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Economic Interdependence and Macro-economic Shocks Synchronization in West African Monetary Zone Member Countries

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Abstract
Does financial sector develop in line with its nature? Does part of financial development, which is in line with its nature, approve mainstream opinion in regard to finance-growth relationship? By considering financialization phenomenon within an ARDL-Bounds testing approach, this study re-examined the causal relationship between financial development and economic growth in the USA during the period 1961–2012. Using Principal Component Analysis (PCA), indicators of financial sector development (FD) and financialization (FIN) were created. After that, Granger causality test was applied using the ARDL-ECM methodology. According to the results: 1) a bilateral relationship between financial development and economic growth was observed; while financial development had negative and significant impact on economic growth, the influence of economic growth on financial development was not significant although it was positive; 2) financialization significantly affected financial development through efficiency channel. Obtained results can be used by policy makers in different countries, although the study is applied for the USA.

Keywords: Financial Sector Development, Economic Growth, Financialization, ARDL-Bounds Cointegration, Granger Causality.

JEL Classification: O11; O16; O51; G20.

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1.1.Introduction

An Optimal Currency Area (OCA) may be considered as a currency area in which the cost of using the exchange rate as a national adjustment mechanism is greater than the benefits of adopting a monetary or fixed exchange rate policy, Mundell (1961). The cost of an Optimal Currency Area in Mundell's work includes the loss of independence in the national currency and the exchange rate. Likewise, the main positive costs include lower transaction costs and the elimination of exchange rate uncertainty. Recently, the creation of the European Monetary Union has highlighted the importance of optimal common areas in any serious discussion on economic integration (Corsetti, Dedola& Leduc 2008).

In OCA studies, OCA Member States have been set up to take full advantage of the benefits of their monetary union. Mundell (1961) has argued that labour mobility is a crucial factor or even a precondition for achieving an effective monetary union. On his part, McKinnon (1963) emphasized the role of price stability in the economy and globalization, and considered them as optimal conditions for the establishment of a single currency region. Kenen (1969), however, asserted that a variety of marketable products in the region may be a more important reference than labour mobility. In addition, a well-developed economy is more likely to produce a diversified export sector, less exposed to external shocks. Similarly, Eichengreen (1992) has stated that "an economic unit composed of a region is symmetrically affected by disturbances and between which labour and other factors of production freely constitute an Optimal Currency Area"

But recently, the issue of economic interdependence, usually determined by synchronizing macroeconomic shocks, is crucial in the discussion of OCAs. To Fielding and Shields (2001), the cost of monetary union depends on the degree of similarity between price and output shocks in all countries. It also depends on the extent of equality in the macroeconomic shock. In this context, there have been several studies conducted to study the macroeconomic characteristics and the African region and the Economic Community of West African States (ECOWAS), which is related to a macroeconomic shock. Such studies have been conducted to determine their suitability for a monetary union. Bayoumi and Ostry (1998), Fielding and Shields (2003), Houssa and Leuven (2004) and Houssa (2008) are among these studies.

In addition, it is fitting to note that existing studies on the synchronization of macroeconomic shocks are divided in the region. Bayoumi and Ostry's (1998) study did not link the countries of sub-Saharan Africa as an effective monetary union, suggesting that costs of the monetary union are high. On the contrary, studies by Fielding and Shields (2003) and Houssa and Leuven (2004) have shown negative correlations among members of the African Economic and Monetary Union, suggesting asymmetry of shocks. The results of recent studies are also mixed and mainly concern French-speaking members of ECOWAS, neglecting the English-speaking members of the WAMZ (Houssa, 2008; Etta-Nkwelle, Augustine & Lee, 2012).

In addition, most studies in this area have used either unlimited Vector Auto-regression (VAR) or Structural Vector Auto-regression (SVAR), without seriously considering macroeconomic shocks in key trading partner economies, mostly in developed countries. Despite empirical efforts on the subject in Africa and the ECOWAS sub-region, efforts are yet to be made to determine the extent of macro-economic shock synchronization in the WAMZ member states. It is this scholarship lacuna that this study seeks to fill. It has also been noted that no many studies have examined the nature of economic interdependence among WAMZ member states by taking into account developed economies outside the zone. To do this, there is a need to develop a more advanced method. It is also necessary to expand the discussion area to meet the requirements of the present time. This is why Global Vector Autoregression (GVAR) and structural VAR are used as methodologies in this study. This will explain the external macroeconomic shocks in relevant trading partners outside the zone. Explanation of the external macroeconomic shocks or economic partners outside the zone specific variables was obtained from GVAR. This study also used SVAR for structural identification of shocks.

Also, virtually all studies in this area have used Unlimited Vector Autocorrelation VAR or Structural Vector Creation (SVAR), without taking into account macroeconomic shocks in the economies of major trading partners, particularly in developed countries. Despite empirical efforts in this area in Africa and in the ECOWAS sub-region, further efforts have been made to determine the extent of synchronization of the macroeconomic shock in the WAMZ member states. It is the scholarly void that this study aims to fill. Only few studies have examined the nature of economic interdependence among WAMZ member states by taking into account developed economies outside the zone. It is therefore necessary to develop a more advanced method. It is also necessary to broaden the area of discussion to current needs. This is why the Global Vector Autoregression (GVAR) method and structural VAR are used as methodologies in this study. This will explain the external macroeconomic shocks to the relevant trading partners outside the zone. Explanation of external macroeconomic shocks or economic partners outside zone specific variables was obtained from GVAR. This study also applied SVAR for the structural identification of shocks.

While the second part of this discussion provides background information on WAMZ countries, the third part is devoted to relevant studies that are related to the main argument advanced in this study. The fourth part presents the study's methodology, and the fifth discusses the results, from which conclusions were drawn.

1.2.Background Information of WAMZ

Recently, the dominant problem of an OCA is whether it is convenient for some countries to adopt a single currency by abandoning their national currencies or by adopting the currency of another country or even by joining other countries to create a common currency (Edwards, 2006). It is in this regard that the Economic Community of West African States (ECOWAS), a group of 15 African countries, including a monetary union, decided to form a new monetary union. The existing monetary union includes only the ECOWAS countries located in the former French colonies, known collectively as the West African Economic and Monetary Union (WAEMU). In April 2000, ECOWAS decided to establish another monetary union in the region (Houssa, 2008).

As a result, non-WAEMU members of ECOWAS have reached an agreement for the creation of another monetary union- the West African Monetary Area (WAMZ). This was done with the hope that UEMOA and WAMZ would come together to form a broader, stronger and more organized monetary union within ECOWAS. In an attempt to track regional monetary integration, six West African countries (the Gambia, Ghana, Guinea, Liberia, Nigeria and Sierra Leone) decided in 2000 to create another monetary zone within the institute. This is known as the West African Monetary Fund (WAMI) in 2003.

Given the situation of economic convergence, one of the prerequisites for optimal OCA efficiency in the studies conducted is that many OCAs have seriously considered the convergence hypothesis. To meet the requirements of an OCA, WAMZ members state established criteria for economic convergence and divided them into primary and secondary criteria. For example, the main objectives targeted four indicators: inflation (single-digit inflation at the end of 2000 and 5% at the end of 2003); the total budget deficit of GDP at current market prices (maximum 5% in 2000 and 4% in 2002), financing of the budget deficit by the central bank (ceiling of 10% of tax revenues of previous years), foreign exchange reserves (3 months import (CIF) in 2000 and 6 months in 2003).

The secondary criterion covered five pillars: 1) new domestic debt obligations and existing ones should be settled by the end of 2003, 2) Tax revenue for GDP should not be less than 20 per cent billing for total tax revenue should not exceed 35 percent, 3) exchange rate stability, defined as <15 per cent of the quoted central rate on 1 April 2002, 4) a positive real interest of> 0, 5) a public investment / tax revenue of> 20 per cent. However, it should be noted that these economic convergence criteria, in particular the primary criteria introduced in 2000 to ensure the successful start of WAMZ in 2003, were not met by the Member States.

Consequently, the zone has experienced three launch dates.

2. Empirical Review

It may be difficult to provide general empirical findings of the Optimal Currency Area (OCA). This is due to the proliferation of empirical findings that specifically test the authenticity of various properties of OCA as advanced in theoretical representation. Nevertheless, there are studies that seem to examine the theory of optimal global currency areas from a holistic perspective. Some of them include Ghosh and Wolf (1994), Artis, Kohler and Melitz (1998), Alesina, Barro, and Tenreyro (2003) and Tenreyro and Barro (2003).

Ghosh and Wolf (1994), for instance, in their study covering 120 countries calculated the optimal currency associations for six different economic regions. It was revealed from the study that there is a slight correlation between geographical proximity and country regime in an optimal currency region. Based on this, the model showed that limiting monetary unions to geographic neighbouring countries might not be cost effective. It was also noted from the results that joining a single currency is very expensive for most regions of the world, thus stabilization benefits across regions can be achieved with few currencies. Additionally, the results suggested that accepting a common currency around the world may be too expensive. And neither Europe nor the United States can create an optimal currency range, because the cost of adopting a single currency exceeds estimates of cost savings. In conclusion, they stated that there is no benefit for Germany and the US to adopt a monetary union.

Another study by Artis, Kohler, and Melitz (1998), based on high level of bilateral trade and symmetry of shock, proposed four major optimal currency areas in the world. The first area covers almost all of Western Europe; the second area covers the whole of Mesoamerica and the northern ridge of South America; the third area includes a good portion of the Middle East, and the fourth area englobes the entire ASEAN area, including China and Australia. Also, Alesina, Barro, and Tenreyro (2003) employed large datasets to identify best monetary anchor for some countries. The accused alternative anchors are the US dollar, the euro and the yen. The basis for the analysis is the effects of monetary integration on trade, price and output volatility. Their results suggest that there is a unique "best anchor" for only a small number of Latin American countries: the euro for Argentina and the US dollar for Costa Rica and Honduras. However, the choice of euro for Mexico and Ecuador as the "best" anchor, according to one of the criteria, weakens the validity of this analysis. In another study by Tenreyro and Barro (2003), using instrumental variables to deal with the endogenity of some of the OCA criteria, they indicated that the adoption of a single currency improves bilateral trade, increases the co-flow of the national price levels, and reduces the flow of national output.

A study by Romain Houssa (2008) employed a dynamic structural factor model to estimate two structural shocks that would otherwise be impossible using VAR models and other techniques used in previous studies. The results showed that the cost of monetary union is high in cost in West Africa. The study further argued that WAMZ countries' inflation is higher which implies a loss of competitive advantage for those countries, if they form a monetary union with CFA countries. He submitted that the formation of monetary union in that West African countries will be challenging due the presence of asymmetric shocks in the sub-region. Alagidede Coleman and Cuestas (2012) also investigated the inflation behaviour and trends of the Real Gross Domestic Product (RGDP) in WAMZ member countries. The study established heterogeneity in shocks among WAMZ member countries using fractional integration and co-integration approach.

Another study of Fielding, Lee and Shields (2012) investigated a mechanism through which macroeconomic shocks in a country impact on another country in the UEMOA Union. They established the existence of heterogeneity across member countries using the degree of similarity between macroeconomic transmission mechanisms. However, the study did not incorporate macroeconomic variables in advanced economies and key trading partners outside the zones, making the estimated model incomplete in a globalized economic system. In recent times, other studies have been covered by Balogun (2009) and Omotor and Niringiye (2011), but they all agreed that the cost of monetary unionization would be high for the region without any serious deviation from previous investigations.

Another round of studies by Asongu (2014a, b) investigated the monetary and fiscal policy convergence using the proposed WAM and EAM zones as point of references. The studies fundamentally employed GMM and VAR econometric methods of analyses. Despite the rigorous analyses, the studies concluded that there is no real monetary and fiscal policy convergence in WAM and EAM zones. A similar study by Harvey and Cushing (2015) examine the suitability of WAMZ as common currency area using a structural vector autoregressive model. The study also provided evidence of asymmetric shocks responses which suggests that countries are suitable as optimum currency area in their current state. These relatively recent studies still employed usual method of analysis and ended up with similar conclusions. This makes the study of this nature highly imperative.

3. Model Specification (GVAR)

GVAR as developed by Pesaran, Schuermann, and Weiner (2004) was primarily adopted to examine the existence of macroeconomic interdependence among the WAMZ member economies in particular and the global economy in general. The advantage of adopting this approach is that it provides a relatively simple but effective way to model a complex, high-dimensional system. In addition, the GVAR approach offers a wide range of tools for managing the cause of dimensionality that may arise from a study of this nature- that is, spreading parameters as the model's dimension grows.

In constructing GVAR, two steps are essentially important: the country-specific model and the global VAR. The VARX * which is a country-specific model for each country. Each country VARX * model is country-specific domestic variables connected to deterministic variables. The variables include time development, country-specific foreign variables, and global variables. The variables in each country-specific model of WAMZ member states are:

GDP_{it} = Gross Domestic Product of country *i* at time *t* in US dollars

$CPI_{it} =$ Consumer Price Index for country *i* at time *t*

$EXCH_{it} =$ Exchange Rate of country *i* currency at time *t* in US dollars

$FDI_{it} =$ Foreign Direct Investment (net flow) for country *i* at time *t*

$INT_{it} =$ Monetary Policy Rate for country *i* at time *t*

p_t^W = World Commodity Price Index

p_t^o = World oil price

In the GVAR model designed, the US is specified as country 0, and the US exchange rate is regarded as —E_{0t}—with the value of 1. Also, in the model, each WAMZ country-specific model comprises of: domestic variables $(GDP_{it}, CPI_{it}, INT_{it}, EXCH_{it}, FDI_{it})$ foreign variables $(GDP_{it}^*, CPI_{it}^*, INT_{it}^*, EXCH_{it}^* FDI_{it}^*)$ from WAMZ member countries and important trading partners (US, Euro Zone, Japan and China).

In addition, the model has two global variables: the world oil price (p_t^o), and the World Commodity Price Index (p_t^W) .

In country-specific VARX* specified, all macroeconomic variables employed are weighted, using the volume of trade between the countries. In the country-specific models, foreign variables are designed as follows:

$$GDP_{it}^* = \int_{j=0}^{N} w_{ij}\, GDP_{jt}, CPI_{it}^* = \int_{j=0}^{N} w_{ij}\, CPI_{jt} \quad (1)$$

$$,EXCH_{it}^* = \int_{j=0}^{N} W_{ij}\, EXCH_{jt},$$

$$FDI_{it}^* = \int_{j=0}^{N} w_{ij}\, FDI_{jt}, INT_{it}^* = \int_{j=0}^{N} w_{ij}\, INT_{jt} \quad (2)$$

The weights w_{ij} for $i, j = 0,1, \dots, N$ are trade weights between country *i* and country *j*, constructed using total annual trade of domestic economy country between 1990 and 2013 period. w_{ii} is 0 for any country *i*. It is assumed that variables are integrated of order one *I*(1).. Specifically, for all the countries, country-specific VARX*(1, 1) models can be constructed as follow:

$$X_{it} = \delta_{i0} + \delta_{i1} t + \Phi_i X_{i,t-1} + \Lambda_{i0} X_{it}^* + \Lambda_{i1} X_{i,t-1}^* + \Gamma_{i0} d_t + \Gamma_{i1} d_{t-1} + \varepsilon_{it} \quad (3)$$

Following Pesaran *et al* (2004), the country-specific VARX* model is usually estimated with the condition that the foreign and global variables are weakly exogenous. The presumption of weak exogeneity of foreign variables shows that each country is regarded as a small open economy, with the exception of the US. Thus, the global variables, $d = (p_t^o \; and \; p_t^W)$, were defined as endogenous variables in the US model.

3.2. Model Specification (SVAR)

In this study, Structural Vector Autoregression (SVAR) was used for shocks identification. But unlike previous studies where macroeconomic variables of important trading partners were given little or no consideration, this study focuses on aggregated macroeconomic variables of important trading partners' side-by-side with their domestic counterparts. The framework is as follows. Given a structural moving average of a vector of variables X_t and an equal number of shocksε_t, so that

$$X_t = A_0\varepsilon_t + A_1\varepsilon_{t-1} + A_2\varepsilon_{t-2} + \cdots = \sum_{i=0}^{\infty} A_i\varepsilon_{t-i} \quad (4)$$

In matrix form, the model can be written as:

$X_t = \boldsymbol{A}(\dot{L})\ \varepsilon_t$

Where

$X_t = [\Delta y_t^*, \Delta e_t^*, \Delta p_t^*, \Delta y_t, \Delta e_t, \Delta p_t]'$, comprising aggregate foreign real GDP of strategic trading partners represented by y_t^*, aggregate real exchange rate of partners e_t^*, aggregate price level of important partners p_t^*, domestic real GDP y_t domestic real exchange rate e_t and domestic general price level p_t all are presented in log difference forms. **A** is a 6*6 matrix which defines the impulse responses of all endogenous variables to structural shocks

$\varepsilon_t = [\varepsilon_t^{S*}, \varepsilon_t^{d*}, \varepsilon_t^{m*}, \varepsilon_t^{S}, \varepsilon_t^{d}, \varepsilon_t^{m}]'$

It includes external supply shock ε_t^{S*}, external demand shock ε_t^{d*}, external monetary shock ε_t^{m*}, domestic supply shock ε_t^{S}, domestic demand shock ε_t^{d}, and domestic monetary shock ε_t^{m} in that order. It is believed that they are serially uncorrelated and orthonormal, with a variance covariance matrix normalized to the identity matrix. The series in the model aggregate foreign real GDP, total foreign real exchange rate, total foreign price level, domestic real GDP, domestic real exchange rate and domestic price level can be structurally broken down as follows

$$\Delta y_t^* = A_{11}(L)\varepsilon_t^{s*} \quad (5)$$

$$\Delta e_t^* = A_{21}(L)\varepsilon_t^{s*} + A_{22}(L)\varepsilon_t^{d*} + A_{23}(L)\varepsilon_t^{m*} \quad (6)$$

$$\Delta p_t^* = A_{31}(L)\varepsilon_t^{s*} + A_{22}(L)\varepsilon_t^{d*} + A_{33}(L)\varepsilon_t^{m*} \quad (7)$$

$$\Delta y = A_{41}(L)\varepsilon_t^{s*} + A_{42}(L)\varepsilon_t^{d*} + A_{43}(L)\varepsilon_t^{m*} + A_{44}(L)\varepsilon_t^{s} + A_{45}(L)\varepsilon_t^{d} + A_{46}(L)\varepsilon_t^{m} \quad (8)$$

$$\Delta e = A_{51}(L)\varepsilon_t^{s*} + A_{52}(L)\varepsilon_t^{d*} + A_{53}(L)\varepsilon_t^{m*} + A_{54}(L)\varepsilon_t^{s} + A_{55}(L)\varepsilon_t^{d} + A_{56}(L)\varepsilon_t^{m}\Delta e_t^* = A_{21}(L)\varepsilon_t^{s*} + A_{22}(L)\varepsilon_t^{d*} \quad (9)$$

$$\Delta p = A_{61}(L)\varepsilon_t^{s*} + A_{62}(L)\varepsilon_t^{d*} + A_{63}(L)\varepsilon_t^{m*} + A_{64}(L)\varepsilon_t^{s} + A_{65}(L)\varepsilon_t^{d} + A_{66}(L)\varepsilon_t^{m} \quad (10)$$

The decomposition presented in equations (5) to (10) implies that the aggregate foreign variables are exogenous to domestic shocks which imply that all domestic variables are affected by exogenous shocks, but domestic shocks do not affect exogenous shock. The assumption can be explicitly explained as follows:

- Aggregate foreign real GDP is strictly exogenous. This assumption is plausible because demand shock and monetary shocks in WAMZ member countries do not influence real output in the developed countries. This is also in line with small open economy assumption.
- Aggregate foreign real exchange rate is exogenous to domestic variables, but it can be influenced by a shock to foreign real GDP and its own shock.
- Aggregate foreign price level is also exogenous to domestic variables, but it can be influenced by a shock to foreign real GDP, shock to real to real exchange rate and its own shocks.

Domestic real GDP is affected by shocks to foreign variables and shocks from itself in the long-run. However, it is not affected by monetary shocks ε_t^{m} or demand shocks ε_t^{d}. This restriction is in line with Balnchad's natural rate hypothesis and it implies that

$\sum_{i=0}^{\infty} A_{41i} \neq 0, \sum_{i=0}^{\infty} A_{42i} \neq 0, \sum_{i=0}^{\infty} A_{43i} \neq 0, \sum_{i=0}^{\infty} A_{44i} \neq 0, \sum_{i=0}^{\infty} A_{45i} = 0,$ $and \sum_{i=0}^{\infty} A_{46i} = 0.$

• Domestic real exchange rate is affected by shocks to foreign variables and shocks from itself in the long-run. Also, it is affected by demand shocks ε_t^d. Thus $\sum_{i=0}^{\infty} A_{51i} \neq 0, \sum_{i=0}^{\infty} A_{52i} \neq 0, \sum_{i=0}^{\infty} A_{53i} \neq 0, \sum_{i=0}^{\infty} A_{54i} \neq 0, \sum_{i=0}^{\infty} A_{55i} \neq 0,\ and \sum_{i=0}^{\infty} A_{56i} = 0.$

Domestic price level is affected by shocks to foreign variables and shocks from itself in the long-run. Also, it is affected by demand shocks ε_t^d and monetary shocks ε_t^m. Thus, $\sum_{i=0}^{\infty} A_{61i} \neq 0, \sum_{i=0}^{\infty} A_{62i} \neq 0, \sum_{i=0}^{\infty} A_{63i} \neq 0, \sum_{i=0}^{\infty} A_{64i} \neq 0, \sum_{i=0}^{\infty} A_{65i} \neq 0,\ and\ \sum_{i=0}^{\infty} A_{66i} \neq 0.$

The model can be rewritten as a system of structural equations as follows:

$$\begin{bmatrix} \Delta y_t^* \\ \Delta e_t^* \\ \Delta p_t^* \\ \Delta y_t \\ \Delta e_t \\ \Delta p_t \end{bmatrix} = \begin{bmatrix} A_{11} & 0 & 0 & 0 & 0 & 0 \\ A_{21} & A_{22} & 0 & 0 & 0 & 0 \\ A_{31} & A_{32} & A_{33} & 0 & 0 & 0 \\ A_{41} & A_{42} & A_{43} & A_{44} & 0 & 0 \\ A_{51} & A_{52} & A_{53} & A_{54} & A_{55} & 0 \\ A_{61} & A_{62} & A_{63} & A_{66} & A_{65} & A_{66} \end{bmatrix} \begin{bmatrix} \varepsilon_t^{S*} \\ \varepsilon_t^{d*} \\ \varepsilon_t^{m*} \\ \varepsilon_t^{s} \\ \varepsilon_t^{d} \\ \varepsilon_t^{m} \end{bmatrix} \qquad (11)$$

Considering Huang and Guo (2006) estimates from the structural moving average model in Eq. (4) is not directly recovered, rather they are obtained by estimating a reduced form of VAR model for the observed variables. In the structural VAR model, the external variables follow an autoregressive process, and the three home variables are modeled as functions in their own layer and layer of the external variables. Accordingly:

$$\Delta Z_t^* = \tau + \sum_{i=1}^{n} \Gamma_i \Delta Z_{t-i}^* + \mu_t^* \qquad (12)$$

and

$$\Delta X_t = \tau + \sum_{i=1}^{n} \Gamma_i X_{t-i} + \sum_{i=1}^{n} \Omega_i Z_{t-i}^* + \mu_t \qquad (13)$$

Where $Z_t^* = [\Delta y_t^*, \Delta e_t^*, \Delta p_t^*)'$ and $X_t = [\Delta y_t, \Delta e_t, \Delta p_t)'$, Γ_i and Ω_i are coefficient matrixes. μ_t^* and $\mu_t = [\mu_t^1, \mu_t^2, \mu_t^3, \mu_t^4, \mu_t^5, \mu_t^6]$ are a mixture of structural innovations of observed residuals. In order to obtain the relationships between reduced form of innovations for the domestic variables and the corresponding structural stocks, eq. (4) can be written as MA representation of form:

$$X_t = \theta + \sum_{i=1}^{n} G_i \mu_{t-i} \qquad (20)$$

Where

$$\theta = (1 - \sum_{i=1}^{n} \Gamma_i)^{-1} (\tau + \sum_{i=1}^{n} \Omega_i\, \Delta y_{t-1}^*) \qquad (21)$$

The G_i is called impulse response and procured form:

$$\sum_{j=0}^{\infty} G^j L^j = (I - \sum_{i=1}^{\infty} \Gamma_i L^j)^{-1} \qquad (22)$$

Recovering structural shocks involves a special decomposition of reduced-form innovations. Considering the arrangement of variables in VAR, Blachard and Quah (1989) long run restriction was offered as follows:

With respect to arrangement of variables in our VAR Model

$\sum_{i=0}^{\infty} a_{21i} = \sum_{i=0}^{\infty} a_{31i} = \sum_{i=0}^{\infty} a_{32i} = \sum_{i=0}^{\infty} a_{41i} = \sum_{i=0}^{\infty} a_{42i} = \sum_{i=0}^{\infty} a_{43i} = \sum_{i=0}^{\infty} a_{51i} = . \sum_{i=0}^{\infty} a_{51i} \sum_{i=0}^{\infty} a_{53i} = \sum_{i=0}^{\infty} a_{54i} = \sum_{i=0}^{\infty} a_{61i} =. \sum_{i=0}^{\infty} a_{62i} = \sum_{i=0}^{\infty} a_{63i} = 0, \sum_{i=0}^{\infty} a_{64i} = \sum_{i=0}^{\infty} a_{65i} = 0$

The implication of these restrictions is that:

$$\sum_{i=0}^{\infty} A_j = \sum_{i=0}^{\infty} C_j A_0$$

It is a lower triangular matrix. According to Blachard and Qual (1989), the restrictions, as stated above, identify A_0 and V_t which can be retrieved by $V_t = A_0^{-1} e_t$.

4. Presentation of Results

Table 1:Unit Root Tests for the Domestic Variables at the 5% Significance Level

Domestic Variables	Statistic	Critical Value	CHINA	EURO	GAMBIA	GHANA	JAPAN	NIGERIA	SLEONE	USA
DGDP	ADF	-2.8	-8.1	-4.17	-4.241	-2.98	-6.39	-4.035	-3.4	-3.92
DGDP	WS	-2.5	-8.3	-4.32	-4.42	-2.84	-6.01	-3.825	-3.602	-3.829
DDGDP	ADF	-2.8	-12.6	-8.3	-4.944	-4.98	-10.9	-5.071	-4.867	-8.111
DDGDP	WS	-2.55	-12.9	-8.51	-5.148	-4.82	-10.9	-5.25	-5.071	-8.180
DDCPI	ADF	-2.89	-1.92	-2.54	-4.653	-2.45	-4.30	-2.603	-10.28	-6.175
DDCPI	WS	-2.55	-2.17	-1.90	-4.848	-2.58	-3.22	-2.715	-10.01	-5.931
DDDCPI	ADF	-2.89	-5.15	-10.8	-9.993	-17.1	-12.2	-11.85	-14.53	-10.67
DDDCPI	WS	-2.55	-5.32	-10.8	-10.20	-17.1	-12.3	-12.14	-14.46	-10.79
DEXCH	ADF	-2.89		-6.26		-3.86	-4.36	-3.852		-5.524
DEXCH	WS	-2.55		-6.33		-3.94	-4.51	-4.026		-5.696
DDEXCH	ADF	-2.89		-11.3		-8.55	-9.38	-7.671		-10.46
DDEXCH	WS	-2.55		-11.5		-8.79	-9.63	-7.85		-10.67
DINT	ADF	-2.89	-5.65	-5.00	-4.162	-5.37	-3.39	-7.329	-5.19	-4.247
DINT	WS	-2.55	-4.01	-4.69	-4.345	-5.55	-3.28	-7.507	-4.791	-3.85
DDINT	ADF	-2.89	-8.79	-7.55	-11.90	-9.50	-6.88	-9.581	-11.61	-6.267
DDINT	WS	-2.55	-8.86	-7.76	-11.32	-9.70	-7.08	-9.354	-11.12	-6.201
DFDI	ADF	-2.89	-4.67	-3.11	-5.537	-4.97	-3.97	-5.550	-4.82	-5.45
DFDI	WS	-2.55	-4.83	-3.32	-5.74	-5.14	-4.03	-4.838	-4.97	-5.62
DDFDI	ADF	-2.89	-4.97	-7.62	-4.807	-4.93	-7.92	-4.91	-4.99	-5.01
DDFDI	WS	-2.55	-5.18	-7.81	-5.011	-5.13	-8.10	-5.043	-5.193	-5.212

Table 2: Unit Root Tests for the Foreign Variables at the 5% Significance Level

Foreign Variables	Statistic	Critical Value	CHINA	EURO	GAMBIA	GHANA	JAPAN	NIGERIA	SLEONE	USA
DGDP*	ADF	-2.89	-4.87	-6.01	-4.616	-6.23	-7.67	-5.132	-6.798	-6.25
DGDP*	WS	-2.55	-4.94	-6.22	-4.783	-6.446	-7.83	-5.291	-6.981	-6.46
DDGDP*	ADF	-2.89	-7.20	-8.71	-8.267	-9.544	-12.3	-9.949	-11.69	-10.6
DDGDP*	WS	-2.55	-7.39	-8.95	-8.491	-9.796	-12.6	-10.21	-11.97	-10.9
DDCPI*	ADF	-2.89	-4.05	-1.91	-2.211	-2.321	-2.12	-3.581	-2.154	-1.89
DDCPI*	WS	-2.55	-3.18	-2.18	-1.990	-2.527	-2.38	-3.522	-2.377	-2.13
DDDCPI*	ADF	-2.89	-10.6	-9.58	-9.963	-9.84	-7.61	-9.832	-7.864	-8.47
DDDCPI*	WS	-2.55	-10.7	-9.78	-10.03	-10.06	-7.75	-10.00	-7.960	-8.61
DEXCH*	ADF	-2.89	-6.04	-5.82	-6.199	-6.202	-5.77	-5.843	-6.071	-6.22
DEXCH*	WS	-2.55	-6.19	-6.00	-6.291	-6.29	-5.93	-6.005	-6.195	-6.32
DDEXCH*	ADF	-2.89	-11.4	-11.1	-11.27	-11.23	-10.7	-10.89	-11.15	-8.79
DDEXCH*	WS	-2.55	-11.6	-11.3	-11.49	-11.45	-10.9	-11.11	-11.3	-9.03
DFDI*	ADF	-2.89	-3.59	-5.45	-3.100	-5.351	-4.21	-3.829	-3.172	-3.21
DFDI*	WS	-2.55	-3.75	-5.61	-3.305	-5.557	-4.39	-4.004	-3.376	-3.40
DDFDI*	ADF	-2.89	-7.81	-4.8	-7.595	-4.97	-5.10	-7.966	-7.631	-7.69
DDFDI*	WS	-2.55	-7.99	-5.0	-7.780	-5.183	-5.31	-8.15	-7.817	-7.8

4.1. Unit Root Results of Variables for Estimation

Table 1 also shows Weight-Symmetric Augmented Dickey Fuller (WS-ADF) unit root test performed on all domestic variables. The results show that the variables in the models are primarily I (1). This suggests that while the hypothesis of non-stationarity is rejected at the level of most of the variables, the hypothesis is accepted at first difference. It is thus assumed that all our variables are I (1) for the specification and estimation of GVAR. Similarly, Weight-Symmetric Augmented Dickey Fuller (WS-ADF) unit root test was performed on all foreign variables. The results also show that the variables in the models are primarily I (1). It is thus assumed that all our variables are I (1) for the specification and estimation of GVAR.

a. Co-integration Results

Generally, the GVAR program creates the spreadsheet called coint_max and trace. It contains both traces and maximum eigenvalue statistics used to determine the dimension of each model's co-integration space and the critical values of trace statistics. Testing is usually performed using track statistics at the 5% level of importance. In this model, estimation of VARX * was performed for each country in the GVAR system, based on the number of co-integrating vector imposed according to the result of the trace statistics in Table 3 (with layers selected by AIC). The results of the co-integrating test indicate five co-integrating relationships with Nigeria and Japan and four for the United States. It contains three integral relations with China, Euro and Gambia and also shows two integral relations with Ghana, one for Guinea and Sierra Leone and none for Liberia.

Table 3. Co-integrating Relationships for the Individual VARX* Models

Country	Co-integrating relations
CHINA	3
EURO	3
THE GAMBIA	3
GHANA	2
JAPAN	5
NIGERIA	5
SLEONE	1
USA	4

Table 4. Test for Weak Exogeneity

Test for Weak Exogeneity at the 5% Significance Level

Country	F test	Fcrit_0.05	GDP*	CPI*	INT*	EXCH*	FdI*	Poil	Pmat
CHINA	F(3,69)	2.737492	0.6187	0.658466	2.40512	1.593881	0.885105	0.93041	0.653907
EURO	F(3,78)	2.721783	1.001871	1.866166	0.356491	1.488769	0.518138	0.72476	2.256413
GAMBIA	F(3,79)	2.720265	0.274291	1.450226	1.705091	0.057461	0.850839	1.396344	1.178296
GHANA	F(2,79)	3.11226	0.346222	0.47396	0.048376	1.415144	0.938179	1.26963	0.575643
JAPAN	F(5,66)	2.353809	1.306738	1.509685	1.154321	3.905952*	0.723666	1.075094	2.424193*
NIGERIA	F(5,76)	2.33492	1.366231	1.006931	1.234894	1.227053	0.311418	1.715312	1.93898
SLEONE	F(1,82)	3.957388	0.011584	0.406333	0.007802	2.692929	2.746811	0.002116	1.102319
USA	F(4,72)	2.498919	0.172417	0.944262			0.840158	1.988367	0.794831

*****5% significance level. Source: Author's computation***

4.2. Weak Exogeneity Tests

The calculation of the GVAR model is based on the assumption that foreign variables are slightly exogenous, with respect to the long-term parameters of VARX * and to test the accuracy of this assumption, weak exogenous tests are usually performed on all foreign and global variables that will enter the country-specific VARX * model. After Dees et al. (2007), weak exogenous tests were performed using common meaning of the estimated error correction conditions for the country-specific foreign and global variables. The results are presented in Table 4. In general, from the results we can accept the hypothesis of weak exogenity for most foreign and global variables, except in few cases of foreign reserve in euro, foreign reserve in Nigeria and commodity price in Japan. This means that weak exogenous assumptions cannot be rejected at the 5% level in 4 out of 80 cases, which represents a fraction of only 4%.

4.3. Generalized Factor Error Variance Decomposition (GFEVD)

In order to provide a robust empirical platform for macroeconomic interdependence, we attempted a breakdown of shocks into gross domestic product in the WAMZ member states. This is in order to determine the relative contribution of external (WAMZ and non-WAMZ countries) and domestic shocks to their fluctuations. In addition, we have focused on variables that are very important in terms of their contribution to innovations for the mentioned variables. After Dees et al. (2007b), we calculated the Generalized Factor Error Variance Decomposition (GFEVD). This approach has the advantage of being invariant to the order of variables in the system and given non-zero correlation between such errors, the individual impact contributions to GFEVD do not need the sum of units. GFEVD basically calculates the proportion of the forecast errors for each variable explained by simultaneous and future values of the system's non-orthogonalized generalized shocks.

Table 5a: Nigeria Real GDP Innovation

	CHINA	CHINA	EURO	EURO	EURO	GHANA	JAPAN	JAPAN	NIGERIA	NIGERIA	NIGERIA	NIGERIA	USA	USA
	GDP	FDI	GDP	CPI	FDI	GDP	GDP	FDI	GDP	CPI	EXCH	INT	GDP	FDI
0	2.070	4.713	13.7	7.72	10.14	6.8	6.2	4.1	47.1	2.2	3.81	1.2	2.97	2.9
1	2.031	1.653	12.5	6.64	14.34	0.47	1.4	1.46	19.7	0.6	10.5	9.57	0.97	1.8
2	1.291	0.819	6.80	1.90	4.11	0.18	0.9	0.49	18.3	2.1	9.9	23.7	2.03	1.5
3	0.859	0.426	5.64	0.71	1.47	0.2	0.9	0.16	15.2	2.8	8.73	31.0	2.21	1.64
4	0.642	0.475	5.54	0.60	0.61	0.24	0.8	0.082	13.4	3.17	7.61	32.9	1.778	2.07

Table 5 b: Ghana Real GDP Innovation

	CHINA	CHINA	GHANA	GHANA	GHANA	JAPAN	USA	USA		
	CPI	EXCH	GDP	CPI	INT	FDI	EXCH	INT	P_t^o	P_t^w
0	9.845207	8.706428	81.05952	1.469752	26.52375	0.466857	1.019923	0.434278	1.866104	2.02904
10	15.10945	14.56584	31.29573	2.717148	16.4375	1.264617	1.23416	1.21635	1.56927	3.326179
20	15.87897	15.89733	13.6176	3.255304	9.200613	1.102132	1.703099	1.417344	2.863857	2.870462
30	15.94497	16.20452	10.62982	2.716393	6.931824	0.910396	2.127059	1.3589	3.858748	3.007515
40	15.34396	16.88981	9.493299	2.753092	6.43228	0.838276	2.570961	1.396187	3.954947	3.039214

In Table 5, the results of GFEVD show the percentage contributions of external and domestic variables to innovation in Nigerian Real GDP at five quarters. The results indicate that in the short-term, apart from the dominant contribution of Nigerian real GDP to its forecast error during the periods, variables from Europe, China, Japan and US showed substantial contributions to forecast error of Nigerian Real GDP. Specifically, GDP and FDI from these trading partners explain Nigerian GDP. Apart from these partners, Ghana is the only WAMZ member country with meaningful contribution to GDP forecast error in Nigeria. Precisely, GDP in Ghana contributes to about 6% to GDP forecast error in Nigeria, and this is more than what trading partner like the US contributes. However, in the medium and long term, domestic variables (interest rate and exchange rate) have the highest contributions to GDP forecast error in Nigeria.

Similarly, in Table 5b, the results of GFEVD show the percentage contributions of external variables and domestics variable to innovation in Ghanaian Real GDP at five quarters. Just like Nigeria, in the short-term GDP in Ghana has the highest contribution to its own forecast error (81%), and this is followed by interest rate in the country with 26.5 %. During this period, foreign variables from China dominate the forecast error of Real GDP in Ghana, specifically, inflation and exchange rate. Also, none of the WAMZ member countries has a meaningful contribution to forecast error of Real GDP in Ghana. In the medium and long term, Inflation and exchange rate from China are still emerged as the major determinants of Real GDP forecast error in Ghana.

Table 6: Gambia Real GDP Innovation

	CHINA	CHINA	EURO	EURO	EURO	GAMBIA	GAMBIA	JAPAN	NIGERIA	USA	USA	USA	
	GDP	FDI	GDP	INT	FDI	GDP	INT	GDP	GDP	EXCH	INT	FDI	P_t^o
0	0.56457	2.306101	1.631559	0.54682	1.371552	83.67751	9.190117	5.706852	2.061566	4.402801	1.983852	6.046547	1.324187
10	2.593223	1.218309	0.945	5.118777	2.890348	15.53763	1.490859	1.370141	1.30682	6.01554	1.443966	7.225621	15.8816
20	3.387394	1.643083	1.544222	4.340641	3.507789	8.241494	1.507736	0.962088	0.947136	3.418807	1.094286	5.288776	25.75488
30	3.890239	1.504002	3.032177	5.634154	3.377684	7.061126	1.490765	0.926173	0.907405	2.66924	1.382656	4.905374	28.53677
40	3.919714	1.559595	3.052236	6.599362	3.121071	6.325721	1.474456	0.950529	0.93655	2.361063	1.445294	4.56509	27.02531

Table 6 presents GFEVD results of the Gambia's Real GDP at a five-quarter horizon, with the contributions of domestic and foreign variables in the short, medium and long term. In the short-term, as expected, Real GDP in the Gambia has the highest contribution to its own forecast error, contributing roughly 83%, and this is followed by the contribution of FDI inflow into the country. During this period, outflow of FDI from US is the highest contributing foreign variable to Real GDP forecast error in the Gambia, and this is followed by Real GDP in Japan. None of the WAMZ member countries has a meaningful contribution. In the medium and long term, global variable (crude oil price) emerged as the major determinant of Real GDP forecast error in the Gambia in the long-term.

Table 7: Sierra Leone Real GDP Innovation

	CHINA	**CHINA**	**CHINA**	**EURO**	**JAPAN**	**NIGERIA**	**NIGERIA**	**SLEONE**	**SLEONE**	**USA**
Panel A										
	EXCH	INT	FDI	INT	INT	INT	GDP	GDP	CPI	EXCH
0	10.44479	3.787359	17.75371	4.250283	17.45971	13.10236	9.507359	60.80282	2.732448	2.42874
10	2.153543	10.32398	9.114996	1.516085	6.849301	2.554715	5.808612	42.44589	12.26876	5.294928
20	2.019417	12.72883	3.728041	0.656733	3.412669	1.118493	5.330609	33.2116	13.48887	3.873179
30	3.383421	13.92763	2.162017	0.398477	2.235312	1.25729	5.293689	27.44388	13.81653	2.384426
40	4.204697	14.45715	1.544431	0.329447	1.901506	1.660088	5.376402	24.61073	14.09611	1.698144

Unlike what obtained in other WAMZ member countries, GFEVD results of GDP in Sierra Leone at a five-quarter horizon, as shown in Table 7, indicate that variables from Nigeria (Interest rate and FDI) make substantial contribution to forecast error of real GDP in Sierra Leone in the short, medium and long term. However, countries outside the Zone still contribute greatly, especially China through Interest Rate (INT), Exchange Rate (EXCH) and Foreign Direct Investment (FDI) in short, medium and long term.

4.4. Linearly Dependence of Macroeconomic Shocks in WAMZ Zone

In line with the goal of this study to determine the level of macroeconomic shock synchronization among the WAMZ member states, which always serve a different degree of convergence in the form of an optimal currency area, we achieved country-specific variables that include domestic and foreign variables from our Global VAR and estimated them using ANSWER, which allows us to impose the necessary restrictions necessary for shock detection. According to Bayoumi (1994), the size and correlation of the underlying disturbance is important for the choice of a currency union, that is, if two economies converge, their underlying disturbances are expected to be linearly dependent.

To achieve this, macroeconomic shocks in the WAMZ member states are broken down to three. They are: Supply Shock, Demand Shock and Monetary shock. In light of Clarida and Gali's study (1994), shocks to economic growth adapted to supply shocks, shocks to real exchange rates are identified as demand shocks, while shocks to price changes are also identified as monetary shocks. In addition, shock reduction in the work of Blachard and Quah (1989) claims that only supply shocks affect changes in real output levels over the long term, while both supply and demand shocks affect the long-term exchange rate. Monetary shocks do not affect either changes in the actual output level or the real exchange rate. Based on this, a brief limitation of six by six matrices was introduced. In addition, we extracted residues from our structural VAR and performed linear dependency tests. The results are presented in Tables 8, 9, and 10.

Table 8: Correlation of Monetary Shocks (1990-2014)

	Nigeria	**Ghana**	**Gambia**	**Sirrelone**	**USA**	**Euro**	**China**	**Japan**
Nigeria	1.0000							
Ghana	0.0743	1.0000						
	0.4671							
Gambia	0.2067**	0.0819	1.0000					
	0.0412	0.4229						
Sirrelone	0.0078	0.2224**	-0.0538	1.0000				
	0.9396	0.0277	0.5991					
USA	0.1926*	0.1733*	-0.0184	0.0347	1.0000			
	0.0575	0.0879	0.8576	0.7347				
Euro	0.4721***	0.1065	0.0908	-0.0118	0.3336***	1.0000		
	0.0000	0.2967	0.3737	0.9079	0.0008			
China	0.0978	0.0147	-0.0832	-0.0101	0.0924	0.3237***	1.0000	
	0.3382	0.8857	0.4153	0.9217	0.3655	0.0011		
Japan	0.4331***	-0.0621	0.0196	-0.1312	0.1938*	0.4290***	0.1247	1.0000
	0.0000	0.5435	0.8477	0.1980	0.0559	0.0000	0.2213	

*Significant at 10%.,** Significant 5% *** significant at 1%

Table 8 shows the results of correlation coefficients of domestic supply shocks in four WAMZ member countries (The Gambia, Ghana, Sierra Leone and Nigeria) and G4 countries (USA, Euro, China and Japan). The results show that there are statistically significant Monetary shocks symmetries between Nigeria and the Gambia on the one hand and between Ghana and Sierra Leone, on the other hand. Outside the Zone, Nigeria has monetary shocks symmetries with virtually all G4 countries, except China. This shows the extent of monetary policy interdependence between the country and the big economies around the world. As expected, the G4 countries also demonstrate strong statistically significant monetary shocks symmetries with one another, especially between Euro and the USA. Other correlation coefficients are positive, except between the Gambia and Sierra Leone, though they are statistically insignificant, thus suggesting low level of monetary shocks synchronization in the region.

Table 9: Correlation of Demand Shocks (1990-2014)

	Nigeria	Ghana	Gambia	Sirrelone	USA	Euro	China	Japan
Nigeria	1.0000							
Ghana	-0.0848	1.0000						
	0.4066							
Gambia	0.0901	0.0274	1.0000					
	0.3779	0.7888						
Sirralone	0.1751*	-0.0205	0.0938	1.0000				
	0.0846	0.8414	0.3583					
USA	-0.0777	0.1748	0.0738	-0.0900	1.0000			
	0.4469	0.0852	0.4700	0.3781				
Euro	-0.1443	0.1892*	-0.0180	-0.0840	0.8059***	1.0000		
	0.1562	0.0621	0.8606	0.4111	0.0000			
China	-0.0570	0.1291	-0.1475	-0.1510	-0.0231	0.0161	1.0000	
	0.5771	0.2051	0.1473	0.1379	0.8214	0.8750		
Japan	-0.1276	0.0764	-0.0546	-0.0668	0.6209***	0.7544***	-0.0576	1.0000
	0.2104	0.4544	0.5934	0.5136	0.0000	0.0000	0.5731	

***Significant at 10%.,** Significant 5% *** significant at 1%**

Table 10: Correlation of Supply Shocks (1990-2014)

	Nigeria	Ghana	Gambia	Sirrelone	USA	Euro	China	Japan
Nigeria	1.0000							
Ghana	0.4629***	1.0000						
	0.0000							
Gambia	0.1345	0.0320	1.0000					
	0.1866	0.7548						
Sirrelone	0.1201	0.0582	-0.2162***	1.0000				
	0.2387	0.5694	0.0325					
USA	0.1111	0.0814	-0.0160	0.1152	1.0000			
	0.2762	0.4255	0.8757	0.2586				
Euro	0.1051	0.1639	0.0883	-0.0571	0.6201***	1.0000		
	0.3029	0.1067	0.3870	0.5764	0.0000			
China	0.0555	-0.0714	-0.0793	0.0531	0.0865	0.0697	1.0000	
	0.5874	0.4851	0.4375	0.6033	0.3968	0.4952		
Japan	-0.0725	-0.0518	0.0851	0.0250	0.1604	0.0719	0.0160	1.0000
	0.4781	0.6122	0.4046	0.8069	0.1145	0.4818	0.8757	

***Significant at 10%.,** Significant 5% *** significant at 1%**

Similarly, Table 9 shows the results of correlation coefficients of demand shocks. The results indicate that WAMZ member countries do not have demand shocks symmetry with one another, and this is extended to G4 countries. In general, we can conclude that there is low levels of demand shocks synchronization in the Zone. This suggests that WAMZ member countries have different underlying characteristics that uniquely determine their demand behavior, and this has serious implications for monetary union. The reason for this is that we will have to device different policy measures to stimulate demand in their respective country.

In a similar vein, Table 10 shows that there is a statistically significant positive correlation between Nigeria and Ghana which suggests supply shocks symmetrize between the two countries, and negative significant relationship between the Gambia and Sierra Leone which suggests asymmetric supply shocks between the two countries. This is not too good for the Zone.

5. Conclusions and Policy Implications

The study concludes that economic interdependence among WAMZ members is still weak and that external variables outside the Zone are largely responsible for macroeconomic behaviours among member countries. This suggests that there is no important macroeconomic link among WAMZ member countries. This might have to do with low level of trade relations among WAMZ member countries, and many of them still maintain strong economic ties with trading partners outside the Zone at the expense of other WAMZ members.

Also, the results from liner dependence tests show evidence of weak macroeconomic shocks synchronization in the Zone. However, Nigeria and Ghana seem to perform relatively better. The result is similar to those of previous studies, especially works by Horvath and Grabowski (1997), Bayoumi and Ostry (1995), Fielding and Shields (2001) and Harvey and Cushing (2015). However, there are some levels of improvement in the signs, coefficient values and the shocks symmetries. This might be as a result of improved methodology or the recent efforts of WAMZ member countries towards improved economic integration in the Zone.

Generally, as a matter of policy, the Zone still needs to devise strategies to encourage seamless flow of factors of production among member countries. If this is done, there is the possibility that the much-needed macroeconomic symmetry can be achieved. What this implies is that WAMZ member countries should cooperate and form a kind of synergy in the area of exchange rate policy coordination. This will help to create demand shock symmetry. In addition, if the Zone is serious at instituting a monetary union, as it proposes to do, it must begin its implementation with Nigeria and Ghana, considering the strategic economic positions of both countries. By extension, a country like Iran and other oil producing countries can have more market space for oil products because Nigeria can create more markets for its oil products in WAMZ member countries.

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