ESTIMATING EFFECTS OF NOMINAL EXCHANGE RATES AND OIL PRICE SHOCKS IN THE PRESENCE OF STRUCTURAL BREAKS

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Abstract

Macroeconomic stability is an objective emerging economy desired to achieve but oil price shocks and fluctuations in nominal exchange rates tend to restrain the ability of these economies to achieve such macroeconomic balance. Regrettably, exchange rates and oil price shocks are prone to have structural breaks in defined periods. We therefore, implemented a bivariate diagonal BEKK model, Zivot-Andrews and Bai-Perron breakpoint tests to evaluate the effect of exchange rates and oil price shocks in the presence of structural breaks on macroeconomic stability in developing countries. Break dates were observed for Benin Republic and Côte d'Ivoire between 1997M01 and 1996M09, Gambia in 2003M12, Niger in 2011M04, Ghana in 2000 and 2008, and Nigeria in 2020. All break dates were attributed to various causes including COVID-19 pandemic, the United States (US) invasion of Iraq in 2003, the US recession, and the Persian Gulf crisis. The findings showed variations in oil prices and exchange rates have a hostile impact on the level of the consumer price index (CPI) after controlling for structural breaks for all countries excluding Burkina Faso. Hence, shocks conveyed significant instability in the domestic price levels of Gambia, Benin, Niger, Ghana, and Nigeria. Models of inflation should be examined after controlling for external crises and structural breaks.

Keywords: Currency Values, Structural Breaks, Global Financial Crisis, Diagonal BEKK-GARCH Model, WAEMU

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1. INTRODUCTION

Macroeconomic stability is an objective emerging economy desired to achieve but oil price shocks and fluctuations in the nominal exchange rates tend to restrain the ability of these economies to achieve such macroeconomic balance. For instance, International Monetary Fund (IMF, 2022) noted that oil price shocks represent a direct fiscal restraint for emerging countries through fuel subsidies while the effects of such subsidies are unpopular. Also, Umoru (2022) noted that the increase in the pump price of fuel above 220 Nigerian naira (NGN, ₦) per litre and inflation rate above 16% had increased the rate of poverty in Nigeria and this situation is not different from all other African countries covered in this study as the restrictedness in their trading relationship with the advanced nations make emerging economies vulnerable to any shock from oil price and changes in the nominal exchange rate.

Oil prices are unstable and thus produce ripple effects from fluctuations, also referred to as shocks. When shocks emanate from fluctuating prices of crude oil, countries in the market would be required to adjust economic decisions and interact with the shocks due to the present indispensable nature of oil prices. Nonetheless, like other time series, exchange rates and oil price shocks are prone to have structural breaks in defined periods. Economies of various emerging African countries have over time been synonymous with falling currency values and also depend on crude oil either on the supply side or the demand side (Olayungbo & Umechukwu, 2022). For the supply side, oil-producing countries depend so much on oil and thus have their economies seemingly controlled by movements in the price of this commodity. On the demand side, most African countries rely on products from oil for energy with very minimal emphasis on sustainable energy sources such as wind. As a result, movement in prices also referred to as shocks, exerts a level of influence on economic indicators.

The oil market unlike other commodity markets has prices regulated by international forces rather than just local demand, supply and other related factors as in commodity markets. As a result, shocks that emanate from dynamic oil prices imposed on oil-exporting countries and oil-importing countries as well may have a significant influence on economic situations in such climates. Mordi and Adebiyi (2010) raise that in the event of rising oil price shocks for oil-importing countries, the cost of production rises, causing a decline in output to the extent to which demand is elastic and disposable income can stretch. More than the effect of oil price shocks on production and aggregate demand and income, there seems to be a relationship between these shocks and nominal exchange rates. Such a relationship could stem from the exchange of currencies in the imports and exports of oil. Oil is sold in barrels and prices are fixed at dollar per barrel. The fixed dollar denominations imply that African countries have to engage in foreign exchange transactions. The demand for local currencies in the foreign exchange market for most African countries is less than the dollar causing the value of these local currencies to be lower.

When oil prices increase, oil-importing countries would need to obtain more dollars or use more dollars increasing the demand for foreign currency for local ones. In return, local currencies might take a downward turn affecting macroeconomic conditions over time. Increased cost of production from rising input (oil) prices would lead to increased prices of output and less quantity produced, sponsoring inflationary pressures. In the advent of shocks from opposing movements, effects are expected to reverse with fewer units of local currencies purchasing oil. Cost of production and outputs are to fall, ceteris paribus with oil prices falling (Ouedraogo, 2013). While it is rational to assume that a one-dollar rise in oil prices would have the same magnitude of unfavourable reactions on a local economy as a one-dollar fall in oil prices, occurrences in the real world might differ because several factors determine the state of the macroeconomy. This state is referred to as asymmetrical reactions, in other words, non-equal or varied reactions from two opposing occurrences. For example, a movement in the oil price of $110 per barrel to $111 per barrel causes the exchange rate of NGN to move from ₦340 to ₦320 per USD. The asymmetrical reaction would be that movement in oil price from $110 per barrel to $109 per barrel will cause the exchange rate to rise from ₦340 per USD to ₦360 per USD. An asymmetrical reaction would mean that exchange rates can move to ₦385 per USD.

We attempted to examine the asymmetric effect of oil price shock and normal exchange rates on macroeconomic stability after controlling for structural breaks in Africa. Aside from asymmetry, economists have identified that there may be a sudden change in the pattern of relationships among time series and have termed such as structural breaks. In the influence of oil prices and exchange rates on macroeconomic stability, other factors such as COVID-19 that erupted at the end of 2019 could influence the behaviour of macroeconomic variables. This study is conducted to ascertain if there are structural breaks and asymmetry in the effects of nominal exchange rates and oil prices on macroeconomic stability in selected developing countries.

Studies previously conducted in this area either examined the asymmetric effect of oil prices on macroeconomic performance or the effect of exchange rates on economic growth for developed countries. No study has examined the asymmetric effect of oil price shock and normal exchange rate on macroeconomic stability at the same time for emerging nations. A gap, therefore, exists in this area. Moreover, the previous studies on developed countries generated inconsistent findings on the behaviour and significance of the impact of exchange rates and oil price shocks on macroeconomic stability. Hence, the need for this study. The study is significant because its empirical findings are useful to policymakers as these government functionaries would have our published findings as a reference for mathematical models of macroeconomic variables of study to be simulated before the actual implementation of monetary policies.

The research findings also add to the existing literature on the effects of shocks to global oil prices and nominal exchange rates on macroeconomic stability. In particular, the findings of this study provide empirical evidence on the behaviour of nominal exchange rate and oil price changes to

macroeconomic stability. This is beneficial to policymakers responsible for the growth and stability policies of emerging nations. The study also presents behavioural patterns of exchange rates and oil price shocks concerning structural breaks and the impact of this behaviour on respective African economies.

The remainder of this research work is composed as follows. Section 2 provides a review of recent literature on the macroeconomy effects of shocks to nominal exchange rates and oil prices. Section 3 is the methodology section which maps out how materials including research data were sourced and analysed to achieve study objectives. It also includes econometric models that were estimated. Section 4 had the results of each econometric technique presented in tables and discussed adequately in line with implications for policy making and monitoring. Recommendations and conclusions were outlined in Section 5 in line with study findings to improve the relevance of the work for monetary policy implementation.

2. LITERATURE REVIEW

The key concepts of this study, nominal exchange rates, oil price shocks and macroeconomic performance jointly resonate with the direct transmission channels hypothesis. This hypothesis is classified into three transmission channels that explain the relationship between oil prices and exchange rates. Habib et al. (2016) name them as the wealth effect, terms of trade and portfolio channels. For the terms of trade (TOT) transmission channel, oil prices influence the general price level of commodities obtainable in the country (inflation and consumer price index), in turn affecting the rate of currency concerning other currencies in real terms. Consequently, a country that is highly dependent on oil and imports would have costs related to energy consumption rise influencing prices of other commodities since the latter commodities depend on energy consumed in transportation and manufacturing costs. For oil-exporting countries, increased oil prices would mean more money from exports and could increase money in circulation raising price levels or disposable income in aggregate terms.

Wealth channel propagated by Golub (1983), imports and exports of oil facilitate wealth transfer from importing nation to the exporting one especially when oil prices rise. The transfer of wealth occurs in the currency of the exporting country or US dollars, the generally accepted standard foreign currency weakening the power of the importing country's local currency. The wealth channel is popularly adjoined with short-run effects. For a longer-term effect, the portfolio transmission channel by Krugman (1980) offers a theoretical explanation of the study variables. It explains that exporters of oil might prefer US dollars to local currencies for trade in oil for dollar investments, causing demand for the US dollars to rise against the demand for local currencies of both importing and exporting countries and vice versa. The study presupposes that this may be the case for African countries causing constant depreciation of local currencies.

Nominal exchange rates refer to regular spot rates applicable on the foreign exchange markets at a specific period that takes no cognisance future inflation. Dada and Oyeranti (2012) express that for developing countries, these rates of depreciation, and are controversial and sensitive because their economic environments are characterised by inadequate structures such as expansion or retraction of imports for proper transformation. Basing analysis on past and present exchange rate data about the Nigerian economy, Umoru (2022) noted that it was disappointing to see as of April 17, 2022, the naira exchanged at ₦600 to a dollar at the parallel market and ₦417 at the Nigerian Autonomous Foreign Exchange Market (AFEM) with a consequence of welfare of Nigerians. Yakub et al. (2019) employed monthly time series to examine the effect of volatility in the exchange rate on trade in Nigeria spanning 1997 to 2016 fiscal years. The generalized autoregressive conditional heteroskedasticity (GARCH) model measured volatility of nominal exchange rate volatility while autoregressive distributed lag (ARDL) bound testing was used to test the link between variables Granger causality was also employed to determine the causality directions of variables. A short-run relationship which by nature was negative was found between trade and exchange rate volatility but no relationship was found in the long run. The study recommended the intervention of the apex monetary authority in stabilizing the exchange rate market in the face of volatility.

Recently, Umoru et al. (2023b) reported that despite not being subjected to manipulations by individual nations, variability in oil prices generates shocks that other variables react to. In related research, Umoru et al. (2023e) established that fluctuations in exchange rates negatively impacted the emerging economies of Africa. Utilizing the nonlinear ARDL (NARDL) methodology, the authors established that 0.94, 0.85, and 0.91 devaluations of the nominal exchange rates in Nigeria, Malawi, and Zambia, surpassed 0.12, 0.10, and 0.17, appreciation respectively. Also, it has been documented empirically that the devaluation-oil price shock triggered by the COVID-19 contagion occasioned negative output growth rates in Ghana, Sierra Leone, Nigeria, and Gambia, respectively (Umoru et al., 2023c). Similarly, basing analysis on the Markov-regime switching estimates Umoru et al. (2023a) found that oil-producing and exporting countries have their exchange rates oscillate due to fluctuating oil prices. In what follows, Umoru et al. (2023d) reported that devaluation of the nominal exchange rate aggravates national inflation as nominal exchange rate movement results from price changes in trading economies. Akinlo and Onatunji (2020) used the ARDL bound testing approach for co-integration and error correction modelling techniques on panel data. They found that long-run link exists among variables in cross-sectional analysis. In addition, exchange rate instability was found to have a negative and significant effect on domestic investment in Guinea, Liberia Togo, Sierra Leone, Nigeria, Gambis, and Côte d'Ivoire. Morina et al. (2020) also studied the volatility of real exchange rates on economic growth in fourteen countries in Central and Eastern Europe for seventeen years. Using time series data, the fixed effects panel regression results established that real exchange rate movements had a significant and negative effect on economic growth.

Fofanah (2021) studied four countries in the West African Monetary Zone (WAMZ) to determine how economic growth is being affected by

the real exchange rate, exports and imports statistical tools used were Pearson correlations and random effects regression models. The results revealed a positive link between economic growth and each of the exports and imports nominal rates as independent variables. Nguse et al. (2021) examined the volatility of the exchange rates on international trade in Ethiopia from twenty-eight years till 2019. International trade was measured by trade openness. Control variables introduces into the regression model were gross domestic product (GDP), foreign direct investment (FDI) and inflation regression results revealed a significant but negative influence of exchange rate on trade. Its volatility, however, influenced international trade positively, long-run analysis using the ARDL model was also found to be positive and significant for study variables. With shocks that arise from adjustments of local currencies, prices as well as demand are impacted accordingly. Worse still is the impact of such adjustments on import-dependent economies common to most African countries. Oil prices fluctuate between periods and this fluctuation is uniform because prices are regulated and fixed by certain authorities and not just by mere demand and supply. As a result, a level of uncertainty is involved in the oil trade. The uncertainty in price movements makes shocks that emanate from changes have ripple effects on economies as not much is initially done to cushion the changing prices.

Olayungbo and Umechukwu (2022) examined the influence of oil price shocks on the economies of oil-exporting countries — Gabon, Egypt, Nigeria, and Algeria. The study used data from 1980Q1 to 2018Q4 analysed for stationarity, long-run relationship, weak exogeneity and persistence profile. The study also employed the vector autoregressive model. It was found that oil price shocks have significant asymmetric effects on the Algerian and Egyptian economies while this was null in Nigeria and Gabon. Jiang and Liu (2021) in their work examined the asymmetric effect of crude oil prices on capital markets. The authors used a NARDL model to determine impacts that had the probability of having different patterns of impact in the long and short-run. The study examined six international financial markets across China, the US, Hong Kong, Germany, the United Kingdom, and Japan using monthly data from January 2007 to March 2020. Oil price shocks were measured using Brent Crude and West Texas Intermediate (WTI) oil futures. Findings revealed that positive and negative price fluctuations of crude oil had significant asymmetric effects on stock prices in the four markets examined.

Ahmad et al. (2022) were broader in their measure of macroeconomic performance. They used inflation, exchange rate, GDP and interest rates as a proxy for macroeconomic performance and found the relationship of each to volatility in oil prices. Time series from eight Asian countries were analysed using vector autoregressive model (VAR). Results revealed that indicators of macroeconomic performance were highly affected by shocks from small fluctuations in oil prices. The variance decomposition of the study found that the macroeconomic impact of crude oil shocks was not uniform across sampled countries. According to Li et al. (2021), Helmi et al., (2023), Akinsola and Odhiambo (2020), and Baumeister and Hamilton (2019), the influence of oil price shocks on macroeconomic balance as measured by relevant variables exhibits time-varying characteristics. Basing findings on the NARDL model, Alenoghena and Aghughu (2022) reported an asymmetrical relationship between oil price volatility and economic stability for the Nigerian economy. Gylych et al. (2022) found that oil price changes greatly influenced the level of inflation in developing countries. Ouedraogo (2013) used the VAR model and found that the fluctuations in the world oil price negatively affected living costs. According to Dramani and Frimpong (2020), oil market shocks stimulate macroeconomic instability measured by inflationary trends in Ghana. Omolade et al. (2019) also reported significant output effects of oil price shocks in African countries based on structural VAR (SVAR). Umar and Chin (2018) reported that negative and positive oil price variations directly impacted Algeria, Angola, Libya, and Nigeria.

Hamilton (2008) argues that the multiplier effect of shocks from rising oil prices is more damaging than the favourable effect of equivalent shocks from falling oil prices. Hamilton (2008) reported that the effect of oil price shocks is asymmetric and dependent on the intensity of shocks and where it emanates from. This thought of Hamilton was a simple way to state that asymmetry exists in the effects of oil prices on macroeconomic performances. Oil price declines would increase real per capita income available to citizens of a country with a lower cost of production, transportation and other energy-related costs. However, a rise in real income may cause inflation from more money in circulation. On the more positive side, it could create more investments in the real sector if short-term interest rates are low. Devaluation of exchange rates in an import-dependent economy could also cause more reliance on locally produced goods since foreign goods will cost more than was obtainable before devaluation occurred. The increased demand for local goods and services could increase manufacturing output, especially in conditions of local sourcing of raw materials.

Dada and Oyeranti (2012) analysed the pattern of impact the exchange rate exerts on Nigeria's economy. Using time series yearly from 1970 to 2009, the study found no significant relationship between GDP and exchange rate in the country. The study also found that a relationship exists between monetary policies which the exchange rate is a part of, and oil exports after adopting VAR and simultaneous modelling. Mordi and Adebiyi (2010) employed the SVAR model in their research for Nigeria. Data spanned 1999M01 to 2008M12. Results provide evidence of the asymmetric effects of oil price shocks on output. In asymmetry, it was found that oil price decreases posed higher effects that an increase in the price. Besso and Feubi Pamen (2017) found that oil price shocks negatively impacted GDP growth in the long-run.

Riman et al. (2013) employed VAR in determining impulse responses of variables to shocks from changing oil prices in Nigeria. The study found that oil price shocks were significant inverse determinants of local investment and exchange rate movements. Kelikume (2017) analysed relevant data with a vector error correction model (VECM) to get impulse response functions (IRFs) for reactions of variables to shocks from oil and exchange rate. The IRFs were estimated from the VECM model. Findings revealed that shocks from the exchange rates and oil prices

influenced price levels positively. Zhang and Tu (2016) found that the impact of shocks from oil prices had no form of asymmetry in its impact on production in China though the impact was of a significant magnitude. In sum, there was no consensus on the findings of different studies and this limits the ability to infer conclusions on the effect of oil price shocks and exchange rates on macroeconomic stability. As a result, this study sought to empirically determine the effect of positive and negative values of these two variables (asymmetric effect) on the macroeconomic development of sampled countries. The study also extended the investigation of the macroeconomic relationship between structural breaks that characterise each oil price shock and exchange rates, and macroeconomic expansion.

3. RESEARCH METHODOLOGY

A structural break is a discontinuous shockwave that is unpredicted and causes sudden alteration over time in the estimated coefficients of regression models and this induces forecasting errors. Some breaks are endogenous while most often, breaks are exogenous to the model specification. There are different methods of testing for the presence or otherwise of a structural break in a model. These comprise the cumulative sum chart (CUSUM) test, the Chow test, the supremum-Wald (sup-Wald) test, the supremum-Lagrange multiplier (sup-LM) test, the supremum-Likelihood ratio (sup-LM) test, the Gregory-Hansen test, the Hatemi-J test, the Hansen and Nyblom test method, the MZ test, the Quandt likelihood ratio (QLR) test. Also, the Bayelsa VAR method, VAR-GARCH approach etc can be deployed in estimating the effects of exchange rates and oil price fluctuation on the macroeconomy. The methodology of the BEKK-GARCH model is applied in this research. The BEKK model is among the oldest and most popular multivariate GARCH models. We opted to implement the Zivot-Andrews and Bai-Perron methods to test for a unit root in the model should the case there exists a structural break because the Zivot-Andrews unit root test makes provision for at least one endogenously determined structural break while the Bai-Perron test is a test of multiple break points in the data generating process (DGP). Also, we utilized the BEKK-GARCH methodology to examine the shocks to oil prices and nominal exchange rates because the means and variances of exchange rates and oil prices as macro variables do vary over time, making the same mostly non-stationary variables. In this circumstance, estimation with the least squares method yields misleading and spurious findings. The multivariate BEKK-GARCH is simply an extension of univariate GARCH models (Tse & Tsui, 2002). To derive the BEKK model, we begin with the bi-variate mean equation:

$$M_t = \rho_1 + \rho_2 X_{t-1} + \varepsilon_t \quad (1)$$

$$X_t = \rho_3 + \rho_4 Y_{t-1} + \varepsilon_t \quad (2)$$

where, ρ_1 and ρ_3 are constant, ρ_2 and ρ_4 are the coefficients of X_1 and M_1. The error term ε_t is $\varepsilon_t = H^{1/2}(v_t)$, ε_t has the mean of zero and conditional variance H_t, v_t is white noise. The BEKK-GARCH model is then derived as the conditional variance-covariance equation given in Eq. (3) below:

$$H_t = Q + \sum_{i=1}^{p} E_i' \varepsilon_{t-i}' \varepsilon_{t-i} E_i + \sum_{j=1}^{q} W_j' H_{t-j} W_j \quad (3)$$

where, $Q = C'C$ is the constant, H_t is $r * c$ matrix, Q, E, and W are $r * c$ parameter matrices, E is the ARCH effect, W is the GARCH effect, p and q are the ARCH and GARCH orders respectively. Typically, $p = q = 1$, hence, the conditional variance-covariance equation and matrix form become:

$$H_t = Q + E_1' \varepsilon_{t-1}' \varepsilon_{t-1} E_1 + W' H_{t-1} W \quad (4)$$

$$H_t = \begin{pmatrix} c_{11} & c_{12} \\ 0 & c_{22} \end{pmatrix} + \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix}' \varepsilon_{t-1}' \varepsilon_{t-1} \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} + \begin{pmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{pmatrix}' H_{t-1}' \begin{pmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{pmatrix} \quad (5)$$

Equation (5) is the BEKK-GARCH (1,1) model. The matrix elements c_{11}, c_{12} and c_{22} are the constant coefficients. The elements a_{11}, a_{12} and a_{21}, a_{22} measures the effect of past shocks/news on X_t and Y_t on the conditional variance. The elements b_{11}, b_{12} and b_{21}, b_{22} captures the persistence of volatility in X_t and M_t. The diagonal BEKK-GARCH model is a restricted version of Eq. (4) where the off-diagonal components of the ARCH effect (a_{12}, a_{21}) and GARCH effect (b_{12}, b_{21}) are restricted to zero:

$$H_t = \begin{pmatrix} c_{11} & c_{12} \\ 0 & c_{22} \end{pmatrix} + \begin{pmatrix} a_{11} & 0 \\ 0 & a_{22} \end{pmatrix}' \varepsilon_{t-1}' \varepsilon_{t-1} \begin{pmatrix} a_{11} & 0 \\ 0 & a_{22} \end{pmatrix} + \begin{pmatrix} b_{11} & 0 \\ 0 & b_{22} \end{pmatrix}' H_{t-1}' \begin{pmatrix} b_{11} & 0 \\ 0 & b_{22} \end{pmatrix} \quad (6)$$

Thus, unlike the BEKK-GARCH model presented in Eq. (5), the restricted (diagonal) BEKK-GARCH model in Eq. (6) does not reveal the degree of volatility spillover that might exist between X_t and M_t. The specification of our model, therefore, centres on the specification of four mean equations presented as follows:

$$exr_t = \rho_1 + \rho_2 mep_{t-1} + \varepsilon_t \quad (7)$$

$$mep_t = \rho_3 + \rho_4 exr_{t-1} + \varepsilon_t \quad (8)$$

$$exr_t = \rho_1 + \rho_2 oilp_{t-1} + \varepsilon_t \quad (9)$$

$$mep_t = \rho_1 + \rho_2 oilp_{t-1} + \varepsilon_t \quad (10)$$

where, exr_t is the nominal exchange rate, mep_t is macroeconomic stability proxy as inflation rate, $oilp_t$ is the global average price of crude oil, per barrel. The diagonal BEKK-GARCH (1,1) model in matrix form in Eq. (6) is estimated separately for equations (7) and (8), and equations (9) and (10). The diagonal elements of the ARCH effect (a_{11}, a_{22}) measure the effects of the post-shock/news on each pair of bivariate variables in equations (6) and (7) on their current volatility respectively. Similarly, the diagonal elements of the GARCH effect (b_{11}, b_{22}) measure the persistence of volatility existing between the pair of bivariate variables in equations (8) and (9) respectively. The off-diagonal elements of the GARCH effect are assumed to be

zero, indicating no volatility transmission effect. Similarly, if the off-diagonal element of the ARCH effects is zero, indicating no spillover effect. That is, shock/news on the variables in the system does not spill over.

In this study, we conducted firstly, various unit root tests using the Zivot-Andrew breakpoint test, and augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. The study also proceeds to conduct the Bai-Perron breakpoint tests. Next, the study examines the multivariate ARCH test. The diagonal BEKK-GARCH model presented in Eq. (5) was estimated and the A and B matrices (which are the ARCH and GARCH effects) are interpreted. All estimations in the study were done using EViews 10. The member states of the West African Economic and Monetary Union (WAEMU) and WAMZ covered are based on data availability within the study framework. Regarding variables description and data, it suffices to clarify that macroeconomic performance was measured using the GDP growth rate because this indicator tends to be a more representative indicator of development. The data on the exchange rate and consumer price index (CPI) were obtained from the World Bank commodity index and IMF databases while data on oil prices were obtained from the Organization of the Petroleum Exporting Countries (OPEC). All variables are in log difference to ensure the stationarity of the series.

4. RESULTS AND DISCUSSION

Table 1 displayed the descriptive statistics. The mean value of the oil price is $50.06. Within the sample range, the highest average crude oil price is $132.83 and the minimum is $10.41. The standard deviation (a measure of variability) is 30.9. The mean CPI is highest for Nigeria, followed by Ghana and Côte d'Ivoire.

Table 1. Descriptive results

Variables	*Mean*	*Median*	*Maximum*	*Minimum*	*Std. dev.*	*Skewness*	*Kurtosis*
Average oil price	50.06	45.47	132.83	10.41	30.9	0.62	2.27
Nigeria_cpi	99.79	67.85	367.1	3.12	91.19	1.14	3.41
Niger_cpi	89.12	89.71	120.09	43.79	18.74	-0.64	2.74
Ghana_cpi	98.73	60.59	346.12	2.25	98.35	0.96	2.69
Gambia_cpi	92.67	83.14	199.98	39.12	45.09	0.68	2.38
Côte_d'Ivoire_cpi	89.41	91.15	119.74	43.56	20.87	-0.51	2.27
Burkina_Faso_cpi	89.07	89.36	117.51	48.2	18.74	-0.47	2.19
Benin_cpi	88.46	91.16	119.55	38.73	21.53	-0.64	2.55
Nigeria_exr	144.92	129.57	411.5	9.56	102.3	0.8	3.03
Niger_exr	536.7	538.84	768.85	246.2	100.32	-0.61	4.57
Ghana_exr	1.75	0.92	5.88	0.04	1.77	1.06	2.73
Gambia_exr	27.11	27.98	51.96	8.49	14.35	0.25	1.8
Côte_d'Ivoire_exr	536.7	538.84	768.85	346.2	10.32	-0.61	3.57
Burkina_Faso_exr	536.7	538.84	768.85	216.2	100.5	-0.31	2.17
Benin_exr	536.7	538.84	768.85	123.2	100.3	-0.21	3.57

Source: Authors' elaboration.

Ghana displayed the highest variability in CPI level followed by Nigeria and Gambia. The minimum CPI in Ghana seems to have the maximum and minimum CPI within the union. The mean value of the nominal exchange rate of domestic currency to a dollar is the highest for Nigeria among the WAEMU member states observed in this study. The mean variability is also highest for Nigeria followed by Gambia. Among the WAEMU member states, their mean value is 536.7 and a standard deviation of 100.3.

Table 2. ADF test results

Variables	*t-stat*	*p-value*	*t-stat*	*p-value*	*t-stat*	*p-value*
	Constant		*Constant and trend*		*None*	
Oil price	-12.41	0.00	-12.40	0.00	-12.41	0.00
Nigeria_exr	-18.01	0.00	-18.04	0.00	-17.76	0.00
Nigeria_cpi	-2.50	0.12	-2.41	0.37	-1.94	0.05
Niger_exr	-17.70	0.00	-17.74	0.00	-17.69	0.00
Niger_cpi	-13.53	0.00	-13.60	0.00	-13.30	0.00
Ghana_exr	-4.93	0.00	-5.32	0.00	-3.76	0.00
Ghana_cpi	-4.24	0.00	-5.48	0.00	-2.28	0.02
Gambia_exr	-4.29	0.00	-4.53	0.00	-3.80	0.00
Gambia_cpi	-8.35	0.00	-8.50	0.00	-1.92	0.05
Côte_d'Ivoire_exr	-17.70	0.00	-17.74	0.00	-17.69	0.00
Côte_d'Ivoire_cpi	-3.66	0.01	-4.70	0.00	-2.93	0.00
Burkina_Faso_exr	-17.70	0.00	-17.74	0.00	-17.69	0.00
Burkina_Faso_cpi	-4.80	0.00	-5.26	0.00	-3.62	0.00
Benin_exr	-17.70	0.00	-17.74	0.00	-17.69	0.00
Benin_cpi	-5.62	0.00	-6.04	0.00	-5.02	0.00

Source: Authors' elaboration.

Table 2 showed the unit root test for the various countries' exchange rates and CPI as well as oil prices. The variables are in log difference and we subject them to a unit root test to be sure no variable is stationary at the second difference. Oil price is stationary when we consider different data-generating processes. As for the consumer price index, all the countries are stationary for all the data generating process except for Nigeria is only stationary when no intercept and trend in the data generating process. The different countries' exchange rates are stationary at first difference.

Table 3 presents the Zivot-Andrews breakpoint test. The null hypothesis is that whenever there was a break date, the series is non-stationary. The alternative hypothesis is that the series with a given break date is stationary. The null hypothesis is accepted for oil prices and the Côte d'Ivoire CPI except for the 10% significance level for the oil prices.

Table 3. Zivot-Andrews breakpoint test, constant

Variables	*t-stat*	*Probability*	*Break date*
Oil price	-12.61	0.06	2008M08
Nigeria_exr	-18.18	0.02	1999M06
Niger_exr	-17.91	0.01	2000M11
Ghana_exr	-5.99	0.00	2000M09
Gambia_exr	-16.44	0.00	2003M11
Gambia_cpi	-11.38	0.00	2001M01
Côte_d'Ivoire_exr	-17.91	0.01	2000M11
Côte_d'Ivoire_cpi	-10.01	0.11	1998M07
Burkina_Faso_exr	-17.91	0.01	2000M11
Benin_exr	-17.91	0.01	2000M11

Source: Authors' elaboration.

Considering the data-generating process to have a trend, the null hypothesis is rejected for exchange rates among the WAEMU. For the WAMZ countries, we accepted the null and conclude these countries' exchange rates are non-stationary at given break dates.

Table 4. Zivot-Andrews breakpoint test, trend

Variables	*t-stat*	*Probability*	*Break date*
Oil price	-12.42	0.46	2004M04
Nigeria_exr	-18.08	0.14	2006M11
Nigeria_cpi	-10.33	0.08	1997M10
Niger_exr	-17.90	0.04	2003M02
Niger_cpi	-13.67	0.62	1999M02
Ghana_exr	-5.58	0.22	2004M08
Ghana_cpi	-7.99	0.51	2006M12
Gambia_exr	-15.96	0.30	2000M11
Gambia_cpi	-11.14	0.01	2003M01
Côte_d'Ivoire_exr	-17.90	0.04	2003M02
Côte_d'Ivoire_cpi	-9.95	0.70	1998M10
Burkina_Faso_exr	-17.90	0.04	2003M02
Burkina_Faso_cpi	-12.36	0.59	1999M01
Benin_exr	-17.90	0.04	2003M02
Benin_cpi	-16.70	1.00	1999M03

Source: Authors' elaboration.

Table 5 displays the Bai-Perron breakpoint test on the mean return equations. We varied the lag exchange rates and lag price levels for the respective countries. When both the country exchange rate and global oil price are controlled in examining macroeconomic stability, the break dates observed on the mean equation indicate Benin Republic and Côte d'Ivoire have break dates between 1997M01 and 1996M09. These break dates came after the Persian Gulf crisis which occurred in the 1990s and coincide with the Asian economic crisis. During the first gulf war, oil prices shot up drastically and the US enter into a recession. We observed no break point for the bivariate mean equations. For Niger, when varying the lag exchange rate, a breakpoint was observed for 2001M09 and no breakpoint for the second bivariate mean equation.

The Gambia has multiple breakpoints for both bi-variate equations. Varying the lag of the exchange rate, the Gambia break dates occurred in 2003M12 and 1999M07. Among the global crisis which occurred before this period is the US invasion of Iraq in 2003 after the September 11, 2001, attack. The break date for Côte d'Ivoire is in 2000M07. The breakpoint observed for Ghana is 2000M10, 2008M07 and 2009M02. The second mean equation break dates are 2000M11, 2001M01, and 2008M03. No breakpoint exists for Burkina Faso and Nigeria when varying the price level. As for the lag of exchange rate, break dates are observed for Nigeria in 1996M12 and no break date for Burkina Faso. Niger has a break date in 2011M04. The global crisis during the era was the uprising in Egypt and Libya. Ghana is the only country that experience break dates in 2000 and 2008 when controlling domestic prices and oil prices in examining the behaviour of the nominal exchange rates. These periods coincide with the US recessions in the 2000s and the 2008 global financial crisis. Except for Ghana which experienced break dates in 2008 and 2009, no other countries experienced break dates in this episode. These African countries were not immune to the financial and economic crisis.

Table 5. Bai-Perron breakpoint test results

Breaking variable	*Break dates*	*Break dates*
	_EXR(-1)	*_CPI(-1)*
Benin	Nil	Nil
Niger	2001M09	Nil
Gambia	2003M12, 1999M07, 1999M07, 2003M12	1999M09, 1999M09
Côte d'Ivoire	2000M07, 2000M07	Nil
Ghana	2009M02, 2000M10, 2000M10, 2008M07	2000M11, 2001M01,2008M03, 2008M03
Burkina Faso	Nil	Nil
Nigeria	1996M12, 1996M12	Nil

Source: Authors' elaboration.

Table 6 displays the diagonal BEKK-GARCH models for the member states of WAMZ sampled based on data availability within the sample range. The members are Gambia, Ghana, and Nigeria. The ARCH effect presented in Table 6 is the diagonal elements of the matrix which measured the effect of post-shock on the exchange rate and price level on the current volatility level. From Table 6, shock on the price level and exchange rate have a significant impact on the current volatility of the consumer price index. In other words, news on exchange rates and price levels posed significant instability in macroeconomic performance. Similarly, news on the exchange rates and price levels had a significant adverse impact on exchange rate volatility. This so indicates bidirectional causality between exchange rate and macroeconomic performance.

Table 6. Diagonal BEKK-GARCH models for WAMZ

Country	*Constant*	*Coefficient*		*z-statistic*	*Prob.*
Gambia	Constant	M (1,1)	0.00	20.00	0.00
		M (1,2)	0.00	10.00	0.76
		M (2,2)	0.02	10.01	0.05
	ARCH effect	A1 (1,1)	0.22	13.02	0.00
		A1 (2,2)	0.64	15.03	0.00
	GARCH effect	B1 (1,1)	0.97	6.00	0.00
		B1 (2,2)	0.85	8.01	0.00
Ghana	Constant	M (1,1)	-0.01	12.01	0.12
		M (1,2)	0.02	90.03	0.59
		M (2,2)	0.14	22.02	0.00
	ARCH effect	A1 (1,1)	0.19	24.02	0.00
		A1 (2,2)	0.95	25.05	0.00
	GARCH effect	B1 (1,1)	0.98	30.00	0.00
		B1 (2,2)	0.64	30.01	0.00
Nigeria	Constant	M (1,1)	0.00	18.00	0.72
		M (1,2)	0.14	11.53	0.80
		M (2,2)	33.81	27.81	0.00
	ARCH effect	A1 (1,1)	0.23	20.03	0.00
		A1 (2,2)	0.00	30.96	1.00
	GARCH effect	B1 (1,1)	0.97	30.01	0.00
		B1 (2,2)	0.65	52.10	0.00

Source: Authors' elaboration.

The BEKK-GARCH models of the member states of the WAEMU are presented in Table 7. Except for Burkina Faso, the impact of exchange rate news on CPI is statistically significant for Benin, Niger, and Côte d'Ivoire.

Table 7. Diagonal BEKK-GARCH models for WAEMU

Country	*Constant*	*Coefficient*		*z-statistic*	*Prob.*
Benin	Constant	M (1,1)	0.19	1.73	0.00
		M (1,2)	0.57	20.48	0.00
		M (2,2)	5.01	20.34	0.00
	ARCH effect	A1 (1,1)	0.21	22.70	0.00
		A1 (2,2)	0.00	30.04	0.00
	GARCH effect	B1 (1,1)	0.93	26.24	0.00
		B1 (2,2)	0.86	19.86	0.00
Niger	Constant	M (1,1)	0.45	3.06	0.00
		M (1,2)	0.32	5.72	0.00
		M (2,2)	4.85	6.28	0.00
	ARCH effect	A1 (1,1)	0.47	8.42	0.00
		A1 (2,2)	0.00	4.00	0.00
	GARCH effect	B1 (1,1)	0.77	13.81	0.00
		B1 (2,2)	0.86	11.62	0.00
Burkina Faso	Constant	M (1,1)	0.00	0.36	0.72
		M (1,2)	0.14	0.36	0.72
		M (2,2)	5.73	0.39	0.70
	ARCH effect	A1 (1,1)	0.00	0.00	1.00
		A1 (2,2)	0.00	0.00	1.00
	GARCH effect	B1 (1,1)	1.00	149.95	0.00
		B1 (2,2)	0.83	1.76	0.08
Côte d'Ivoire	Constant	M (1,1)	0.10	4.41	0.00
		M (1,2)	0.32	`10.95	0.00
		M (2,2)	4.30	23.45	0.00
	ARCH effect	A1 (1,1)	0.36	6.36	0.00
		A1 (2,2)	-0.02	-9.23	0.00
	GARCH effect	B1 (1,1)	0.87	37.88	0.00
		B1 (2,2)	0.88	3.02	0.00

Source: Authors' elaboration.

On the extent of persistency on the volatility level in response to previous conditional variance, it is very much significant for consumer price level and that of the exchange rate. This implies the current volatility of the CPI and exchange rates are quite responsive significantly to the previous month's volatility. For Ghana, news on exchange rates and price levels poses significant macroeconomic instability in Ghana same way news on the exchange rates and price levels have a significant impact on exchange rate volatility. The current volatility of the CPI and exchange rates are quite responsive significantly to the previous month's volatility. The same finding obtains to Gambia. News or shock on consumer price does pose a significant impact on the current volatility of the consumer price index. A similar observation has been observed for Gambia and Ghana. The persistency of the conditional variance is significant. However, the News on the exchange rate does not have a significant impact on current volatility. This indicates unlike other member states of WAMZ, Nigeria's current volatility of the nominal exchange rate is irresponsive to previous market news on exchange rates.

The volatility of the CPI and exchange rate for each country in WAMZ is presented in Figure 1.

The volatility of the CPI in Nigeria does not exhibit volatility clustering. However, the intensity has decreased over time. Though there were some pockets of spikes in volatility in the early 2000s. The exchange rate volatility does not exhibit volatility clustering as well nevertheless, the volatility movement seems to have maintained a regular trajectory. Ghana's CPI has had an irregular spike within the first half of the sample. Significant spikes were recorded between 1995 and 2000. Though, there is no volatility clustering. The exchange rate for Ghana has had a series of spikes in the volatility level and a significant volatility clustering is evident in the first part and last part of the entire period.

The Gambia CPI has had downward irregular spikes in the volatility level. Overall, the volatility level decreased but has gained increasing uncertainty from 2020 onward. The exchange rate volatility has had significant spikes in certain periods, the volatility clustering seems to be significant and strong. The WAEMU CPI and exchange rate volatility is displayed in Figures 2 and 3. The Côte d'Ivoire CPI volatility seems to be high between 1995 and 2000. The volatility level seems to be moderate in the mid-period and the later period. Also, for Niger, the CPI exhibits volatility clustering in a few instances. Also, several spikes in volatility are recorded within the study period.

Burkina Faso and Benin consumer price indices do not pose any significant volatility clustering. Though, both countries experience significant spikes in the early periods. For Burkina Faso, several other significant spikes took place. The members' states of WAEMU adopt a common currency. These countries' exchange rates have had a similar pattern in exchange rate volatilities. The reason is that WAEMU is a currency union where all the member states adopt a single currency known as the "franc CFA". The trends in CPI for each country and the oil price is presented in Figure A.1. The CPI for all the countries has a positive trend. Though there are pockets of mild fluctuations in Niger, Burkina Faso, Côte d'Ivoire and Benin. These countries form the WAEMU. The oil price has a positive trend before the global financial crisis. After the deep in oil prices during the heat of the financial crisis in 2008, the oil price upward movement resumed. Another deep in the price happens during the COVID-19 pandemic.

The trend in the exchange rates for each country is presented in Figure A.2. Overall, the exchange rate movement in Nigeria is generally upward trending. Notice, there were few incidences of spikes in the rate. These spikes are akin to depreciation. Nigeria practices a dirty float exchange rate regime. This gives room to the monetary authority to adjust the market rates when the domestic currency is overvalued. Ghana and Gambia, the same members of WAMZ also possess an upward trend in the countries' exchange rates. Ghana, the country recently adopts a flexible exchange rate regime. Since 1957, the countries have experimented series of different exchange rate regimes. The same history of exchange rate management applies to Nigeria and Gambia. As for other countries in the WAEMU, their exchange rate regime is pegged to CFA France.

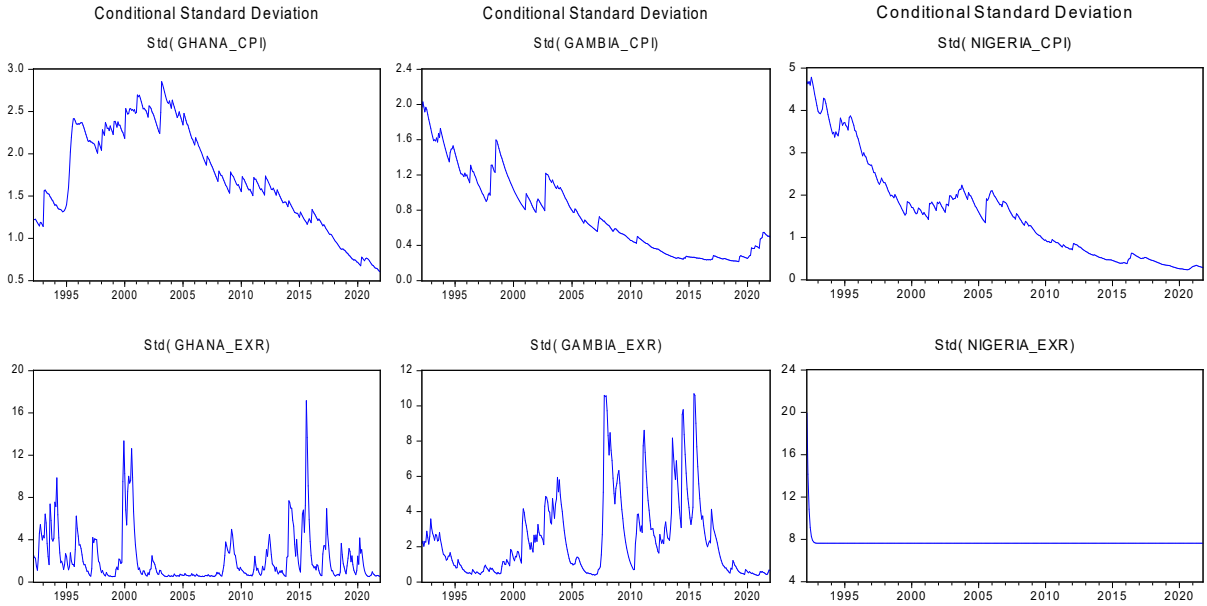
Figure A.3 displays the model residuals for all the countries. The model residuals for the CPI model in Niger, Burkina Faso, Benin, Gambia and Côte d'Ivoire fall within the homoscedastic range. Though there are few instances of a spike in the residuals. For these same countries, the exchange rate models have homoscedastic residuals. Ghana and Nigeria consumer prices model residuals are heteroscedastic. Gambia residuals for the CPI model, in most instances, are stable within the homoscedastic range. As for the exchange rate model, Ghana and Gambia residuals tends to be heteroscedastic given the significant spikes. In Nigeria's case, the model residuals are homoscedastic. In sum, the study established the stability of macroeconomic performance in Burkina Faso. This implies, domestic and global economic crises do not pose instability in the mean equation specification for the aforesaid country. The inference is of policy relevance and does not require policy adjustment in any case of major events within the study period. When shocks are explained by changes in nominal exchange rates and oil prices in the mean equation, the estimate is stable for all other countries except Ghana and Nigeria. Knowledge of economic crisis is to be considered when drawing inferences for the case of Ghana and Nigeria. In effect, Nigeria and Ghana's exchange rates model should be examined after controlling for an external economic crisis.

The study observed, shock on the innovation from the mean equation obtained using a nominal exchange rate and oil prices have a meaningful impact on macroeconomic stability, which in this case is measured by domestic price level. The implication is that instability in the price can be linked to shocks in the exchange rate and oil price innovations. The central bankers have among other core mandates, the need for price stability. As shown, this macroeconomic stability can be attained if the monetary authority insulates the domestic economy from shocks to oil prices and exchange rate movements. The findings emanating from the member states of WAEMU indicated the uncertainties in macroeconomic performance are influenced by previous news on exchange rate movements and changes in global oil market prices. There is a need for exchange rates to be healthily anchored on prevailing domestic prices to achieve market value and woe investors into these emerging economies. The reason is that when an exchange rate is irresponsive to market shocks, investors may perceive the market value of the domestic currency might be overvalued or undervalued. Besides, in WAMZ, Nigeria which is a major oil-producing economy, and other countries are major importers of refined crude oil. Any shock to oil prices and exchange rates pass-through to the domestic price level thus hampering the macroeconomic stability of these countries.

Many countries in West Africa have had to battle with insecurity. Among the WAMZ members' states, Nigeria is the worst hit by insecurity. The channelling of resources to maintain security is an attempt to improve macroeconomic stability. Unfortunately, such investment in security has crowded out investment in key sectors of the economies. These countries need to invest in infrastructure to cover the infrastructural gaps which are hampering the growth and stability of these countries. With the recent economic crisis, as with the 2020 COVID-19 lockdown and

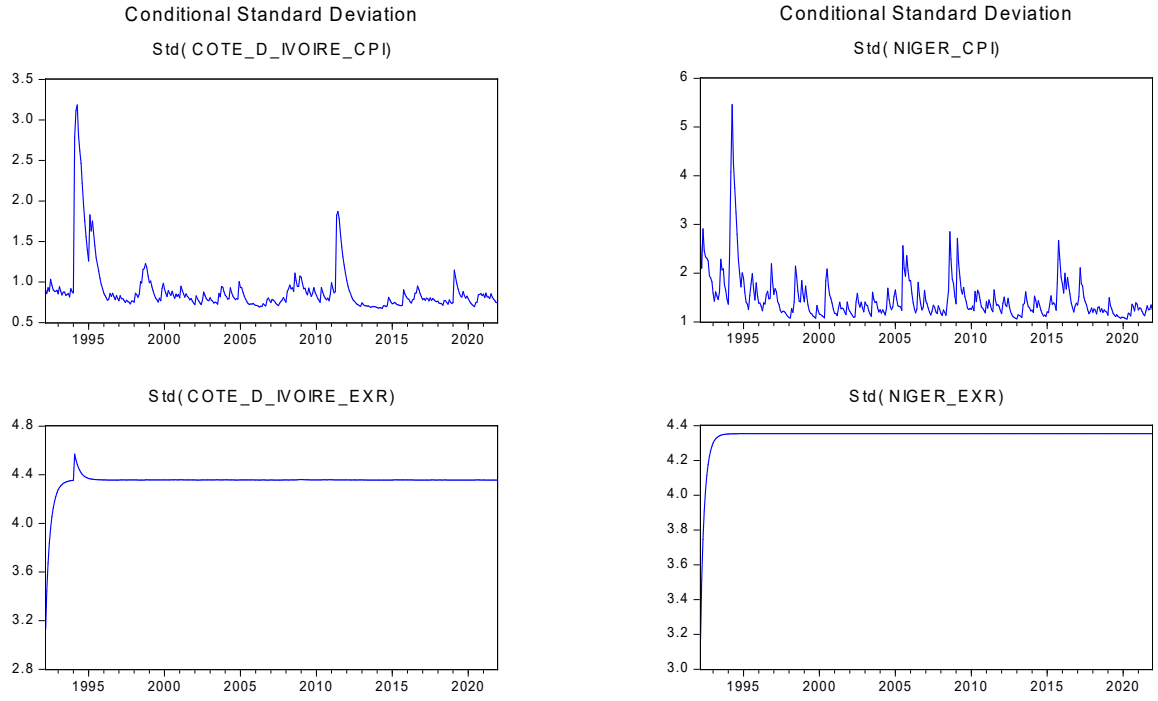
the Russian-Ukraine war, the World Bank and IMF have downgraded macroeconomic performance and stability in these countries and the decade-old achievement in poverty reductions had been reversed. The same applies to the price stabilization policies pursued by these countries. The Russian-Ukraine war created an increase in global prices and worsened price instability in Africa.

Figure 1. The volatility of the exchange rate and CPI in WAMZ



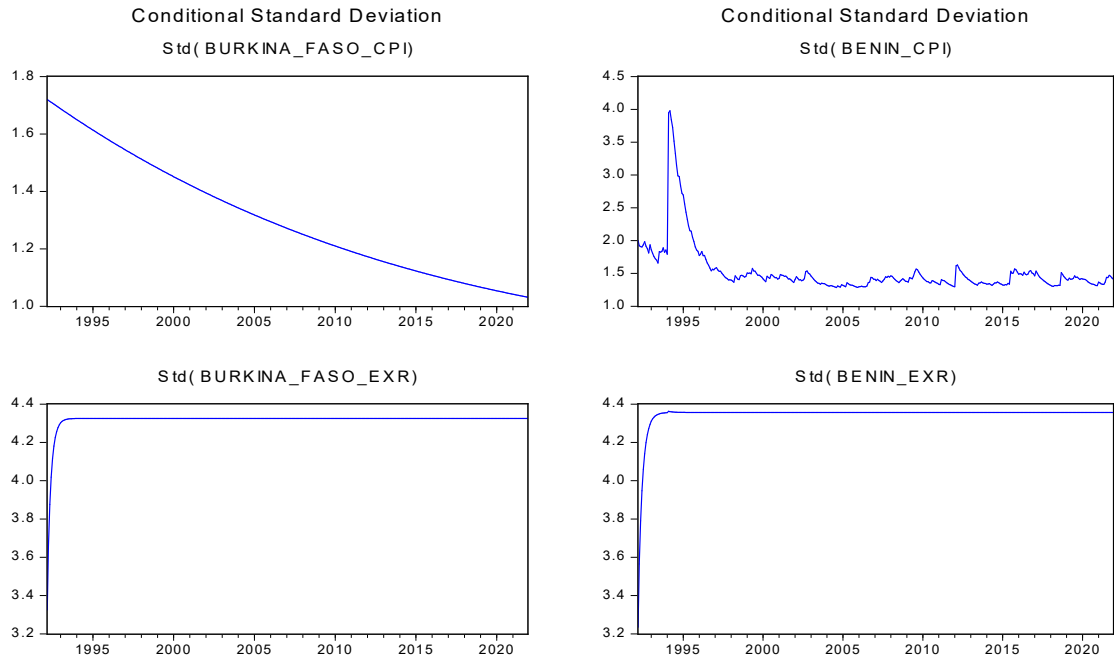
Source: Authors' elaboration.

Figure 2. Volatility of exchange rate and CPI in WAEMU



Source: Authors' elaboration.

Figure 3. Volatility of exchange rate and CPI in WAEMU continuation



Source: Authors' elaboration.

5. CONCLUSION

This research implements monthly data from February 1992 to December 2022 excluding holidays to examine the asymmetrical effect of nominal exchange rates and global oil price movements on macroeconomic stability in WAMZ countries given the presence of structural breaks. Zivot-Andrews breakpoint test, ADF test, PP test, and Bai-Perron breakpoint tests were all conducted to assess structural breaks in nominal exchange rates. A bivariate diagonal BEKK-GARCH model was adopted to examine the relationships between exchange rates, CPI and oil prices. The sampled countries are Gambia, Burkina Faso, Benin, Nigeria, Niger, Ghana and Côte d'Ivoire. The countries formed the Economic Community of West African States (ECOWAS) member states and were grouped as WAMZ and WAEMU. The findings showed member states of WAMZ responded significantly to changes in the global oil price index and to shocks in exchange rate volatility. Volatility was found to be highly persistent for all the countries within the monetary zone. Uncertainties in macroeconomic performance in these countries are significantly influenced by past shocks on inflation rates and exchange rates. The implication of this is current macroeconomic uncertainties are tied to market news on global oil market prices and exchange rate movements in these countries. Break dates were observed for Benin Republic and Côte d'Ivoire between 1997M01 and 1996M09. The observed break dates could be attributed to the Persian Gulf crisis of the 1990s which overlapped with the Asian economic crisis. Accordingly, at the instance of the first gulf war, oil prices skyrocketed which saw the US sliding into recession. Also, the break date was found for Gambia in 2003M12. The US invasion of Iraq in 2003 was one of the notable global catastrophes that ensued. This could be responsible for the Gambian break dates that occurred in the twelfth month of 2003.

Niger had a break date in 2011M04. The global crisis during the era was the uprising in Egypt and Libya. Ghana is the only country that experience break dates in 2000 and 2008 when controlling domestic prices and oil prices in examining the exchange rates. These periods coincide with the US recession in the 2000s and the 2008 global financial crisis. Countries like Burkina Faso did not experience break dates. Nigeria also had break dates in 2020. This was attributed to the COVID-19 pandemic. Current uncertainties in exchange rates in Nigeria are significantly induced by global shocks. This could be explaining the fact that Nigeria does not have one official exchange rate. Several exchange rates exist as in the case of the Bureau de Change, interbank exchange rates, and official exchange rates. There is a need for exchange rates in Nigeria to be well anchored on prevailing domestic prices to achieve market value and woe investors into the economy.

The persistence of the volatility of exchange rates is significant for all countries except Burkina Faso and Niger. Regional integration can be threatened by increased instability due to an increase in macroeconomic instability. To enhance regional trade and boost countries' macroeconomic stability, exchange rate stability is required to weaken currency fluctuations and their negative impact on the macroeconomic performance of these countries. Macroeconomic stability can be attained if the monetary authority insulates the domestic economy from shocks to oil prices and exchange rate movements. Besides Nigeria which is a major oil-producing economy, other countries of West Africa are major importers of refined crude oil. Any shock to oil prices and exchange rates pass-through to the domestic price level thus hampering the macroeconomic stability of these countries.

Given that most of the WAMZ countries are highly dependent on energy, the government can influence stability in these economies by implementing strong monetary policies to mitigate global shocks on oil prices. There is a strong need for harmonization of monetary policies among the member of the monetary zone and effective inflation anchoring to mitigate the impact of bad news on worsening macroeconomic instability in these countries. For the fact that our sample was limited by the data available to us on the countries enlisted, we recommend that further researchers replicate this study for a larger sample of emerging countries using other advanced econometric techniques of analysis such as the global VAR methodology.

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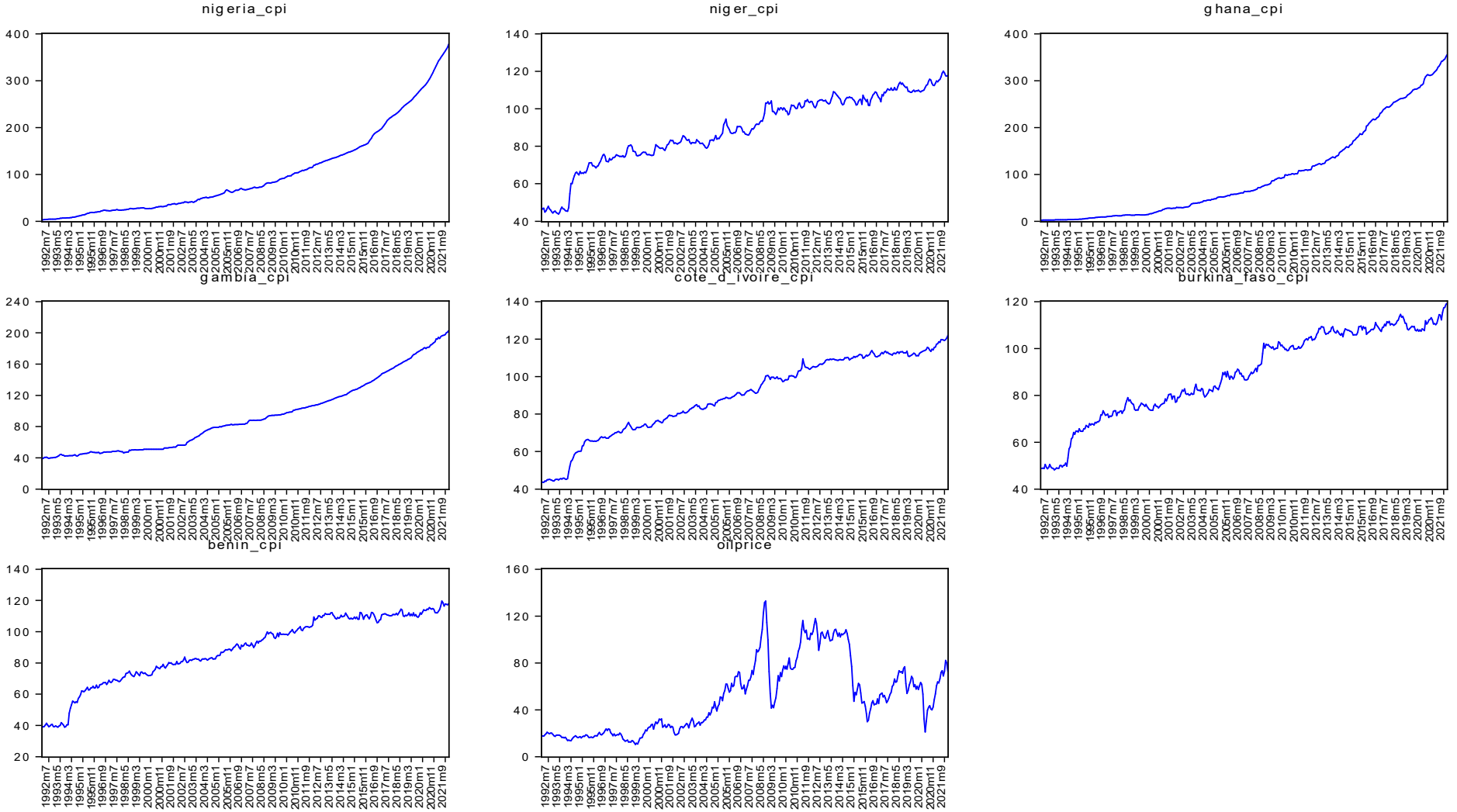
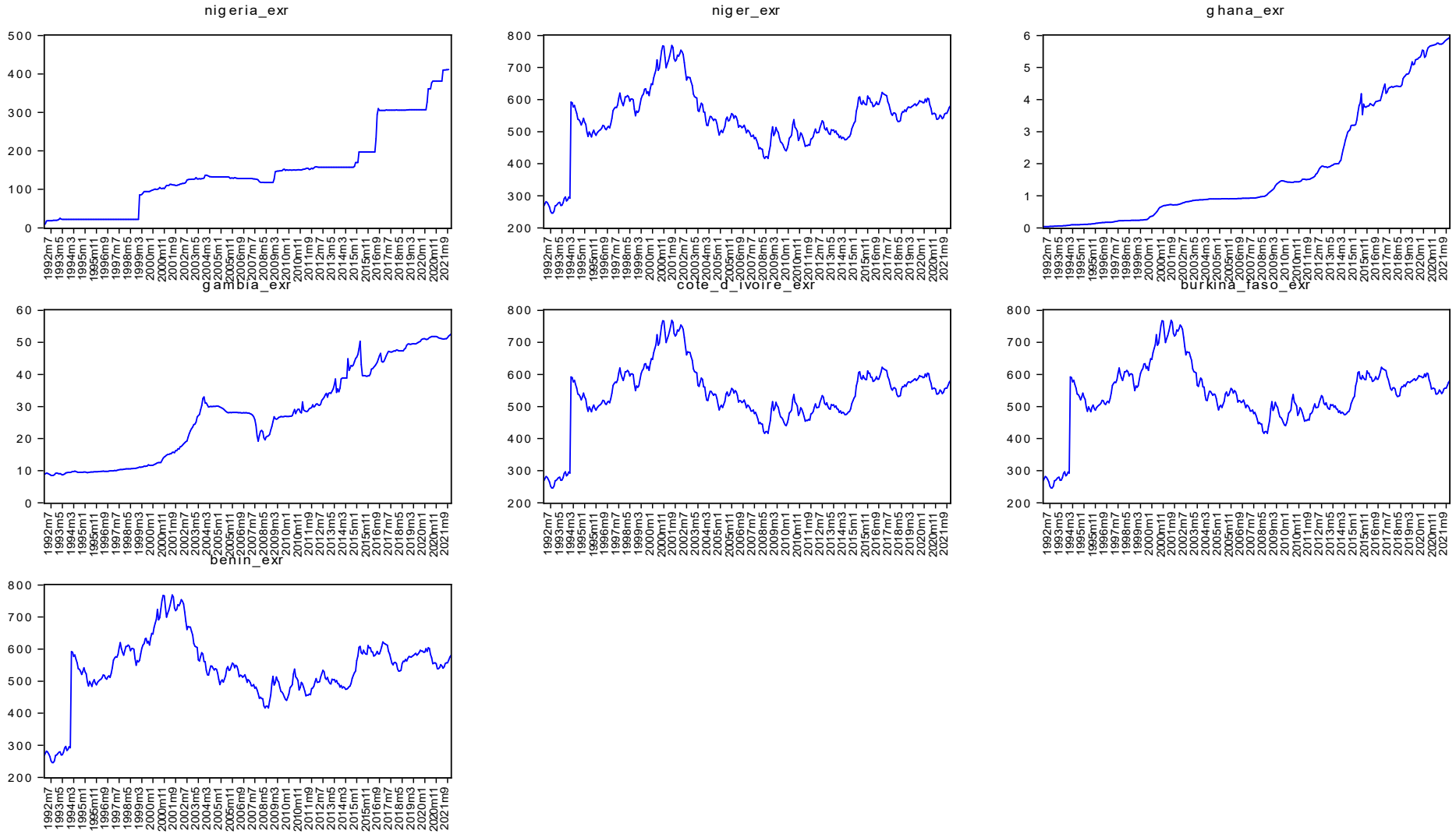
APPENDIX

Figure A.1. Trends in inflation and global average crude oil price



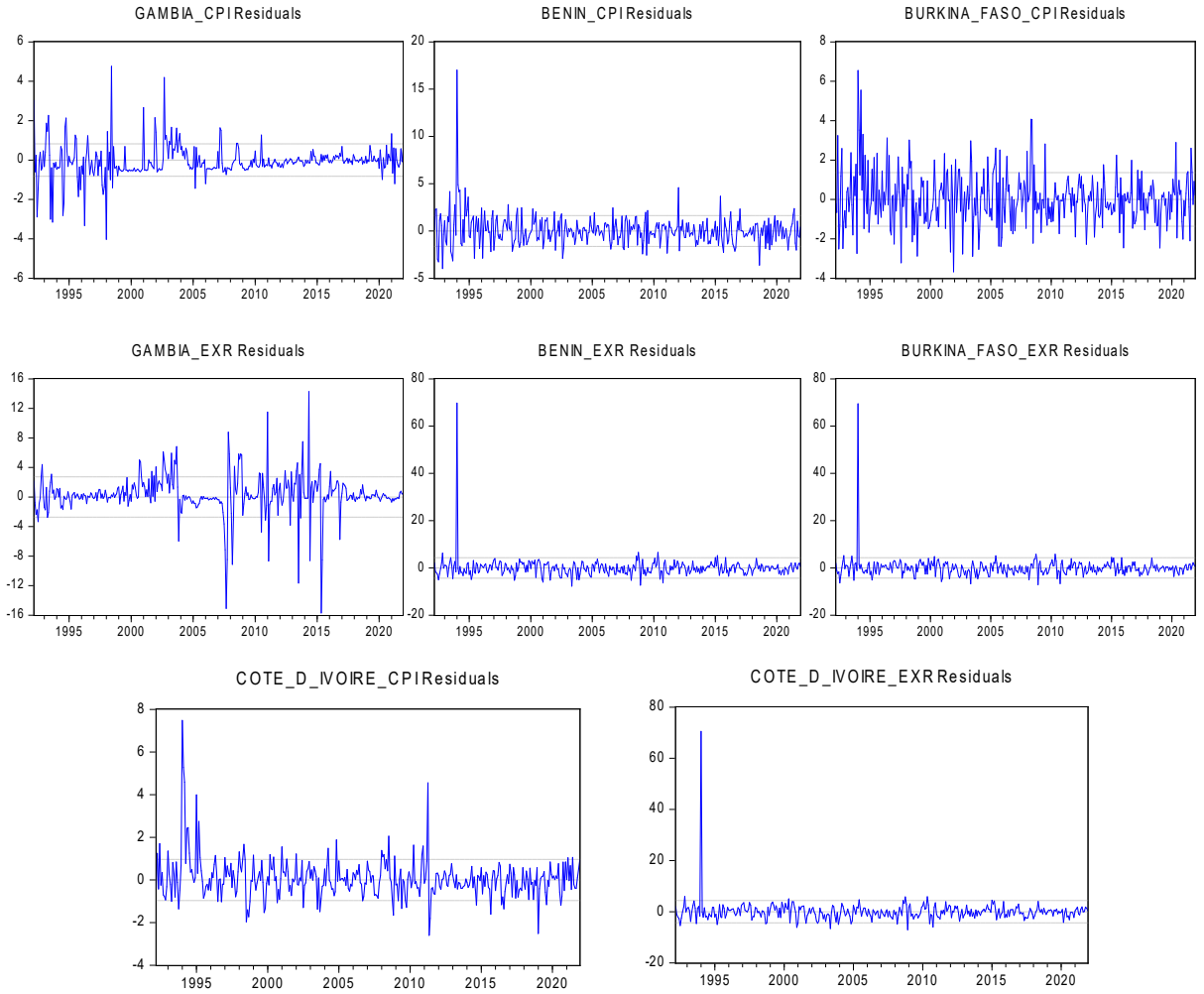
Source: Authors' elaboration.

Figure A.2. Trends in nominal exchange rates



Source: Authors' elaboration.

Figure A.3. Trends in nominal exchange rates continuation



Source: Authors' elaboration.