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Impact of Exchange Rate on Selected Macroeconomic Variables: A case study of West African Monetary Zone

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1. Introduction

From macroeconomic angle, there are macroeconomic objectives which every economy intends to attain at every point in time towards economic growth and development. The conflicts among macroeconomic objectives which call for trade off between one or two objectives challenges the responsibility of economic policy makers towards ensuring those macroeconomic objectives' conflicts are at minimum misalignment in order to ensure economic growth and development in an economy. The presence of wider degree of conflicts among macroeconomic objectives contributes towards the ineffectiveness of monetary policy in most developing economies of the world. In an open economy, the desirable economic goals are the attainment of internal and external balance. Internal balance is a steady growth of the domestic economy consistent with a low unemployment rate. External balance is the achievement of a desired trade balance or desired international flow. The external finance of exchange rate fluctuations has adverse effects on economic performance of most economies due to inability to achieve expected realistic exchange rate and price stability. The role of exchange rate in international finance needs proper understanding of its fundamental determinants which task the monetary authority to ensure crucial investigations, if monetary authority objectives are to be attained and ensure attainment of macroeconomic objectives.

In an open economy, monetary policy has a direct impact on aggregate demand as well as exchange rate. Movement in the exchange rates in turn reinforces the effects of monetary innovation on the aggregate demand through its impacts on intermediate output demand. In reality, exchange rate movement can be matter in the design of monetary policy in an open economy which calls the decision makers to include exchange rate term in the policy reaction function which plays an improving role in

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the performance of monetary policy rules while exchange rate has indirect effects on inflation and output in the policy reaction function.

This study examines the impact of exchange rate on macroeconomic variables under currency union in four West African Monetary zone countries (Ghana, Gambia, Nigeria and Sierra Leone). Exchange rate is an important transmission channel in an open economy for foreign shocks that the central bank may respond to within month or quarter which reacts instantly to monetary policy surprise. Exchange rate is highly significant in the formation of monetary policy and in itself is also influenced by monetary policy. Finding shows that all the four countries in the study try to achieve and maintain price stability with different monetary policy frameworks, in Gambia and Nigeria exercise monetary targeting framework, Ghana and Sierra Leone adopt inflation targeting.

In spite of the various studies towards assessing currency union in West African monetary Zone, to the study knowledge, there is hardly any concrete empirical study that has been investigated to assess the impact of exchange rate on macroeconomic variables in open economies of West African Monetary zone. Studies such as Balogun (2008) assessed the alternative reconsideration of macroeconomic convergence criteria for WAMZ. Balogun (2007) investigated the monetary policy and economic performance of WAMZ. Canetti and Greene (1991) studied the monetary growth and exchange rate depreciation as a cause of inflation in African countries. Jimoh (2004) found the monetary approach to exchange rate determination in Nigeria while Acheampong (2007) researched on a monetary approach to exchange rate liberation regime in Ghana. West African Monetary Agency (2009) undertook a study toward the money supply and macroeconomic convergence in Economic Community of West African States. Consequently, a research gap thus exists.

Thus, the present study tends to seek an answer if exchange rate has significant impact towards the selected macroeconomic parameters of participating countries in the determination of macroeconomic out turn in the WAMZ selected countries which could imply significant losses when the countries involved give up its control for the period of a declaration of second monetary zone in West African region between 2000 and 2010. The objective is to investigate the effect of exchange rate on selected macroeconomic variables in open economies of West African Monetary zone.

2. Empirical survey

Koray and McMillan (1998) investigated the response of exchange rate and trade balance to monetary policy innovations for US economy. The study indicated that contractionary monetary policy shocks leads to transitory appreciations of real and the nominal exchange rate. The finding supported J-curve hypothesis where exchange rate appreciations are related to a temporary contractionary shocks to monetary policy lead to a short-lived improvement in the trade balance which is then followed by

deterioration. Siok Kun Sek (2009) studied the reaction of monetary policy to exchange rate in three east- Asia economies (Korea, Philippines and Thailand). The paper disclosed the reactions of monetary policy to exchange rate shocks as well as consumer price inflation (demand shocks) and output (supply shocks) have declined under the inflation targeting environment. Monetary functions responded weakly to the exchange rate movement before and after the financial crisis. Claudio Soto (2003) investigated monetary policy, real exchange rate and current account of Chile where a sticky price model was used which involved two rules, a modified Taylor rule comprised of forecast inflation targeting and output gap while the alternative rule included an additional target for real exchange rate. In the baseline, modified Taylor rule model showed that central bank reacted more aggressive in response to cost push shocks, the consequence resulted to less volatile inflation than under alternative rule where the cost of this policy was a larger variance in output, real exchange rate and current account. Under real exchange rate targeting policy, the increment in the real interest rate was almost one to one with the shocks which implied a lower volatility in the real exchange rate, consumer price inflation and output gap. The implication was that real exchange rate targeting in the policy reaction function could help to reduce the volatility of the external account and also reduced the volatility of the output gap but introduced more volatility in the inflation. Sushanta and Mallick (2010) examined macroeconomic shocks, monetary policy and implicit exchange rate targeting of India using SVAR between second quarter 1996 and first quarter 2009 where the study revealed that intervention of monetary authority through contractionary monetary policy such policy had a permanent negative impact on output and inflation while exchange rate appreciated in the long run . Continuous intervention of monetary authority in foreign exchange rate market to stabilise exchange rate shocks signaled an exchange rate targeting strategy where there was excessive management of exchange rate turn out to produce massive foreign reserves as the study indicated

Marcio Holland (2005) assessed monetary policy and exchange rate in Brazil where the empirical result in the reaction functions (interest rate) did not response to real exchange rate shocks but they did respond to nominal depreciation as well as strong reactions towards inflationary pressures such reaction function improved credibility. Zams and Cooray (2007) studied analysis of the exchange rate channel and monetary rule a case of Indonesia changing from managed floating to flexible exchange rate. The study established that exchange rate in Indonesia was becoming less volatile but the magnitude change in the currency and depreciation were quite high. The study also placed that there would be difficulty in implementing inflation targeting directly without considering exchange rate movement. Here, central bank was advised to apply optimal monetary policy rule to the exchange rate as the reaction functions. Garcia and Malet (2005) observed that in Argentina economy, the pressure in exchange rate market against a particular currency had been measured a sum of the loss of international reserve plus the loss nominal value of that currency. The study

indicated that there was a positive and double direction relationship between exchange market pressure and domestic credit. Output growth happened to be crucial in determination of exchange market pressure more than domestic credit or interest rate. Girardin and Nicholas (2001) assessed Japan monetary policy in late 90's where impulse response function in a VAR level established that the main channels of transmission of interest rate shock did not involve bank lending rate but mainly asset prices both via the share price and exchange rate. Shocks on bank reserves had no significant effects on price or exchange rate and absence of significant impact on output. The study discovered that exchange rate shocks would certainly help the country to get out of price inflation. Positive shocks on share price would lead to a boost in output.

Jimoh (2004) looked into the monetary approach to exchange rate determination in Nigeria as a case study where the approach provided an adequate representation of Nigeria data. The study emphasised on adequate attention toward domestic credit creation to achieve an acceptable level for its exchange rate and stipulated that significant economic growth and low interest rate may cause exchange rate appreciation rather depreciation. Chuka (2009) examined the effects of monetary policy innovations in Nigeria. Acheampong (2007) assessed a monetary approach to exchange rate liberalisation regime a case study of Ghana where VECM was adopted. The result indicated that exchange rate shocks in the short run returned to its long run equilibrium at a very fast rate and that exchange rate was influenced by money aggregate and income. The study further made known that those economic agents in the foreign exchange market were very responsive to the development of the market which underscored the point of prudential management of Ghanaian exchange rate. Bathalowew and Kargbo (2010) examined the exchange rate and monetary dynamics in Sierra Leone with quarterly data between 1983Q1 and 2008Q4 using autoregressive distributed lag (ARDL) modeling technique in order to estimate the long run relationship and short run dynamics. In the long run, coefficient of exchange rate had negative significance statistically with real M2 while exchange rate was negatively and statistically significant to foreign interest rate.

However, this study will compliment from the methodological angle by exploring Structural Vector autoregressive (SVAR) modeling technique comprising four countries from WAMZ through estimation of SVAR on each country of the zone in order to appreciate the significant degree of magnitude towards the impact of exchange rate on selected macroeconomic variables of West African Monetary zone. Most existing studies used least square methods, descriptive statistics, correlation approach and Vector autoregressive (VAR) modeling technique by exploring panel data approach analysis.

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3. Econometric Methodology

This study uses the structural version of reduced form VAR which indicates isolation of the influence of shocks from those of structure proposed by Blanchard and Quah (1989). The modification of the structural VAR model according to Kim (2003) and Kim and Roubin (2000) identified exogenous policy shocks and policy reaction functions describing according to the economy as:

$$B(L)y_t=\sum_t \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

In which B(L) indicates lag operator matrix L, y_t implies vector of (nx1) while $\sum_t$ is the disturbance vector (nx1) with variance $Var(\sum_t)=\alpha$ and α happens to be a diagonal matrix.

$$Y_t = C(Z)y_{t-1} + e_t \ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Equation 2 is the general reduced form of VAR, where C(Z) is a matrix of lag operator while var $(e_t)= \sum$.

$$C(Z)= -A^{-1}A^{0}(Z)\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

Equation 3 indicates restriction assigned on the contemporaneous structural parameters and allows non-recursive structures. $A^0(Z)$ is the coefficient matrix without the contemporaneous coefficient A^0 . Assuming $\sum = A^{-1}\alpha A^{-1}$ and $\sum$ consists of n (n-1)/2 parameters, the study needs at least n (n+1)/2 restrictions on A^0.

In this study, eight variables are included in order to explain possible interactions between the policy and non-policy variables and embedded with two blocks in the model. One is the foreign block with two variables and domestic block with six domestic variables. Foreign variables are block exogenous to the economy. This indicates that domestic variables cannot be in the lag structure of the foreign variables because small size of such economy to the global economy cannot make any domestic variables to influence movement in foreign variables either with a lag or contemporaneously. The variables in the study are foreign interest rate (f), world oil price (p), fiscal policy (fp), inflation (inf), real income (g), monetary policy (mp) and monetary aggregate (ms) and exchange rate (ex). Monetary policy instruments are domestic interest rate and money supply.

The model represented by a eight component vector defined can be written as:

$$Y_t= (f_t, p_t, fp_t, inf_t, g_t, mp_t, ms_t, ex_t) \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

To estimate VAR model in equation 4 below, the identification restrictions are specified taking to capture both real and monetary aspects of the optimum currency area literature. The model specification is shown as follow:

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$$\begin{pmatrix} \sum^{f} \\ \sum^{p} \\ \sum^{fp} \\ \sum^{inf} \\ \sum^{g} \\ \sum^{mp} \\ \sum^{ms} \\ \sum^{ex} \end{pmatrix} = \begin{pmatrix} f^{0} \\ p^{0} \\ fp^{0} \\ inf^{0} \\ y^{0} \\ mp^{0} \\ ms^{0} \\ ex^{0} \end{pmatrix} + \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & a_{32} & 1 & 0 & 0 & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & a_{45} & 0 & 0 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 & a_{56} & 0 & 0 \\ a_{61} & a_{62} & 0 & a_{64} & a_{65} & 1 & 0 & a_{68} \\ a_{71} & a_{72} & a_{73} & a_{74} & a_{75} & a_{76} & 1 & 0 \\ a_{81} & a_{82} & a_{83} & a_{84} & a_{85} & a_{86} & a8_{7} & 1 \end{pmatrix} \begin{pmatrix} e^{f} \\ e^{p} \\ e^{fp} \\ e^{inf} \\ e^{g} \\ e^{mp} \\ e^{ms} \\ e^{ex} \end{pmatrix} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(5)$$

where f^{o},p^{o},fp^{o},inf^{o},g^{o},mp^{o}, and ex^{o} are constants. 'a' represents coefficients. The structural disturbances (left hand side) indicates the shocks of foreign interest rate, world oil price, fiscal policy, inflation, real GDP growth, monetary policy, monetary aggregate, and exchange rate respectively. The 'e' terms in the right hand side are residuals in the reduced form which can be interpreted as unexpected movement of variables in the model. It should be noted that exchange rate and oil price variables are incorporated in the monetary policy reaction function so as to control the current responses of monetary policy to the state of the economy as well as including the exchange rate term in the policy reaction function to capture the response of monetary policy to this variable over time in the selected WAMZ zone as indicated according to Kim and Roubini (2000) and adopted by Siok Kun Sek (2009).

As pointed out from equation 5, innovations in foreign interest rate, e^{f}, are entirely characterized to its own shocks ($\sum^{f}$**).** Innovations to world oil price, $e^{p,}$ are attributed to respond contemporaneously to its own shocks ($\sum^{p}$**)**. Innovations to fiscal policy, e^{fp}, respond contemporaneously to innovations in world oil price, ep and its own shocks which reflect shocks ($\sum^{fp}$). Innovations to inflation, e^{inf}, are assumed to reflect innovations in foreign interest rate, world oil price, fiscal policy, which also influences its own shocks ($\sum^{inf}$) and innovations to real income contemporaneously. Innovations to real income, e^{y}, are assumed to reflect the developments in IS curve i.e. innovations in domestic interest rate (monetary policy) and inflation rate. The innovations are attributed again to innovations in foreign interest rate, world oil price, fiscal policy and its own shocks ($\sum^{g}$). Innovations to monetary policy are allowed to respond to innovations in foreign interest rate, world oil price, inflation, real income, real exchange rate and its own shocks ($\sum^{mp}$) contemporaneously. Innovations to monetary aggregate respond contemporaneously to innovations in foreign interest rate, world oil price, fiscal policy, inflation rate, real income, monetary policy and own shocks ($\sum^{ms}$). Innovations to exchange rate are assumed to reflect innovations in

foreign interest rate, world oil price, fiscal policy, inflation, real income, monetary policy, monetary aggregate and own shocks ($\sum^{ex}$).

To summarise according to Kim and Roubini (2000) and Siok Kun Sek (2009), the first and second equations represent exogenous shocks from the foreign economies while the third equation indicates exogenous shocks from domestic economy. Fourth and fifth equations describe domestic goods market equilibrium while sixth and seventh equations explain domestic money market equilibrium. The last equation stands as the exchange rate market.

4. Data

The study focuses on four countries in West African Monetary Zone namely, Gambia, Ghana, Nigeria and Sierra Leone targeting towards currency union in the year 2015. The full sample series are from the inception year of the zone, April, second quarter, 2000 to fourth quarter of 2010 in order to find out how convergent or symmetrical macroeconomic indicators of the countries are towards currency union in the zone. The study uses a set of data to estimate the system equation of Structural VAR model obtained from the African Development Indicators published by the World Bank while world oil price was extracted from Organisation of Petroleum Exporting Countries Statistical bulletin and Ghanaian monetary policy was derived from Central Bank of Ghana. The set of data consists of money aggregate (ratio of m2 to GDP), exchange rate, monetary policy (money market rate or short run interest rate), real income growth (real GDP growth), inflation rate, fiscal policy (ratio of budget deficit/surplus to GDP), the world oil price (world oil price in US dollar) and foreign interest rate (US money market interest rate).Only exchange rate and world oil price are in logarithm form.

5. Result and Discussion

5.1 Unit root test

The data were subjected to stationary scan called stationary test using Augmented Dickey Fuller (ADF) test so as establish their univariate time series behaviour in order to determine the basic unit of observation. This is to determine whether the sequence estimation should use the level, first or second difference of each time series before conducting the estimations. Thus, the evidence suggests that first differencing is sufficient or that these macro variables do not have two unit roots

5.2 Empirical Analysis

This section is to analyse the results with a view of providing logical answers to the study's research question ''has exchange rate impacted selected macroeconomic parameters of intending nations of WAMZ economy?'' The model specified eight variable system namely foreign interest rate, world oil price, fiscal policy, inflation rate, growth rate, monetary policy, and money supply and exchange rate. The model

uses quarterly series; a two quarterly lag structure was used given two lags in each VAR equation, after considering stationary test. The study reports that the variables are co-integrated using a vector error correction (VEC) models where long run behaviour of endogenous variables converge towards their co-integrating (long run equilibrium) correlations and also allows a wide range of short run dynamics as well as the correlation matrix summary. Using the VAR techniques, the impulse response functions and the variance decompositions are estimated. Impulse Response Function (IRF) indicates the direction and size of the effect of a one standard deviation shock to one variable on other system variables over time while Variance Decompositions (VDC) show the percentage of the forecast error variance for each variable that may be attributed to its own innovations and to fluctuations in other variables in the system. Thus, model variables are converted to first difference prior to estimation of the model, here IRFs and VDCs are reported. This study is interested in how exchange rate impacts selected macroeconomic variables such as foreign interest rate, world oil price, fiscal policy, inflation, growth rate, money supply and monetary policy. The study presents this analysis from the perspective of each country's exchange rate and national macroeconomic variables

The Gambia

From table 1a of the test statistics of Gambia, the co-integrating relationships are shown indicating that monetary policy, monetary aggregate, and exchange rate adjust to the deviations from their long run paths within two quarters. The monetary policy and exchange rate establish their long run relationships at one percent while money aggregate establishes significant at five percent. The rest variables tend to have their convergence to their equilibrium paths beyond two quarters structurally specified. On the summary of the correlation matrix presented in table 1b, exchange rate, inflation, real GDP growth and monetary policy have inverse relationships while foreign interest rate, world oil price, fiscal policy and money supply tend to be positive relationships seem to be indicated by correlation matrix of the reduced form of errors.

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Table 1a-Gambia: Test Statistics

	Foreign interest rate	World oil price	Fiscal policy	inflation	Growth rate	Money supply	Monetary policy	exchange rate
Co integrating equation	-0.00707	0.330034	0.00973	0.089006	0.032063	0.189096	0.068975	-0.71076
t-statistics	-0.26199	1.16413	0.24434]	1.22975	0.38255	5.25446	1.77761]	-3.16187
Adjust R^2	-0.73021	-0.09627	-0.75648	-0.65626	-0.76097	0.214978	-0.34387	0.420178

Table 1b-Gambia: Correlation among reduced - form errors

	Foreign interest rate	World oil price	Fiscal policy	inflation	Growth rate	Money supply	Monetary policy	exchange rate
Foreigninterest rate	1	0.129654	0.292614	-0.54237	0.010622	-0.22343	-0.06674	0.517006
World oil price	0.129654	1	-0.04767	-0.26243	-0.10073	-0.36756	-0.16553	0.371012
Fiscal policy	0.292614	-0.04767	1	0.207482	0.224568	-0.31114	-0.07833	0.339846
inflation	-0.54237	-0.26243	0.207482	1	0.531344	0.176207	-0.20312	-0.66159
Growth rate	0.010622	-0.10073	0.224568	0.531344	1	0.329192	-0.28226	-0.13986
Money supply	-0.22343	-0.36756	-0.31114	0.176207	0.329192	1	-0.55628	0.047696
Monetary policy	-0.06674	-0.16553	-0.07833	-0.20312	-0.28226	-0.55628	1	-0.22642
exchange rate	0.517006	0.371012	0.339846	-0.66159	-0.13986	0.047696	-0.22642	1

In conducting the impulse response analysis of VAR system, the table 1c indicates for Gambia that the responses of the macroeconomic variables to a one standard deviation in the exchange rate as indicated is zero in the first period or quarter. The response of foreign interest rate to the shock in exchange rate turns negative in second period and third period while the rest periods grow with positive response in mild responses. A more volatile response is obtained in world oil price, inflation, monetary aggregate and monetary policy. World oil price witnesses sharp and positive increases after fourth period there is positive fluctuations continuously throughout the tenth period. The shock in exchange rate to response of fiscal policy is symmetrical throughout the ten periods witnessing soft response. Inflation and GDP growth rate have positive effect with exchange rate but response of inflation occurs with sharp increase and growth rate is mild. The response of monetary aggregate shock turns out to positive where there are fluctuating effects due to exchange rate shock throughout

the ten quarters. The effects of exchange rate on monetary policy and oil price are the largest symmetrically over the ten periods, 0.79 and 1.06 respectively. Variance decompositions are presented in table 1d-Gambia showing exchange rate shocks impact different macroeconomic variables. The variance decompositions are explained using average outcomes over the ten periods. It is see that exchange rate shocks contributed 0.001% and 0.04% to variation in foreign interest rate and fiscal policy respectively. World oil price variation and monetary aggregate innovation are explained by 0.96% and 0.45% by exchange rate. Exchange rate innovation accounted 0.05% and 0.41% to growth rate and inflation shocks respectively. 5.16% of monetary policy innovation is described by exchange rate innovation while its own past shocks accounted 7.22%. There is little evidence that exchange rate directly causes growth rate, fiscal policy, monetary aggregate and inflation but impacted monetary policy by 5% within ten periods.

Table 1c-Gambia: Response selected macro variables to exchange rate

Period	Foreign interest rate	World oil price	Fiscalpolicy	inflation	Growth rate	Moneysupply	Monetarypolicy	exchange rate
1st	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	2.213764
2nd	-0.007632	0.626775	0.017984	0.150731	0.051766	0.081695	0.326687	-0.056870
3rd	0.004423	0.693438	0.041250	0.210440	0.081853	0.075467	0.471299	1.112088
4th	-0.005398	0.813436	0.050076	0.311774	0.117112	0.157953	0.684858	0.360841
5th	0.015098	0.599602	0.052995	0.223146	0.090649	0.041145	0.511258	1.973160
6th	0.005485	1.024291	0.060470	0.314696	0.122282	0.119002	0.703265	0.407757
7th	0.007611	0.879620	0.063072	0.317258	0.124488	0.113679	0.711257	1.108632
8th	0.003055	1.010854	0.068266	0.368899	0.142942	0.155683	0.820407	0.698795
9th	0.015162	0.821178	0.067070	0.300994	0.121019	0.078127	0.683565	1.646136
10th	0.008510	1.059883	0.069886	0.351063	0.137842	0.126161	0.787001	0.670407

Table 1d-Gambia: Variance Decomposition of Real Exchange Rate

Period	Foreign interest rate	World oil price	Fiscal policy	inflation	Growth rate	Money supply	Monetary policy	exchange rate
1st	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	5.537260
2nd	0.002349	0.256099	0.005898	0.123273	0.010889	0.155285	2.213321	5.296021
3rd	0.002135	0.499321	0.024801	0.240662	0.025395	0.227215	4.053161	6.267235
4th	0.002242	0.730117	0.041830	0.437123	0.046903	0.536597	6.147584	6.260391
5th	0.005608	0.801829	0.054517	0.429337	0.050692	0.448191	5.619056	7.688143
6th	0.005109	1.126860	0.068368	0.504426	0.062249	0.519972	6.166328	7.563787
7th	0.005106	1.295109	0.080082	0.558873	0.071087	0.568740	6.496899	8.155174
8th	0.004594	1.517445	0.092100	0.640644	0.082704	0.687795	7.050751	8.369435
9th	0.006256	1.591047	0.100875	0.646014	0.086445	0.651382	6.840992	9.112825
10th	0.006256	1.787927	0.109387	0.680467	0.092918	0.687217	6.968917	9.140623
average	0.001	0.96	0.04	0.41	0.05	0.45	5.16	7.22

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Ghana

From Table 2a, the test statistics of Ghana shows the long run equilibrium where world oil price, fiscal policy, growth rate, monetary policy and exchange rate adjust to the deviations from their long run paths in two quarters where fiscal policy and monetary policy establish 10% significance, exchange rate 5% significance and growth rate 1% significance while other variables fail to converge to their equilibrium paths within specified structural lags. The correlation matrix of the reduced form error is in table 2b showing the test statistics. The exchange rate indicates inverse relationships with fiscal policy, inflation, monetary policy, and money supply, and symmetrical alignment exists between exchange rate with foreign interest rate, world oil price and growth rate

Table 2a-Ghana: Test Statistics

	Foreign interest rate	World oil price	Fiscal policy	inflation	Growth rate	Money supply	Monetary policy	exchange rate
Co integrating equations	-0.00292	-0.1507	0.014172	0.062524	-0.02632	0.017874	0.001951	-0.05198
T- statistics	-0.28884	-1.62029	1.48783	1.17601	-3.42618	1.33361	0.18960	-1.84312
Adjusted R^2	-0.84089	0.18485	-0.72853	-0.51009	-0.14343	-0.05621	-0.85104	0.110046

Table 2b-Ghana: correlation among reduced - form errors

	Foreign interest rate	World oil price	Fiscal policy	inflation	Growth rate	Money supply	Monetary policy	exchange rate
Foreign interest rate	1	0.048878	-0.03639	0.017389	-0.06209	-0.13041	-0.70917	0.674128
World oil price	0.048878	1	-0.81149	0.135125	0.960221	-0.05934	-0.19169	0.412692
Fiscal policy	-0.03639	-0.81149	1	-0.08718	-0.78369	0.145774	0.321604	-0.09665
inflation	0.017389	0.135125	-0.08718	1	0.182607	0.62186	-0.46579	-0.01871
Growth rate	-0.06209	0.960221	-0.78369	0.182607	1	-0.05454	-0.20188	0.353519
Money Supply	-0.13041	-0.05934	0.145774	0.62186	-0.05454	1	-0.202	-0.14837
Monetary policy	-0.70917	-0.19169	0.321604	-0.46579	-0.20188	-0.202	1	-0.28846
exchange rate	0.674128	0.412692	-0.09665	-0.01871	0.353519	-0.14837	-0.28846	1

The table 2c contains the impulse response functions of macroeconomic variables to shock of exchange rate relating to Ghana. The response of foreign interest rate to shocks in the exchange rate shock is positive throughout the ten periods which indicates that exchange rate shocks have positive low effects on foreign interest rate. The effects of exchange rate shocks on world oil price are positive from second to third period after in which their effects are mixed in the rest period while its impact on money supply is mixed but the magnitude derived is insignificantly unrecognised. The response of fiscal policy shocks to exchange rate shocks is asymmetrical over the ten quarter horizons with low impact. The impact of exchange rate on inflation and

monetary policy is negative. The impact on monetary policy is an insignificant magnitude throughout ten periods suggesting less half percent appreciation of exchange rate as well as moderate falling of inflation with less one percent which implies an appreciation of exchange rate. A more mild response is obtained for growth/real output symmetrically with exchange rate. Variance decompositions are presented in table 2d-Ghana containing exchange rate shocks impact different macroeconomic variables. The variance decompositions are analysed using average outcomes over the ten periods. Foreign interest rate innovations, fiscal policy innovations, monetary policy innovations, inflation innovations, and monetary aggregate innovation are affected with little magnitude valued at 0.02%, 0.04%, 0.02%, 0.20%, and 0.02% respectively by exchange rate innovation. Its own past innovations accounted 5.74%. The outcome implies that the feedback from macroeconomic variables to exchange rate cause little impacts.

Table 2c-Ghana: Response of selected macro variables to Real Exchange Rate

Period	Foreign interest rate	World oil price	Fiscal policy	inflation	Growth rate	Money supply	Monetary policy	Exchange rate
1st	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.594340
2nd	0.023833	0.638318	-0.024428	-0.453418	0.065422	0.006310	-0.020304	0.336497
3rd	0.023317	0.044201	-0.038938	-0.343615	0.073678	-0.006228	-0.044947	0.380407
4th	0.012024	-0.375800	-0.006206	-0.180513	0.017474	0.000308	-0.035837	0.199802
5th	0.022384	0.332969	-0.027783	-0.318057	0.058483	-0.004839	-0.037548	0.413132
6th	0.017309	-0.074563	-0.015458	-0.276105	0.035031	0.000942	-0.011041	0.275390
7th	0.014244	-0.018051	-0.011364	-0.235564	0.026304	0.001839	-0.018747	0.303001
8th	0.015526	0.197553	-0.023478	-0.259436	0.049251	-0.001396	-0.027391	0.383769
9th	0.017492	-0.001656	-0.017268	-0.273678	0.038521	-0.000115	-0.016226	0.299277
10th	0.016626	0.031539	-0.017151	-0.259005	0.037156	-0.000486	-0.024892	0.324080

Table 2d-Ghana: Variance Decomposition: Real Exchange Rate

Period	Foreign interest rate	World oil price	Fiscal policy	inflation	Growth rate	Money supply	Monetary policy	exchange rate
1st	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	3.393138
2nd	0.023141	0.341127	0.024724	0.274843	0.250973	0.001666	0.006422	4.245407
3rd	0.031471	0.320893	0.055408	0.270196	0.324918	0.002498	0.024514	5.166874
4th	0.026777	0.426636	0.040562	0.211095	0.235735	0.001920	0.027346	5.270977
5th	0.029709	0.470342	0.046706	0.222444	0.276304	0.002040	0.028943	5.905300
6th	0.028941	0.466477	0.043918	0.218255	0.266289	0.001755	0.023964	6.150232
7th	0.027231	0.451873	0.040061	0.207448	0.247589	0.001578	0.021546	6.365239
8th	0.026327	0.469872	0.041861	0.205163	0.257413	0.001420	0.021164	6.949644
9th	0.026291	0.459856	0.040375	0.205040	0.251259	0.001273	0.019604	7.096845
10th	0.026038	0.454858	0.039132	0.202334	0.245214	0.001156	0.019327	7.349879
average	0.02	0.39	0.04	0.20	0.24	0.02	0.02	5.74

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Nigeria

Evidence from table 3a of Nigeria test statistics, the co-integrating relationships implies that fiscal policy, inflation, and monetary policy get adjusted to deviations from their long run paths less than two quarters where the remaining variables disconverge to their paths within the selected quarters. Fiscal policy and inflation establish 5 % significance while world oil price and monetary policy establish at 10 % and 1% significance. The correlation matrix of the reduced form error is in table 3b-Nigeria implying the test statistics; depreciating exchange rate has symmetrical relationship with foreign interest rate, world oil price, fiscal policy, inflation and monetary policy while growth rate and monetary aggregate establish asymmetrical correlation with depreciating exchange rate suggested by reduced form-error correlation matrix from table 3b**.**

Table 3a-Nigeria: Test Statistics

	Foreign interest rate	World oil price	Fiscal policy	inflation	Growth rate	Money supply	Monetary policy	exchange rate
Co integrating equations	-0.17041	-1.9774	-1.43968	-0.98627	-0.1626	0.444401	0.439559	0.57164
T-statistics	-0.95665	-1.15101	-1.69275	-1.63785	-0.46026	2.33810	1.00921	0.65319
Adjust R^2	-0.68447	0.100227	-0.56452	-0.57834	-0.75467	-0.41565	-0.66723	0.010803

Table 3b-Nigeria: correlation among reduced – form errors

	Foreign interest rate	World oil price	Fiscal policy	inflation	Growth rate	Money supply	Monetary policy	exchange rate
Foreigninterestrate	1	0.123576	0.135071	-0.5808	-0.1792	-0.29661	-0.50813	0.030658
World oil price	0.123576	1	0.495767	-0.01591	-0.12644	-0.60885	-0.12871	0.773316
Fiscal policy	0.135071	0.495767	1	-0.37466	-0.17	-0.28759	-0.58797	0.339538
inflation	-0.5808	-0.01591	-0.37466	1	-0.2314	0.25487	0.392812	0.43361
Growth rate	-0.1792	-0.12644	-0.17	-0.2314	1	-0.48883	-0.03183	-0.4513
Money Supply	-0.29661	-0.60885	-0.28759	0.25487	-0.48883	1	0.297989	-0.27975
Monetary policy	-0.50813	-0.12871	-0.58797	0.392812	-0.03183	0.297989	1	0.03473
exchange rate	0.030658	0.773316	0.339538	0.43361	-0.4513	-0.27975	0.03473	1

The table 3c-Nigeria has to do with the response of macroeconomic variables shocks to one standard deviation shock in exchange rate of Nigeria as indicated is zero in the first period. Foreign interest rate shocks and growth rate shock in response to exchange rate shock implies positive relationships over the ten quarters as statistically

insignificant climaxing at 0.07 and 0.10 at eight quarter and 4th quarter for foreign interest rate and growth rate respectively. Positive correlation between growth rate and exchange rate implies low appreciation of exchange rate. The impact of exchange rate on inflation and fiscal policy is positive over ten periods happen to be more volatile response with sharp increase and decrease from period to period. Monetary aggregate response to exchange rate is negatively sharp in all the periods stating depreciation of exchange rate accelerates increase in monetary aggregate. The impact of exchange rate on monetary policy compared with monetary aggregate is greater. Monetary policy has positive correlation with exchange rate, controlling of exchange rate movement indicates strong reaction of monetary policy to further strengthen the local currency. On oil price shock, the effect of exchange rate is mixed, fifth, seventh, ninth and ten quarters turn to be negative while the rest periods witnessed positive relationship with exchange rate. Apart from second period with 0.69 and fifth period with -0.71, the remaining periods are less statistically significant. Variance decompositions are presented in table 3d-Nigeria containing exchange rate shocks impact different macroeconomic variables. The variance decompositions are analysed using average outcomes over the ten periods. Exchange rate explained little contribution to monetary policy with a climax of 1.62% while its own innovation is less than 3%. Monetary aggregate, foreign interest rate and world oil price are impacted by exchange rate with less half percent throughout the ten periods. It is surprising to observe that exchange rate shocks do not explain a significant proportion of variation in macroeconomic variables like fiscal policy, inflation and growth rate with infinitesimal contributions, climaxing 0.85%, 0.3% and 0.07% respectively. Nearly, all the macroeconomic variables are caused by exchange rate with little or no evidence.

Table 3c-Nigeria: Response of selected macro variables to Exchange Rate

Period	Foreign interest rate	World oil price	Fiscal policy	inflation	Growth rate	Money supply	Monetary policy	exchange rate
1st	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.967214	0.967214
2nd	0.061627	0.686412	0.513782	0.351990	0.058504	-0.158728	0.180176	0.180176
3rd	0.074800	0.143701	0.665426	0.471908	0.079590	-0.190130	0.281244	0.281244
4th	0.091516	0.107879	0.833816	0.600841	0.102439	-0.230831	0.135716	0.135716
5th	0.043633	-0.710573	0.426201	0.319834	0.055872	-0.107648	0.237423	0.237423
6th	0.058491	0.013580	0.527321	0.378309	0.064437	-0.147803	0.202231	0.202231
7th	0.061129	-0.057905	0.533807	0.374764	0.062903	-0.156036	0.274977	0.274977
8th	0.069927	0.036267	0.630241	0.451315	0.076678	-0.176900	0.211091	0.211091
9th	0.059133	-0.212949	0.542775	0.393136	0.067273	-0.148755	0.239707	0.239707
10th	0.062866	-0.084253	0.569784	0.409633	0.069793	-0.158724	0.211597	0.211597

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Table 3d-Nigeria: Variance Decompositions of Real Exchange Rate

Period	Foreign interest rate	World oil price	Fiscal policy	inflation	Growth rate	Money supply	Monetary policy	exchange rate
1st	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	3.120075
2nd	0.156247	0.377685	0.459752	0.432472	0.035075	0.176349	0.883900	3.067609
3rd	0.261621	0.347171	0.801244	0.788733	0.066648	0.294971	1.582021	3.056707
4th	0.365731	0.322432	1.143779	1.170087	0.103589	0.409365	2.264638	2.924752
5th	0.320751	0.589950	1.024759	1.126816	0.093772	0.355309	1.973949	2.857149
6th	0.313250	0.547157	1.001550	1.136140	0.091052	0.346484	1.888794	2.771689
7th	0.312590	0.511296	0.990758	1.128853	0.088933	0.346991	1.849470	2.748341
8th	0.323091	0.478232	1.023673	1.170771	0.092293	0.358736	1.907745	2.688979
9th	0.318501	0.471776	1.013821	1.173657	0.091738	0.353004	1.885717	2.653779
10th	0.318607	0.449124	1.015461	1.185509	0.091950	0.352915	1.881557	2.606546
average	**0.28**	**0.41**	**0.85**	**0.93**	**0.07**	**0.30**	**1.62**	**2.54**

Sierra Leone

Table 4a, Test statistics of Sierra Leone reports from the co-integrating relationship is an indication that inflation and monetary aggregate were able to adjust to deviations from their long run paths within two quarters and establish statistical significance at 1% and 10% respectively excluding monetary policy and exchange rate. In the rest variables, absence of convergence within two quarters was established as specified structurally. The report in table 4b of correlation matrix implies the exchange rate establishes asymmetrical relationship with foreign interest rate, world oil price, fiscal policy, inflation, and monetary aggregate while growth rate and monetary policy found symmetrical correlation with exchange rate.

Table 4a-Sierra Leone: Test Statistics

	Foreign interest rate	World oil price	Fiscal policy	inflation	Growth rate	Money supply	Monetary policy	exchange rate
Co integrating equation	0.010227	-0.65414	0.123987	-0.74237	-0.04537	-0.03481	0.059385	0.505281
T- statistics	0.16590	-1.06388	0.25512	-5.17541	-0.15748	-0.52136	1.31635	1.03804
Adjust R^2	-0.73804	0.007111	-0.76747	0.212887	-0.7707	-0.73113	-0.49577	-0.05396

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Table 4b-Sierra Leone: correlation among reduced - form errors

	Foreign interest rate	World oil price	Fiscal policy	inflation	Growth rate	Money supply	Monetary policy	Exchange rate
Foreign interest rate	1	0.160407	0.424321	-0.0111	-0.28555	0.631953	-0.31937	-0.0368
Worldoilprice	0.160407	1	-0.25691	0.393707	-0.02209	0.326339	-0.0885	-0.13614
Fiscal policy	0.424321	-0.25691	1	-0.07047	-0.08307	0.221756	-0.08679	-0.19711
inflation	-0.0111	0.393707	-0.07047	1	-0.63766	-0.11674	0.136801	-0.08295
Growth rate	-0.28555	-0.02209	-0.08307	-0.63766	1	-0.05615	-0.08223	0.423731
Money supply	0.631953	0.326339	0.221756	-0.11674	-0.05615	1	-0.56277	0.216995
MonetaryPolicy	-0.31937	-0.0885	-0.08679	0.136801	-0.08223	-0.56277	1	-0.26128
exchange rate	-0.0368	-0.13614	-0.19711	-0.08295	0.423731	0.216995	-0.26128	1

From table 4c, the result of impulse response function of Sierra Leone data, it could be deduced that the impact of exchange rate on foreign interest rate is mixed without statistical significance while monetary policy reaction toward exchange rate shock is weak with symmetrical insignificance, that the appreciation of exchange rate here is too low to have an impact, climaxing at 0.08 at fifth period. The appreciation of exchange rate has non-statistical significance on growth rate because 0.11 at fourth period is the peak. The responses of fiscal policy and monetary aggregate to the shocks from exchange rate are negative over the ten periods less volatile and mild with monetary aggregate while in fiscal policy, it was volatile between second and fifth period after which the fluctuation was low with less effect. There is negative impact of exchange rate on oil price which indicates that depreciation of exchange rate accelerates increase in oil price in Sierra Leone. Variance decompositions are presented in table 4d-Sierra-Leone containing exchange rate shocks impact different macroeconomic variables. The variance decompositions are analysed using average outcomes over the ten periods. The most surprising is that exchange rate shocks account for a significant proportion of variation in inflation with rate shocks accounting for 10.13% apart from its own past innovations with 24% while proportion of variation in monetary aggregate is 2.82%. Exchange rate innovations account for less half percent of the shocks in the other variables such as foreign interest rate, fiscal policy, growth rate and monetary policy. The variance decomposition provides evidence of feedback from inflation to exchange rate, implying that inflation is caused by exchange rate.

Table 4c-Sierra Leone: Response of selected macro variables to Exchange Rate

Period	Foreign interest rate	World oil price	Fiscal policy	inflation	Growth rate	Money supply	Monetary policy	exchange rate
1st	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	4.478211
2nd	-0.010680	1.028143	-0.170527	0.968890	0.059314	-0.084169	0.048771	1.034194
3rd	-0.005035	0.322770	-0.234955	1.357114	0.083530	-0.136978	0.077924	1.807077
4th	-0.011316	-0.058461	-0.334083	1.929334	0.118566	-0.186490	0.106632	1.758047
5th	0.004899	-0.863130	-0.228520	1.282300	0.079341	-0.149615	0.083772	1.970001
6th	0.004192	-0.357180	-0.214576	1.182193	0.073124	-0.137902	0.077207	1.882807
7th	-0.001402	-0.061035	-0.199773	1.127215	0.069494	-0.120017	0.067855	1.914158
8th	-0.001466	-0.235631	-0.198200	1.113688	0.068655	-0.118545	0.067022	1.961989
9th	-0.001886	-0.038758	-0.216299	1.222589	0.075358	-0.129387	0.073202	1.866557
10th	-0.001916	-0.140899	-0.225367	1.274958	0.078589	-0.134999	0.076373	1.872515

Table 4d-Sierra Leone: Variance Decomposition of Real Exchange Rate

Period	Foreign interest rate	World oil price	Fiscal policy	inflation	Growth rate	Money supply	Monetary policy	exchange rate
1st	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	25.09650
2nd	0.004580	0.746679	0.018248	6.415940	0.006283	0.634885	0.080765	24.21445
3rd	0.003807	0.702249	0.035247	10.86915	0.012494	1.793239	0.193683	24.35171
4th	0.005485	0.600086	0.061239	14.25688	0.021952	3.185947	0.341667	23.47015
5th	0.004784	0.905697	0.062316	12.86062	0.022158	3.596297	0.376782	23.30560
6th	0.004240	0.873602	0.061733	11.93744	0.021720	3.803870	0.389165	23.31852
7th	0.003665	0.794113	0.060169	11.48960	0.021124	3.819415	0.383685	23.38368
8th	0.003233	0.755069	0.058898	11.19802	0.020621	3.815939	0.378024	23.38819
9th	0.002910	0.697680	0.058933	11.16102	0.020612	3.874776	0.379946	23.38231
10th	0.002651	0.657599	0.059464	11.18000	0.020785	3.956882	0.384972	23.35656
average	0.002	0.65	0.05	10.13	0.02	2.82	0.28	24

6. Conclusion

The outcomes of the study's examination revealed differences and similarities on their respective impact of exchange rate on macroeconomic variables among the four countries. The investigations revealed that monetary policy and money supply got adjusted to deviation from their long run paths within two quarters in Gambia, Ghana and Nigeria while exchange rate co-integrating relationship occurred in Gambia and Ghana. The correlation matrix disclosed mixed outcomes between exchange rate and macroeconomic variables selected among the countries where the symmetrical existence occurs between mostly Gambia and Ghana while moderate correlation occurred with Nigeria.

Impulse response function suggests that growth rate has positive responses symmetrically and mildly to exchange rate depreciation in the zone. Interestingly,

Ghanaian economy has distinctive features among the four economies in the zone where the selected macroeconomic variables reacted to exchange rate depreciation which is in line with theory. Gambia and Nigeria have econometrical symmetries in term of responses of foreign interest rate shock, world oil price shock inflation shocks, fiscal policy shock and monetary policy due to shocks in exchange rate depreciation in different magnitudes.

Furthermore, exchange rate depreciation influenced growth rate with little evidence in Ghana, Nigeria and Gambia more than Sierra Leone. The contribution of exchange rate depreciation to money supply and inflation is much in Sierra Leone when compared with other economies and more surprisingly, the past exchange rate influenced the current exchange rate strongly in Sierra Leone but moderately in other economies in the zone. However, entry into a currency union involves the loss of an independent exchange rate for both economies. This is likely to be more costly for Sierra Leone to have more bearing on the exchange rate under a common currency.

On the final note, for monetary union to be established, substantial positive correlations are good candidates. By the study's results which based on the mixed outcomes, it is wise to start with economies with moderate similarities which are the most promising countries such as Gambia, Ghana and Nigeria. It should be noted that credible institutions that can enhance effective surveillance with stringent rules towards imposing sanctions for non-compliance are strictly applied.

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