4. OPTIMUM CURRENCY AREA AND SHOCK ASYMMETRY: A DYNAMIC ANALYSIS OF THE WEST AFRICAN MONETARY ZONE (WAMZ)

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Abstract

This study accesses the feasibility of forming an Optimum Currency Area (OCA) in the West African Monetary Zone (WAMZ) from the symmetry of economic shocks which affect member economies. It applies a simple bivariate variant of the vector autoregressive (VAR) model. The results relatively suggest the feasibility of the WAMZ forming an OCA. The likelihood of incoming shocks problems seem to exists from the results. It is advisable that future research apply the more informative minimum distance estimation (MDE) technique.

Keywords: optimum currency area, shocks, asymmetry, West African Monetary Zone, vector autoregressive.

JEL Classification: F15, F33, R11

1. Introduction

Discussions on optimal currency areas (OCA) have aroused much interest in the literature on economic integration. Two reasons may be adduced to this. First, the inconclusiveness in both the theoretical and empirical literature as what should make-up the appropriate OCA criteria. Second, the success story of the European Monetary Union (EMU) since its formation; partly as an economic union with a single currency, the ***Euro*** launched in January, 1999. The common theme around the OCA question specifically is whether it is rewarding for some countries to adopt a common currency by giving up their national currencies or to adopt another country's currency, or join other nations to create a regional currency (Edwards, 2006). The first option is an

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issue of “dollarization”- the adoption of another country’s currency. The second option is the “independent currency union” - creating a multi-nation currency. The major cost associated with either of the options is the inability to formulate and implement an independent monetary policy required for country-specific stabilization purpose. This may exacerbate business-cycle volatility if the adopting country’s output is not sufficiently correlated with those of the union as a whole (Karras, 2007). On the other hand, the most appealing reasons in favour of a common currency to participating economies are the elimination of transaction cost and exchange risks; thus enhancing price and exchange rate stability, and lower steady-state inflation rate. In addition, stability of money arising from participating in an OCA could in turn promote intra-regional trade and investment flows (Yuen, 2000).

The OCA theory however requires that standard economic criteria as well as some necessary level of political preconditions be satisfied by countries seeking a common monetary arrangement. These as articulated by Ramayandi (2006) and Yuen (2000) are; (i) greater intra-regional trade; (ii) symmetry in the nature of economic structural shocks; (iii) similarities of past macroeconomic policies; and (iv) size and openness of the economies among others. The necessary political pre-conditions include the joint readiness and commitment to establish a credible transnational institution that will enhance the currency pegs of the participating countries.

Series of studies have however focussed on the different factors that determine the feasibility and benefits of joining a monetary union using various criteria. The most studied determinant is the symmetry of macroeconomic structural shocks. Bayoumi and Eichengreen (1993) was one of the earliest empirical papers that dealt with the issue of macroeconomic disturbances among different group of countries using a variant of the vector autoregression (VAR) methodology proposed by Blanchard and Quay (1989). Since then a series of papers have been churned out (Yuen, 2000; Buigut and Valer, 2005; Edward, 2006; Cortinhas, 2006; Karras, 2007; Balli and Osman, 2008; Hsu, 2009; Omotor, 2010 among others). Most of these papers concentrated on countries in the EU, Asia, Latin America and few on African countries except Eastern and Southern Africa.

In all these, application of the VAR technique to West African countries is relatively sparse in the empirical literature on OCA and shock asymmetry. The only works so far identified are limited to Fielding and Shields (2001) and Karras (2007). Fielding and Shields identified and compared only the economic shocks of the CFA monetary union in West Africa; while Karras study is broadly on the African continent. The present paper like Omotor (2010) concentrates only on the West African Monetary Zone (WAMZ) member states and uses recent data..

This paper is equally a follow-up to earlier effort by Omotor (2010) who analyzed the pattern of economic shocks of the WAMZ member states using some descriptive statistics and simple growth model of real output. The major conclusion reached in the study is that the WAMZ is suitable for an OCA though it recognized the low level of member states compliance with the primary convergence criteria set by them. One observed limitation of the initial study is the simplified variant of the VAR technique used in the extraction of the macroeconomic shocks. In this current paper, the objectives of analysing the feasibility of forming an OCA in the zone and symmetry of economic shocks which affect the member countries is extended by applying the Vector Autoregressive (VAR) technique.

The structure of this paper is as follows. Section2 discusses the theoretical framework and method of study. Section 3 provides a description of the data. Section 4 presents the empirical results; while section 5 summarises the salient conclusions.

2. Theoretical Framework and Method of Study

The underlying theoretical framework of our VAR is the aggregate demand (AD)-aggregate supply (AS) model as identified by Bayoumi and Eichengreen (1994)[2]. The short-run AS curve in the AD-AS framework is upward sloping due to sticky wages and allowing for changes in AD to influence output. A higher price level lowers the real wage, with an impetus to induce higher employment and raising output. In the long-run, AS curve is vertical at full employment level of output and prevents AD shocks to have long-term real effects on the economy. The aggregate demand curve is downward sloping both in the short- and long-run to reflect the assumption that lower prices induces demand. A positive supply shock say originating from changes in technology, shifts both AS and the long-run aggregate supply curve to the right leading to an increase in output and decrease in price permanently. A positive demand shock to aggregate demand increases output in the short-run due to its impacts first on prices, then on real wages and other sensitive determinants of AS. The long term effect of a positive AD shock is a permanent increase in prices. In summary, output and prices move in the same direction when the economy is hit by demand shocks and in the opposite directions when due to supply shocks. In addition, both supply and demand shocks have long-run effects on the level of prices in opposite direction. Succinctly put, in the AD-AS framework; AD shocks are assumed to have only temporary effects on output, while AS shocks have permanent effects on output.

We employ a two-variable VAR model with the right-hand side variables being log differences of real output (Δy_t) and log differences of price level (Δp_t) assuming the variables are unit root. We assume that fluctuations in y_t and p_t are the results of two underlying types of shocks: supply and demand shocks with the vector $X_t \equiv \begin{bmatrix} \Delta y_t \\ \Delta p_t \end{bmatrix}$ stationary. If we let ε_t be the vector of demand and supply shocks, (e_{dt}, e_{st}), using the lag operator *L*, an infinite moving average representation of the structural model can be represented as:

$$X \equiv \begin{bmatrix} \Delta y_t \\ \Delta p_t \end{bmatrix} = \sum_{i=0}^{\infty} L^i \begin{bmatrix} \alpha_{11,i} & \alpha_{12,i} \\ \alpha_{21,i} & \alpha_{22,i} \end{bmatrix} \begin{bmatrix} e_{dt} \\ e_{st} \end{bmatrix} = \sum_{i=0}^{\infty} L^{'} A_i \varepsilon_{t-1} \quad (1)$$

where Δy_t and Δp_t as earlier noted are changes in the log of output and prices and *L* is the lag operator. A_i represents the impulse response function of the shocks to the elements of the vector X_t, and e_{dt}, e_{st} are independent white noise supply and demand shocks normalized such that Var (ε_t) = I. If we assume that only supply shocks have long-run effects on output or if we decompose the shocks, such that AD-AS framework assumes that demand shocks do not have any effect on output in the long-run, the cumulative effects of demand shocks on the growth rate of output Δy_t or the change of the log of output Δy_t must be zero:

$$\sum_{i=0}^{\infty} \alpha_{12,i} = 0 \tag{2}$$

The model defined by Equations (1) and (2) can be estimated using a vector autoregression. As is the practice in any vector autoregression, each element of X_t is regressed on the lagged values of all the elements of X. Using φ to represent the estimated coefficients, the VAR can be put in a matrix form as:

$$\begin{aligned} X_t &= K + \varphi_1 X_{t-1} + \varphi_2 X_{t-2} + ... + \varphi_n X_{t-n} + e_t \\ X_t &= [I - \varphi(L)]^{-1} e_t \\ X_t &= [I - \varphi(L) + \varphi(L)^2 + ...] e_t \\ X_t &= e_t + D_1 e_{t-1} + D_2 e_{t-2} + D_3 e_{t-3} ... \end{aligned} \tag{3}$$

where K is a vector of constants, e_t represents the residuals from the equations in the vector autoregression $\begin{bmatrix} e_{yt} \\ e_{xt} \end{bmatrix}$. Noting that X_t is comprised of Δy_t and Δp_t, and e_t is made up of residuals from the regression of lagged values of Δy_t and Δp_t on current values of each in turn; the residuals are marked e_{yt} e_{pt} respectively (Bayoumi and Eichengreen, 1994:11). Equation (3) can be converted into the model defined in Equations (1) and (2), by transforming the residuals from the VAR (e_t) into supply and demand (ε_t). From Equation (3), the long-run impact of the shocks on output and prices is equal to $[I - \varphi(1)]^{-i}$.

The VAR methodology is standard in the literature and as such there are no further details regarding the procedure of extracting the disturbances or shocks. Further details are however readily available in Hamilton (1994), Bayoumi and Eichengreen (1994), Amisano and Giannini (1997) etc.

3. Data Description

This paper uses annual data for the five WAMZ member countries, namely, Gambia, Ghana, Guinea, Nigeria and Sierra Leone. The data are obtained from the World Bank's 2009 *World Development Indicators.* The sample period covers 1981-2008. This short period was to ensure that consistent data was assembled as long as a period is possible. The GDP deflator series for Guinea was not available before 1981 in the World Bank publications.

The descriptive statistics of the data using simple mean and standard deviations of the variables were first examined. The variables are GDP at constant 1990 prices in US dollar and GDP deflator (annual %) as a measure of inflation. Table 1 presents the mean and standard deviation of real output and inflation at levels and for each economy. Tables (2) and (3) depict the correlations of growth and inflation.

The WAMZ economies from Table 1, shows that they all experienced low average rate of growth and a coherent higher prevalence of inflation rates. The low growth of output may be as a result of the fact that the growth is measured as the change in the logarithm of real GDP and as such, a value of 0.01 represents a change of roughly 10 percent. Despite this, the growth rates are factually low. The volatility of output growth and inflation for all the economies follow a similar pattern of variation. The implication of these preliminary results is that the economies may be candidates suitable for a common monetary union.

The cross-country correlation coefficients of the WAMZ member output growth are reported in Table 2. We could not find any statistically satisfying co-movement in the output growth pattern of members' economies. This further confirms the results initially reported by Omotor (2010). Table 3 reports the cross-correlations of inflation for the WAMZ economies. It shows that correlation coefficients for all the individual economies save for Nigeria with Gambia and Ghana with Nigeria are not significant. Even for the economies identified to be significant, they are weakly significant. Thus, not much will be lost should the WAMZ economies come together to commence the monetary union. However, whether the patterns of correlation of output and prices reflect an underlying shock asymmetry is an issue better resolved empirically using the VAR technique. This is presented in section 4.

As a prelude to the estimation exercise, the series in logarithm form were first tested for unit roots using the Augmented Dickey-Fuller (ADF) test. The series (available on request) were found to be integrated of order 1 except the real output of Sierra Leone that is integrated of order 2. Consequently, we proceed to estimate the model using a first difference VAR technique. The results and analysis are presented in the following section.

4. Estimation and Empirical Results

The first differences of the variables were used in the estimation exercise to ensure stationarity. The VAR model for each country was estimated with lag length set at one as the Akaike Information Criteria (AIC) and Schwarz Information Criteria (SIC) indicate.

Table 1

Real Output Growth and GDP Deflator: Means and Standard Deviations

Countries	Real Output		GDP deflator	
	Mean	Std. Deviation	Mean	Std. Deviation
Gambia, The	0.032	0.027	1.91	0.84
Ghana	0.041	0.031	3.28	0.56
Guinea	0.034	0.041	2.41	1.21
Nigeria	0.037	0.076	2.81	0.99
Sierra Leone	0.008	0.010	3.17	1.04

Source: Authors' computations.

Table 2

Correlations of Growth

	Gambia, The	Ghana	Guinea	Nigeria	Sierra Leone
Gambia, The	1.000				
Ghana	0.144	1.000			
Guinea	0.139	0.223	1.000		
Nigeria	0.026	0.266	0.073	1.000	
Sierra Leone	-0.087	0.126	-0.358	0.201	1.000

Note: $\alpha_{0.05} = 0.707$

Source: Authors' computations.

Table 3

Correlations of Inflation

	Gambia, The	Ghana	Guinea	Nigeria	Sierra Leone
Gambia, The	1.000				
Ghana	-0.31 (-1.64)	1.000			
Guinea	0.20 (1.03)	0.01 (0.05)	1.000		
Nigeria	-0.34 (-1.79)	0.06 (0.32)	-0.04 (-0.20)	1.000	
Sierra Leone	0.028 (0.01)	-0.13 (-0.66)	-0.05 (-0.25)	0.27 (1.40)	1.000

Source: Authors' computations, t-values in parentheses.

The choice of 1 lag as indicated by the lag length selection criteria is further justified by the short period of analysis (1981-2008) despite the fact that in some cases the optimal lag length was higher. As Enders (2004) cited in Loius, Balli and Osman (2008:11) noted, OLS estimates will still be asymptotically efficient and consistent in this case provided that the independent variables are the same for each equation.

The test for stability using the roots of characteristic polynomial show that the root lays outside the unit circle, thus ensuing that each VAR satisfies the stability condition[3]. From the estimated VAR, the underlying supply and demand shocks were recovered by extracting the residuals from each economy's VAR analysis and their correlation coefficients computed. This was done to circumvent the complexities involved in the analysis of structural VAR (SVAR). Bayoumi and Eichengreen (1993) used a less simplified technique with favourable results. The results are presented in Table 4a and 4b.

The interpretation of the results reported in Table 4a and 4b takes a clue from Buigut and Valev (20050. According to them, positive and significant correlations are considered symmetric, while negative correlations signify asymmetric. Following the monetary economics theory, the more symmetric the shocks, the more feasible it becomes for a group of economies to establish a monetary union. The correlations of the contemporaneous supply shocks in Table 4a and 4b are generally small and asymmetry seems to prevail. However, Bayoumi and Ostry (1997) argued that a weak pattern in the correlations is also discernable. Consequently, from Table 4a, Nigeria, the major economy in the WAMZ, recorded correlations (positive) of demand shocks with Ghana, Guinea and Sierra Leone except Gambia which may imply a sizable symmetry of the zone.

The correlations of demand shocks recorded in Table 4b do clearly reinforce the (a)symmetry observed in Table 4a, only if we (do not) stick to Bayoumi and Ostry (1997) stance of weak positive correlations to imply symmetry. The demand shocks for Nigeria again were positively correlated with the other countries - Gambia, Ghana and Guinea except Sierra Leone. Gambia correlated positively with Ghana and Guinea. In general, the correlations found for the WAMZ economies at best can be described as weakly symmetric. This overall assessment should not tantamount to mean that the WAMZ member countries have a single currency as further diagnoses using the Impulse Response Functions (IRFs) and Variance Decomposition analysis may reinforce or erode the initial observation on symmetry of the economies.

Table 4a

Correlations of Contemporaneous Supply Shocks

Gambia	Gambia	Ghana	Guinea	Nigeria	Sierra Leone
	1.000				
Ghana	-0.523	1.000			
Guinea	-0.016	0.095	1.000		
Nigeria	-0.320	0.113	0.155	1.000	
Sierra Leone	-0.094	-0.176	0.213	0.090	1.000

Table 4b

Correlations of Contemporaneous Demand Shocks

	Gambia	Ghana	Guinea	Nigeria	Sierra Leone
Gambia	1.000				
Ghana	0.290	1.000			
Guinea	0.196	-0.140	1.000		
Nigeria	0.007	0.079	0.047	1.000	
Sierra Leone	-0.045	0.077	-0.165	-0.015	1.000

Source: Authors' calculations.

Impulse Response Functions (IRFs). In order to have the benefit of comparing the responses of the economies to the shocks in terms of magnitude and speed of adjustments, the IRFs were analyzed. The rule of thumb is that the larger the size of the shock, the more disruptive its effects will be on the economy. In the same vein, slower the adjustment after disturbances, the larger will be the cost of maintaining a single currency (Buigut and Valev, 2005: 15).

For preciseness and space, we did not present the graphical displays of the IRFs. Table 5 (Appendix) reports the long-run size of the IRFs to supply and demand shocks over a six period horizon. The impulse responses of output level to a supply shock for the WAMZ are all largely small. In fact, Gambia, Ghana and Guinea recorded 0 percent from the second period onward; while Nigeria recorded same from the third period onward. The implication of this is that the speed of adjustment is relatively high, with most effects dissipating by the second year and all by the third year. The only exemption is Sierra Leone whose cumulated effect of a supply shock is positive all through; and its speed of adjustment moderately high.

Unlike the output response, the effects of price level demand shock did not follow any consistent pattern over the six periods. Although responses were negative in most periods, the sharp fall experienced in the second year were eroded in the third year. The price level response to demand shock in the WAMZ economies may best be described as cyclical. The impulse response of the price level to supply shock dissipated out-rightly from the first year for all the WAMZ economies. One deduction that can be made from Table 5 is that output and prices moved in the same direction when the economies are hit by supply shocks and cyclically when due to demand shock. This is at variance with the aggregate demand – aggregate supply (AD-AS) framework which posits that output and prices move in the same direction, when the economy is hit by demand shocks and in opposite directions when due to supply shocks.

Variance Decomposition. The variance decomposition (VD) as proportion of real output and price variability due to demand and supply shocks is shown in Table 6 (Appendix). VD relays the shocks that are more predominant in accounting for the variability in the vector X_t of the movements in the two variables $\begin{bmatrix} \Delta y_t \\ \Delta p_t \end{bmatrix}$. One importance of the decomposition is that differences in the cause of variability in the economies could be an indication of underlying differences in the transmission mechanism and policy strategies of the economies being studied.

As can be observed from Table 6, the percentage variability of real output accounted for by supply shock is not largely dispersed as it ranged between 76 percent and 97 percent over the six years period. This result show less variation than those obtained from Eastern and Southern African economies (Buigut and Valev, 2005). The variance decomposition of the price level indicates that demand shocks account for a high level price variability (60 percent to 95 percent) across the WAMZ economies. The implication of the results is that structural supply and demand shocks contribute to output changes and price variations in the same way across the WAMZ economies.

Conclusion

The objective of this study is to access the feasibility of forming an Optimum Currency Area (OCA) in the West African Monetary Zone (WAMZ) from the symmetry of economic shocks which affect member economies. We apply a simple bivariate variant of the vector autoregressive (VAR) model with the right-hand side variables being log differences of real output and prices; assuming that the fluctuations in them are the two underlying supply and demand shocks respectively.

The major findings from the study indicate that the volatility of output growth and inflation for all the economies follow a similar pattern of variation. Second, the WAMZ economies are weakly symmetric both terms of supply and demand shocks. Third, output and prices of the economies moved in the same direction when they are hit by supply shocks and cyclically, when due to demand shocks. This observation is at variance with the aggregate demand – aggregate supply (AD-AS) framework which posits that output and prices move in the same direction, when hit by demand shocks and in opposite directions, when due to supply shocks. This variant does not suggest existence of strange OCA bed fellows as recent literature has even countered that satisfying OCA criteria may after be its formation. Finally, structural supply and demand shocks contribute to output changes and price variations in the same way across the WAMZ economies.

Although the general results may suggest the feasibility of the WAMZ forming an OCA from the relative symmetry of the shocks, some of the results equally reflect a weak modesty of VAR type applied in this study. The commingling shocks problems arising from the symmetry of shocks have important implication for the reliability of any inference drawn from them. For this reason, it seems advisable to use the recent but popular minimum distance estimation (MDE) technique. The MDE technique according to Feve, Matheron and Sahuc (2009), consists of estimating structural parameters of dynamic stochastic general equilibrium (DSGE) models such that it minimizes a weighted distance between theoretical impulse response functions (IRFs) of key macroeconomic variables to structural shocks and those derived from a structural vector autoregression (SVAR).

Sources of Data

GDP Deflator:World Bank (2009) World Development Indicators

<http://data.un.org/Data.aspx?q=GDP&d=WDI&f=Indicator_Code%3ANY.GDP.DEFL.KD.ZG> [Accessed on May 6th, 2010]

GDP (current US$): World Bank (2009) World Development Indicators

<http://data.un.org/Data.aspx?q=GDP&d=WDI&f=Indicator_Code%3aNY.GDP.MKTP.CD> [Accessed on May 6th, 2010]

Endnotes

1. The Conference is jointly organised by the West African Monetary Institute (WAMI) and The Center for Research on Political Economy (***CREPOL***).
2. See Louis, et.al. (2008); Abu-Bader and Abu-Qarn (2006); and, Bayoumi and Eichengreen (1994) for detailed AD-AS theoretical model.
3. Bayoumi and Eichengreen (1993).

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Table 5

Long-run Size of Impulse Response to Positive Shock

	Impulse response of output level to supply shock						Impulse response of price level to demand shock						Impulse response of price level to supply shock					
Time	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
Gambia	0.03	0.00	0.00	0.00	0.00	0.00	9.53	0.51	0.10	0.01	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00
Ghana	0.01	0.00	0.00	0.00	0.00	0.00	14.90	-10.23	4.42	-2.50	1.20	-0.64	0.00	0.00	0.00	0.00	0.00	0.00
Guinea	0.01	0.00	0.00	0.00	0.00	0.00	13.73	-5.58	1.99	-0.76	0.28	-0.11	0.00	0.00	0.00	0.00	0.00	0.00
Nigeria	0.08	0.02	0.00	0.00	0.00	0.00	24.15	-10.26	3.49	-1.38	0.49	-0.19	0.00	0.00	0.00	0.00	0.00	0.00
Sierra Leone	0.08	0.06	0.03	0.02	0.01	0.01	32.72	-7.50	0.15	-0.71	-0.29	-0.20	0.00	-0.02	-0.01	-0.01	0.00	0.00

Note: Multiply by 100 to get percent change in variable.

Table 6

Variance Decomposition: Proportion of Real Output and Price Variability due to Demand and Supply shocks

	Variation in output due to demand shocks						Variation in price due to demand shock						Variation in price due to supply shock					
Time	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
Gambia	8.51	8.49	8.49	8.49	8.49	8.49	91.49	91.51	91.51	91.51	91.51	91.51	0.00	11.29	11.42	11.43	11.43	11.43
Ghana	46.43	39.60	39.28	39.05	39.02	39.01	53.57	60.40	60.72	60.95	60.98	60.99	0.00	22.86	23.12	23.76	23.82	23.86
Guinea	18.97	20.55	20.61	20.63	20.63	20.63	81.03	79.45	79.39	79.37	79.37	79.37	0.00	8.21	8.44	8.51	8.52	8.52
Nigeria	4.43	5.29	5.20	5.20	5.20	5.20	95.57	94.71	94.79	94.80	94.80	94.80	0.00	2.21	2.23	2.26	2.26	2.26
Sierra Leone	4.72	9.51	10.04	10.33	10.42	10.45	95.28	90.49	89.96	89.67	89.58	89.55	0.00	3.82	4.06	4.18	4.22	4.23
													Variation in output due to supply shock					
													1.00	**88.71**	**88.58**	**88.57**	**88.57**	**88.57**
													1.00	77.14	76.88	76.24	76.18	76.14
													1.00	91.79	91.56	91.49	91.48	91.48
													1.00	97.79	97.77	97.74	97.74	97.74
													1.00	96.18	95.94	95.82	95.78	95.77