inflation in terms of the total output gap.

This research differs from the existing literature in several ways; first we capture distinctly food sector and non food sector; secondly, different exchange rate regimes are added to the model to account for exchange rate regimes and food price volatility through internationally traded goods; thirdly, we introduce Engel laws features, and finally, we develop a small open economy DSGE model will capture those keys features.
4. The Two-country Dynamic Stochastic General Equilibrium Model

The theoretical model consists of two economies, respectively CEMAC region as domestic economy, and Nigeria as foreign economy, to emphasize the bilateral trade between two economies sharing the same border. The specificity of the model relies on the inclusion of food sector and vulnerability to food price volatility. Each economy is thus populated by households, Central bank, government and three types of producers: entrepreneurs, capital producers, and retailers. The model contains net food importer feature, vulnerability to supply shock, large spending allocated to food consumption, the money preference and Engel’s Law in the food market, price stickiness, monopolistic competition in final goods market, capital adjustment costs and incomplete pass-through of exchange rate via law of one price deviation. The model disentangle food sector from non food sector, both in consumption function and production function. The Central Bank sets the short-term nominal interest rates, namely in the case of CEMAC, as a currency area, there is a unified monetary policy that sets the unique nominal interest rate. Capital producers build new capital and sell it to the entrepreneurs. Entrepreneurs produce wholesale goods and sell them to retailers. Domestic and imported goods retailers set nominal prices of final goods à la Calvo (1983). The government finances its expenditures in purchases of aggregate public goods via lump-sum taxes.

4.1. The representative household program

There is in each economy, a continuum of infinitely-lived households represented by the unit interval [0, 1]. Each household maximizes the one period utility function which depends on consumption ($C$) and labor hours ($H$), given by:

$$
\max E_t \sum_{k=0}^{\infty} \beta^k \frac{\sigma_{c}^{-1}}{\sigma_{c} - 1} - \frac{\sigma_{h}^{-1}}{\sigma_{h} - 1}
$$

Because the model consists of a two-country DSGE model, consumption $C_t$ is a composite index which depends on the consumption of goods domestically produced and goods produced in the second economy, as follow:
Under the assumption of the law of one price, the price indexes for the two economies are respectively:

\[
\begin{align*}
\text{CEMAC} & \quad C = \frac{C_1 C_2^{1-\gamma}}{\gamma^\gamma (1-\gamma)^{1-\gamma}} \\
\text{NIGERIA} & \quad C^* = \left(\frac{C_1^*}{C_2^*}\right)^{1-\gamma} \left(\frac{C_2^*}{C_1^*}\right)^\gamma \\
\end{align*}
\] (2)

To introduce the food price volatility in the analysis we desegregate the consumption basket into food goods \(C_{F,t,j}(j)\) and non food goods \(C_{NF,t,j}(j)\). Given the Engel’s law feature in Nigeria and CEMAC, we assume that the food demand is subject to subsistence requirement \(Z \geq 0\) following O’conell et al (2009). The household consumption demand is a CES function expressed as:

\[
C_t(j) = \left[\frac{1}{\alpha_c} \left( C_{F,t,j}(j) - Z \right)^{\frac{\epsilon_k-1}{\epsilon_c}} + \left(1 - \alpha_c\right) \left( C_{NF,t,j}(j) \right)^{\frac{\epsilon_k-1}{\epsilon_c}} \right]^{\frac{\epsilon_c}{\epsilon_k-1}}
\] (4)

The consumption price index (CPI) associated with the household consumption demand is defined as:

\[
P_t = \left[\alpha_c P_{F,t,j}^{1-\epsilon_c} + \left(1 - \alpha_c\right) P_{NF,t,j}^{1-\epsilon_c} \right]^{\frac{1}{1-\epsilon_c}}
\] (5)

The optimal allocation of spending between food and non-food goods in each economy can be writing as:
This minimization problem leads to the demand functions for food goods $C_{F,t}(j)$ and imported non food goods $C_{NF,t}(j)$ in each economy as follow:

$$C_{F,t}(j) = \left[ \frac{1}{\alpha_{P,F}} \left( C_{F,t}(j) - Z \right)^{\alpha_{P,F}} + (1-\alpha_{P})^{\frac{1}{\alpha_{P}} \left( C_{NF,t}(j) \right)^{\alpha_{P,F}} - \frac{\alpha_{P,F} - 1}{\alpha_{P}} \right]$$

$$(6)$$

Regarding food goods, they encompassed imported goods and domestic goods, combined according to a constant-elasticity of substitution (CES) basket, in each economy, as follow:

$$C_{F,t} = Z + \alpha_{C} \left[ \frac{P_{F,t}}{P_t} \right]^{-\alpha_{C}} C_{F,t}(j)$$

$$C_{NF,t} = \alpha_{C} \left[ \frac{P_{NF,t}}{P_t} \right]^{-\alpha_{C}} C_{NF,t}(j)$$

$$(7)$$

Similarly, the optimal allocation of spending between domestic and foreign food goods can be writing in each economy as:

$$Min P_{H,t} C_{H,t} + P_{M,t} C_{M,t} = P_{F,t} C_{F,t}$$

$$Subject to$$

$$C_{F,t}(j) = \left[ \frac{1}{\alpha_{P,F}} \left( C_{H,t}(j) \right)^{\alpha_{P,F}} + (1-\alpha_{F})^{\frac{1}{\alpha_{F}} \left( C_{M,t}(j) \right)^{\alpha_{F,F}} - \frac{\alpha_{F,F} - 1}{\alpha_{F}} \right]$$

$$(8)$$

This spending minimization on domestic and foreign food goods yields in each economy to the demand functions for domestically produced $C_{F,t}(j)$ and imported food goods $C_{F,t}(j)$ as follow:
\[ C_{H,t} = \alpha_F \left[ \frac{P_{H,t}}{P_{F,t}} \right]^{-\epsilon_{ty}} C_{F,t} (j) \quad C_{M,t} = \alpha_F \left[ \frac{P_{M,t}}{P_{F,t}} \right]^{-\epsilon_{ty}} C_{F,t} (j) \] (10)

The aggregate food price \( P_{F,t} \) is given as:
\[
P_{F,t} = \left[ \alpha_F P_{H,t}^{-\epsilon_{ty}} + (1 - \alpha_F) P_{M,t}^{-\epsilon_{ty}} \right]^{\frac{1}{1-\epsilon_{ty}}} \] (11)

The corresponding aggregate prices over the varieties \( j \) of domestic food price and foreign food price in each economy are given as:
\[
P_{H,t,j} = \left( \int_{0}^{1} P_{H,t,j} (j)^{\frac{1}{\epsilon_{ty}}} \, dj \right)^{\frac{1}{\frac{1}{\epsilon_{ty}}} - 1} \quad \text{and} \quad P_{M,t,j} = \left( \int_{0}^{1} P_{M,t,j} (j)^{\frac{1}{\epsilon_{ty}}} \, dj \right)^{\frac{1}{\frac{1}{\epsilon_{ty}}} - 1} \] (12)

The log-linearization form of above equation around the steady and taking its first difference leads us to the following consumption price-based inflation:
\[
\begin{cases}
\text{CEMAC} & \hat{\pi}_i = \alpha \hat{\pi}_{F,i} + (1 - \alpha) \hat{\pi}_{NF,i} \\
\text{NIGERIA} & \hat{\pi}_i^* = \alpha \hat{\pi}_{F,i} + (1 - \alpha) \hat{\pi}_{NF,i}^*
\end{cases} \] (13)

4.2. Production sectors

Firms produce according to a decreasing return to scale function. Given the food and non-food disaggregation, firms face a non-wage income implicitly remunerates land in the food sector or capital in the non-food sector (Durevall and Ndung’u 2001).

4.2.1. Food sector

In each economy, firms in the food sector are perfectly competitive and prices are flexible prices. Food sector is vulnerable to sectoral productivity shock. The main idea here is the desegregation of food sector into tradable food sector and non tradable food sector.

4.2.1. a. Tradable goods producers

In each economy, the production technology for tradable food goods \( Y_{F,t}^T \) depends on a unit of labor employed \( L_{t}^T \) and the level of technology \( A_t^T \), given by:
\( Y_{F,t}^T = \alpha_{F,t}^T \left( L_{F,t}^T \right)^{-\alpha_{F,t}} \)  \( (14) \)

The firm takes the price and the wage as given, and chooses the quantity produced and the labor required to maximize its profit:

\[ \Pi_{MF,t} = P_{MF,t} Y_{MF,t} - W_{MF,t} L_{MF,t} \]  \( (15) \)

The optimal condition of this program implies the usual equation that links labor productivity and real wages as follow:

\[ W_{MF,t} L_{MF,t} = (1 - \alpha_F) P_{MF,t} Y_{MF,t} \]  \( (16) \)

Together with the production function we obtain labor demand function as:

\[ L_{F,t}^T = \left( \left( 1 - \alpha_F \right) A_{F,t}^T \frac{P_{F,t}}{W_t} \right)^{1 / \alpha_{F,t}} \]  \( (17) \)

4.2.1.b. Non tradable goods producers

The production technology for tradable food goods \( Y_{F,t}^{NT} \) depends on a unit of labor employed \( L_{F,t}^{NT} \) in non tradable sector and the level of technology \( A_{F,t}^{NT} \), expressed by:

\[ Y_{F,t}^{NT} = A_{F,t}^{NT} \left( L_{F,t}^{NT} \right)^{1 - \alpha_{NT}} \]  \( (18) \)

The firm takes the price and the wage as given, and chooses the quantity produced and the labor required to maximize its profit:

\[ \Pi_{HF,t} = P_{HF,t} Y_{F,t} - W_{F,t} L_{HF,t} \]  \( (19) \)

The optimal condition of this program implies the usual equation that links labor productivity and real wages:

\[ W_{F,t} L_{HF,t} = (1 - \alpha_F) P_{HF,t} Y_{HF,t} \]  \( (20) \)

Together with the production function we get demand for labor:

\[ L_{HF,t} = \left( \left( 1 - \alpha_{HF} \right) A_{HF,t} \frac{P_{HF,t}}{W_t} \right)^{1 / \alpha_{HF}} \]  \( (21) \)

The log-linearization form of previous equation around the steady and taking its first difference leads us to the following food inflation:

\[ \hat{\pi}_{F,t} = \alpha_F \hat{\pi}_{HF,t} + (1 - \alpha_F) \hat{\pi}_{MF,t} \]  \( (22) \)
To fully capture the reality concerning the bilateral trade between Nigeria and CEMAC, we assume that the Law of One Price Gap (LOPG) is violated in import, expressed as follow:\(^8\):

\[ P_{M,t} \neq S_t P_t^* \tag{23} \]

These deviations of the prices in foreign currency of imported food goods relative to their original level of producers countries are due for example to the presence of importing firms in monopolistic competition which practice “local currency pricing” conversely to “producers currency pricing”\(^9\). In fact, importing firms are monopolistically competitive and have a small degree of pricing power in the domestic market. This means that when retail firms sell imported food goods to domestic consumers, they charge a mark-up over their costs, creating a wedge between the world market price of foreign food goods and domestic currency price of these goods when they are sold to consumers (Devereux and Engel 2001; Chari et al. 2002; Monacelli 2003; Monacelli 2005). Those prices spreads are called deviations relatively the Law of One Price Gap (LOPG), and defined as:

\[ LOPG_t = \frac{S_t P_t^*}{P_{M,t}} \tag{24} \]

Where, \( P_t^* \) represents the general index price of rest of the world (ROW).

Hence, the term of trade between Nigeria and CEMAC is expressed as the ratio of the domestic final goods price and imported final goods price, as follow:

\[ TOT_t = \frac{P_{Hf,t}}{P_{Hf,t}} \tag{25} \]

The real exchange rate is thus expressed as follow:

\[ RER_t = \frac{S_t P_t^*}{P_t} \tag{26} \]

---

\(^8\) The Law of One Price Gap holds only if it equals to unity, otherwise, it does not hold.

\(^9\) When there is a completed “pass-through”, meaning that the fluctuations of exchange rate is completely transmitted to prices, the Law of One Price Gap is verified in import, so the prices in foreign currency of imported goods from the rest of the world is defined as: \( P_{M,t} = S_t P_t^{Rwc} \).
The log-linearizing of the term of trade between Nigeria and CEMAC around the steady state leads to:

\[ t_{\text{tot}} = \hat{p}_{Mf,t} - \hat{p}_{Hf,t} \]  

(27)

By taking the first difference of the previous relation of term of trade, we obtain the relation between imported food inflation and home food inflation, as follow:

\[ \Delta t_{\text{tot}} = \hat{\pi}_{Mf,t} - \hat{\pi}_{Hf,t} \]  

(28)

By substituting the change of the term of trade into the food inflation equation, we obtain:

\[ \hat{\pi}_{F,t} = \hat{\pi}_{Hf,t} + a\Delta t_{\text{tot}} \]  

(29)

Where \( \Delta t_{\text{tot}} \) is the log-linearization of the effective term of trade formula around the symmetric steady state, and \( (a) \) is the openness bias.

From the previous relations, we obtain the log-linearization relation between the real exchange rate, deviations relative to the LOPG and the term of trade, given as:

\[ \hat{r}_{er,t} = \hat{\text{logpg}},(1-a)\hat{t}_{\text{tot}}, \]  

(30)

Where, \( \text{logpg}, \) represents the Law of One Price Gap and \( (1-a)\hat{t}_{\text{tot}}, \) captures the heterogeneity of the consumption basket composition between domestically and imported goods. Those both factors explain the deviation from Purchasing Power Parity (PPP)\(^{10}\). Since Nigeria and CEMAC are price taker in international markets for their exports, we assume that the Law of One Price Gap holds for export in this study.

4.2.2. Non food sector

In each economy, firms in the non food sector operate in a monopolistically competitive market. Sticky prices are set à la Calvo (1983) mechanism and there is employment subsidy. Hence, the variety of each good is produced by a single firm according to a technology

\(^{10}\) When the \( \hat{\text{log}} \) \( p_{rs} \) increases, the increasing effect of prices \( (P_{rw}^{bw}) \) of imported goods from the ROW is transmitted weakly to prices of those similarly goods denominated on the national market of imported firms, and thus weakly to inflation of aggregated index of consumption price.
common across sector firms $\left( A_{NF,j} \right)$ and using labor $\left( L_{NF,j} \right)$ as the only input. The production technology $\left( Y_{NF,j} \right)$ depends also on economy wide total factor productivity $\left( A \right)$, given by:

$$ Y_{NF,j} = A_{NF,j} \left( L_{NF,j} \right)^{1-\alpha} $$  \hspace{1cm} (31) 

Firms are allowed to set prices according to a stochastic time-dependent rule as in Calvo (1983). In each period, a firm faces a probability $\psi_{NF}$ of not being able to re-optimize its price. All firms that reset their price at $t$ will choose the same $P_{tj}^{N}$ in order to maximize the expected present discounted value of profits, under the constraint that the firm must satisfy demand at the posted price. Thus, the firm program is given by:

$$ \max_{\psi_{NF}} E_t \sum_{k=0}^{\infty} \left( \psi_{NF} \right)^k \left[ Q_{t+j+k} P_{NF,j+t} Y_{NF,j+k+t} - \psi_{NF} Y_{NF,j+k+t} \right] $$  \hspace{1cm} (32) 

Subject to following demand function:

$$ Y_{NF,j+k+t} = \left( \frac{P_{NF,j+t}}{P_{NF,j+k+t}} \right)^{-\eta_N} C_{NF,j+k} $$  \hspace{1cm} (33) 

And to the following labor cost:

$$ \psi_{NF,j+k+t} = W_{t+k} \left( \frac{Y_{NF,j+k+t}}{A_{NF,j+k}} \right)^{\frac{1}{1-\alpha_N}} $$  \hspace{1cm} (34) 

The first order condition of the above program is given by:

$$ \sum_{k=0}^{\infty} \left( \psi_{NF} \right)^k \left[ Q_{t+j+k} P_{NF,j+t} Y_{NF,j+k+t} - \frac{\eta_N}{\eta_N-1} \psi_{NF} Y_{NF,j+k+t} \right] = 0 $$  \hspace{1cm} (35) 

Replacing $Q_{t+j+k}$ by its expression in equation (35) and log-linearizing around zero-inflation steady-state, we obtain:

$$ \hat{P}_{NF,j} = \hat{P}_{NF,j-1} + \hat{\pi}_{NF,j} + E_t \sum_{k=0}^{\infty} \beta \psi_{NF} \left( \hat{\pi}_{NF,j+k} \right) \left[ \left( \hat{\pi}_{NF,j+k} \right) + \left( 1 - \beta \psi_{NF} \right) E_t \left[ m_{t+k} \right] \right] $$  \hspace{1cm} (36)
Solving the equation recursively rearranging it yields to the non food inflation:

\[ \hat{\pi}_{NF,i} = (1 - \beta \psi_{NF}) E_t \left[ \hat{\pi}_{NF,i} \right] + \psi_{NF} \hat{\pi}_{NF,i-1} + \frac{(1 - \beta \psi_{NF})(1 - \psi_{NF})}{\psi_{NF}} m \hat{c}_i \]  

(37)

4.3. **Central Banks Program**

4.3.1. **The BEAC and the fixed exchange rate regime**

Following the monetary convention with French, as stated in the previous section, the BEAC keeps the nominal exchange rate pegged at a predetermined level such as:

\[ S_i = \bar{S} \quad \forall t \]  

(38)

Subsequently, the BEAC sets the nominal interest rate to satisfy the uncovered interest rate parity given by the previous relation.

4.3.2. **The Central Bank of Nigeria (CBN) and the floating exchange rate regime**

The Taylor-type reaction function of the CBN under this monetary policy regime is as follows:

\[ \hat{r}_i = \rho \hat{r}_{i-1} + (1 - \rho) \left( \beta_1 \hat{\pi}_i + \beta_2 \hat{y}_i + \beta_3 \Delta \hat{\pi}_i \right) + \epsilon_{r,i} \]  

(39)

4.4. **Government Program**

Fiscal policy remains the responsibility of each national government. Governments intervene in the economy by an active policy of public spending \( (g_i) \), funded by lump-sum taxes \( (T_i) \), expressed as:

\[
\begin{cases}
\text{CEMAC} & \hat{T}_i = P_i \hat{g}_i \\
\text{NIGERIA} & \hat{T}^{*}_i = P^{*}_i \hat{g} 
\end{cases}
\]  

(40)

For model simplification, each national government follows a national fiscal rule which is supposed to be fully exogenous, so as defined as, an autoregressive process:
\[
\begin{align*}
\text{CEMAC} & \quad \hat{g}_t = \rho_{\hat{g}} \hat{g}_{t-1} + \varepsilon_{\hat{g}}, \\
\text{NIGERIA} & \quad \hat{g}^*_t = \rho^*_{\hat{g}} \hat{g}^*_{t-1} + \varepsilon^*_{\hat{g}},
\end{align*}
\] (41)

5. **Data sources and analysis**

This study used quarterly data spanning over the period of 1996Q1-2010Q4 extracted from the Data Base of International Monetary Fund (IFS 2012), World Bank (2012) and the Central Bank of Nigeria database (CBN 2012). The selected observables variables used to estimation include, term of trade, real GDP, Consumption Price Index (CPI), consumption, foreign food inflation and nominal interest rate. The choice of the sample period is fundamentally informed by the necessity to avoid the influence of 1994 devaluation of the CFA Franc of the CEMAC in the analysis. We didn’t consider Nigeria case when chosen the sample period for two main reasons. In the once, as explained above, Nigeria experienced several devaluations throughout the time. In the other linking, Nigeria monetary policy regime is based on flexible exchange rate. Since the DSGE model variables are expressed in terms of log-deviations from their steady-state values, the selected data have been pre-processed for estimation. Some of the series who exhibit periodic fluctuations have been seasonally adjusted using the multiplicative decomposition of the Census X12 process in Eviews software. Furthermore, series in the data set have been smoothed through natural logarithm transformation. Thereafter, unit root tests to ascertain the stationary status of the logarithm transformed series have been performed.

6. **Empirical Methodology**

6.1. **Bayesian estimation technique description**

The empirical methodology of the theoretical model of this paper is the Bayesian methodology. Basically, different methods for estimating DSGE model have been identified in the literature, namely, the maximum likelihood method, the method of generalized moments, the M-estimator method, and the methods of simulated moments. Faced with all the shortcomings of those usual methods, Bayesian methodology becomes the widely
Bayesian estimation in its technical aspect is a mix between calibration and maximum likelihood which are connected by Baye’s rule. Unfortunately, since in most cases it is not possible to specify the joint distribution of parameters explicitly, it is typical to conduct Bayesian estimation by using stochastic simulation, namely, Markov-chain Monte-Carlo simulation rather than the straightforward maximum likelihood estimation (Adebiyi and Mordi 2012). Specifically, the Bayesian inference is based on the Metropolis-Hastings algorithm, as one of the oldest among existing Markov-Chain Monte-Carlo sampling methods.

Bayesian approach provides thus a rigorous framework to formalize our prior beliefs and to determine how they should be updated once the data are observed. For the model chosen and the vector of structural parameters, \( \Theta \), the prior distribution is denoted as follows:

\[
\Gamma(\Theta)
\]

This joint density, \( \Gamma(\Theta) \), defines our uncertainty about the parameters \( \Theta \) until we have paid attention to the data, that is the prior information.

Given a sample:

\[
Y^*_T = \{y^*_t\}_{t=1}^T
\]

Where \( y^*_t \) is a vector of k parameters.

The density of vector of parameters conditionally to the model and to its parameters \( \Theta \) is given by:

\[11\] The maximum likelihood method can pose some difficulties in estimations when the model size becomes important. For the method of generalized, the results of sur-identified case are highly dependent on the calculation of the weight matrix. The M-estimator method submits the specification of the DSGE model to the VAR modeling and identification schemes considered. Finally, for the methods of simulated moments, in many cases, it is difficult to determine analytically or by direct numerical integration moments or density of data coming from a structural model.
This likelihood function is the information conveyed by the data. From Bayes' theorem, we meet those two orthogonal sources of information to obtain the posterior density which is expressed as follows:

$$
\Gamma \left( Y^*_i; \Theta \right) = \Gamma \left( \Theta \right) \Gamma \left( Y^*_i/\Theta \right)
= \Gamma \left( Y^*_i \right) \Gamma \left( Y^*_i/\Theta \right)
$$ (45)

$$
\Gamma \left( \Theta/ Y^*_i \right) = \frac{L \left( \Theta/ Y^*_i \right) \Gamma \left( \Theta \right)}{\Gamma \left( Y^*_i \right)}
= \frac{L \left( \Theta/ Y^*_i \right) \Gamma \left( \Theta \right)}{\int \Gamma \left( Y^*_i/ \Theta \right) \Gamma \left( \Theta \right) d\Theta}
$$ (46)

Where, $\Gamma \left( Y^*_i \right)\,$ represents the marginal density.

Thus, the posterior distribution of the parameters vector is proportional to the likelihood function and prior distribution, and is expressed as follows:

$$
\Gamma \left( \Theta / Y^*_i \right) \equiv L \left( Y^*_i/ \Theta \right) \Gamma \left( \Theta \right)
$$ (47)

Bayesian inference focuses on the posterior expectations because they are Bayes estimators in the case of a quadratic loss function. Hence, the Bayesian approach requires the use of stochastic simulations, including the techniques of Monte-Carlo via Markov-Chains, in order to have the posteriori distribution function of parameters and therefore make the inference. In general, Bayesian inference deals on the expectation of the interest function, namely:

$$
E \left[ g \left( \Theta / Y^*_i \right) \right] = \frac{L \left( \Theta/ Y^*_i \right) \Gamma \left( \Theta \right)}{\Gamma \left( Y^*_i \right)}
= \frac{L \left( \Theta/ Y^*_i \right) \Gamma \left( \Theta \right)}{\int \Gamma \left( Y^*_i/ \Theta \right) \Gamma \left( \Theta \right) d\Theta}
$$ (48)

Where $g \left( \Theta \right)\,$ is the function of interest.
These moments are calculated by a Monte-Carlo method based on random draws of parameter values, following their posterior distribution law. The difficulty in applying this method is that if the value of this distribution at each point can be calculated numerically, it is not enough to allow the performance of a simple random draws. Several methods have been developed to solve this problem, the most widely used in economics is the Metropolis-Hastings algorithm (AM-H). The mode and the Hessian of the posterior distribution are used to initialize the algorithm of Metropolis-Hastings. The AM-H is schematically as follows:

1. We begin with an initial value $\Theta_0$.

From this value, the expression $L(Y^* / \Theta, k)\Gamma(\Theta, k)$ is evaluated.

2. At each iteration $i$.

$$
\hat{\Theta}_i = \begin{cases} 
\hat{\Theta}_{i-1} & \text{with probability of } 1 - \pi \\
\Theta_i & \text{with probability of } \pi 
\end{cases} 
$$

(49)

Where $\Theta^*_i = \Theta_{i-1} + b \psi$ and $\pi = \min \left(1, \frac{L(Y^* / \Theta^*_i, k)\Gamma(\Theta^*_i, k)}{L(Y^* / \hat{\Theta}_{i-1}, k)\Gamma(\hat{\Theta}_{i-1}, k)} \right)$, $\psi$ defines the Hessian matrix of the posterior distribution evaluated at the mode. The value of $b$ determines the acceptance rate of the algorithm.

If this rate is too low, the Markov-Chain does not visit a broad set of values in a reasonable number of iterations. If this rate is too high, the Markov chain does not remain long enough in areas of high probability.

6.2. The calibration of the theoretical model
As the starting point of DSGE empirical methodology, the calibration method provides the priors information of the parameter of the model. In this analysis, parameters are calibrated according the stylized facts of each economy, economic theories, and existing empirical literature. Other parameters are sets so that they reflect economy at the steady state. The rest of parameters are estimated. Parameters can be categorized into five broad groups: (1) utility function, (2) food sector, (3) non-food sector, (4) Shocks persistence, (5) calculated parameter.
Table 1: Parameters calibration

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Nigeria Value</th>
<th>CEMAC Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta$</td>
<td>Discount factor</td>
<td>0.99</td>
<td>0.98</td>
</tr>
<tr>
<td>$\sigma_c$</td>
<td>Inverse of the intertemporal elasticity of substitution</td>
<td>2.98</td>
<td>1.81</td>
</tr>
<tr>
<td>$\sigma_l$</td>
<td>Inverse of elasticity of labor supply</td>
<td>0.33</td>
<td>0.40</td>
</tr>
<tr>
<td>$\alpha_c$</td>
<td>Share of food goods in the consumption bundle</td>
<td>0.7</td>
<td>0.6</td>
</tr>
<tr>
<td>$\omega_c$</td>
<td>Elasticity of substitution between food and non-food goods</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>$\omega_F$</td>
<td>Elasticity of substitution between food T and N</td>
<td>0.75</td>
<td>0.75</td>
</tr>
<tr>
<td>$\alpha_F$</td>
<td>Share of tradable in food consumption</td>
<td>0.8</td>
<td>0.7</td>
</tr>
<tr>
<td>$\chi$</td>
<td>Elasticity of substitution between different varieties of goods</td>
<td>0.44</td>
<td>0.40</td>
</tr>
<tr>
<td>$\alpha^T$</td>
<td>Scale effect on labor, tradable</td>
<td>0.25</td>
<td>0.3</td>
</tr>
<tr>
<td>$\psi_{NF}$</td>
<td>Probability of non-food price non-adjustment</td>
<td>0.3</td>
<td>0.5</td>
</tr>
<tr>
<td>$\eta_N$</td>
<td>Scale effect on labor, non-tradable</td>
<td>0.25</td>
<td>0.2</td>
</tr>
<tr>
<td>$\rho$</td>
<td>Lag of monetary policy rate</td>
<td>0.70</td>
<td>0.51</td>
</tr>
<tr>
<td>$\beta_1$</td>
<td>Inflation gap coefficient</td>
<td>1.50</td>
<td>1.62</td>
</tr>
<tr>
<td>$\beta_2$</td>
<td>Output gap coefficient</td>
<td>0.50</td>
<td>0.37</td>
</tr>
<tr>
<td>$\beta_3$</td>
<td>Exchange rate coefficient</td>
<td>0.25</td>
<td>0.5</td>
</tr>
<tr>
<td>Calculated parameter*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$a$</td>
<td>Openness degree</td>
<td>0.70</td>
<td>0.65</td>
</tr>
<tr>
<td>$C_Y$</td>
<td>Consumption GDP ratio</td>
<td>0.787</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Source: constructed by author
*Author calculation’s based on IFS data

Those data alongside with calibrated parameters of the model are used for estimations of the above structural model using Bayesian methodology.

6.3. The estimation results of the theoretical model

In order to sample from the posterior, random walk Metropolis-Hastings (MH) algorithm is utilized to produce 100,000 draws from the posteriors. Essentially, the table contains the prior distribution used, the prior standard deviation, the prior mean, the posterior mean, as well as the confidence interval. Regarding prior distribution used, Gamma and Normal distribution have been considered for parameters constrained to be positive, Beta distribution have been chosen for parameters constrained in the interval $[0,1]$, Inversed Gamma distribution is associated to shock precision. For the posterior mean, the general guideline is satisfied, since most of parameters have a relatively close value between the prior and the posterior. This overall result implies that, the designed DSGE model provides a good point of departure for
the examination of the effect of food prices volatility on trade between food-oriented economies in Africa facing different exchange rate regimes.

Moreover, results reveal that Nigeria (0.8) appears to be the most open economy that in CEMAC (0.6). Such a high interchange with the rest of the world suggests that the Nigerian economy is naturally strongly exposed to external shocks, like the food prices volatility, which may reduce the ability of the CBN to control domestic variables, especially prices.

The parameter estimates of the elasticity of substitution between home and imported food goods in the consumption basket of domestic households, is higher than its prior mean value for both economies, and even higher than (1) for Nigeria. It should be noted that a high value of this parameter points to a high degree of adjustment of consumers from these countries in response to changes in relative prices of domestic goods and imported goods.

The estimated posterior mean value of the Calvo probability is lower than the prior mean of 0.5 for home food prices and for imported food prices for both economies. Lower values show that domestic prices and foreign prices respectively are re-optimized frequently in a given year. The more the firms reset their prices in a given year, the more inflation is subdued and inversely when price setting is staggered. Therefore, the lower posterior mean (<0.5) of the probability of not resetting prices in both economies brings into the fore that inflation is subdued in those economies.

The posterior estimates of the monetary policy rule coefficients provide plausible reaction function of the Central Bank to inflation’s deviation from its implicit target, output growth’s deviation from its potential, and exchange volatility. First, the degree of interest rate persistence is high, and even is far above the prior mean of 0.70 for Nigeria. This result implies the persistence of the low level of trade between CEMAC and Nigeria in presence of food price volatility. Second, the response of the interest rate to inflation’s deviation from its target is estimated to be higher than the prior mean value of 1.5 for both economies. But, the output gap coefficient is below its prior mean of 0.50 for both economies countries. This finding shows that Central Banks in these countries overreact to inflation than output. Third, the estimated coefficient of the response of interest rate to volatility in exchange rate is above its prior mean for Nigeria and meets the prior for CEMAC. This result confirms the effectiveness of the Nigeria floating exchange rate.
Third, exchange rate-policy shocks suggest the superiority of the insulating role of a flexible exchange rate regime over the fixed exchange rate. Nonetheless, the contraction in economic activity remains smaller under flexible exchange rate than under fixed exchange rates. In addition, the impact of exchange rate on prices indicates a low and an incomplete exchange-rate pass-through in both economies. The low pass-through is partly attributed to the low and stable inflation rate arising from the implementation of the monetary union features by the BEAC and the improving of the subsisting monetary framework of the CBN.

5. Propagation of shocks

The dynamic of the model is appraised using impulse responses functions of main variables, such as, output, consumption, interest rate, inflation, real exchange rate and term of trade, following food prices shocks in both economies.

5.1. Impulses Responses Function in Nigeria following a food price shock

The graph 1 summarizes the behavior of the log-linearized model to a positive food price shock with zero mean and unit variance in Nigeria, that is, an increase in the foreign food price. Under the effect of food prices shock, domestic inflation rate increases. Supply gradually adjusts to the demand, which explains the drop in consumption and lead to a sharp deterioration of term of trade in Nigeria. Since the CBN aims to stabilize inflation, the central bank reacts to inflation by increasing the nominal interest rate. But, the reaction is slow and does not lead to sufficiently rapid price stabilization. Therefore, real exchange rates appreciate, explaining the behavior of household consumption. The positive effect of the shock on output does not offset the negative effect of the shock on domestic prices, as result the bilateral trade between Nigeria and CEMAC declines persistently.

Concerning the differences in the behavior between the two economies following the shock, the role of the degree of openness and share of foods good imports is relevant. We can observe that, the economy which is more affected by the food price shock is Nigeria. It has a huge degree of openness than CEMAC and imports more food than CEMAC. Consequently, the vulnerability of the economy to food price volatility increases more in reaction to shock, and it is transmit on domestic headline inflation. The inflation pressure is thus too high in Nigeria than CEMAC, leading a deterioration of term of trade between Nigeria and CEMAC.
Thus, the impulse response function analysis reveals that, following a foreign food price shock in Nigeria, the floating exchange rate regime is dominant than fixed exchange rates regime to tackle the shocks.

Graph 1: Nigeria Impulse Response Function of Food Price Shock
5.2. Impulse Responses Function in CEMAC following a food price shock

Similarly, the impulse response function analysis reveals that, following a foreign food price shock in CEMAC, the floating exchange rate regime is dominant than fixed exchange rates regime to tackle the shocks, even if the magnitude is less in this case.

Graph 2: CEMAC Impulse Response Function of Food Price Shock
7. Welfare Evaluation

The cost of welfare that we will use in our methodology, represents the fraction of deterministic consumption that households are willing to sacrifice so that they are indifferent between a constant sequence of consumption and labor hours and a stochastic sequence (after the shock) of the same variables under different exchange rate regimes:

\[ X((1+x)C, L) = E\left(X(C, L)\right) \]  \hspace{1cm} (50)

The second order Taylor approximation around the steady state of the unconditional expectation of the utility function of the representative household is given by:

\[ E\left(X(C, L)\right) = X(C, L) + C^{\sigma}E\left(C\right) - \frac{1}{2}\sigma C^{\sigma} \text{var}\left(C\right) - L^{\eta}E\left(L\right) - \frac{1}{2}\eta L^{\eta} \text{var}\left(L\right) \]  \hspace{1cm} (51)

Since \( x^{\text{var}} \) is the measure of the cost of well-being that allows to assess the basic relation, it is thus the portion of permanent consumption dropped as a result of the shock on the unconditional variances of the variables and \( x^{\text{var}} \) is such that:

\[ X((1+x^{\text{var}})C, L) = X(C, L) - \frac{1}{2}\sigma C^{\sigma} \text{var}\left(C\right) - \frac{1}{2}\eta L^{\eta} \text{var}\left(L\right) \]  \hspace{1cm} (52)

\( x^{\text{var}} \) can be found easily as:

\[ x^{\text{var}} = \left[1 - \frac{1}{2}\sigma(1-\sigma) \text{var}\left(C\right) - \frac{1}{2}\eta \left(\frac{1-\sigma}{C^{\sigma}}\right) L^{\eta} \text{var}\left(L\right)\right]^{-\frac{1}{1-\sigma}} - 1 \]  \hspace{1cm} (53)

Here, we consider only the effect of a particular shock on the volatilities of variables (volatility effect on welfare) and not on their level. This choice does not affect the arrangement of the different exchange rate regimes.

The values of \( x^{\text{var}} \), loss of well-being after the two types of shocks for each of economy and under different exchange rate regimes are presented in Table 2.

Table 4 shows for both economies that the more monetary policy induces a rigid exchange rate the more it is costly in terms of welfare. These results are consistent with those previously obtained in the previous sections.
Table 2: welfare cost (in percentage of consumption) of alternatives exchange rate regimes in presence of alternative shocks

<table>
<thead>
<tr>
<th>External shocks</th>
<th>Monetary policy regimes</th>
<th>Nigeria</th>
<th>BEAC issuing zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food prices shocks</td>
<td>Fixed exch. Rate</td>
<td>0.023</td>
<td>0.018</td>
</tr>
<tr>
<td></td>
<td>Floating exch. Rate</td>
<td>0.001</td>
<td>0.004</td>
</tr>
<tr>
<td>Productivity shock</td>
<td>Fixed exch. Rate</td>
<td>0.52</td>
<td>0.27</td>
</tr>
<tr>
<td></td>
<td>Floating exch. Rate</td>
<td>0.028</td>
<td>0.019</td>
</tr>
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</table>
6. Conclusion and policy implications

Food prices volatility clearly accentuated the low level of bilateral trade between Nigeria and CEMAC. But, the scope of the phenomenon is influenced by the type of monetary policy regime. The current research analyzes the complexity of the concerns in terms of food prices volatility implications for trade and monetary policy among two Sub-Saharan economies.

In the first step, the considered economies were differentiated according to their monetary policy regimes. We thus develop a two-country DSGE model with different monetary policy regimes to empirically analyze this important issue. The second step, concern the calibration and the estimation of the model to assessing the trade and monetary policy effect of food prices volatility in Sub-Saharan economies. The specifics of both economies, their position as net food importers, vulnerability to supply shock, large spending allocated to food consumption, the money preference and Engel’s Law in the food market have been emphasized on.

The mains findings are that the designed DSGE model provides a good point of departure for the examination of the effect of food prices volatility on trade between food-oriented economies in Africa facing different exchange rate regimes. Moreover, results reveal that Nigeria encompasses a huge degree of vulnerability to food prices shock than CEMAC region. Furthermore, result suggests that food prices volatility accentuate the low level of bilateral trade between Nigeria and CEMAC. In addition, results show an incomplete pass-through of exchange rate to domestic inflation in both economies. The low pass-through is partly attributed to the low and stable inflation rate arising from the implementation of the monetary union features by the BEAC and the improving of the subsisting monetary framework of the CBN.

More importantly, results reveal that in the presence of adverse foreign food prices shocks, floating exchange rate regime is dominant than fixed exchange rates regime for each economy to tackle the shocks. Through welfare analysis, results confirm that, facing external food price shocks, the floating exchange rate regime is best for bilateral trade intensification between Nigeria and CEMAC.

As policy implication, to enhance trade, monetary policymakers in both economies should cooperate by establishing mechanism able to offset the impact of food price volatility. In
addition, policymakers in both economies ought to implement economic strategies to better understanding the dynamics of global food prices so as to design appropriate policy interventions for trade intensification when food prices shocks recur.
8. References


Dzaka, T. (2009), Stratégie de développement du Commerce en République du Congo, PNUD.


