# ECONOMIC FUNDAMENTALS AND NOMINAL EXCHANGE RATE IN AFRICAN OIL PRODUCING COUNTRIES: EVIDENCE FROM ASYMMETRIC COINTEGRATION

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## ABSTRACT
The role of exchange rates is very important in the international market, and the variability of exchange rates, in appreciation or depreciation, is directly connected with a country's economic performance. Exchange rate variations in oil-producing African countries have been too high, resulting in volatilities due to domestic and foreign shocks. High exchange rate volatility may translate into reduced. Several studies on the relationship between economic fundamentals and exchange rates focused more on Africa or country-specific countries, with limited focus on African oil-producing countries using asymmetric cointegration. Therefore, this study examines the relationship between some economic fundamentals and exchange rates in African oil-producing countries. The dynamic panel nonlinear autoregressive distributed lag and linear autoregressive distributed lag were used to investigate the relationship between economic fundamentals and nominal exchange rate (NER). The NARDL result shows that that there is evidence of both short and long-run asymmetric relationship between economic fundamentals and the nominal exchange rate. The study recommended that policymakers in African oil-producing countries should encourage strong and stable currencies that will stabilize each country's economy.

**Keywords: Economic fundamental, Nominal exchange rate, Asymmetric, Terms of trade, Money supply**

**JEL CLASSIFICATION: C23, C52, F31, N17**

## 1. INTRODUCTION

The exchange rate is the price of a country's currency in terms of another country's currency and is one of the major components of macroeconomic discussions. There are factors of different fundamentals such as terms of trade, net foreign asset, foreign deficit, money supply, real income, inflation rates, unemployment, real interest rates, consumer preferences, and government trade policy, help to know the changes in supply and demand of currencies and the reason why some currencies appreciate, and some depreciate.

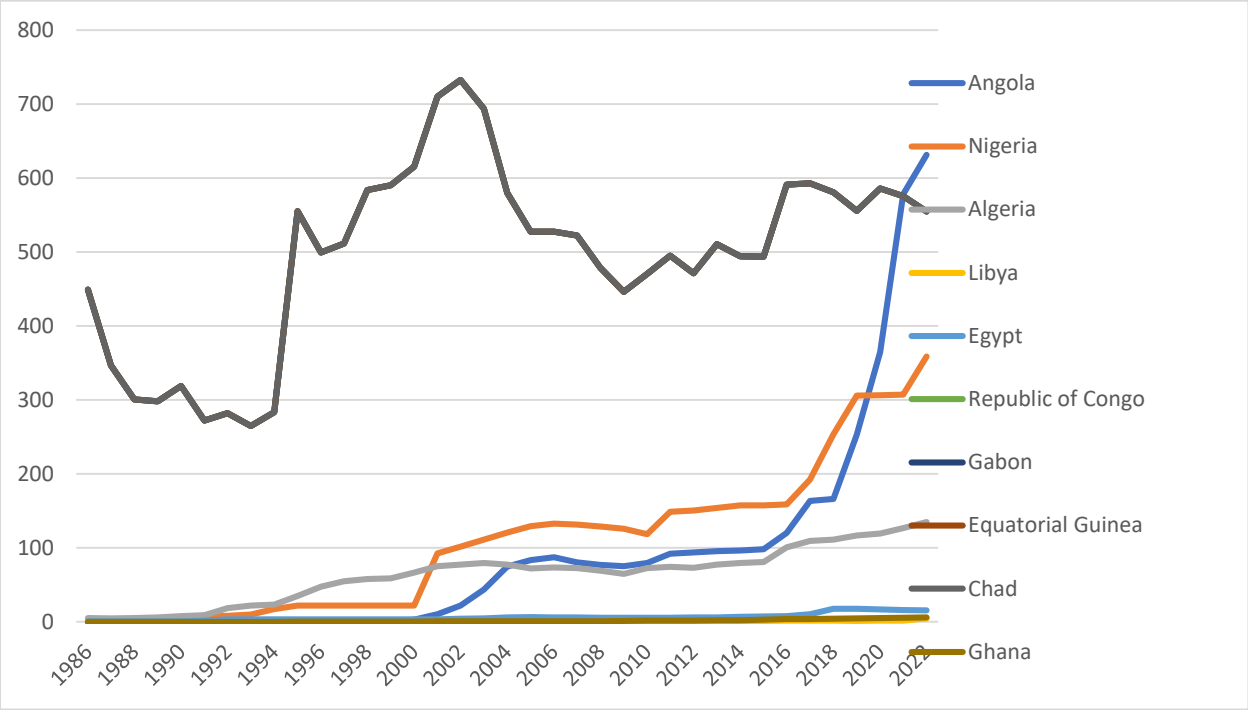
In developed countries, it is impossible to overstate the effectiveness of a stable exchange rate in attaining macroeconomic goals. Every free market economy in the world relies on the exchange rate to determine its level of trade, which is crucial in the economic integration process. However, the exchange rate of currencies among countries of the world is monitored closely, examined, and manipulated by macroeconomic indicators by governments (Adejayan & Oke, 2021; Nadabo & Dakyong, 2023; Vidyavathi et al., 2016). Exchange rates allow you

to compare the prices of goods, services, and assets in different currencies from different nations. In addition, the exchange rate is one of the determinants used to evaluate an economy's performance. A strong and viable exchange rate represents a perfectly viable economy, and a weak currency reflects a very sensitive and fragile economy. The exchange rate has a key impact on the capability of many developing countries, particularly those in oil-producing countries in Africa, to achieve optimal levels of industrial activities (Oshota, 2023; Ramasamy & Abar, 2015).

The nominal floating exchange rate is often regarded as an asset price in exchange rate modelling. According to the standard asset pricing theory, its current price should reflect the market's expectations concerning present and future economic conditions. However, a long-standing puzzle in international economics and finance is the disconnection between exchange rate movements and macroeconomic fundamentals (Rufai et al., 2022; Weiwei & Junye, 2014). Exchange rate variations in oil-producing African countries have been too high, resulting in volatilities due to domestic and foreign shocks. High exchange rate volatility may translate into a reduction of trade flows, foreign direct investment (FDI), and instability in both interest rates and inflation rates. Instability in macroeconomic variables imposes a real cost to households' decision-making, firms' profitability, financial stability, and economic performance of a country concerning export performance, interest rates, foreign direct investment, and inflation. For instance, researchers have argued that excessive exchange volatility has reduced economic growth through its impact on trade and investment (Anyanwu et al., 2017; Thomas et al., 2023) Most currencies were weakened in 2022 against the US dollar for trade invoicing and external debt. Official exchange rates in non-pegged countries in which the exchange rate is not fixed to another currency, depreciated by 7% (per cent) at the end of 2022, which exceeds 20% (per cent) in some countries. There were large exchange rate spreads in parallel markets in some countries (Burundi, Ethiopia, and Nigeria) at times. Also, official exchange rates are in pegged countries in which the exchange rate is fixed to another currency (mostly to the euro or the South African Rand). These countries witnessed their currencies weaken against the US dollar. The exchange rate pressures also manifested in the depletion of reserve assets, as foreign exchange inflows slowed, and central banks used their reserves to finance imports and repay foreign debt. An index combining depreciation against the US dollar and reserve depletion shows that exchange rate pressures were at a six-year peak in 2022 on average and were higher in pegged countries.

African oil-producing countries recorded substantial depreciation against other major currencies largely due to the global appreciation of the US dollar in the second quarter of 2015. Also, at the end of January 2022, another depreciation of oil-producing countries' currencies was recorded, raising concerns about the effect of the fast depreciation of the currencies on other macroeconomic variables and the economy.

Figure1:Oil Producing Countries Nominal Exchange Rate 1986 – 2022




Source: Authors' compilation.

Figure 1 shows the growth rate of the nominal exchange rate plotted for the study period (1986-2022). Chad among the oil-producing countries in Africa recorded the highest nominal exchange rate in 2002 with a value of 732.4 and it has been at the high side since 1986. Angola recorded the highest nominal exchange rate in 2022 with a value of 631.4 and recorded the lowest nominal exchange rate in 1996 with a value of 0.002. Nigeria on the other hand, recorded the highest nominal exchange rate in 2022 with a value of 358.8, and the lowest value in 1986 with a value of 0.766. Algeria also recorded its highest value in 2022 with a value of 135.1. The oil-producing countries like Libya, Egypt, Congo, Gabon Guinea, and Ghana have the lowest nominal exchange rate values from 1986 to 2022 (World Development Indicator [WDI], 2023).

There is a gap in information on whether the recorded exchange rate movements have resulted in exchange rate volatility and to what extent it has impacted macroeconomic variables such as growth, interest rate, inflation, foreign direct investment (FDI), net foreign asset, and trade flows. Against this backdrop, this study examined the extent of exchange rate volatility in oil-producing countries and identified its subsequent impact on economic fundamentals. There are differences between oil-producing countries and non-oil-producing countries in Africa because the depreciation in the oil-producing countries is very high. After all, oil-producing countries depend majorly on oil exports, and the depreciation level of the non-oil-producing countries is not as high as oil-producing countries. This study aims to examine the effect of economic fundamentals on nominal exchange rates in African oil-producing countries.
Following this section, we structure the rest of the paper as follows. Section 2 provides the literature review for the study while Section 3 explains the methodology applied for economic fundamentals and nominal exchange rate nexus, as we present the dynamic heterogenous panel data model and the discussion of results. Section 5 however concludes the paper.

## 2. LITERATURE REVIEW

2.1 Conceptual Review

### 2.1.1 Exchange rate

The exchange rate is the relative price of one currency to another, the amount of foreign currency that may be bought for one unit of domestic currency. The exchange rate reflects the ratio at which one currency can be exchanged for another. It is the exchange rate between a foreign currency and the home country's currency. It also specifies the value of one currency in terms of another. The price of one country's currency represented in terms of another currency is known as the exchange rate. It determines the relative prices of domestic and imported commodities and the degree of the external sector's involvement in international commerce (Ashogbon et al., 2023; Dada, 2022).

### 2.1.2. **Nominal Exchange Rate**

The nominal exchange rate is defined as the number of domestic currency units needed to purchase a unit of a given foreign currency. The nominal exchange rate is the actual foreign exchange market rate. It is the price of one currency in terms of another. It may be quoted as so many units of domestic currency per unit of a foreign currency or conversely (Emeka et al., 2020). In Nigeria, it is estimated as units of Naira per unit of a foreign currency (US Dollar). In the UK, it is estimated as units of foreign currency per unit of a pound sterling. The concept of Nominal exchange rate is important in many respects. It determines the cost of imports and the level of revenue to exporters. It is also used for policy purposes as a variable to compensate for movements in the differential inflation rate. According to Mordi and Audu (1991), a nominal exchange rate (NER) at which a currency is traded at a given time is established at the interplay of demand and supply in the foreign exchange market. In the era of flexible regimes, the nominal exchange rate is used to moderate output fluctuation since that is probably the strongest appeal of floating exchange rates (Alagidede & Ibrahim, 2016).

### 2.1.3 **Economic Fundamentals**

Economic fundamentals are key economic performance indicators closely monitored by government businesses and consumers. Macroeconomic fundamentals include changes in employment, national income, rate of growth, gross domestic product, inflation, price level, exchange rate, terms of trade, and interest rate (Munyao, 2017). Economic fundamental analysis looks at the underlying forces that are moving the markets. Long-term investors generally use it, but traders can also use it to gain an understanding of the market they want to trade. The combination of fundamental analysis alongside technical analysis, which is the price level, can be a powerful combination that empowers traders and paints a complete picture of the market (Pozzi & Sadaba, 2018)

2.2 Theoretical Review

### 2.2.1 **Scapegoat Theory of Exchange Rate**

Bacchetta and Wincoop (2004) propose a scapegoat theory of exchange rates to explain the instability in the relationship between exchange rates and economic fundamentals. The scapegoat theory of exchange rate means that the expectation of the structural parameter associated with that variable becomes much larger than the structural parameter. The variable temporarily has a large weight in the reduced form of the exchange rate equation, which may cause an unrelated change to an unobserved fundamental. The scapegoat theory starts from the premise that agents may have a fairly accurate idea about the relationship between fundamentals and exchange rates in the long run; there is significant uncertainty about the

structural parameters over the short to medium term. This implies that when currency movements over the short to medium term are inconsistent with their priors about the underlying structural relationships, agents search for scapegoats to account for these inconsistencies. Unobservable fundamentals may drive such currency movements, yet for agents, it may be rational to assign additional weight to some fundamentals, thus making it a scapegoat for observed exchange rate changes.

### 2.2.2. **Portfolio Balance Exchange Rate Theory**

The theory suggests that the effect runs from the stock prices to the exchange rate. According to Efuntade and Efuntade (2022), the Portfolio balance theories indicate that activities in the capital account determine the exchange rate. The theory indicates that foreign investors will be attracted to the domestic market when stock prices increase. The arrival of foreign investors will result in a huge influx of capital inflows. Given that foreign investors change their foreign currency into the domestic currency, there will be a huge demand for money. The huge demand for money might be inflationary, which can prompt the intervention of monetary authorities through increasing the interest rate, which can further result in more funds flowing into the country. On the other hand, when stock prices decrease, this may diminish corporate wealth and the country's wealth. The theory, therefore, emphasizes that the effect runs from stock prices to the exchange rate. Again, the theory highlights that the link between the variables depends on what happens to the interest rate.

### 2.2.3 **Monetary Model of Exchange Rate**

The monetary model of exchange rate determination posits a strong link between the nominal exchange rate and a simple set of monetary fundamentals. The monetary model's clear-cut intuition that its supply and demand for money determines a country's price level and that the price level in different countries should be the same when expressed in the same currency makes it an attractive theoretical tool for understanding fluctuations in exchange rates over time. It also provides a long-run benchmark for the nominal exchange between two currencies and, thus, a clear criterion for determining whether a currency is significantly "overvalued" or "undervalued" (Rapach & Wohar, 2002). The relevant economic fundamentals for exchange rate determination are factors influencing the relative supply and demands for national money stocks, and the current account does not have a role in influencing exchange rate development in the monetary model.

### 2.2.4 **Interest Rate Parity Theory**

Interest Rate Parity (IPR) theory analyzes the relationship between the spot rate and a corresponding forward (future) rate of currencies. The IPR theory states interest rate differentials between two different currencies will be reflected in the premium or discount for the forward exchange rate on the foreign currency if there is no arbitrage –the activity of buying shares or currency in one financial market and selling it at a profit in another. The theory further states that the size of the forward premium or discount on a foreign currency should be equal to the interest rate differentials between the countries in comparison (Ge & Sun, 2024). The interest rate parity theory relates the difference between foreign and domestic interest rates with the difference in spot and future exchange rates. This parity condition states that the domestic interest rate should equal the foreign interest rate plus the expected change in the exchange rates. If investors are risk-neutral and have rational expectations, the future exchange rate should perfectly adjust, given the present interest-rate differential.

### 2.2.5 **Purchasing Power Parity Theory**

Purchasing power parity (PPP) was propounded by Cassel (1918) when the PPP theory was expressed in terms of statistical averages of prices, and he was also the first to test it empirically. According to this theory, the exchange rate of any pair of currencies is the point where their respective purchasing powers are equal. The purchasing power of a currency is what a unit of the currency can buy, and the price determines this power. According to Lipsey (2007), in the long term, the average exchange rates of any pair of currencies depend on their relative purchasing powers. Purchasing Power Parity (PPP) states that the exchange rate between two currencies is in equilibrium when their purchasing power is the same in each country. That is the law of one price: identical goods should sell for identical prices in different countries' markets (Kasem & Al-Gasaymeh, 2021).

## 2.3. Empirical Review

Bilal and Shahbaz (2019) investigated the relationship between nominal and real effective exchange rates during the last two devaluations in Algeria. The study's empirical results suggested that the nominal devaluation leads to real devaluation not only in the long run but also in the short run in Algeria for both devaluations. However, all coefficients estimated for the second devaluation are lower than the first. The study analysis shows that reducing imports through the devaluation of the dinar led to a significant increase in import prices. However, the present study shows that considering all of the structural problems of the Algerian economy, the devaluation of the dinar may lead to more severe inflation than anticipated by the Algerian government. Meanwhile, Smahi (2018) investigated Algeria's inflation using an ARDL Testing Approach. The model used inflation as the dependent variable and public expenditure, money supply, oil prices, import, and effective exchange rate as independent variables. The empirical finding of the study shows that in the short-run analysis, only external factors (import price, oil price, and effective and nominal exchange rates) impact inflation in Algeria. However, regarding the impact on inflation, fiscal and monetary policies cannot be statistically significant on their own.

Yabu and Kimolo (2020) investigated exchange rate volatility and its implications on macroeconomic variables in East African countries using the ARDL and PMG (Pooled Mean Group) model. The result indicates that exchange rate volatility is noticed to positively affect the lending rates in the long run at the 1 per cent significance level. The results also show that a 1 per cent increase in exchange rate volatility raises exports by 0.97 per cent. In the short-run model, exports also positively and significantly affect lending rates. The study's long-run and short-run findings show that nominal exchange rate volatility is linked with an increase in interest rates through its impact on the current account deficit. Husaini and Lean (2021), examined the asymmetric impact of oil price and exchange rate on disaggregation price inflation using a nonlinear autoregressive distributed lag model (NARDL). The study finds that an increase in oil price has a greater impact on the producer price index (PPI) than the consumer price index (CPI). Also, a decrease in the oil price is only significant in reducing both CPI and PPI in Thailand. The result also shows that an increase in the exchange rate is significant in an increase in both the CPI and PPI and a decrease in the exchange rate failed to reduce both the CPI and PPI.

Okonkwo et al. (2021) studied exchange rate and foreign direct investment in Nigeria from 1981-2018 using the unit root test, stationarity test, multi-collinearity, cointegration

relationship, and error correction model (ECM). The findings revealed that both the real and nominal exchange rates are positively related to foreign direct investment. Ahmad and Aworinde (2016) examined the role of structural breaks, nonlinearity, and asymmetric adjustments in African bilateral real exchange rates using Threshold cointegration tests. The findings indicated that the threshold cointegration has a long-run relationship between the nominal exchange rate and the consumer price index.

## 3. METHODOLOGY

### 3.1. Theoretical Framework

This study is hinged on the scapegoat theory of exchange rate propounded by Bacchetta and Wincoop (2004). The study considered the fundamental-based exchange rate models that can be reduced to a single stochastic difference equation used by Pozzi and Sadaba (2018). The equilibrium value of the exchange rate in these models depends on the present value of expected future fundamentals. The study will consider an interest rate parity condition between a local and a benchmark country and an equation that contains determinants of the interest rate differential between these countries:

$$E_t(s_t+1)-s_t=\bar{i}_t+z_t \quad (1)$$

$$\bar{i}_t=\mu\left[s_t-f_t\beta_t-x_t\right] \quad (2)$$

Where: $s_t$ = the log nominal exchange rate; $E_t$ = denotes the rational expectations operator conditional on time *t* information; $\bar{i}_t$ = short-term nominal interest rate differential between the local country and the benchmark country; $z_t$ = the exchange risk premium or deviation from UIRP,

$f_t$ = 1 ×*K* vector of observed macroeconomic fundamentals; $\beta_t$ = the *K* ×1 vector of corresponding time-varying parameters, and *x* = an unobserved fundamental or component.

Equation (2) represents the interest rate differential obtained from the differential in Taylor rules between the local and the benchmark countries. Alternatively, this represents the interest rate differential as obtained from the reduced form monetary model of exchange rates, which is obtained by combining a Purchasing Power Parity condition with money market equilibrium in both countries. The unobserved component in the Taylor rule model represents a relative shock to the Taylor rule. In the monetary model, the unobserved component represents an unobserved relative money demand shock, possibly augmented with an exchange rate shock.

Assuming that the parameter vector $\beta_t$ is unknown, that means:

$$E_t(\beta_{kt})\neq\beta_{kt} \quad \text{for k = 1, ……., k} \quad (3)$$

Concerning the parameter μ, it is assumed that μ is known and constant. The signal $y_t$ is given by

$$y_t=f_t\beta_t+x_t \quad (4)$$

The agents know this signal as

$$y_t\equiv s_t-\frac{1}{\mu}\bar{i}_t \quad (5)$$

agents observe $s_t$, $\bar{i}_t$ and μ. If $\beta_t$ were unknown agents, it could infer the value of the unobserved component x. given that $\beta_t$ is unknown, $y_t$ gives an imperfect signal of $\beta_t$ because of the unobserved component x. Equations (1)-(5) and solving gives

$$s_t = (1-\lambda)\left[ y_t + \sum_{j-1}^{\infty} \lambda^j E_t(y_{t+j}) \right] - \lambda \left[ z_t + \sum_{j=1}^{\infty} \lambda^j E_t(z_{t+j}) \right]$$

Or

$$s_t = (1-\lambda)\left[ f_t\beta_t + x_t + \sum_{j-1}^{\infty} \lambda^j E_t(f_{t+j}\beta_{t+j} + x_{t+j}) \right] - \lambda \left[ z_t + \sum_{j=1}^{\infty} \lambda^j E_t(z_{t+j}) \right] \quad (6)$$

Where the result obtained by imposing the transversality condition

$$\lambda^{\infty} E_t(s_{t-\infty}) = 0 \quad (7)$$

and where we define the discount factor λ as

$$\lambda \equiv \frac{1}{1+\mu} \quad (8)$$

Assuming that the observed macroeconomic fundamentals $f_t$ and corresponding time-varying unknown parameters $\beta_{t\ follow}$ random walk, this shows that,

$$x_t = \rho_x x_{t-1} + \varepsilon_t^x \quad (9)$$

$$z_t = \rho_z z_{t+1} + \varepsilon_t^z \quad (10)$$

$$f_{kt} = f_{k,t-1} + \varepsilon_{kt}^f \qquad \text{k = 1,……k} \quad (11)$$

$$\beta_{kt} = \beta_{k,t-1} + \varepsilon_{kt}^{\beta} \qquad \text{k = 1,……k} \quad (12)$$

Where all processes are assumed to be mutually independent. Using the process in equation (6), it gives

$$s_t = (1-\psi) f_t\beta_t + \psi f_t E_t(\beta_t) + (1-\psi)x_t + \Phi_{zt} \quad (13)$$

Where

$$\psi \equiv \frac{\lambda(1-\rho_x)}{1-\rho_x\lambda} \quad (14)$$

$$\Phi \equiv -\frac{\lambda}{1-\rho_z\lambda} \quad (15)$$

However, $(1-\psi) f_t\beta_t$ captures the standard impact of macro fundamentals on the exchange rate $s_t$ through the time-varying structural parameters $\beta_t$. This $\psi f_t E_t(\beta_t)$, captures the impact of macro fundamentals on the exchange rate through the occurrence of scapegoat effects as captured by the expectations about the unknown parameters through $E_t(\beta_t)$. Also, $(1-\psi)x_t$, it captures the role of the unobserved component $x_t$. $\Phi z_t$, and captures the impact of uncovered interest rate parity (UIRP) deviations or exchange rate risk premiums $z_t$.

## 3.2 Model Specification

This study adopts a nonlinear relationship to investigate the relationship between economic fundamentals and nominal exchange rates in African oil-producing countries. Unlike the symmetric case, this version of the panel ARDL, referred to as nonlinear PARDL, allows for asymmetric response of economic fundamentals to nominal exchange rate. In other words, under this scenario, positive and negative shocks are not expected to have identical impacts on nominal exchange rate. Thus, following the specification of Salisu and Isah (2017), the asymmetric is expressed below:

$$\begin{aligned}\Delta ner_{it} &= \eta_i + \gamma_{1i} ner_{i,t-1} + \gamma_{2i}^{+} tot_{t-1}^{+} + \gamma_{2i}^{-} tot_{t-1}^{-} + \gamma_{3i}^{+} nfa_{t-1}^{+} + \gamma_{3i}^{-} nfa_{t-1}^{-} + \gamma_{4i}^{+} fd_{t-1}^{+} + \gamma_{4i}^{-} fd_{t-1}^{-} \\ &+ \gamma_{5i}^{+} inf_{t-1}^{+} + \gamma_{5i}^{-} inf_{t-1}^{-} + \gamma_{6i}^{+} gdp_{t-1}^{+} + \gamma_{6i}^{-} gdp_{t-1}^{-} + \gamma_{7i}^{+} int_{t-1}^{+} + \gamma_{7i}^{-} int_{t-1}^{-} + \gamma_{8i}^{+} ms_{t-1}^{+} + \gamma_{8i}^{-} ms_{t-1}^{-} \\ &+ \gamma_{9i}^{+} fdi_{t-1}^{+} + \gamma_{9i}^{-} fdi_{t-1}^{-} + \sum_{j=1}^{p1} \lambda_{ij} \Delta ner_{i,t-j} + \sum_{j=0}^{p2} \left( \delta_{ij}^{+} \Delta tot_{t-j}^{+} + \delta_{ij}^{-} \Delta tot_{t-j}^{-} \right) \\ &+ \sum_{j=0}^{p3} \left( \delta_{ij}^{+} \Delta nfa_{t-j}^{+} + \delta_{ij}^{-} \Delta nfa_{t-j}^{-} \right) + \sum_{j=0}^{p4} \left( \delta_{ij}^{+} \Delta fd_{t-j}^{+} + \delta_{ij}^{-} \Delta fd_{t-j}^{-} \right) \\ &+ \sum_{j=0}^{p5} \left( \delta_{ij}^{+} \Delta inf_{t-j}^{+} + \delta_{ij}^{-} \Delta inf_{t-j}^{-} \right) + \sum_{j=0}^{p6} \left( \delta_{ij}^{+} \Delta gdp_{t-j}^{+} + \delta_{ij}^{-} \Delta gdp_{t-j}^{-} \right) \\ &+ \sum_{j=0}^{p7} \left( \delta_{ij}^{+} \Delta int_{t-j}^{+} + \delta_{ij}^{-} \Delta int_{t-j}^{-} \right) + \sum_{j=0}^{p8} \left( \delta_{ij}^{+} \Delta ms_{t-j}^{+} + \delta_{ij}^{-} \Delta ms_{t-j}^{-} \right) \\ &+ \sum_{j=0}^{p9} \left( \delta_{ij}^{+} \Delta fdi_{t-j}^{+} + \delta_{ij}^{-} \Delta fdi_{t-j}^{-} \right) + \mu_i + \varepsilon_{it}\end{aligned} \tag{16}$$

Where NER is the Nominal Exchange Rate, TOT is Terms of Trade, NFA is Net Foreign Assets, FD is Foreign Deficit, INF is Inflation, GDP is Gross Domestic Product, INT is Interest Rate, MS is Money Supply, FDI is Foreign Direct Investment. Furthermore, $tot_t^{+}, tot_t^{-}, nfa_t^{+}, nfa_t^{-}, fd_t^{+}, fd_t^{-}, gdp_t^{+}, gdp_t^{-}, int_t^{+}, int_t^{-}, ms_t^{+}, ms_t^{-}, fdi_t^{+}$ *and* $fdi_t^{-}$ denote the positive and negative of term of trade, net foreign asset, foreign deficit, inflation, gross domestic product, interest rate, money supply and foreign direct investment, respectively. The long run (elasticity) coefficients the economic fundamentals proxies, for $tot_t^{+}$ and $tot_t^{-}$ are calculated $-\frac{\gamma_{2i}^{+}}{\gamma_{1i}}$ *and* $-\frac{\gamma_{2i}^{-}}{\gamma_{1i}}$. These shocks are computed respectively as positive and negative partial sum decompositions of economics fundamentals changes as defined for term of trade below:

$$tot_t^{+} = \sum_{k=1}^{t} \Delta tot_{ik}^{+} = \sum_{k=1}^{t} max\left(\Delta tot_{ik}, 0\right) \tag{17}$$

$$tot_t^{-} = \sum_{k=1}^{t} \Delta tot_{ik}^{-} = \sum_{k=1}^{t} min\left(\Delta tot_{ik}, 0\right) \tag{18}$$

The error correction version for equation (16) yields the following

$$\begin{aligned}\Delta ner_{it} &= \tau_{it} \zeta_{i,t-1} + \sum_{j=1}^{NI} \alpha_{ij} \Delta ner_{i,t-1} + \sum_{j=0}^{N2} \left( \vartheta_{ij}^{+} \Delta tot_{t-j}^{+} + \vartheta_{ij}^{-} \Delta tot_{t-j}^{-} \right) + \sum_{j=0}^{N3} \left( \vartheta_{ij}^{+} \Delta nfa_{t-j}^{+} + \vartheta_{ij}^{-} \Delta nfa_{t-j}^{-} \right) \\ &+ \sum_{j=0}^{N4} \left( \vartheta_{ij}^{+} \Delta fd_{t-j}^{+} + \vartheta_{ij}^{-} \Delta fd_{t-j}^{-} \right) + \sum_{j=0}^{N5} \left( \vartheta_{ij}^{+} \Delta inf_{t-j}^{+} + \vartheta_{ij}^{-} \Delta inf_{t-j}^{-} \right) + \sum_{j=0}^{N6} \left( \vartheta_{ij}^{+} \Delta gdp_{t-j}^{+} + \vartheta_{ij}^{-} \Delta gdp_{t-j}^{-} \right) \\ &+ \sum_{j=0}^{N7} \left( \vartheta_{ij}^{+} \Delta int_{t-j}^{+} + \vartheta_{ij}^{-} \Delta int_{t-j}^{-} \right) + \sum_{j=0}^{N8} \left( \vartheta_{ij}^{+} \Delta ms_{t-j}^{+} + \vartheta_{ij}^{-} \Delta ms_{t-j}^{-} \right) + \sum_{j=0}^{N9} \left( \vartheta_{ij}^{+} \Delta fdi_{t-j}^{+} + \vartheta_{ij}^{-} \Delta fdi_{t-j}^{-} \right) \\ &+ \mu_i + \varepsilon_{it}\end{aligned} \tag{19}$$

The error-correction term $\left(\zeta_{i,t-1}\right)$ captures the long run equilibrium nonlinear fin the asymmetric panel ARDL specified in equation (19), as it is associated parameter $\tau_i$ is the speed of adjustments term that measures how long it takes the system to converge to its long run equilibrium in the presence of a shock.

3.3 Data and Sources

The secondary data sources are used in this study. The nature of the data is formed by pooling the cross-section and time series data composed of annual data on nominal exchange rate term of trade, net foreign asset, foreign deficit, inflation, gross domestic product, interest rate, money supply and foreign direct investment for ten (10) African oil-producing countries. The data

spans from 1986 to 2022. The studied countries include Angola, Nigeria, Algeria, Libya, Egypt, the Republic of Congo, Gabon, Ghana, Equatorial Guinea, Chad, Sudan or South Sudan, South Africa, Cameroon, Tunisia, Cote d'Ivoire, DRC Congo, Niger, Mauritania, and Morocco. The study data was culled from the World Development Indicators (WDI).

## 4. RESULT AND DISCUSSION OF FINDINGS

### 4.1 Panel unit root test results

As conventional for macro panels with large T, we subject the relevant variables to a panel unit root test. The dynamic heterogeneous panel data model – the preferred model in this study – is usually considered where non-stationarity is a concern. We consider four different types of panel unit root tests. As presented in Table 1, the first type involves panel unit root tests with the null hypothesis of unit root with the common process (Breitung, 2000; Levin et al., 2002 tests). The second type assumes unit root with individual unit root process (Im et al., 2003; ADF Fisher tests).

We find that the explained variable in our study – $ner$ – integrated after first difference– [I(1)] under Breitung and IPS and LLC, while independent variables – $tot, nfa, fd, inf, gdp, int\,r$ *and* $ms$ – are integrated of mixed order – [I(0)] and [I(1)] – regardless of the test type. Thus, the underlying framework for estimation in this study, which accounts for inherent heterogeneity and non-stationarity in the panel data series, is valid for our analyses. In essence, the unit root test results further reaffirm the appropriateness of our choice of panel-ARDL model as the preferred estimation framework in the context of this study.

Table 1: Panel Unit Root Test

| Test Method | *ner* | *tot* | *nfa* | *fd* | *inf* | *gdp* | *int r* | *ms* | *fdi* |
|---|---|---|---|---|---|---|---|---|---|
| ***Null Hypothesis: Unit Root with common process*** | | | | | | | | | |
| Breitung [t-stat.] | -6.80***[b] | -1.95**[a] | -2.16**[a] | -2.39**[b] | -5.60***[a] | -4.46***[a] | -2.13**[a] | -6.43***[b] | -8.38***[b] |
| Levin, Lin & Chu [t*] | -3.97***[b] | -2.40***[a] | -5.61***[a] | -12.49***[a] | -5.50***[a] | -3.28***[b] | -6.35***[b] | -3.40***[a] | -6.94***[b] |
| ***Null Hypothesis: Unit Root with Individual process*** | | | | | | | | | |
| Im, Pesaran & Shin [z-t-tilde-bar] | -7.57***[b] | -10.01***[b] | -7.59***[b] | -5.10***[a] | -7.62***[a] | -4.88***[b] | -1.33*[a] | -4.61***[a] | -9.05***[b] |
| ADF Fisher [Chi-square] | - | - | 3.84***[b] | 6.56***[a] | 3.83***[a] | 1.72***[a] | 4.34***[b] | 4.24***[a] | 2.04***[a] |
| *Number of Cross-Sections* | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| *Number of Periods* | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 |
| *Total Number of Observations* | 370 | 370 | 370 | 370 | 370 | 370 | 370 | 370 | 370 |

Source: Authors' compilation

Note: a and b denote stationarity at level and at first difference, respectively, while ***, **, * indicate statistical significance at 1%, 5% and 10%, respectively.

### 4.2 Non-Linear Panel Coefficient Estimates

We first estimated the PARDL model with the MG and PMG estimators and then subjected the results from these estimators to the Hausman test. The PMG estimator was the efficient estimator under the null, while the MG estimator was the efficient estimator under the alternative hypothesis. Our Hausman test results substantially support the PMG estimator as the efficient estimator for modelling the asymmetric association among the variables. Hence, only the results obtained from the preferred estimator are reported and discussed in this study.

**Long-run asymmetric Dynamic**

The regression results for the asymmetric case are displayed in Table 2. In the long run, term of trade (TOT) positive and negative shocks, net foreign asset (NFA) negative shock, inflation rate (INF) negative shock with GDP, money supply (MS) and FDI positive and negative shocks exerted a significant positive effect on nominal exchange rate in Africa oil-producing countries. Meanwhile, net foreign asset (NFA) positive shock and foreign deficit (FD) negative shock combined negatively influenced the average NER in these African oil-producing countries.
The estimated elasticities of TOT positive (negative) shocks pertaining to NER was 4.2089 (0.3563), indicating that *Ceteris paribus*, a 4.2089% (0.3563) increase (decrease) in NER was a result of a 1% increase (decrease) in TOT, whereas, *ceteris paribus*, the 1% decrease in NFA positive shock gave a 0.001% increase in NER, as a 0.0015 per cent decrease in NER is as a result of a one per cent decrease in NFA negative shock.

Table 2: Models with Asymmetry

| **Variables** | **MG** | **PMG** |
|---|---|---|
| $\delta^{ltot+}$ | 0.4643 | -0.3871* |
| | (0.6259) | (0.2286) |
| $\delta^{ltot-}$ | 0.5688 | -0.3828 |
| | (0.6244) | (0.2554) |
| $\delta^{lnfa+}$ | 0.0589 | -0.0103* |
| | (0.0555) | (0.0058) |
| $\delta^{lnfa-}$ | 0.0301 | -0.0052 |
| | (0.0360) | (0.0056) |
| $\delta^{lfd+}$ | -4.0273 | 1.8683 |
| | (10.0809) | (1.5261) |
| $\delta^{lfd-}$ | -5.3166 | 2.2466 |
| | (6.5920) | (2.0986) |
| $\delta^{linf+}$ | 0.1091 | -0.0090 |
| | (0.1696) | (0.0338) |
| $\delta^{linf-}$ | 0.1243 | -0.0470 |
| | (0.1729) | (0.0480) |
| $\delta^{lgdp+}$ | 0.1726 | -0.0072 |
| | (0.1633) | (0.0356) |
| $\delta^{lgdp-}$ | -0.0290 | -0.0578 |
| | (0.3898) | (0.0444) |
| $\delta^{lintr+}$ | -0.9890 | -0.0384 |
| | (0.7840) | (0.0558) |
| $\delta^{lintr-}$ | -1.1228 | -0.0578 |
| | (0.7883) | (0.0525) |
| $\delta^{lms+}$ | -0.0838 | -0.0104 |
| | (0.3503) | (0.0165) |
| $\delta^{lms-}$ | -0.4184 | -0.1202** |
| | (0.3498) | (0.0503) |
| $\delta^{lfdi+}$ | -0.1850 | -0.0119 |
| | (0.1640) | (0.0155) |
| $\delta^{lfdi-}$ | -0.3761* | -0.0771* |
| | (0.2086) | (0.0456) |
| Constant | -2.772 | 13.5998*** |
| | (110.0675) | (4.8705) |
| $\lambda^{ltot+}$ | 11.2635 | 4.2089*** |
| | (11.8527) | (0.1596) |
| $\lambda^{ltot-}$ | -4.4389 | 0.3563*** |
| | (3.6726) | (0.1342) |
| $\lambda^{lnfa+}$ | -0.0639 | -0.0010** |
| | (0.0436) | (0.0005) |
| $\lambda^{lnfa-}$ | 0.1056 | 0.0015*** |
| | (0.1198) | (0.0005) |
| $\lambda^{lfd+}$ | 245.5212 | 0.0000 |

| | | |
|---|---|---|
| | (249.6638) | (0.0000) |
| $\lambda^{lfd-}$ | -19.5307 | -0.0001* |
| | (24.1248) | (0.0000) |
| $\lambda^{linf+}$ | 3.7815 | 0.0861** |
| | (3.8302) | (0.0399) |
| $\lambda^{linf-}$ | -0.8000 | -0.0536 |
| | (0.7769) | (0.0566) |
| $\lambda^{lgdp+}$ | 0.5002 | 0.0328* |
| | (0.6183) | (0.0184) |
| $\lambda^{lgdp-}$ | 3.3170 | 0.0650** |
| | (3.5483) | (0.0292) |
| $\lambda^{lintr+}$ | -4.4901 | 0.0633 |
| | (5.0053) | (0.0520) |
| $\lambda^{lintr-}$ | -7.6468 | -0.0203 |
| | (8.1462) | (0.0272) |
| $\lambda^{lms+}$ | -3.2389 | 0.0247** |
| | (3.7735) | (0.0120) |
| $\lambda^{lms-}$ | 4.6749 | 0.5259** |
| | (5.1952) | (0.2220) |
| $\lambda^{lfdi+}$ | -0.7144 | 0.1285** |
| | (0.4902) | (0.0632) |
| $\lambda^{lfdi-}$ | -0.7530** | 0.1274** |
| | (0.3803) | (0.0606) |
| $\gamma^{ECT}$ | -0.0800 | -0.0272*** |
| | (0.3803) | (0.0456) |
| Hausman Test ( $X_k^2$ ) | | 25.51 |
| | | (0.3074) |

Source: Authors' Compilation

Note: TOT is term of trade, NFA is the net foreign asset, FD is foreign deficit, INF represents inflation, GDP is gross domestic product, INTR is the interest rate, MS represents money supply and FDI is the foreign direct investment. All variables are in their logarithmic transformation. The values in parentheses are the standard errors. The $\lambda s'$ are for the long run, while the $\delta s'$ are for the short run. ***, ** & * imply significance at the 1%, 5% and 10% levels, respectively

Furthermore, the estimated elasticities of FD adverse shocks about NER was -0.0001, portraying that all things being equal, a 0.0001% increase in NER resulted from a 1% decrease in FD negative shock. Meanwhile, *ceteris paribus*, the 1% increase in INF positive shock generated a 0.0861% increase in NER. Furthermore, the estimated elasticities of GDP upsurges (decline) pertaining to NER was 0.0328 (0.0650), portraying that all things being equal, a 0.0328 % (0.0650) increase (decrease) in NER was a result of a 1% increase (decrease) in GDP positive (negative) shock. More so, ceteris *paribus*, a 1% increase (decrease) in money supply (MS) positive (negative) shock gave a 0.0247 % (0.5259%) increase (decrease) in NER in the African oil-producing countries.

Finally, as a 1% increase in FDI positive shock brings about a 0.1285% increase in NER, the same 1% decrease in FDI negative shock further ignites a 0.1274 % decrease in NER in the African oil-producing countries, *ceteris paribus*.

**Short-run asymmetric Dynamic**

The ECT coefficient (-0.0272) was negative and statistically significant at the 1% level and elaborates how speedily the variables converge to equilibrium, indicating that the explanatory variables, despite the positive and negative shocks witnessed, speedily adjusted back to equilibrium at a minimal rate of 2.72 per cent annually in the African Oil producing countries. The short-run exhibited that terms of trade (TOT) and net foreign asset (NFA) positive shocks combined with money supply (MS) and FDI negative shocks exerted a significant negative effect on nominal exchange rate in African oil-producing countries.

The short-run findings revealed that the elasticity of TOT positive shock pertaining to NER is -0.3871, indicating that *ceteris paribus*, a 1% rise in TOT is expected to decrease NER by 0.3871%. Meanwhile, as NFA positive shock increases by one per cent, it reduces NER by 0.0103 per cent, *ceteris paribus*. Likewise, money supply (MS) negative shock exhibited a significant negative impact on NER, indicating that *ceteris paribus*, the elasticity of MS decline on NER is -0.1202 suggesting that a 1% decrease in MS is expected to increase NER by 0.1202%. Finally, the FDI negative shock has a significant negative effect on NER with -0.0771 magnitude, portraying that a 0.0771 increase in NER resulted from a one per cent decrease in FDI negative shock, *ceteris paribus.*

The next is testing for the long and short-run asymmetric impact of the explanatory variables on NER, using the Wald test.

Table 3: Wald Test

| Variable | Long run | | | Short run | | |
|---|---|---|---|---|---|---|
| | Chi2 | Prob | Remark | Chi2 | Prob | Remark |
| *ltot* | 1.36 | 0.2429 | Symmetric | 0.01 | 0.9408 | Symmetric |
| *ln fa* | 6.38 | 0.0115*** | Asymmetric | 0.60 | 04372 | Symmetric |
| *lfd* | 2.77 | 0.0960* | Asymmetric | 0.37 | 0.5413 | Symmetric |
| *l inf* | 3.73 | 0.0535* | Asymmetric | 4.41 | 0.0358** | Asymmetric |
| *lg dp* | 3.17 | 0.0749* | Asymmetric | 3.08 | 0.0793* | Asymmetric |
| *l int r* | 2.34 | 0.1264 | Symmetric | 032 | 0.5697 | Symmetric |
| *lms* | 5.37 | 0.0204*** | Asymmetric | 4.86 | 0.0276** | Asymmetric |
| *lfdi* | 0.00 | 0.9503 | Symmetric | 3.54 | 0.0598 | Asymmetric |

Source: Authors' Compilation

Note: ***, ** & * imply significance at the 1%, 5% and 10% levels, respectively

From Table 3, it could be adjudged that net foreign asset (NFA), foreign deficit (FD), inflation (INF), gross domestic product (GDP) and money supply (MS) exerted asymmetric impact and association with nominal exchange rate (NER) in the African oil-producing countries, in the long run. Meanwhile, inflation rate (INF), GDP and money supply (MS) established an asymmetric relationship with NER in the short run.

Following the report of asymmetry and symmetry relationship as revealed via the Wald test in Table 3, we make a pronouncement on the acceptance or rejection of the null hypothesis using the rule of thumb that if the number of variables with asymmetry is equal to or more than that of symmetry, we cannot accept the null hypothesis; otherwise, we cannot reject the null hypothesis. From Table 3, it is established that five (5) – net foreign asset (NFA), foreign deficit (FD), inflation (INF), GDP, and money supply (MS) – out of the eight (8) explanatory variables were asymmetry in the long run; hence, we cannot accept the null hypothesis that states economic fundamentals does not have long-run effect on the nominal exchange rate in African oil-producing countries. Meanwhile, since it was only three variables – inflation rate (INF), GDP, and money supply (MS) – that possessed nonlinear association on NER in the short run, we therefore cannot reject the null hypothesis of economic fundamentals does not have shot run asymmetric effect on the nominal exchange rate in African oil-producing countries. Hence, we conclude that economic fundamentals do not have a shot-run asymmetric effect on nominal exchange rates in African oil-producing countries.

4.4 Discussion of Findings

The findings of this study show that there is a significant asymmetric relationship between gross domestic product (GDP) and nominal exchange rate in African oil-producing countries which is in line with Dada's (2022) study on the asymmetric effect of real exchange rate on growth in Africa. Similarly, Samuel et al. (2018) and Cuestas et al. (2022) found that the nominal exchange rate (NER) has a positive impact on the real GDP. Ewubare and Ushie (2022), showed that there is a long-run relationship between GDP and nominal exchange rate (NER). This is contrary to the findings of the study of Nwachukwu, et al; (2016) in a study on nominal exchange rate misalignment in Nigeria. The study's findings show that gross domestic product (GDP) was found to be non-significant both in the long run and in the short run.
Furthermore, Ashour (2023) studied on asymmetric effect of real effective exchange rate and Saudi non-oil export determinants. The findings show that positive shocks to the nominal exchange rate (NER) have a negatively significant effect in the long run which coincides with the result of the study which states that there is no asymmetric relationship between terms of trade and nominal exchange rate. On the contrary, Truong and Vo (2023) findings confirm that the nominal exchange rate has asymmetric effects on the trade balance in both the long-run and short-run using nonlinear autoregressive distributed lag (NARDL) and this is in line with Olubiyi and Biala (2022), Ayele (2022) and Bhat and Bhat (2021) state that there is a statistically insignificant deterioration of the trade balance following an appreciation and a statistically significant improvement following depreciation.

Additionally, the findings of the study show that there is a significant asymmetric relationship between money supply and nominal exchange rate and this is in line with the study of Moayed, et al. (2023) on the study of the effects of trade openness and some macroeconomic variables on exchange rate volatility in Iran. Alagidede and Ibrahim (2016) indicated that the nominal exchange rate is significantly influenced by the money supply in the long run. Also, Eslamloueyan and Kia (2015) money supply influences the nominal exchange rate both in the long run and short run However, the result of the study shows that net foreign assets (NFA) have a significant asymmetric relationship with the nominal exchange rate (NER) from the Wald test in the long run while it shows a symmetric relationship in the short run. This is in agreement with the study of Ayele (2022). The empirical estimation results generally showed that the NER of sample LDCs appreciate for net foreign asset position, the NER misalignment in turn could have a negative and positive significant impact on the net foreign assets of LDCs long-run.

## 5. CONCLUSION AND POLICY RECOMMENDATION

The findings of the result of the linear or symmetric model showed that all variables are insignificant except for terms of trade and gross domestic product (GDP) that are negatively and positively statistically significant to the real exchange rate at 10% and 1%, respectively in the short run. In the long run foreign direct investment and foreign deficit are negatively significant at 1% and 10% respectively while money supply is positively significant at 1%. The asymmetric model indicated that a positive coefficient of the terms of trade, inflation, gross domestic product, money supply, and foreign direct investment has a positive change (increase+) indicating that an increase in these economic fundamentals variables in the previous period has a positive and statistically significant impact on the nominal exchange rate (NER) in the current period. A negative coefficient for net foreign assets of the positive change (increase+) indicates that a decrease in net foreign assets in the previous period has a negative change and significant statistical impact on the nominal exchange rate A positive coefficient for terms of trade, Net foreign asset, gross domestic product, money supply, and foreign direct

investment (FDI) of the negative change (decrease+) indicates that an increase in these economic fundamentals variables in the previous period has a positive and statistically significant impact on the nominal exchange rate in the current period. A negative coefficient for a foreign deficit of the negative change (decrease-) indicates that a decrease in this foreign deficit in the previous period has a positive and statistically significant impact on the nominal exchange rate (NER) in the current period. Therefore, the policymaker must ensure political stability because it is important for investors to have confidence in the country's future growth and to explore different market opportunities to strengthen the currency exchange.

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