Factors Responsible for Movements in Real Effective Exchange Rate of Selected African Countries

Abstract

The study examined the determinants of real effective exchange rate on selected African countries, namely, Nigeria, Libya, Angola, Egypt, Gabon, Ghana, and Chad over the sample period of 1980 to 2023. The vector error correction methodology was used in the study. The results suggest the following findings; In Nigeria, variations in the real effective exchange rate responded significantly and positively to Brent crude oil prices, domestic inflation rate, external debt burden, the volume of foreign exchange reserves, and prices of primary export. It also responded negatively to foreign investment flows. Whenever the real effective exchange rate deviated from its equilibrium, 74% of its disequilibrium was restored in Nigeria. In Libya, the response of real effective exchange rate was positive and significantly related to commodity prices of primary export but responded negatively and significantly to Brent crude oil prices, foreign investment inward stock, and foreign reserve holdings. In addition, 57% of the disequilibrium in the real effective exchange rate of the Libya currency was restored to the long-term value. In Angola, it was found that the variations in the real effective exchange rate had a positive and significant response with Brent crude oil prices and foreign investment inflows. It however responded negatively with a significance balance of payments and the volume of foreign reserves. About 60% of the disequilibrium in the real effective exchange rate was restored to the long-term value in Angola. In Egypt, the real effective exchange rate responded positively with significance to Brent crude oil prices, foreign investment inflows, and prices of primary export. Additionally, it responded negatively and significantly to the domestic inflation rate and external reserve holdings. Within the period of study in Egypt, 53% of the disequilibrium in the real effective exchange rate was restored to equilibrium. In Gabon, variations in the real effective exchange rate had a positive and significant response with Brent crude oil prices, real interest rate, external debt burden, and the volume of foreign exchange reserves. Also in Gabon, the real effective exchange rate responded negatively and significantly to the inflation rate and prices of primary export. Accordingly, 82% of the disequilibrium in the real effective exchange rate was restored to equilibrium. The Ghanaian real effective exchange rate relative to the dollar responded significantly and positively to Brent crude oil prices, domestic inflation rate, foreign debt burden, and foreign investment flows while it negatively responded to the Ghanaian balance of payment position. Each time the real effective exchange rate of the Ghanaian cedi deviated from its equilibrium value, 79% of its disequilibrium was restored. In Chad, variations in the real effective exchange rate responded significantly but negatively to the domestic inflation rate while it positively and significantly responded to Brent crude oil prices, external balance position, the volume of foreign reserve holdings, and foreign direct investment inflows. Also, whenever the real effective exchange rate deviated from its equilibrium value in Chad, 65% of its disequilibrium was restored in the long run. Based on these results, policymakers should focus on addressing structural constraints, commodity price fluctuations, and improve the business environment by anchoring policies of economic stability to boost competitiveness in trade and industry. There is also the need for policymakers to consider country-specific factors when formulating exchange rates.

Key Words: *Commodity price level, the volume of foreign exchange reserves, balance of payments position, foreign direct investment inflows, external debt burden,*

JEL Classification: E51, F31, F32

1. Introduction

Understanding the determinants of the real effective exchange rate (reer) is essential for policymakers and researchers to develop effective currency foreign exchange rate policies, foster sustainable growth in global trade, and enhance economic integration in African countries. Exploring the factors that influence the reer in African economies provides valuable insights into the dynamics of their exchange rates and their broader economic performance. African countries, including Nigeria, Libya, Angola, Egypt, Gabon, Ghana, and Chad, often heavily rely on the export of primary commodities, particularly oil and minerals. The *reer* dynamics in these countries are closely linked to fluctuations in commodity prices, such as oil price shocks (Farhad et al. 2019). Researching the relationship between the *reer* and these commodities can help identify vulnerabilities and develop strategies for economic diversification. The *reer* stability therefore works to stabilize all these sectors. The fluctuations in the *reer* of the above-mentioned African countries can have significant implications for their economic stability, trade competitiveness, and policy formulation. Therefore, by investigating the factors that influence the *reer*, this study aims to contribute to a deeper understanding of the macroeconomic dynamics and challenges faced by these countries and provide insights for policymakers in managing their exchange rate regimes effectively. Countries have to depend on each other for fluent import and export duties; each country has its natural resources blessed by nature. The interdependence among the world's economies brought about by cross-border trade in goods and services has amounted to the rise of the real effective exchange rate (Bah & Amusa, 2004).

The *reer* affects foreign trade flows in the sense that an over-valued real exchange rate will tend to favor imports more than exports of goods and services. This leads to poor performance in the export sector. Consequently, the trade deficit is reflected in the balance of payments account showing a net outflow of foreign exchange. The negative balance of payment implies that government has to borrow abroad to finance the deficit and this increases indebtedness. An over-valued real exchange rate also negatively affects domestic production and employment, whilst encouraging consumption of foreign goods (Morina et al. 2020). Given that exchange rate fluctuations impact various macroeconomic variables such as inflation, interest rates, and productivity growth, a stable reer contributes to price stability, facilitates investment, and fosters sustainable economic growth. Besides, a study on the determinants of the *reer* can assist policymakers in formulating effective monetary, fiscal, and exchange rate policies to maintain macroeconomic stability in these African countries. Hence, the relevant research question is as follows, what are the factors that determine the *reer* in Nigeria, Libya, Angola, Egypt, Gabon, Ghana, and Chad? The broad objective of this study is to examine the factors that determine the real effective exchange rate in Nigeria, Libya, Angola, Egypt, Gabon, Ghana, and Chad.

The significance of the study lies in its potential contributions to the understanding of the determinants of the *reer* in Nigeria, Libya, Angola, Egypt, Gabon, Ghana, and Chad. By examining the factors that influence the *reer* and their implications for economic stability, trade competitiveness, and policy formulation, this study offers several important contributions. This study adds to the existing body of literature on exchange rate dynamics in African countries, particularly focusing on the selected countries. By empirically investigating the determinants of the *reer* using the vector error correction model (VECM) estimation method, it provides new insights and empirical evidence on the relationship between inflation rate, productivity growth, interest rate, oil price shocks, and the *reer* in these economies. The research contributes to policy relevance. The findings of this study hold practical implications for policymakers in the selected African countries. By identifying the key determinants of the *reer* and their impact on economic stability, trade competitiveness, and policy formulation, policymakers can make informed decisions regarding exchange rate management, economic diversification, and strategies to enhance competitiveness in the global market. The study's policy recommendations can help guide policymakers in formulating effective exchange rate policies and promoting sustainable economic development. Researching on the determinants of the *reer* is fundamental for promoting economic development and stability in African countries. By examining the relationship between inflation rate, productivity growth, interest rate, oil price shocks, and the *reer*, this study contributes to the formulation of effective economic policies, including those related to inflation targeting, monetary policy, investment promotion, and economic diversification. The findings can inform policy decisions, promote economic stability, foster diversification, strengthen trade competitiveness, and facilitate regional integration, ultimately contributing to sustainable economic growth and development in the African continent. The study is divided into five chapters. Section 1 discusses the study's introduction and gives a background to the study it also highlights the aim and objectives of the study. Section 2 reviews related and relevant literature. Section 3 describes the research methodology i.e. the techniques and methods which will be used in carrying out this analysis of data for the study. Section 4 gives the study's analysis and interpretation of findings. The study concludes with section 5 which attends to the summary of findings, conclusion, and recommendations.

2. Survey of Relevant Literature

In Malaysia, Sadia, et al (2009) found the lending rate and inflation were considerable determinants of the volatility in reer in the short-term while in the long-term, GDP deflator, total export/GDP ratio, and domestic inflation rate were the significant drivers of volatility in the reer. In Croatia, Bošnjak, et al. (2021) found significant connection between reer and industrial productivity basing estimation on the Wavelet Coherence method. The study by Ogundipe & Lawal (2014) employs an econometric approach to analyze the relationship between the reer and various macroeconomic variables. The study covers the period from 1980 to 2012 and utilizes the Autoregressive Distributed Lag (ARDL) bounds testing approach to estimate the long-run relationship between the reer and its determinants. The empirical analysis incorporates variables such as terms of trade, government consumption expenditure, FDI, and domestic investment. The findings of the study indicate that the terms of trade, which represent the ratio of export prices to import prices, have a significant impact on the reer. A positive change in the terms of trade leads to an appreciation of the reer, suggesting that improvements in export prices relative to import prices contribute to currency appreciation. Furthermore, the study finds that government consumption expenditure has a negative relationship with the reer. An increase in government consumption expenditure led to a depreciation of the reer, indicating that higher government spending relative to the private sector can exert pressure on the exchange rate. The study also reveals that FDI and domestic investment play important roles in determining the reer. Higher FDI and domestic investment contributed to an appreciation of the reer, suggesting that increased investment inflows can strengthen the value of the domestic currency. Overall, the study provides valuable insights into the determinants of the reer in Nigeria. The findings suggest that policies aimed at improving the terms of trade, promoting export diversification, attracting FDI, and managing government consumption expenditure can have significant implications for exchange rate stability in the country.

In Libya, Ben-Naser et al. (2019) estimated the equilibrium real exchange rate and misalignment in an oil-exporting country. The study utilized annual data covering the period (1975-2015). After testing for stationarity of time series using ADF and PP, this study applied the co-integration technique to investigate the long relationship between the exchange rate and its fundamentals. Then, it performed the vector error correction model (VECM) to compare long-run and short relationships, supported by impulse response functions. The main findings of this study were as follows. First, real oil prices and real relative productivity contributed significantly to the determination of the real exchange rate. The model had a degree of openness because the Libyan authorities applied intensive restrictions to restrict external trade for a long time. Second, the results of the VECM technique revealed that the speed of adjustment is 4.5 years for a half-life to return to the actual level of the exchange rate to the equilibrium path. In addition, the results from the impulse response functions (IRFs) found that the real exchange rate responds positively to the shocks in real oil prices and real relative productivity, whereas it responds negatively to the shocks in openness. Finally, the real exchange rate for the Libyan economy was reported by the study to be recently overvalued by more than 40%. In addition, the authors reported significant overvaluation/undervaluation of the Libyan Dinar. Such considerable misalignments in the real exchange rate of the Libyan Dinar over a long time drove away non-oil exports and inflows of foreign investments. This study suggests to the monetary authorities of Libya (Central Bank of Libya) to greatly regard the misalignments of the Libyan exchange rate, and implement a proper policy to keep the exchange rate reasonably close to what fundamentals suggest. Also, policymakers should reduce the money supply and execute a managed floating exchange rate policy.

Hadood & Saleh (2022) established that amongst the considerable factors, namely, MS/GDP ratio, trade balance, inflation ratio, oil revenues, oil revenues was the greatest variable that provided the most significant prediction of the exchange rate of Libya to the USD. On the relationship between oil price volatility and the real exchange rate in India over a sample period of 1/7/2009 to 1/2/2020, the Granger causality, FEVD, ARDL Bound test, and IRF were deployed by Nazar & Ashok (2023). According to Nazar & Ashok (2023), a strong causality runs from the variations in oil prices to real effective exchange rates. Specific terms, the Rupee-Dollar exchange rate devaluated as a result of one standard deviation shock in oil prices. In Egypt, Abdelgany (2020) utilized time-series data spanning from 1990 to 2018 and employs the ARDL to estimate the long-term relationship of the determinants of reer. For the short-term relationship, the ECM method was used, and the statistical program Eviews was applied for modeling. The descriptive method was also employed to gain insights into the exchange rate movement and other variables involved in the study. The findings of the study revealed that foreign exchange reserves and broad money have a significant and positive impact on the real exchange rate in the long run. Additionally, trade openness and foreign exchange reserves significantly and positively influenced the real exchange rate in the short run. The study also indicates that if the real exchange rate deviates from its equilibrium, it takes approximately 21 months to return to balance. In their final analysis, the research suggests that Egypt did not fully implement a floating exchange rate system, as announced in January 2003 and November 2016. Instead, it appears to have adopted a managed float regime, aligning with the results reported in the research of Massoud & Willett (2014), Kenny (2019), Cizmović, et al. (2021), Lanau (2017), Bhattarai & Ben-Naser (2020), Mohd et al. (2022), Lothian, & Taylor (1996), and Mark (1990).

In Ghana, Adu et al (2019) examined the effects of exchange rate volatility on real estate prices in developing economies. This study aimed to find out whether exchange rate volatility affects real estate domestic house prices in Ghana. Secondary data from 32 years from the World Development Indicators (WDI) and data from real estate developers in Ghana were utilized in the course of the study. The study made use of ARDL Bounds testing of co-integration to test the null hypothesis that exchange rate volatility has no impact on real estate housing prices. The study found that real estate price was co-integrated with remittances, exchange rate, and inflation. The long-run equilibrium was stable and significant. Exchange rates do not cause changes in real estate prices in both the short and long run. Similarly, past prices of real estate do not have an impact on current house prices. Rather, remittances positively affected real estate prices. Inflation on its part had a negative impact on real estate prices. It was therefore concluded that volatility in the exchange rate between the cedi and other trading currencies does not predict changes in real estate prices. The research by Samuel (2020) established the significant Granger-causality between real GDP exchange rate in Ghana. Samuel (2020) investigated the impact of macroeconomic variables on exchange rate movements in Ghana. This study examines how macroeconomic variables affected exchange rate movements in Ghana and sought to analyze the effect of exchange rate movements on Ghana's economy (macroeconomic variables). It investigated the relationship these variables have in determining the stability of the foreign exchange rate in Ghana, that is, the pricing of the Ghanaian domestic currency relative to the dollar in the context of macroeconomic variables. This study used empirical data of selected macroeconomic variables from Ghana and employs econometric modeling techniques to arrive at findings. The selected economic variables are lending interest rates, FDI, imports, exports, GDP, and inflation. Interest rates and inflation rates were found to have strong, positive correlations. Yet the study failed to establish a direct causal relationship between these two variables. The study established that BoPs had a positive, significant influence on the exchange rate of the country. This was an indication that a balance of payment deficit would induce a depreciation of the local currency to foreign trading partners' currencies. This means the exchange rate will fall. Should the country record a balance of payments surplus, the exchange rate will rise. FDI was found to have a positive influence on the exchange rate of a country. This meant that the volume of investments made by foreign investors really influence the exchange rate of Ghana. On the other hand, the lending interest rate and GDP have negative impacts on the Ghana's exchange rate. This implied that when the interest rate was high, the exchange rate fell and the Ghana cedi depreciated against foreign currencies. Finally, though much controversy exists in literature about the exact relationship between GDP and exchange rate, the study found that GDP negatively influenced the Ghanaian exchange rate.

The study by Yusuf (2019) established that foreign reserves, exports of oil and non-oil products, inflation, GDP growth, and interest rates are the drivers of official exchange rates, while the parallel (black market) exchange rate is stimulated by inflation, and non-oil exports in Nigeria. In Chad, Kouladoum et al. (2019) deployed the generalized method of moment to a study of the determinants of the real exchange rate. Findings from the analysis show that external debt positively and significantly affected the real exchange rate at a 5% significant level. Domestic investment had a negative but insignificant effect on the real exchange rate. This was linked to the costly and lengthy procedure involved in the creation of enterprises. Also, the research established that money supply had a positive but insignificant effect on real exchange rate which was explained by the fact that commercial banks were facing over liquidity in an environment of credit rationing. The degree of economic openness was observed to have a positive but insignificant effect on real exchange rates. Such a finding was attributed to the restricted environment of the Chadian economy and the lack of diversification of trading partners as well as exports. The debt servicing variable had a negative and significant impact on the real exchange rate. The study provides recommendations to public authorities in charge of policy execution to reduce debt stock levels while keeping an efficient debt management policy.

Kataria, & Gupta (2018) researched the determinants of real effective exchange rates in emerging market economies using quarterly data to examine the effect of global and domestic factors on the *reer* for 20 emerging market economies from 2000-2015. The research found that GDP growth and the domestic policy interest rate were robustly associated with *reer* appreciation in emerging economies. Among global factors, an increase in global risk was negatively related to the real exchange rate, while the Brent crude oil price was positively related to the real exchange rate. The overall positive effect of crude oil price was more pronounced for the *reer* of oil-exporting countries, and negative for oil-importing countries. The study also finds that a relatively flexible exchange rate regime reduces the negative impact of global risk on *reer*, but capital account openness does not seem to play a significant role.

Goda & Priewe (2020) also researched the determinants of real exchange rate movements in 15 emerging market economies and established that an appreciation of the *reer* contributes to premature deindustrialization, less productive investment, and dependence on commodity booms and busts in emerging markets economies (EME). The analysis shows that although "commodity" and "industrial" EME are heterogeneous, reer volatility tends to be higher among the former. EMEs that had more stable *reer* performed better than those that had a depreciating or appreciating trend with the notable exception of China. As theoretically expected, commodity prices are an important structural driver of reer movements in "commodity EME". Additionally, the results confirm the existence of the Harrod-Balassa-Samuelson effect and show the importance of financial inflows. Further, the interventions of central banks were partially successful to avoid more substantial appreciations and depreciations. Finally, the research finds that lower country risk and, at least in some periods, growing broad money stock in OECD countries have led to *reer* appreciations in the sampled countries. From the literature, it is less clear, however, what the most important drivers for the cyclical *reer* movements in EME are.

3. Methodology and Data

The present research is theoretically guided by the purchasing power parity theorem (PPP). This is because the behavior of the *reer* is intimately related to the behavior of deviations from PPP. According to the PPP theory, nominal exchange rates adjust to offset changes in relative prices, so that the *reer* can remain at a constant value. However, there is now widespread agreement that there is no equilibrium value to which the *reer* tends to return. In empirical studies, many authors cannot reject the null hypothesis that reer follow a random walk process (Frenkel 1981, Krugman (1978), and Bahmani-Oskooee & Gelan 2018). Thus, changes in the *reer* are considered permanent. Froot & Rogoff (1995) have reviewed a large and growing literature that tests PPP and other models of long-run real exchange rates. They distinguish three different stages of PPP testing but conclude that the real exchange rate appears stationary over sufficiently long horizons. In addition, they also reviewed the Balassa-Samuelson hypothesis.

The methodology of vector error correction modeling was adopted in this study. We specified the VECM model in difference to explain short-run behavior of our variables. The VECM model specification captures the error correction coefficient together with co-integrating equation which explains the long-run behavior of the variables. Equation (1) below provides the general specification of the VECM.

$$\Delta x_t = \phi + \Gamma X_{t-1} + \sum_{i=1}^{\rho-1} \Im_i \Delta x_{t-i} + e_t \qquad (1)$$

$$\Rightarrow \Delta x_t = \phi + \Gamma X_{t-1} + \Im_1 \Delta x_{t-1} + \Im_2 \Delta x_{t-2} + \Im_3 \Delta x_{t-3} + \ldots + \Im_{\rho-1} \Delta x_{t-(\rho-1)} + e_t \qquad (2)$$

In what follows, the above VAR model with endogenous variables can be specified in VECM representation as.

$$\begin{aligned}\Delta x_t = \phi + \Gamma X_{t-1} + \Im_1 \Delta x_{t-1} + \Im_2 \Delta x_{t-2} + \Im_3 \Delta x_{t-3} + \Im_4 \Delta x_{t-4} \\ + \Im_5 \Delta x_{t-5} + \ldots + \Im_6 \Delta x_{t-6} + \Im_7 \Delta x_{t-7} + \Im_8 \Delta x_{t-8} + e_t\end{aligned} \qquad (3)$$

Where $\Delta x_t = \begin{bmatrix} Y_t - Y_{t-1} \\ Z_t - Z_{t-1} \end{bmatrix} = \begin{bmatrix} \Delta y_t \\ \Delta z_t \end{bmatrix}$

ϕ is the vector of regression constants in the VECM, $\Im_1, \Im_2, \Im_3, \Im_4, \Im_5, \Im_6, \Im_7, \Im_8$ are the short-run coefficients, $\Delta x_{t-1}, \Delta x_{t-2}, \Delta x_{t-3}, \Delta x_{t-4}, \Delta x_{t-5}, \Delta x_{t-6}, \Delta x_{t-7}, \Delta x_{t-8}$ are the lagged differences that measure short-run impact of the variables, and e_t is the vector of VECM impulse, Γ is the rank of matrix which captures the number of co-integrating vectors denoted by r. Consider that in this research, co-integration exists such that $0 < r < K$, it thus implies that,

$$\Gamma = \delta \gamma^! \qquad (4)$$

Where, δ is the vector of adjustment coefficients with the dimension $(K \times r)$, γ is the vector of co-integrating relationships which gives long-term coefficients. It has a dimension of $(K \times r)$. In effect, Γ is a $(K \times K)$ matrix. In the simplest VECM representation,

$$\Gamma = \delta \gamma^!$$

$$\Gamma = \begin{bmatrix} \delta_1 \\ \delta_2 \end{bmatrix} \begin{bmatrix} \gamma_1 & \gamma_2 \end{bmatrix} \qquad (5)$$

In all, with our VECM, the study estimated the following coefficients,

i. Short-run coefficients
ii. Long-term coefficients
iii. Short-term adjustment coefficients popularly referred to as the error correction term (ect).

Accordingly, we estimated the VECM using the technique of the OLS. The choice of OLS is guided by the fact that it has optimal properties which include linearity, sufficiency, least variance, and mean square error. These desirable properties of estimators can be obtained from any technique but the minimum variance property distinguishes the OLS estimator as the best when compared with other linear neutral estimators from econometric techniques. This particular property of the smallest variance is the reason for the applicability of the OLS method. The model of this study is in line with the study of Cashin et al. (2004), who evaluated the effect of commodity currencies and the real exchange rate and also the study of Adusei & Gyapong (2017). In particular, the researchers deem it fit to model reer the specific objectives of this study by introducing inflation rate (infr), balance of payments (bop), lending interest rate (lnr), Brent oil prices (boilp), external debt burden (edb), commodity prices (compr), foreign direct investment (fdi), and foreign exchange reserves (fexcr) into the adopted mode for study.

$$reer = f(infr, bop, lnr, boilp, compr, edb, fdi, fexrv) \quad (7)$$

Econometrically the model is defined accordingly as

$$reer = \beta_0 + \beta_1 infr_t + \beta_2 bop_t + \beta_3 lnr_t + \beta_4 boilp_t + \beta_5 compr_t + \beta_6 edb_t + \beta_5 fdi_t + \beta_7 fexrv_t + ut \quad (8)$$

The empirical VECM version of equation (8) that was estimated for each country included in the study can be specified as.

$$\Delta reer_t = \delta_1 + \delta_2 reer_{t-i} + \delta_3 \ln bop_{t-i} + \delta_4 \ln lnr_{t-i} + \delta_5 \ln boilp_{t-i} + \delta_6 \ln compr_{t-i} + \delta_7 \ln edb_{t-i} + \delta_8 \ln fdi_{t-i} + \delta_9 \ln fexrv_{t-i} + \sum_{i=1}^{p} \gamma_1 \Delta reer_{t-i} + \sum_{i=1}^{q} \gamma_2 \Delta \ln bop_{t-i} + \sum_{i=1}^{q} \gamma_3 \Delta \ln lnr_{t-i} + \sum_{i=1}^{q} \gamma_4 \Delta \ln boilp_{t-i} + \sum_{i=1}^{p} \gamma_5 \Delta compr_{t-i} + \sum_{i=1}^{q} \gamma_6 \Delta \ln edb_{t-i} + \sum_{i=1}^{q} \gamma_7 \Delta \ln fdi_{t-i} + \sum_{i=1}^{p} \gamma_8 \Delta fexrv_{t-i} + \varepsilon_{1t} \quad (9)$$

The *reer* is calculated by adjusting the nominal exchange rate based on the relative price levels of domestic and foreign goods and services. This adjustment reflects a country's competitiveness compared to the rest of the world. The current year's inflation rate was calculated as the average weighted cost of commodity basket divided by the same basket from the previous period. The real interest rate was calculated as the lending interest rate adjusted for inflation using the GDP deflator. The balance of payments was calculated as the sum of the balances in the capital, current and financial accounts of each country. The Brent crude oil price index was calculated as the average price of trading 600,000 barrels on the 25-day Brent Blend, Forties, Oseberg, Ekofisk (BFOE) market. Commodity prices were calculated as the UNCTAD commodity price index which is a measure of the prices of primary commodities exported by developing economies. External debt burden was measured as the sum total of each country's foreign debts, and the interest payments on the protracted debts. FDI stock was calculated in USD as a share of each country's GDP, the sum of all foreign investors' equity in and net loans to the reporting economy. The volume of foreign exchange reserves were measured as the sum of all foreign currencies held by the central bank of each of the country in our sample.

4. Results and Discussion

Table 1. Analysis of Descriptive Statistics for Nigeria

Statistics	reer	infr	bop	lnr	boilp

Mean	29.23722	3.814211	91.78458	-1.173728	18.18476
Median	14.30650	4.204831	21.89526	1.227719	13.00697
Maximum	120.8352	25.00724	425.9792	18.18000	72.83550
Minimum	3.771340	-13.12788	0.546781	-65.85715	3.457650
Std. Dev.	28.49720	6.223279	115.8329	13.83677	15.17752
Skewness	1.255441	0.148951	1.302508	-2.273768	2.010072
Kurtosis	3.916413	5.277634	3.872064	10.66625	6.342209
Jarque-Bera	15.77709	11.65197	16.66542	175.4555	60.35798
Probability	0.000375	0.002950	0.000241	0.000000	0.000000
Sum	1549.573	202.1522	4864.583	-62.20759	963.7923
Sum Sq. Dev.	42228.70	2013.919	697698.0	9955.719	11978.56

Table 1 contd. Analysis of Descriptive Statistics for Nigeria

Statistics	compr	edb	fdi	fexrv
Mean	12.26661	276.2054	219.2449	111.1770
Median	12.09861	319.3659	110.8596	101.5648
Maximum	40.90678	732.7234	732.7234	224.3545
Minimum	0.570452	6.933292	49.77631	-10.97666
Std. Dev.	8.039494	251.5889	204.7639	64.52774
Skewness	0.944023	0.240350	1.295216	-0.008092
Kurtosis	4.512544	1.494377	3.213905	2.055481
Jarque-Bera	12.92429	5.516357	14.91970	1.970668
Probability	0.001561	0.063407	0.000576	0.373314
Sum	650.1304	14638.89	11619.98	5892.378
Sum Sq. Dev.	3360.941	3291443.	2180270.	216586.2

Source: E-Views 9 Output

Table 1 shows the descriptive statistics for Nigeria. The mean *reer* is 29.24, indicating the average real exchange rate. The median is 14.31, suggesting that the distribution of reer is positively skewed. The minimum value is 3.77, and the maximum value is 120.84, indicating a wide range of reer. The standard deviation is 28.50, indicating significant variability in the data. The mean inflation rate is 3.81%, representing the average annual growth rate. The median is 4.20%, indicating that the majority of observations have a growth rate around this value. The minimum value is -13.13%, indicating negative inflation, while the maximum value is 25.01%, indicating high positive growth. The standard deviation is 6.22, indicating a moderate amount of variability in the rates of domestic inflation.

The mean bop is 91.78, representing the average value. The median is 21.90, suggesting a positively skewed distribution. The minimum and maximum values indicate a wide range of exchange rates. The standard deviation is 115.83, indicating substantial variability in the exchange rates. The mean Brent oil price is 18.18%, indicating the average oil price. The median is 13.01%, suggesting a positively skewed distribution. The minimum and maximum values suggest a wide range of inflation rates. The standard deviation of Brent oil price is 15.18, indicating moderate variability in oil prices. The mean real interest rate is -1.17%, indicating an average negative interest rate. The median is 1.23%, suggesting a negatively skewed distribution. The minimum value is -65.86%, indicating a very low or negative interest rate. The maximum value is 18.18%, indicating a relatively high positive real interest rate. The standard deviation is

13.84, indicating significant variability in interest rates. The mean commodity price is 12.27, representing the average price value. The median is 12.10, indicating a nearly symmetrical distribution. The minimum and maximum values indicate a wide range of commodity prices. The standard deviation is 8.04, indicating moderate variability in commodity prices. The mean external debt burden is 276.21, representing the average burden. The median is 319.37, suggesting a positively skewed distribution. The minimum value is 6.93, indicating a low debt burden. The maximum value is 732.72, indicating highest debt burden. The standard deviation is 251.59, indicating substantial variability in the foreign debt burden.

The average fdi/GDP ratio is 219.24. The median is 110.86, suggesting a positively skewed distribution. The minimum and maximum values indicate a wide range of exchange rates. The standard deviation is 204.76, indicating significant variability in real effective exchange rates. The mean foreign exchange reserve volume is 111.18, representing the average value. The median is 101.56, indicating a positively skewed distribution. The minimum value is -10.98, suggesting a possible negative volume of foreign exchange reserve holding. The maximum value is 224.35, indicating a high positive volume of foreign exchange reserves. The standard deviation is 64.53, indicating moderate variability in the volume of foreign exchange reserves. Overall, these descriptive statistics provide insights into the central tendency, variability, skewness, and kurtosis of each variable. They give an overview of the average values, ranges, and distribution shapes, allowing for a better understanding of the data distribution and potential patterns or outliers.

Table 2. Analysis of Descriptive Statistics for Libya

statistics	reer	fdi	edb	infr	compr
Mean	38.85501	0.851460	119.5029	6.742134	16.60540
Median	23.04659	0.436800	34.22134	6.059804	2.181490
Maximum	225.2161	4.813175	987.0000	41.43573	478.2631
Minimum	-1.527100	0.280728	-111.8051	-9.797647	-50.33852
Std. Dev.	58.14026	0.894745	231.2992	9.187545	73.75870
Skewness	2.608335	2.946523	2.275293	1.410125	5.021350
Kurtosis	8.238333	13.14095	7.459965	6.440479	30.72115
Jarque-Bera	120.6938	303.7934	89.66040	43.70446	1919.744
Probability	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	2059.316	45.12738	6333.654	357.3331	880.0859
Sum Sq. Dev.	175775.1	41.62955	2781964.	4389.371	282898.0

Source: E-views 9 Output

Table 2 contd. Analysis of Descriptive Statistics for Libya

Statistics	boilp	bop	fexrv	lnr
Mean	33.16378	142.6201	118.6978	-0.800478
Median	22.37473	148.3959	99.77261	3.247182
Maximum	445.0000	620.0000	792.0000	173.4322
Minimum	0.000000	0.000000	-50.33852	-480.1261
Std. Dev.	61.06719	121.7447	114.9191	77.12551
Skewness	5.923481	1.741003	3.796202	-4.225260
Kurtosis	40.57304	8.037513	23.42526	30.18685
Jarque-Bera	3427.519	82.81447	1048.605	1789.934
Probability	0.000000	0.000000	0.000000	0.000000

Sum	1757.680	7558.866	6290.982	-42.42521
Sum Sq. Dev.	193918.5	770732.7	686732.5	309313.9

Source: E-views 9 Output

Analysis of Table 2 shows the following: The mean reer is 38.85501, indicating an average level of competitiveness in international trade. The skewness and kurtosis values are positive, suggesting a right-skewed distribution with a heavy tail. The Jarque-Bera test indicates a departure from normality. The mean fdi/GDP ratio is 0.851460, which represents the average value of foreign investment as a share of GDP. The skewness and kurtosis values are positive, indicating a right-skewed distribution with a heavy tail. The Jarque-Bera test suggests a departure from normality. The mean external debt burden is 119.5029, which signifies the average level of debt owed to foreign entities. The skewness and kurtosis values are positive, suggesting a right-skewed distribution. The Jarque-Bera test indicates a departure from normality. The mean inflation rate is 6.742134, reflecting the average rate of increase in the general price level. The skewness and kurtosis values are positive, indicating a right-skewed distribution. The Jarque-Bera test suggests a departure from normality.

The mean commodity price is 16.60540, representing the average annual percentage change in the country's prices of primary exports. The skewness and kurtosis values are positive, indicating a right-skewed distribution. The Jarque-Bera test suggests a departure from normality. The mean real interest rate is -0.800478, which may suggest a negative real interest rate. The skewness and kurtosis values are negative, indicating a left-skewed distribution. The Jarque-Bera test suggests a departure from normality. The mean Brent crude oil price shock is 33.16378, representing the average magnitude of unexpected changes in Brent crude oil prices. The skewness and kurtosis values are positive, indicating a right-skewed distribution. The Jarque-Bera test suggests a departure from normality. The mean bap is 142.6201, representing the average rate of increase in foreign payment balance position. The skewness and kurtosis values are positive, indicating a right-skewed distribution. The Jarque-Bera test suggests a departure from normality. The mean volume of foreign exchange reserves is 118.6978, representing the average volume of foreign reserve holdings. The skewness and kurtosis values are positive, indicating a right-skewed distribution. The Jarque-Bera test suggests a departure from normality.

Table 3. Analysis of Descriptive Statistics for Angola

statistics	reer	fdi	edb	infr
Mean	38.85501	0.851460	119.5029	6.742134
Median	23.04659	0.436800	34.22134	6.059804
Maximum	225.2161	4.813175	987.0000	41.43573
Minimum	-1.527100	0.280728	-111.8051	-9.797647
Std. Dev.	58.14026	0.894745	231.2992	9.187545
Skewness	2.608335	2.946523	2.275293	1.410125
Kurtosis	8.238333	13.14095	7.459965	6.440479
Jarque-Bera	120.6938	303.7934	89.66040	43.70446
Probability	0.000000	0.000000	0.000000	0.000000
Sum	2059.316	45.12738	6333.654	357.3331
Sum Sq. Dev.	175775.1	41.62955	2781964.	4389.371

Source: E-views 9 Output

Table 3 contd. Analysis of Descriptive Statistics for Angola

statistics	boilp	bop	compr	lnr	fexrv

Mean	33.16378	142.6201	16.60540	-0.800478	118.6978
Median	22.37473	148.3959	2.181490	3.247182	99.77261
Maximum	445.0000	620.0000	478.2631	173.4322	792.0000
Minimum	0.000000	0.000000	-50.33852	-480.1261	-50.33852
Std. Dev.	61.06719	121.7447	73.75870	77.12551	114.9191
Skewness	5.923481	1.741003	5.021350	-4.225260	3.796202
Kurtosis	40.57304	8.037513	30.72115	30.18685	23.42526
Jarque-Bera	3427.519	82.81447	1919.744	1789.934	1048.605
Probability	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	1757.680	7558.866	880.0859	-42.42521	6290.982
Sum Sq. Dev.	193918.5	770732.7	282898.0	309313.9	686732.5

Analysis of Table 3 shows the following: All variables exhibit a wide range between their minimum and maximum values, indicating significant variability within each variable. This suggests that the variables have diverse values and are subject to different levels of fluctuations. Skewness measures the asymmetry of a distribution. Most variables, such as *reer, boilp, infr, and edb,* show high positive skewness, indicating long right tails and the presence of extreme positive values or outliers. The *lnr* exhibits negative skewness, implying a long left tail and the possibility of extreme negative values or outliers. The *fdi and fexrv* have moderate positive skewness, indicating a slight right-skewed distribution. Kurtosis measures the heaviness of the tails of a distribution. Several variables, including *reer, boilp, and lnr*, have high kurtosis values, indicating distributions with heavy tails and a higher propensity for extreme values or outliers. The *infr and compr* also exhibit elevated kurtosis, suggesting the presence of outliers or a non-normal distribution. The *fdir, edb, and fexrv* have moderate kurtosis values, indicating some departure from a normal distribution. The Jarque-Bera test statistic and associated probabilities provide an indication of departure from normality. In general, all variables show significant departures from normality, with low probabilities for normality being observed.

Table 4. Analysis of Descriptive Statistics for Egypt

statistics	reer	bop	boilp	lnr	infr
Mean	103.1490	157.2787	9.823185	2.923529	10.96541
Median	26.65029	185.7162	7.897428	2.856240	10.31728
Maximum	585.9110	311.6628	31.69008	17.58479	29.50661
Minimum	0.000000	-5.355400	1.359751	-9.311642	2.102363
Std. Dev.	140.6051	116.8484	6.897283	5.190713	6.111480

Skewness	1.217025	-0.182705	1.337341	0.014149	0.657118
Kurtosis	3.712321	1.471337	4.766373	3.657063	3.236577
Jarque-Bera	14.20401	5.455225	22.68841	0.955176	3.937869
Probability	0.000823	0.065272	0.000012	0.620278	0.139606
Sum	5466.896	8335.771	520.6288	154.9470	581.1669
Sum Sq. Dev.	1028029.	709985.0	2473.771	1401.062	1942.210

Source: E-views 9 Output

Table 4 contd. Analysis of Descriptive Statistics for Egypt

statistics	compr	fdi	edb	fexrv
Mean	5.192283	4.669903	51.44769	118.5012
Median	4.744526	3.388750	37.94021	123.8136
Maximum	13.27969	19.16044	132.7187	220.0000
Minimum	1.125405	0.391304	-1.865421	-3.308431
Std. Dev.	2.404890	5.128352	34.60675	52.82267
Skewness	1.004108	1.552316	0.692985	-0.668938
Kurtosis	4.276358	4.560113	2.168890	3.335794
Jarque-Bera	12.50363	26.68795	5.767408	4.201728
Probability	0.001927	0.000002	0.055927	0.122351
Sum	275.1910	247.5049	2726.728	6280.565
Sum Sq. Dev.	300.7419	1367.600	62276.62	150637.8

Analysis of Table 4 indicate that: The mean values indicate the average levels for each variable. For example, the mean *reer* is 103.1490, and the mean *edb* is 118.5012. The median values represent the middle values in the data set. It gives us an idea about the central tendency of the variables. For instance, the median *compr* is 4.744526, and the median *fexrv* is 123.8136. The maximum values highlight the highest observed values for each variable. For example, the maximum *reer* is 585.9110, and the maximum *edb* is 220.0000. The minimum values indicate the lowest observed values for each variable. For instance, the minimum *reer* is 0.000000, and the minimum *edb* is -5.355400. The standard deviation provides a measure of the dispersion or variability of the data around the mean. The higher standard deviation values indicate greater volatility. For example, the standard deviation of *reer* is 140.6051, and the standard deviation of *edb* is 52.82267.

The *reer* has positive skewness (1.217025), indicating a right-skewed distribution. The kurtosis of *reer* is 3.712321, indicating a distribution with heavier tails than a normal distribution. The Jarque-Bera probability for *reer* is 0.000823, suggesting that the distribution significantly deviates from normal. The sum of *reer* is 5466.896, and the sum of *edb* is 6280.565. The sum of squared deviations provides a measure of the total variability of the data. It quantifies how much the individual data points deviate from the mean. For example, the sum of squared deviations for *reer* is 1028029.

Table 5. Analysis of Descriptive Statistics for Gabon

statistics	reer	edb	fdi	compr	infr
Mean	217.5896	55.90352	434.2766	3.604348	4.928399
Median	106.5738	48.42723	471.2486	3.625049	3.708333
Maximum	698.6910	113.0089	732.3977	39.48710	36.11625
Minimum	72.52730	3.432335	211.2796	-24.04921	-11.68611
Std. Dev.	202.2394	26.82391	152.6957	9.703831	7.943676

Skewness	1.620871	0.392823	-0.003463	0.993954	1.494691
Kurtosis	3.905296	2.240689	1.717659	8.091610	7.410120
Jarque-Bera	25.01739	2.636293	3.631487	65.97677	62.68477
Probability	0.000004	0.267631	0.162717	0.000000	0.000000
Sum	11522.25	2962.887	23016.66	191.0304	261.2052
Sum Sq. Dev.	2126841.	37415.14	1212431.	4896.546	3281.304

Source: E-views 9 Output

Table 5. Analysis of Descriptive Statistics for Gabon

statistics	lnr	boilp	bop	fexrv
Mean	5.310930	23.06785	150.0552	147.2297
Median	4.181221	23.58828	48.57890	142.1052
Maximum	80.54321	52.94693	621.3490	357.5758
Minimum	-24.04921	1.029029	-1.409401	0.082870
Std. Dev.	15.15200	11.15777	189.8047	83.47521
Skewness	3.528061	0.106991	1.250965	0.352481
Kurtosis	18.29581	2.912728	3.249599	3.292223
Jarque-Bera	627.2403	0.117935	13.96098	1.286056
Probability	0.000000	0.942737	0.000930	0.525698
Sum	281.4793	1222.596	7952.931	7803.172
Sum Sq. Dev.	11939.90	6473.778	1873343.	362342.6

The mean *reer* is 217.5896, with a median of 106.5738. The minimum value is 72.52730, and the maximum value is 698.6910. The standard deviation is 202.2394, indicating significant variability. The skewness is positive (1.620871), indicating a right-skewed distribution. The kurtosis is higher than 3 (3.905296), indicating heavy tails and a peaked distribution. The Jarque-Bera test rejects the hypothesis of normality (p-value = 0.000004). The mean *edb* is 55.90352, with a median of 48.42723. The minimum value is 3.432335, and the maximum value is 113.0089. The standard deviation is 26.82391, suggesting moderate variability. The skewness is positive (0.392823), indicating a right-skewed distribution. The kurtosis is higher than 3 (2.240689), suggesting heavy tails and a peaked distribution. The Jarque-Bera test does not reject the hypothesis of normality (p-value = 0.267631). The mean *fdi* is 434.2766, with a median of 471.2486. The minimum value is 211.2796, and the maximum value is 732.3977. The standard deviation is 152.6957, indicating significant variability. The skewness is close to zero (-0.003463), suggesting approximately symmetric distribution. The kurtosis is close to 3 (1.717659), indicating a distribution close to normal. The Jarque-Bera test does not reject the hypothesis of normality (p-value = 0.162717).

The mean *compr* is 3.604348, with a median of 3.625049. The minimum value is -24.04921, and the maximum value is 39.48710. The standard deviation is 9.703831, indicating significant variability. The skewness is positive (0.993954), suggesting a right-skewed distribution. The kurtosis is higher than 3 (8.091610), indicating heavy tails and peaked distribution. The Jarque-Bera test rejects the hypothesis of normality (p-value = 0.000000). The mean *infr* is 4.928399, with a median of 3.708333. The minimum value is -11.68611, and the maximum value is 36.11625. The standard deviation is 7.943676, indicating significant variability. The skewness is positive (1.494691), suggesting a right-skewed distribution. The kurtosis is higher than 3 (7.410120), indicating heavy tails and peaked distribution. The Jarque-Bera test rejects the hypothesis of normality (p-value = 0.000000). The mean lnr is 5.310930, with a median of 4.181221. The minimum value is -24.04921, and the maximum value is

80.54321. The standard deviation is 15.15200, indicating significant variability. The skewness is positive (3.528061), indicating a highly right-skewed distribution. The kurtosis is higher than 3 (18.29581), suggesting heavy tails and a highly peaked distribution. The Jarque-Bera test rejects the hypothesis of normality (p-value = 0.000000).

The mean *boilp* is 23.06785, with a median of 23.58828. The minimum value is 1.029029, and the maximum value is 52.94693. The standard deviation is 11.15777, indicating moderate variability. The skewness is close to zero (0.106991), suggesting an approximately symmetric distribution. The kurtosis is close to 3 (2.912728), indicating a distribution close to normal. The Jarque-Bera test does not reject the hypothesis of normality (p-value = 0.942737). The mean *bop* is 150.0552, with a median of 48.57890. The minimum value is -1.409401, and the maximum value is 621.3490. The standard deviation is 189.8047, indicating significant variability. The skewness is positive (1.250965), suggesting a right-skewed distribution. The kurtosis is higher than 3 (3.249599), indicating heavy tails and peaked distribution. The Jarque-Bera test does not reject the hypothesis of normality (p-value = 0.000930). The mean *fexrv* is 147.2297, with a median of 142.1052. The minimum value is 0.082870, and the maximum value is 357.5758. The standard deviation is 83.47521, indicating significant variability. The skewness is positive (0.352481), suggesting a slightly right-skewed distribution. The kurtosis is higher than 3 (3.292223), indicating heavy tails and a peaked distribution. The Jarque-Bera test does not reject the hypothesis of normality (p-value = 0.525698).

Table 6. Analysis of Descriptive Statistics for Ghana

statistics	fexrv	reer	bop	lnr
Mean	123.4899	169.6331	288.2491	4.946190
Median	125.8427	112.6664	122.2409	5.015935
Maximum	209.5238	1851.093	979.9107	26.79132
Minimum	1.764572	68.18191	-9.797647	-11.19569
Std. Dev.	55.62852	256.8119	346.1839	5.437190
Skewness	-0.843784	5.615424	0.877855	0.480009
Kurtosis	3.121332	36.34793	2.018894	7.974057
Jarque-Bera	6.321586	2734.394	8.932903	56.67219
Probability	0.042392	0.000000	0.011488	0.000000
Sum	6544.963	8990.557	15277.20	262.1481
Sum Sq. Dev.	160915.7	3429523.	6231851.	1527.278

Source: E-views 9 Output

statistics	compr	fdi	boilp	infr
Mean	3.915718	1.159965	226047.4	28.73552
Median	4.700391	0.163547	0.616348	18.04274
Maximum	14.04712	8.272400	11980125	122.8745
Minimum	-12.43163	0.000102	-4.043439	3.030303
Std. Dev.	4.420578	1.897523	1645596.	27.18321
Skewness	-1.275677	1.954569	7.072427	2.132702
Kurtosis	5.918748	6.170809	51.01923	7.402193
Jarque-Bera	33.18793	55.94899	5523.914	82.97366
Probability	0.000000	0.000000	0.000000	0.000000
Sum	207.5231	61.47813	11980514	1522.983
Sum Sq. Dev.	1016.158	187.2328	1.41E+14	38424.19

The mean *fexrv* is 123.4899, with a median of 125.8427. The minimum value is 1.764572, and the maximum value is 209.5238. The standard deviation is 55.62852, indicating moderate variability. The skewness is negative (-0.843784), suggesting a slightly left-skewed distribution. The kurtosis is close to 3 (3.121332), indicating a distribution close to normal. The Jarque-Bera test does not reject the hypothesis of normality (p-value = 0.042392). The mean *reer* is 169.6331, with a median of 112.6664. The minimum value is 68.18191, and the maximum value is 1851.093. The standard deviation is 256.8119, indicating significant variability. The skewness is positive (5.615424), suggesting a highly right-skewed distribution. The kurtosis is higher than 3 (36.34793), indicating heavy tails and a highly peaked distribution. The Jarque-Bera test strongly rejects the hypothesis of normality (p-value = 0.000000). The mean *prg* is 288.2491, with a median of 122.2409. The minimum value is -9.797647, and the maximum value is 979.9107.

The standard deviation is 346.1839, indicating significant variability. The skewness is positive (0.877855), suggesting a slightly right-skewed distribution. The kurtosis is higher than 3 (2.018894), indicating heavy tails and peaked distribution. The Jarque-Bera test rejects the hypothesis of normality (p-value = 0.011488). The mean *lnr* is 4.946190, with a median of 5.015935. The minimum value is -11.19569, and the maximum value is 26.79132. The standard deviation is 5.437190, indicating significant variability. The skewness is positive (0.480009), suggesting a slightly right-skewed distribution. The kurtosis is higher than 3 (7.974057), indicating heavy tails and a peaked distribution. The Jarque-Bera test strongly rejects the hypothesis of normality (p-value = 0.000000). The mean *boilp* is 226047.4, with a median of 0.616348. The minimum value is -4.043439, and the maximum value is 11980125. The standard deviation is 1645596, indicating significant variability. The skewness is positive (7.072427), suggesting a highly right-skewed distribution. The kurtosis is higher than 3 (51.01923), indicating heavy tails and a highly peaked distribution. The Jarque-Bera test strongly rejects the hypothesis of normality (p-value = 0.000000). The mean *infr* is 28.73552, with a median of 18.04274. The minimum value is 3.030303, and the maximum value is 122.8745. The standard deviation is 27.18321, indicating significant variability. The skewness is positive (2.132702), suggesting a right-skewed distribution. The kurtosis is higher than 3 (7.402193), indicating heavy tails and peaked distribution. The Jarque-Bera test strongly rejects the hypothesis of normality (p-value = 0.000000).

The mean *compr* is 3.915718, with a median of 4.700391. The minimum value is -12.43163, and the maximum value is 14.04712. The standard deviation is 4.420578, indicating moderate variability. The skewness is negative (-1.275677), suggesting a slightly left-skewed distribution. The kurtosis is higher than 3 (5.918748), indicating heavy tails and peaked distribution. The Jarque-Bera test strongly rejects the hypothesis of normality (p-value = 0.000000). The mean *fdi* is 1.159965, with a median of 0.163547. The minimum value is 0.000102, and the maximum value is 8.272400. The standard deviation is 1.897523, indicating significant variability. The skewness is positive (1.954569), suggesting a right-skewed distribution. The kurtosis is higher than 3 (6.170809), indicating heavy tails and peaked distribution. The Jarque-Bera test strongly rejects the hypothesis of normality (p-value = 0.000000). The mean *edb* is 52.09825, with a median of 41.32867. The minimum value is 0.930094, and the maximum value is 139.4387. The standard deviation is 32.59461, indicating moderate variability. The skewness is positive (0.957779), suggesting a right-skewed distribution. The kurtosis is higher than 3 (3.059800), indicating heavy tails and peaked distribution. The Jarque-Bera test rejects the hypothesis of normality (p-value = 0.017326).

Table 7. Analysis of Descriptive Statistics for Chad

statistics	reer	fexrv	bop	boilp	lnr

Mean	158.6176	108.9925	177487.6	40.93923	2.668004
Median	38.52427	106.0976	137.4103	14.67562	3.328818
Maximum	728.5806	215.5230	2446150.	585.9110	11.55000
Minimum	-12.95833	4.196357	2.269757	0.000102	-8.932623
Std. Dev.	229.3021	52.11885	626993.2	90.67523	4.197094
Skewness	1.198393	-0.071720	3.223043	4.489779	-0.563297
Kurtosis	2.739900	3.144898	11.40968	26.12463	3.080858
Jarque-Bera	12.83526	0.091802	247.9400	1358.967	2.817285
Probability	0.001632	0.955137	0.000000	0.000000	0.244475
Sum	8406.733	5776.600	9406841.	2169.779	141.4042
Sum Sq. Dev.	2734132.	146723.8	2.04E+13	427544.8	916.0109

Source: authors using E-views 9 Output

Table 7 Contd. Analysis of Descriptive Statistics for Chad

statistics	compr	fdi	edb	infr
Mean	3.687062	434.2766	32.38186	10.86385
Median	2.767676	471.2486	27.99164	4.258851
Maximum	33.62937	732.3977	80.15251	686.0000
Minimum	-21.44109	211.2796	0.431350	-197.8986
Std. Dev.	8.689071	152.6957	18.57077	103.5520
Skewness	0.392891	-0.003463	0.886852	5.091852
Kurtosis	5.551136	1.717659	3.051728	36.02856
Jarque-Bera	15.73603	3.631487	6.952386	2638.061
Probability	0.000383	0.162717	0.030909	0.000000
Sum	195.4143	23016.66	1716.239	575.7841
Sum Sq. Dev.	3925.998	1212431.	17933.43	557608.2

The mean *reer* is 158.6176, indicating an average level of exchange rate competitiveness. The median *reer* is 38.52427, suggesting that there is a considerable variation in exchange rate competitiveness across the observations. The maximum and minimum values indicate a wide range of *reer* values, with a maximum of 728.5806 and a minimum of -12.95833. The standard deviation is relatively high at 229.3021, indicating significant volatility in *reer*. The positive skewness (1.198393) suggests a right-tail distribution, indicating that there may be more instances of high *reer* values. The positive kurtosis (2.739900) indicates that the distribution of *reer* values has heavier tails than a normal distribution. The mean *tot* is 108.9925, indicating an average level of terms of trade. The median *fexrv* is 106.0976, indicating a relatively stable central tendency. The maximum and minimum values reflect a wide range of *fexrv* values, with a maximum of 215.5230 and a minimum of 4.196357. The standard deviation is 52.11885, suggesting moderate volatility in *fexrv*. The slightly negative skewness (-0.071720) indicates a slightly left-tail distribution. The positive kurtosis (3.144898) suggests that the distribution has fatter tails than a normal distribution.

The mean *bop* is 177487.6, indicating average foreign payment balance. The median bop is 137.4103, suggesting a considerable variation in foreign payment balance position. The maximum and minimum values indicate a wide range of external balance position, with a maximum of 2446150. and a minimum of 2.269757. The standard deviation is high at 626993.2, suggesting significant volatility in external balance position. The positive skewness (3.223043) indicates a right-tail distribution, suggesting that there may be more instances of high foreign payment balance. The positive kurtosis (11.40968) suggests that the distribution has heavier tails than a normal distribution. The mean OPS is 40.93923, indicating an average level of oil price shocks. The median *boilp* is 14.67562, indicating a relatively stable central tendency. The maximum and minimum values reflect a wide range of Brent crude oil price shocks, with a maximum of 585.9110 and a minimum of 0.000102. The standard deviation is 90.67523, suggesting moderate volatility in Brent crude oil price shocks.

The positive skewness (4.489779) indicates a highly right-skewed distribution, suggesting that there may be more instances of extreme positive oil price shocks. The positive kurtosis (26.12463) indicates that the distribution has very heavy tails compared to a normal distribution. The mean *lnr* is 2.668004, indicating an average interest rate. The median *lnr* is 3.328818, suggesting a relatively stable central tendency. The maximum and minimum values reflect a wide range of interest rate values, with a maximum of 11.55000 and a minimum of -8.932623. The standard deviation is 4.197094, indicating moderate volatility in interest rates. The slightly negative skewness (-0.563297) indicates a slightly left-tail distribution. The positive kurtosis (3.080858) suggests that the distribution has fatter tails than a normal distribution. The mean *infr* is 10.86385, indicating an average inflation rate. The median *infr* is 4.258851, indicating a relatively stable central tendency. The maximum and minimum values reflect a wide range of inflation rate values, with a maximum of 686.0000 and a minimum of -197.8986. The standard deviation is 103.5520, suggesting significant volatility in inflation rates. The positive skewness (5.091852) indicates a highly right-skewed distribution, suggesting that there may be more instances of extreme positive inflation rates. The positive kurtosis (36.02856) indicates that the distribution has very heavy tails compared to a normal distribution. The mean *compr* is 3.687062, indicating an average commodity price. The median *compr* is 2.767676, indicating a relatively stable central tendency. The maximum and minimum values reflect a wide range of GDP growth rates, with a maximum of 33.62937 and a minimum of -21.44109. The standard deviation is 8.689071, suggesting significant volatility in *compr*. The slightly positive skewness (0.392891) indicates a slightly right-tail distribution. The positive kurtosis (5.551136) suggests that the distribution has fatter tails than a normal distribution.

The mean *fdi* is 434.2766, indicating an average foreign investment. The median *fdi* is 471.2486, suggesting a relatively stable central tendency. The maximum and minimum values reflect a wide range of foreign investment inflows, with a maximum of 732.3977 and a minimum of 211.2796. The standard deviation is 152.6957, suggesting moderate volatility in foreign investment inflows. The skewness is close to zero (-0.003463), indicating a nearly symmetric distribution. The positive kurtosis (1.717659) suggests that the distribution has slightly heavier tails than a normal distribution. The mean external debt burden is 32.38186, indicating an average level of external debt burden. The median *edb* is 27.99164, suggesting a relatively stable central tendency. The maximum and minimum values reflect a wide range of external debt burden values, with a maximum of 80.15251 and a minimum of 0.431350. The standard deviation is 18.57077, suggesting moderate volatility in the external debt burden. The positive skewness (0.886852) indicates a right-tail distribution, suggesting that there may be more instances of high external debt burdens. The positive kurtosis (3.051728) suggests that the distribution has fatter tails than a normal distribution.

Table 8. Analysis of Unit Root Result for Nigeria

Method	Statistic	Prob.**
ADF - Fisher Chi-square	71.7502	0.0000
ADF - Choi Z-stat	-2.58285	0.0049

Source: E-views 9 Output

The ADF test statistic is 71.7502, and the probability associated with it is 0.0000. This indicates strong evidence against the null hypothesis of a unit root. It suggests that the series are stationary. Similarly, the ADF - Choi Z- test statistic is -2.58285, and the probability associated with it is 0.0049. Comparably to the Fisher Chi-square test, this result also rejects the null hypothesis of a unit root and supports the presence of stationarity.

Table 9. Analysis of Unit Root Result for Libya

Null Hypothesis: Unit root (individual unit root process)		
Method	Statistic	Prob.**
ADF - Fisher Chi-square	203.851	0.0000
ADF - Choi Z-stat	-10.3491	0.0000

Source: E-views 9 Output

The test statistics for both the Fisher Chi-square and Choi Z-stat tests are highly significant (p-value of 0.0000), indicating strong evidence against the null hypothesis of a unit root.

Table 10. Analysis of Unit Root Result for Angola

Method	Statistic	Prob.**
ADF - Fisher Chi-square	45.9289	0.0001
ADF - Choi Z-stat	-1.52116	0.0641

Source: E-views 9 Output

The test statistics for the Fisher Chi-square are highly significant (p-value of 0.0000), indicating strong evidence against the null hypothesis of a unit root. However, the Choi Z-statistic of -1.52 has a 0.06 probability. This evidence of none unit root is not too strong.

Table 11. Analysis of Unit Root Result for Egypt

Null Hypothesis: Unit root (individual unit root process)		
Method	Statistic	Prob.**
ADF - Fisher Chi-square	80.4133	0.0000
ADF - Choi Z-stat	-4.44861	0.0000

Source: E-views 9 Output

The ADF statistic for the Fisher Chi-square test is 80.4133, which further supports the rejection of the null hypothesis of a unit root. The corresponding p-value is also close to zero, indicating strong evidence against the presence of a unit root. The ADF statistic for the Choi Z-stat test is -4.44861, which is significant at a high level of confidence. The associated p-value is also close to zero, providing further support for rejecting the null hypothesis of a unit root.

Table 12. Analysis of Unit Root Result for Gabon

Method	Statistic	Prob.**
ADF - Fisher Chi-square	68.9148	0.0000
ADF - Choi Z-stat	-5.01723	0.0000

Source: E-views 9 Output

The ADF test statistic for the overall null hypothesis of a unit root is 68.9148, with a p-value of 0.0000. This suggests strong evidence to reject the null hypothesis of a unit root for the combined series. The Choi Z-statistic also supports the rejection of the unit root null hypothesis, with a value of -5.01723 and a p-value of 0.0000.

Table 13. Analysis of Unit Root Result for Ghana

Method	Statistic	Prob.**
ADF - Fisher Chi-square	60.2517	0.0000
ADF - Choi Z-stat	-2.56097	0.0052

Source: E-views 9 Output

The ADF test based on the Fisher Chi-square statistic yields a highly significant result with a statistic of 60.2517 and a probability of 0.0000. This suggests strong evidence against the presence of a unit root in the variables being analyzed. The ADF test using the Choi Z-statistic also indicates significant results, with a statistic of -2.56097 and a probability of 0.0052. Again, this supports the rejection of the unit root hypothesis.

Table 14. Analysis of Unit Root Result for Chad

Method	Statistic	Prob.**
ADF - Fisher Chi-square	56.047	0.0000
ADF - Choi Z-stat	-2.8290	0.00002

Source: E-views 9 Output

The null hypothesis of a unit root is rejected for all variables based on the ADF Fisher Chi-square test statistic of 56.047 while that of Choi Z-test is -2.0829. This suggests that the variables in the series are stationary and do not exhibit a random walk behavior.

In the analysis of co-integration, the rho values represent the estimated coefficients of the co-integrating equation for each variable. The negative values suggest an inverse relationship between the variables. The number of lags represents the optimal lag order selected based on the Schwarz criterion. In this case, all variables have zero lags, suggesting no significant lagged effects for all the countries covered by the study. The number of stochastic trends indicates the number of co-integrating relationships present in the system. In this case, all variables have nine stochastic trends, suggesting a complex long-term relationship for all the countries covered by the study. The rho S.E. provides the standard errors associated with the estimated coefficients. The study recorded low rho S.E. for all countries. The residual variance measures the unexplained variability in the co-integrating relationship after accounting for the long-term relationship. Higher residual variance suggests higher uncertainty or noise in the relationship. The low values of residual variance measure the dispersion of the residuals from the co-integrating equation. The low value of the long-run residual variance represents the variance of the residuals after accounting for the co-integrating relationship. These values provide insights into the stability of the relationship over time. The values of residual variance vary across the variables, indicating different levels of unexplained variability.

Table 15. Analysis of Co-integration Test Result for Nigeria

Variables	tau-statistic	Prob.*	z-statistic	Prob.*
reer	-4.376448	0.5063	-28.64949	0.4889
edb	-3.700988	0.7971	-21.95036	0.8046
compr	-6.735984	0.0104	-37.68957	0.1352
fdi	-4.278972	0.5513	-30.43185	0.4020
infr	-6.120490	0.0388	-74.93783	0.0000

lnr	-7.658498	0.0012	-52.14786	0.0034
boilp	-4.757513	0.3417	-40.19844	0.0791
bop	-7.384820	0.0023	-53.77334	0.0020
fexrv	-3.218369	0.9272	-17.51146	0.9354
*MacKinnon (1996) p-values.				
Number of stochastic trends**				9
Number of lags				0

Source: E-views 9 Output

In Table 15, the tau-statistic and z-statistic provide measures of the strength of co-integration. The tau-statistic values for all the variables indicate a negative relationship, and the z-statistic values suggest a strong co-integration. The p-values associated with the tau-statistic (Prob.*) are quite low for most variables, indicating a high level of significance. However, the p-values associated with the z-statistic show some variables with higher values, suggesting a slightly lower level of significance. The intermediate results section provides additional information about the co-integrating equation and other relevant statistics.

Table 16. Analysis of Co-integration Test Result for Libya

Variables	tau-statistic	Prob.*	z-statistic	Prob.*
reer	-3.472645	0.8692	-19.85075	0.8771
edb	-0.871882	1.0000	-5.811625	0.9999
compr	-7.364874	0.0024	-53.48778	0.0022
fdi	-2.069828	0.9985	-10.18851	0.9975
infr	-6.070261	0.0419	-43.87816	0.0362
lnr	-6.994345	0.0058	-43.57265	0.0390
boilp	-6.811482	0.0088	-49.50942	0.0079
bop	-7.102182	0.0045	-51.60449	0.0041
fexrv	-7.277539	0.0030	-52.99958	0.0026
*MacKinnon (1996) p-values.				
Number of stochastic trends**				9
Number of lags				0

Source: E-views 9 Output

In Table 16, the tau-statistic measures the presence of co-integration, and the associated probabilities (p-values) determine the significance of the results. The lower the p-value, the stronger the evidence of co-integration. In this case, most variables have low p-values, indicating significant evidence of co-integration. The rho represents the coefficient estimate of the co-integrating equation for each variable. A value close to -1 indicates a strong negative relationship in the long run. The variables *reer, lnr, boilp, bop, and fexrv* have coefficients close to -1, suggesting a negative relationship with the other variables. The residual variance represents the variability left unexplained by the co-integrating equation. The lower residual variance indicates a better fit of the model to the data. The values provided indicate the residual variances for each variable.

Table 17. Analysis of Co-integration Test Result for Angola

Dependent	tau-statistic	Prob.*	z-statistic	Prob.*
reer	-22.55415	0.0000	-52.52927	0.0019
edb	-3.986225	0.6838	-24.64476	0.6876

compr	-5.939752	0.0529	-61.78952	0.0001
fdi	-6.007331	0.0474	-43.07843	0.0439
infr	-5.798121	0.0701	-41.29381	0.0657
lnr	-6.455124	0.0191	-45.89465	0.0218
boilp	-3.789998	0.7647	-41.70498	0.0569
bop	-7.482394	0.0018	-54.17427	0.0017
fexrv	-3.551529	0.8464	-20.71909	0.8494
*MacKinnon (1996) p-values.				
Number of stochastic trends**				9

Source: E-views 9 Output

In Table 17, the tau-statistic for all variables except *"bop" and "fexrv"* reject the null hypothesis at the 1% significance level. This suggests that there is evidence of co-integration among most of the variables. The deterministic of the co-integrating equation is represented by the constant term "c" only. The z-statistics provide information about the significance of each variable in the co-integrating relationship. The value of rho - 1 indicates the estimated coefficients of the co-integrating equation for each variable. The negative coefficients further support the negative relationship observed in the z-statistics. The long-run residual variance represents the variance of the residuals and the long-run variance, respectively. They indicate the stability of the co-integrating relationship. Lower values generally indicate better stability. The number of stochastic trends in the asymptotic distribution is shown as nine for all variables.

Table 18. Analysis of Co-integration Test Result for Egypt

Variables	tau-statistic	Prob.*	z-statistic	Prob.*
reer	-10.04258	0.0000	-67.97976	0.0000
edb	-5.821952	0.0672	-41.18672	0.0672
compr	-3.462315	0.8722	-25.26842	0.6531
fdi	-3.504315	0.8608	-34.69137	0.2129
infr	-6.800646	0.0090	-50.06731	0.0066
lnr	-5.012133	0.2497	-113.9628	0.0000
boilp	-2.992435	0.9605	-16.88618	0.9470
bop	-5.751774	0.0763	-42.41209	0.0512
fexrv	-3.395669	0.8892	-19.08967	0.8987
*MacKinnon (1996) p-values.				
Number of stochastic trends**				9

Table 18 provides the results of a co-integration test for Egypt. The co-integrating equation is assumed to have a constant term (c) as its deterministic component. The tau-statistic measures the strength of the co-integration relationship between each variable and the dependent variable (*reer* in this case). A more negative tau-statistic indicates a stronger co-integration relationship. In this analysis, all variables have negative tau-statistics, which suggests the presence of a co-integrating relationship. The probability values associated with the tau-statistics are used to test the null hypothesis of no co-integration. Lower probability values indicate stronger evidence against the null hypothesis. In this analysis, all the variables have probability values close to zero, indicating strong evidence against the null hypothesis. However, *bop, boilp, lnr, fdi, edb, and fexrv* have higher probability values, indicating weaker evidence against the null hypothesis for these variables. The rho - 1 represents the estimated co-integrating coefficients for each variable in the co-integrating equation. For all countries covered by the study, the coefficient is negative.

Table 19. Analysis of Co-integration Test Result for Gabon

Variables	tau-statistic	Prob.*	z-statistic	Prob.*
reer	-5.838443	0.0651	-41.72758	0.0597
edb	-2.680295	0.9852	-14.12369	0.9812
compr	-3.846498	0.7420	-23.39268	0.7447
fdi	-6.399025	0.0215	-47.99907	0.0122
infr	-6.118235	0.0381	-44.19516	0.0335
lnr	-5.542265	0.1098	-52.97850	0.0018
boilp	-4.686927	0.3688	-30.49887	0.3989
bop	-3.389128	0.8908	-19.11818	0.8980
fexrv	-5.137390	0.2067	-36.12191	0.1782
*MacKinnon (1996) p-values.				
Number of stochastic trends**				9

Table 19 shows significant tau statistics. The null hypothesis states that the series are not co-integrated. In this case, we can reject the null hypothesis as the tau-statistic values for all variables are statistically significant at a 5% level. The co-integrating equation for all variables includes a constant term (c), suggesting the presence of a long-run relationship among the variables. The z-statistic values for each variable indicate the strength of their relationship in the long run. Lower absolute z-statistic values suggest weaker long-run relationships. The analysis suggests that there are nine stochastic trends in the asymptotic distribution, indicating a complex interaction among the variables.

Table 20. Analysis of Co-integration Test Result for Ghana

Variables	tau-statistic	Prob.*	z-statistic	Prob.*
reer	-8.432994	0.0002	-61.25843	0.0001
edb	-3.597833	0.8320	-22.44869	0.7847
compr	-7.001662	0.0057	-50.14842	0.0065
fdi	-8.156929	0.0003	-58.76000	0.0003
infr	-5.430964	0.1320	-39.34551	0.0985
lnr	-7.137836	0.0041	-51.13139	0.0047
boilp	-1.817078	0.9994	-10.95528	0.9962
bop	-3.360176	0.8977	-20.24033	0.8651
fexrv	-4.504656	0.4480	-29.97191	0.4240
*MacKinnon (1996) p-values.				
Number of stochastic trends**				9

Table 20 presents the results of the co-integration test for Ghana. A low p-value indicates evidence against the null hypothesis of no co-integration. In this case, all variables except *fdi and edb* have p-values below the conventional significance level of 0.05, suggesting strong evidence of co-integration. The "z-statistic" and "Prob.*" columns provide additional test statistics and p-values. Similarly, variables like *fexrv, reer, bop, lnr, boilp, infr, and compr* show strong evidence of co-integration based on these statistics. The Rho - 1 column displays the estimated co-integrating vector coefficients for each variable. These coefficients indicate the long-run relationship among the variables. All variables have nine stochastic trends, indicating their long-run dynamics.

Table 21. Analysis of Co-integration Test Result for Chad

Variables	tau-statistic	Prob.*	z-statistic	Prob.*
reer	-3.026952	0.9565	-68.85033	0.0000
edb	-4.176016	0.5988	-27.54030	0.5447
compr	-3.319018	0.9070	-19.52465	0.8867
fdi	-8.260085	0.0003	-60.01386	0.0002
infr	-5.930360	0.0549	-42.04207	0.0557
lnr	-7.514654	0.0017	-54.58298	0.0015
boilp	-6.023294	0.0460	-43.27031	0.0419
bop	-2.597545	0.9889	-16.12528	0.9590
fexrv	-1.246238	0.9999	-6.036051	0.9999
*MacKinnon (1996) p-values.				
Number of stochastic trends**				9

In Table 21, the tau-statistic and z-statistic values are used to evaluate the co-integration of each variable. The p-values associated with these statistics are calculated using the MacKinnon (1996) method and are used to determine the significance of the results. The tau-statistic values for all variables are negative, indicating a potential co-integrating relationship. However, the p-values associated with the tau-statistic suggest that the null hypothesis of no co-integration cannot be rejected for any of the variables. The p-values are all greater than 0.05, which is commonly used as the significance level. The z-statistic values, which provide an alternative test for co-integration, also show high significance levels (p-values) for all variables. The number of stochastic trends suggests that there are nine stochastic trends in the asymptotic distribution.

Table 22. Analysis of Vector Error Correction Result for Nigeria

Dependent variable is reer	
Variables	Coefficients
reer(-1)	0.687787
	[4.30627]
ec(-1)	-0.745101
	[-2.86458]
c	1.6198
	[3.91140]
fexrv	0.743115
	[2.04304]
bop	-0.113253
	(-0.38940)
boilp	0.47595
	(2.92123)
infr	1.588997
	[31.35891]
edb	1.917576
	[14.87194]
compr	0.5764

	[3.1279]
lnr	0.365894
	[11.61425]
fdi	-0.249964
	[-2.89006]
R-squared	0.683147
Adj. R-squared	0.603933
Sum sq. resids	619864.5
S.E. equation	124.4854
F-statistic	8.624131
Log likelihood	-312.2043
Akaike AIC	12.67468
Schwarz SC	13.09135
Mean dependent	206.3781
S.D. dependent	197.8036

In Table 22, the R-squared value of 0.6831 indicates that the model explains approximately 68.31% of the variation in the dependent variable, *reer*. The adjusted R-squared value of 0.6039 suggests that the model accounts for around 60.39% of the variation while considering the degrees of freedom. The *reer* (-1) has a positive coefficient of 0.6878, which implies that a one-unit increase in the lagged *reer* variable leads to a 0.6878 unit increase in the current *reer*. The coefficient is statistically significant (t-statistic of 4.3063). Whenever the real effective exchange rate deviated from its equilibrium, 74% of its disequilibrium was restored in Nigeria. Other independent variables such as *c (1.6198), fexrv (0.7431), bop (-0.1133), boilp (0.0476), infr (-1.5890), edb (-1.9176), compr (0.5730), lnr (0.3659), and fdi (-0.2499)* are also included in the model. Each variable has a coefficient and a corresponding t-statistic value, which measures their significance in explaining the variation in the *reer*.

The sum of squared residuals (619864.5) provides a measure of the model's overall fit, with lower values indicating a better fit. The standard error of the equation (124.4854) reflects the average dispersion of the observed *reer* values around the predicted values. The F-statistic (8.6241) indicates the overall significance of the model, testing the joint significance of all the independent variables together. The log likelihood (-312.2043) is used in maximum likelihood estimation and model comparison, with higher values indicating a better fit. The AIC and SC help compare models, with lower values suggesting a better trade-off between goodness of fit and model complexity.

Table 23. Analysis of Vector Error Correction Result for Libya

Dependent variable is reer	
Variables	Coefficients
reer(-1)	0.883738
	[8.7722]
ec(-1)	-0.571562
	[-5.6797]
c	36.98652
	[3.2207]
fexrv	-0.174536
	[-3.02714]
bop	-0.02144

	[-1.28423]
boilp	-0.008254
	[-4.12052]
infr	-0.14540
	[-0.31239]
edb	0.06493
	[1.3333]
compr	0.03221
	[9.31490]
lnr	0.071805
	[0.63925]
fdi	-0.482554
	[-3.09695]
R-squared	0.784460
Adj. R-squared	0.730575
Sum sq. resids	32546.77
S.E. equation	28.52489
F-statistic	14.55804
Log likelihood	-237.0604
Akaike AIC	9.727857
Schwarz SC	10.14453
Mean dependent	36.18742
S.D. dependent	54.95473

In Table 23, the estimate for *reer*(-1) is 0.883738 with a standard error of 0.10074. The t-statistic, which measures the significance of the estimate, is 8.77222. This suggests that the lagged value of *reer* has a significant positive effect on the current value of *reer*. According to the estimated VECM results, in Libya, 57% of the disequilibrium in the real effective exchange rate was restored to the long-term value. The estimates for the other variables follow a similar format. The model also includes a constant term (c) with an estimate of 36.98652. The R-squared value of 0.784460 indicates that the model explains about 78.4% of the variation in the dependent variable(s). The adjusted R-squared value accounts for the number of variables and observations in the model and is 0.730575 in this case. The sum of squared residuals is 32546.77, which measures the overall model fit. The standard error of the equation is 28.52489. The F-statistic of 14.55804 is used to test the overall significance of the model. The log-likelihood, AIC, SBC, mean dependent variable and standard deviation of the dependent variable are also provided.

Table 24. Analysis of Vector Error Correction Result for Angola

Dependent variable is reeR	
Variables	coefficients
reer(-1)	-2.37E-06
	[-0.18439]
ec(-1)	-0.60245
	[-7.43306]
c	180.8820
	[3.95523]
fexrv	-0.200587

	[-10.60448]
bop	-0.129358
	[-21.87131]
boilp	0.27643
	[13.07827]
infr	0.006390
	[0.16991]
edb	-0.000758
	[-0.00475]
compr	-0.850991
	[-2.30074]
lnr	1.045896
	[0.99521]
fdi	0.319814
	[2.83906]
R-squared	0.631796
Adj. R-squared	0.539745
Sum sq. resids	760552.6
S.E. equation	137.8907
F-statistic	30.206950
Log-likelihood	-317.4203
Akaike AIC	12.87923
Schwarz SC	13.29589
Mean dependent	94.94144
S.D. dependent	140.7154

In Table 24, the constant term (c) in the VECM model is 180.8820. It represents the intercept or the average value of the dependent variables when all other independent variables are zero. The coefficient of determination is 0.631796, indicating that approximately 63.18% of the variation in the dependent variables is explained by the independent variables in the model. The adjusted R-squared accounts for the number of independent variables and sample size, and it is 0.539745 in this case. About 60% of the disequilibrium in the real effective exchange rate was restored to the long-term value in Angola. The sum of squared residuals is 760552.6, which measures the overall model fit. The standard error of the equation is 137.8907. The F-statistic is 30.206950, which tests the overall significance of the model. The log-likelihood is -317.4203, used for model comparison. The AIC is 12.87923, which helps compare the quality of different models. The SBC is 13.29589, another criterion for model selection. The mean value of the dependent variables is 94.94144. The standard deviation of the dependent variables is 140.7154.

Table 25. Analysis of Vector Error Correction Result for Egypt

Dependent Variable is reer	
Variables	coefficients
reer(-1)	-0.114450
	[-0.78380]
ec(-1)	-0.534102
	[-2.04710]
c	120.6297
	[17.1317]

fexrv	-0.26890
	[-10.5172]
bop	-0.05271
	[-0.0478]
boilp	9.23540
	[22.1576]
infr	1.48203
	[-2.03094]
edb	0.32578
	[0.81438]
compr	1.372578
	[90.6279]
lnr	0.11262
	[2.46842]
fdi	0.761109
	[13.13370]
R-squared	0.454012
Adj. R-squared	0.317515
Sum sq. resids	526701.8
S.E. equation	115.8341
F-statistic	3.326172
Log-likelihood	-308.5209
Akaike AIC	12.52062
Schwarz SC	12.94729
Mean dependent	100.6750
S.D. dependent	140.2136

In Table 25, the estimates for the coefficients of the lagged variables (*reer*(-1) and *reer* (-2)), as well as the contemporaneous variables (c), are provided, along with their standard errors and t-statistics. Within the period of study in Egypt, 53% of the disequilibrium in the real effective exchange rate was restored to equilibrium. The R-squared value indicates that the model explains approximately 45.4% of the variation in the dependent variable. The adjusted R-squared is slightly lower at 31.8%, indicating that the model might not be a very good fit. The F-statistic tests the overall significance of the model, and in this case, it has a value of 3.326172. However, without the degrees of freedom, it is not possible to determine the statistical significance. Other statistics provided include the sum of squared residuals, standard error of the equation, log-likelihood, AIC, SBC, the mean and standard deviation of the dependent variable. It's important to note that without further context or additional information about the purpose of the analysis and the data used, it's difficult to provide a more specific interpretation of the results.

Table 26. Analysis of Vector Error Correction Result for Gabon

Dependent variable is reer	
Variables	coefficients
reer(-1)	0.451444
	[2.52789]
ec(-1)	-0.826170
	[-11.74994]
c	247.5850

	[1.52841]
fexrv	0.302714
	[18.02923]
bop	0.005292
	[0.07959]
boilp	0.12852
	[3.29922]
infr	-1.982520
	[-21.10147]
edb	0.601459
	[19.02632]
compr	-1.464510
	[-11.06396]
lnr	0.627692
	[6.73345]
fdi	-0.085487
	[-0.52795]
R-squared	0.856085
Adj. R-squared	0.820106
Sum sq. resids	264106.4
S.E. equation	81.25675
F-statistic	23.79413
Log likelihood	-290.4490
Akaike AIC	11.82152
Schwarz SC	12.23820
Mean dependent	202.9038
S.D. dependent	191.5804

In Table 26, *reer* (-1) and *reer* (-2) are lagged values of the real effective exchange rate. The coefficient estimates indicate the impact of the lagged values of *reer* on the current value of *reer*. The t-statistics in square brackets suggest the significance of the coefficients. The t-statistics in square brackets are calculated as the coefficient estimate divided by its standard error. They indicate the significance of the coefficient estimates. If the absolute value of the t-statistic is larger than 2 (in absolute terms), it suggests that the coefficient estimate is statistically significant at the 5% level.

In Gabon, 82% of the disequilibrium in the real effective exchange rate was restored to equilibrium. The R-squared is a measure of how well the model fits the data. In this case, the R-squared value is 0.856085, indicating that the model explains about 85.6% of the variation in the dependent variable. The Adj. R-squared adjusts the R-squared value for the number of predictors in the model. In this case, the adjusted R-squared value is 0.820106. Sum squared residuals represents the sum of squared residuals, which measures the overall goodness-of-fit of the model. S.E. equation is the standard error of the equation. F-statistic is a test statistic for the overall significance of the model. A larger F-statistic value suggests a better overall fit of the model. Log likelihood, Akaike AIC, Schwarz SC are measures of model fit and complexity. Mean dependent and S.D. dependent are the mean and standard deviation of the dependent variable (*reer*) in the sample.

Table 27. Analysis of Vector Error Correction Result for Ghana

Dependent variable is reer	
Variables	coefficients
reer(-1)	-0.140186
	[-0.83618]
ec(-1)	-0.7906578
	[-3.14978]
c	155.8487
	[1.31858]
fexrv	1.357451
	[1.77796]
bop	-0.033800
	[-24.16397]
boilp	0.152921
	[23.14430]
infr	0.843883
	[9.52556]
edb	0.684041
	[2.32254]
compr	0.68520
	[3.60299]
lnr	0.765683
	[1.13752]
fdi	0.97145
	[6.91519]
R-squared	0.458989
Adj. R-squared	0.323737
Sum sq. resids	1852480.
S.E. equation	215.2022
F-statistic	3.393569
Log likelihood	-340.1212
Akaike AIC	13.76946
Schwarz SC	14.18613
Mean dependent	171.6338
S.D. dependent	261.6910

The output of Table 27 provides the coefficient estimates for each lagged value of the variables. For example, *reer* (-1) represents the coefficient estimate for the lagged value of *reer* with a one-period lag. Whenever the real effective exchange rate of the Ghanaian cedi deviated from its equilibrium value, 79% of its disequilibrium was restored. The R-squared value measures the proportion of the total variation in *reer* that can be explained by the independent variables. The adjusted R-squared value adjusts the R-squared value for the number of variables and observations in the model, providing a more accurate measure of the model's explanatory power. The sum of squared residuals, represents the sum of the squared differences between the observed values and the predicted values from the VAR model. The standard error of the equation, which provides an estimate of the overall accuracy of the VAR model's predictions. The F-statistic tests the overall significance of the VAR model. A larger F-statistic indicates a better fit of the model to the data.

Table 28. Analysis of Vector Error Correction Result for Chad

Dependent variable is reer	
Variables	coefficients
reer(-1)	0.151520
	[1.15205]
ec(-1)	-0.651216
	[-4.47381]
c	915.0800
	[6.55912]
fexrv	0.582561
	[4.62936]
bop	0.01356
	[11.35683]
boilp	0.147085
	[2.64297]
infr	-0.148932
	[-5.26873]
edb	-1.01546
	[-1.44645]
compr	1.586835
	[20.64894]
lnr	1.651181
	[1.33687]
fdi	0.671065
	[2.66462]
R-squared	0.707627
Adj. R-squared	0.634524
Sum sq. resids	752611.3
S.E. equation	137.2599
F-statistic	9.681165
Log-likelihood	-317.1864
Akaike AIC	12.87006
Schwarz SC	13.28672
Mean dependent	147.8573
S.D. dependent	227.0493

In Table 28, the coefficient of determination (R-squared) is 0.707627, indicating a reasonably good fit. Also, the estimated VECM results indicated very clearly that whenever the real effective exchange rate deviated from its equilibrium value in Chad, 65% of its disequilibrium was restored in the long-run. The adjusted R-squared accounts for the number of predictors in the model and is a modified version of R-squared. It is 0.634524. The sum of squared residuals is 752611.3, which represents the unexplained variation in the dependent variable. The standard error of the equation is 137.2599. The F-statistic tests the overall significance of the model. Its value is 9.681165. The log-likelihood is -317.1864. The AIC is 12.87006. It is used for model selection, where lower values indicate a better fit. The BIC is 13.28672. Like AIC, it is used for model selection, and lower values indicate a better fit. The mean of the dependent variable is 147.8573. The standard deviation of the dependent variable is 227.0493.

5. Conclusion

This study examined the determinants of real effective exchange rate: evidence from selected African countries namely; Nigeria, Libya, Angola, Egypt, Gabon, Ghana, and Chad. The study carried out some descriptive statistics tests and the result from the unit root test was rejected for all variables based on the ADF test statistics which suggests that the variables in the series are stationary and do not exhibit a random walk behavior in all the African Countries used under estimation. The result of the cointegration test shows there exists a long-run equilibrium relationship among the variables as proven by the probability of tau-statistic and z-statistic. It also estimated the vector error correction model and found that whenever the real effective exchange rate deviated from its equilibrium, 74% of its disequilibrium was restored in Nigeria. In Libya, 57% of the disequilibrium in the real effective exchange rate was restored to the long-term value. About 60% of the disequilibrium in the real effective exchange rate was restored to the long-term value in Angola. Within the period of study in Egypt, 53% of the disequilibrium in the real effective exchange rate was restored to equilibrium. In Gabon, 82% of the disequilibrium in the real effective exchange rate was restored to equilibrium. Whenever the real effective exchange rate of the Ghanaian cedi deviated from its equilibrium value, 79% of its disequilibrium was restored. Also, whenever the real effective exchange rate deviated from its equilibrium value in Chad, 65% of its disequilibrium was restored in the long-run.

The following findings regarding the determinants of real pricing of domestic currencies of the above-mentioned African countries relative to the USD have implications for emerging market economies in developing policies to respond to commodity price fluctuations, variations in foreign investment inflows, inflation differential, the volume of foreign exchange reserves and changes in the global monetary and risk environment.

Higher inflation rates tend to erode a country's competitiveness, leading to a depreciation of the *reer*. Conversely, lower inflation rates enhance a country's competitiveness and contribute to an appreciation of the *reer*. The study found a significant positive link between *infr and reer* in Gabon, Nigeria, and Ghana, but a significant negative link with Chad. This suggests that changes in inflation rates impact the *reer* in these countries. However, no significant relationship was found between *infr and reer* in Libya, Angola, and Egypt. It implies that inflation does not significantly affect the *reer* in these countries, indicating the presence of other influential factors.

The share of FDI to GDP was found to be a significant positive determinant of the real effective exchange rate of Angola, Egypt, Gabon, Ghana, and Chad. This meant that the volume of investments made by foreign investors in Angola, Egypt, Gabon, Ghana, and Chad in real terms contributed to the variations in the real effective exchange rate of those countries unlike Nigeria, where the coefficient of FDI/GDP ratio was significantly negative.

Balance of payments surplus generate appreciation of the real effective exchange rate. Nevertheless, BoP deficit results in a depreciation of the *reer*. The analysis showed that in Nigeria, Angola, and Ghana balance of payment deficit fuels a devaluation of the naira exchange rate in relation to the USD, and other foreign trading partners' currencies. Also, bop deficit fuels the Angolan Kwanza and the exchange rate of the Ghanaian cedi. This indicates a fall in exchange rate values of the naira, Kwanza, and the cedi respectively. However, an insignificant relationship was observed between *bop* and *reer* in Libya and Egypt. This implies that BoP is not a primary driver of the real effective exchange rate dynamics in these countries. The study found a significant relationship between *lnr* and *reer* in Gabon and Nigeria, indicating that changes in interest rates impact the *reer* in this country. In other words, the real interest rate positively and significantly impacted the reer in Nigeria and Gabon. What this means is that in Nigeria and Gabon, higher real interest rates tend to attract foreign capital, thereby raising the demand for the local currencies and appreciating the *reer*. The negative coefficient of real interest rate signifies that lower interest rates stimulate capital outflows, and this devalues the *reer*. In contrast, no significant relationship was observed between *lnr* and *reer* in Libya, Angola, Egypt, Ghana, and Chad. It suggests that the real interest rate do not significantly influence the *reer* in these countries, implying the presence of other determining factors such as capital flows and external shocks.

Brent crude oil price shocks (*boilp*) significantly impact the *reer*, especially for countries heavily dependent on oil exports or imports. Increases in oil prices can lead to deterioration in a country's terms of trade, depreciating the *reer*. In turn, decreases in oil prices can improve a country's terms of trade, appreciating the *reer*. The analysis revealed a significant positive connection between *boilp and reer* in Nigeria, Angola, Egypt, Gabon, Ghana, and Chad. This indicates that fluctuations in Brent crude oil prices impact the *reer* in these countries. However, no significant relationship was found between *boilp* and *reer* in Libya suggesting that Brent crude oil price shocks do not play a significant role in determining the real effective exchange rate of the Libyan Dinar. The price of primary exports otherwise measured as commodity price level was a positive significant determinant of the reer in Nigeria, Egypt, and Ghana. By implication, higher commodity prices in Nigeria, Egypt, and Ghana indicate high level of domestic inflation which erode the value of the domestic currencies of those countries and so attract devaluation of the *reer*. Nonetheless, real effective exchange rate was negatively and considerably influenced by commodity price level in Gabon. This implies that the higher the level of commodity prices in Gabon, the lower the reer and leads to an appreciation of the *reer*.

The study identified a significant positive relationship between *commodity price and reer* in Libya, Egypt, and Chad, indicating that positive changes *in commodity prices* influence the *reer* in these countries. Conversely, an insignificant relationship was observed between *gdpgr and reer* in Nigeria, Angola, Gabon, and Ghana. This implies that *commodity prices* are not the primary driver of exchange rate dynamics in these countries. The findings provide an understanding into the relationships between these determinants and the *reer*, shedding light on the factors influencing exchange rate dynamics in each country. The significant relationships found in some countries, such as inflation rate in Gabon, Ghana, and Chad, foreign payment balance position in Angola, real interest rate in Gabon, Brent crude oil price shock in Nigeria, Angola, and Egypt, and commodity price changes in Libya, Egypt, and Chad, suggest the importance of these variables in shaping the dynamics of the *real* effective exchange rate. It emphasizes the need for policymakers to consider country-specific factors when formulating exchange rate policies and also policymakers should consider these factors while formulating policies to maintain exchange rate stability and promote economic growth in each country.

The findings of a significant relationship between inflation rate and real effective exchange rate in Gabon, Nigeria Ghana, and Chad. This means that as inflation increases in these countries, their *real effective exchange rates* tend to depreciate. Therefore, policymakers in these countries should be mindful of the impact of inflation on their *reer* s, and take steps to mitigate the negative effects of depreciation, such as by increasing interest rates or tightening monetary policy. Contrarily, the findings of no significant relationship between inflation rate and real effective exchange rate in Nigeria, Libya, Angola, and Egypt, suggest that the factors that affect the *reer*s in these countries are different from those in Gabon, Ghana, and Chad that policymakers in these countries should therefore focus on understanding the specific factors that affect their *reer*s, and develop policies accordingly.

Given the significant relationship between *bop and reer* in Angola, policymakers should focus on implementing measures to enhance productivity growth and ensure a stable real effective exchange rate which could involve investing in infrastructure development, promoting technological advancements, and implementing policies that encourage innovation. Although an insignificant relationship was found between *bop and reer* in Nigeria, Libya, Egypt, Gabon, Ghana, and Chad, it does not necessarily imply that productivity growth and exchange rate stability should be disregarded. It is important for policymakers in these countries to continue monitoring the relationship between *bop and reer* and evaluates other factors that might affect productivity growth which might include factors such as political stability, investment climate, access to finance, and regulatory frameworks.

With a significant relationship between *lnr and reer* in Gabon and Nigeria, it is recommended that policymakers should consider utilizing interest rate policies as a tool to manage the exchange rate and promote economic stability. However, monitoring and adjusting interest rates in response to changes in the real effective exchange rate can help mitigate fluctuations and maintain a favorable balance between domestic and external economic conditions. Conversely, an insignificant relationship was found between *lnr and reer* in Libya, Angola, Egypt, Ghana, and Chad, it is recommended that policymakers should focus on implementing comprehensive economic reforms to address structural issues and enhance competitiveness such as improving infrastructure, promoting diversification of the economy, and attracting foreign direct investment.

Nigeria, Angola, and Egypt found to be a significant relationship between oil price shocks and *reer* in these countries, policymakers should consider the implications of oil price shocks on the exchange rate and formulate appropriate strategies and measures to enhance resilience and manage the impact of oil price fluctuations on the *reer* should be prioritized. Libya, Gabon, Ghana, and Chad found a no significant relationship between oil price shocks and *reer* in these countries, it is important for policymakers to remain vigilant and consider other factors influencing exchange rate dynamics. While oil price shocks will not be the dominant driver in these economies, other factors such as political stability, fiscal discipline, foreign direct investment, and productivity growth could significantly impact the *reer*. Policymakers should focus on diversifying their economies, implementing structural reforms, and enhancing economic competitiveness to ensure sustainable growth and stability, regardless of oil price fluctuations. Having a significant positive effect of *compr on reer* in Libya, Egypt, and Chad, it is recommended that policymakers should consider the implications of commodity price level on the exchange rate and formulate appropriate strategies for national output, focus should be given to policies that promote sustainable and inclusive economic growth, such as investment in infrastructure, human capital development, and entrepreneurship support. Contrarily, a significant negative impact of *compr on reer* was found in Nigeria, Angola, Gabon, and Ghana. Overall, it is recommended that policymakers in all the countries in the sample of this study should focus on addressing structural constraints, commodity price fluctuations, and improving the business environment by anchoring policies of economic stability in order to enhance economic competitiveness. This could also be extended to the implementation of policies that support sectors beyond natural resources, and promote private-sector development. Also, there is a need for policymakers to consider country-specific exchange rate stabilization factors when formulating exchange rate policies.

References

1. Farhad T-H., Naoyuki Y., Ehsan R., Youngho C., Trade linkages and transmission of oil price fluctuations, Energy Policy, 133, 2019, 110872, https://doi.org/10.1016/j.enpol.2019.07.008.

2. Bah I., & Amusa H. A. Real exchange rate volatility and foreign trade: evidence from South Africa's Export to the United States," The African Finance Journal, 5(2), 2003, 1-20.

3. Morina, F., Eglantina H., Uğur E., Mirela P., & Marian C. V. The effect of exchange rate volatility on economic growth: Case of the CEE Countries. *Journal of Risk and Financial Management* 2020, 13, no. 8: 177. https://doi.org/10.3390/jrfm13080177

4. Sadia, Haleema & Ahmad, Eatzaz & Ihsan, Hajra. Determinants of real effective exchange rate: evidence from panel unit-root and co-integration approach. 1. 97-119, 2009.

5. Bošnjak, M., Kordić, G. & Novak, I. Real effective exchange rate and industrial productivity in Croatia: Wavelet Coherence Analysis. South East European Journal of Economics and Business, 2021, 16(1), pp.30-37. https://doi.org/10.2478/jeb-2021-0003.

6. Ben-Naser A. Estimating equilibrium real exchange rate and misalignment in an oil-exporting country: Libya's experience. The Journal of Developing Areas 2019, 249-267. https://doi.org/10.1353/jda.2018.0063.

7. Hadood, A. & Saleh, R. Modelling the equilibrium real exchange rate: evidence from oil-exporting country. *Journal of Financial Risk Management*, **11**, 677-705, 2022. doi: 10.4236/jfrm.2022.113033.

8. Nazar Ali, & Ashok Mittal. Nexus between exchange rate volatility and oil price fluctuations: evidence from India. Saudi Journal of Economics and Finance, 2023, 7(3):135-146. DOI: 10.36348/sjef.2023.v07i03.003.

9. Abdelgany, M. Determinants of real exchange rate evidence: from Egypt. مجلة السیاسة والاقتصاد. 7. 2020. 10.21608/jocu.2020.37917.1041.

10. Massoud, Ali & Willett, Thomas. Egypt's exchange rate regime policy after the float. International Journal of Social Science Studies. 2014. 2. 10.11114/ijsss.v2i4.445.

11. Kenny, S. V. macroeconomic performance indicators and exchange rate misalignment in Nigeria. MPRA Paper 93292, 2019. University Library of Munich, Germany.

12. Cizmović, M., Shachmurove, Y. & Vulanovic, M. Real effective exchange rates and deindustrialization: evidence from 25 Post-Communist Eastern European Countries Post-Communist Economies, 33(7), 2021. 863–899. https://doi.org/10.1080/14631377.2020.1867429

13. Lanau, S. 2017. The sectoral effects of real depreciations in Latin America. IMF Working Paper, WP/17/249.

14. Bhattarai, K., & Ben-Naser, A. (2020). Real exchange rate misalignments of Libyan Dinar: Fundamentals and Markov Switching Regimes. Journal of Development Economics and Finance, 1, 151-162.

15. Mohd F. M. A., Sharifah F. S. M., Anis S. M. Y., Shahrina I. & Noor A. I. A GARCH Study on exchange rate determinants: A Case of Malaysia. Journal of Statistical Modeling and Analytics 4(1), 72-84. 2022.

16. Lothian, J.R.,& M.P. Taylor. Real Exchange Rate Behavior: The Recent Float from the Perspective of the Past Two Centuries. Journal of Political Economy, 104, 1996. 488–510.

17. Mark, N. Real and nominal exchange rates in the long run: an empirical investigation. Journal of International Economics, 28, 1990, 115-36.

18. Adu J. J., Okyere F., Amoah, E. & Adu, J. Effects of exchange rate volatility on real estate prices in developing economies, a case of Ghana. Advances in Social Sciences Research Journal. 2019, 6. 268-287. 10.14738/assrj.611.7392.

19. Samuel A., Mohammed I., Aboagyewaa P. & Solomon A. The effect of macroeconomic variables on exchange rate: Evidence from Ghana, Cogent Economics & Finance, 8:1, 2020. 1821483, DOI: 10.1080/23322039.2020.1821483

20. Yusuf W., Yusuf W. A., Oyegoke E., Jelilov G. & Haruna, T. Determinants of exchange rate in nigeria: a comparison of the official and parallel market rates. 22. 2019. 10.18488/journal.29.2019.62.178.18.

21. Kouladoum J-C. & Dombou T. D. R. external debts and real exchange rates in developing countries: evidence from Chad. Sumerianz Journal of Economics and Finance, Sumerianz Publication, 2(1), 2019, 1-6, 01-2019.

22. Kataria, N. & Gupta, A. Determinants of real effective exchange rates in emerging market economies. 2018. https://ssrn.com/abstract=3144172.

23. Goda, T. & Priewe, J. Determinants of real exchange rate movements in 15 emerging market economies. Revista de Economia Política. 40. 2020. 214-237. 10.1590/0101-31572020-3072.

24. Frenkel, J.A. The collapse of purchasing power parities during the 1970's. European Economic Review, 1, 1981, 145-165. http://dx.doi.org/10.1016/0014-2921(81)90055-6

25. Krugman, P.R. Purchasing power parity and exchange rates: another look at the evidence. Journal of International Economics. 8, 1978, 397-407.

26. Bahmani-Oskooee, M. & Gelan, A. Exchange rate volatility and international trade performance from 12 african countries. Economic Analysis and Policy 2018, vol. 58(C), pages 14-21.

27. Froot, K.A., & K. Rogoff. Perspectives on PPP and long-run real exchange rates," in K. Rogoff and G. Grossman, 1995 eds., Handbook of International Economics (Amsterdam: North Holland).

28. Cashin, P., Céspedes, L. F., & Sahay, R. (2004). Commodity currencies and the real exchange rate. Journal of Development Economics, 75, 239-268. https://doi.org/10.1016/j.jdeveco.2003.08.005.

29. Adusei M. & Gyapong, E. Y. The impact of macroeconomic variables on exchange rate volatility in Ghana: The Partial Least Squares Structural Equation Modeling Approach. Research in International Business and Finance, 42(C), 2017, 1428-1444.