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# Asymmetric Effect of Capital Flight on Nigerian Economy: Evidence from Non-Linear Autoregressive Distributed Lag (NARDL) Analysis

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**Abstract**

A limited number of studies have sought an optimal modeling approach to capture the dynamic interplay between capital flight and the economic growth of Nigeria. Most of these studies have traditionally relied on the assumption of a linear relationship to characterize the behavior within the capital flight-growth nexus. In a departure from prior literature, this study, spanning the years 1980 to 2023, employed non-linear autoregressive distributive lagged (NARDL) analysis, aiming to scrutinize the impact of capital flight on Nigeria's economic growth. The study unearthed a nuanced relationship between economic growth and both positive and negative changes in capital flight. Negative changes (capital inflows) were found to enhance growth in both the short and long term, while positive changes (capital outflows) hampered growth. The dynamic multiplier of positive and negative changes in capital flight further illustrates this asymmetry. The red line, encompassing the upper and lower bounds of the 95% confidence intervals, highlights that GDP responds more positively to a positive shock than to a negative shock of capital flight. Hence, to address the asymmetric impact of capital flight on economic growth, immediate measures like tightening regulations and enhancing institutional integrity are necessary. Additionally, implementing long-term strategies such as boosting investor confidence and undertaking structural reforms is vital for sustainable economic development and mitigating capital flight over time.

***Keywords:*** Asymmetry, Capital flight, Economic growth; NARDL

## 1. Introduction

Recently, policymakers have expressed growing concern about the phenomenon of capital flight from developing nations, particularly in the aftermath of the debt crisis and the subsequent sharp decline in capital inflows from developed countries. Capital flight, defined as the movement of domestic capital from capital-starved developing and emerging nations to capital-rich developed economies, has been identified as abnormal capital outflows by economic agents, whether private or public (Nyong, 2003; Mamun, 2020). This departure from the expectations of capital arbitrage theory, which posits that money should flow from resource-rich to resource-scarce nations, is attributed to domestic political pressures and distortions in economic policy, including higher taxes, capital controls, and currency overvaluation.

The abnormal outflows associated with capital flight signify a loss of resources that could otherwise be utilized for local investment, presenting a barrier to economic growth (IMF, 2018). Notably, Nigeria ranks fifth among the African nations most affected by illicit financial flows, incurring estimated annual costs ranging from USD 15 billion to USD 18 billion. Despite stringent regulations governing international money movements, unauthorized cross-border flows persist (Joseph and Omodero, 2019), facilitated by corruption among Nigerian politicians and foreigners monopolizing the technology to exploit natural resources. Multinational corporations contribute to capital flight through practices such as tax evasion, tax avoidance, transfer pricing, and engagement in banking secrecy.

Nigeria, alongside several other African nations, has experienced significant capital outflows towards developed countries (Olawale & Ifedayo, 2015), intensifying the scarcity of resources available for development and contributing to a decline in the growth of the gross domestic product (GDP). Notably, Nigeria grapples with structural challenges, marked by insufficient infrastructure resulting from low levels of savings and investment. Capital flight serves to compound these issues, placing a substantial burden on Nigeria's economic potential. This burden, induced by capital flight, acts as a constraint, hindering the nation's ability to achieve the targeted economic growth and impeding progress towards elevated living standards. Despite increasing concerns and research on capital flight's impact on Nigeria's economic growth and development (Orji et al., 2020), the country continues to grapple with large-scale capital flight driven by private capital seeking higher financial returns and greater perceived safety abroad. The persistent outflow of capital has led to a liquidity shortage, resulting in upward pressure on interest rates and depreciation of the domestic currency. The continuous economic challenges, coupled with structural and political difficulties in Nigeria, prompt essential questions about the impact of capital flight on the Nigerian economy and the causal link between the two phenomena.

Given the above considerations, this study aims to investigate the asymmetric impact of capital flight on economic growth in Nigeria. The motivation for this research stems from the lack of asymmetric studies on the relationship between capital flight and economic growth in Nigeria. Previous research, while examining the long-run effects, often neglected the short-run impact, and employed less reliable methodologies that relies on linear approach. However, recent studies using non-linear or asymmetric estimation techniques have shown better results than the linear model (Cho et al., 2021; Anderl and Caporale, 2021; MacCarthy, Ahulu, and Thor, 2022). To address these shortcomings, this study advocates for the use of the Nonlinear Autoregressive Distributed Lag (NARDL) methodology, aiming to provide a more robust and contemporary analysis of the effect of capital flight on economic growth by decomposing the negative and positive effect of capital flight on economic growth of Nigeria. The asymmetric impact of capital flight on economic growth, involving the decomposition of capital flight into positive and negative components, is justified by its potential to provide a nuanced understanding of this economic phenomenon. By understanding the changes in the positive and negative components, policymakers can design targeted interventions to mitigate the negative impacts while amplifying the positive effects.

**2. Literature review**

The literature on capital flight reveals considerable controversies surrounding its definition and guiding theories, with diverse perspectives among scholars. Tornell and Velasco (1992) and Ajayi (1997) argue that any capital outflows from poor to rich countries should be considered abnormal and perverse. Additionally, distinctions arise between developed and developing countries, where capital outflows from the latter are labeled as capital flight (Ajayi, 1997). Definitions range from encompassing all private capital outflows, regardless of type or duration, to narrowing down to illegal capital exports (Lessard and Williamson, 1987). Kindleberger (1966) and Walter (1987) broadly define capital flight as all capital that "flees" irrespective of motive, while Eggerstedt et al. (1995) describe it as the unreported private accumulation of foreign assets. Some scholars focus on short-term outflows due to economic and political uncertainties as constituting capital flight (Cuddington, 1986). The varying definitions lead to methodological challenges in measuring capital flight, resulting in divergent approaches such as the Hot Money Method, Dooley Method, Residual Method, and Trade Mis invoicing Method.

The Hot Money Method (Cuddington,1986) and Dooley Method (Dooley, 1986) are distinct approaches to measuring capital flight. The Hot Money Method defines it as the short-term movement of capital in the non-bank public sector, including errors and omissions from the balance of payment. In contrast, the Dooley Method equates capital flight to income from foreign assets not reported to the domestic country, allowing differentiation between legal and illegal capital flight. Despite producing larger estimates, the Dooley Method faces a limitation due to the unavailability of data on short-term private sector capital flows in the balance of payments. In another development. the Residual Method (World Bank, 1985; Morgan Guaranty, 1986), is abroad measure of capital flight and indirectly calculates capital outflow by comparing sources of funds with their actual usage. This approach, supported by the World Bank (1985) and Dooley et al (1986) is widely used for measuring capital flight. Another technique, the Trade Mispricing Model (Bhagwati, 1964), addresses illicit fund transfers through over-invoicing of imports and under-invoicing of exports, combining both to estimate illicit cash flight.

Theoretical perspectives encompass the investment diversion theory, debt-driven capital flight theory, tax-depressing theory, austerity-generating theory, and portfolio adjustment theory, offering insights into the motivations and consequences of capital flight from developing countries. The Investment Diversion Theory underscores the role of macroeconomic and political uncertainties, leading to the diversion of capital from developing to developed nations, with adverse effects on domestic investment and economic growth (Kindleberger, 1966; Olatunji &

Oloye, 2015). The Debt-Driven Capital Flight Theory links capital flight to external debt, suggesting a complex interdependency between capital flight, growth, and indebtedness (Krugman, 1988; Boyce, 1992; Onodugo et al., 2014). The Tax-Depressing Theory emphasizes potential revenue loss due to the lack of control over wealth held abroad, impacting the government's ability to service debt and hindering economic development. The Austerity-Generating Approach highlights the challenges faced by the poor as a result of harsh government actions to meet foreign debt obligations, further exacerbating capital flight (Pastor, 1990). Finally, the Portfolio Adjustment Theory points to the influence of an unstable macroeconomic and political environment, coupled with better investment opportunities in developed countries, prompting rational investors to move capital overseas in pursuit of maximum returns and minimum risk (Collier, Hoeffler and Pattillo, 1999). Together, these theories contribute to a nuanced understanding of the dynamics surrounding capital flight.

On the empirics' front, capital flight and its impact on macroeconomic variables has been a focal point in empirical research, with divergent findings and methodologies. Some studies emphasize the macroeconomic factors contributing to capital flight (Uddin, Yousuf and Islam, 2017; Salandy and Henry, 2018; Anetor, 2019), while others examine its effects on specific variables like economic growth (Ajilore, 2010; Bakare, 2011; Richmond, Camara, and Williams, 2017; Lawal et al., 2017; Orji et al., 2020, Mamun, 2020). The relationship between capital flight and economic growth remains contentious, with studies presenting mixed outcomes—some indicating a negative impact (Lawal et al., 2017; Orji et al., 2020), while others suggest a positive influence (Akanbi, 2015; and Owusu, 2016). Notably, MacCarthy, Ahulu, and Thor (2022) employ an asymmetric and non-linear Autoregressive Distributed Lag technique, revealing that both positive and negative changes in capital flight significantly affect economic growth in Ghana.

In the context of Nigeria, numerous studies analyze the impact and causes of capital flight. Findings from studies like Oladimeji et al. (2022) and Oji et al. (2020) demonstrate a significant negative impact of capital flight on Nigeria's economic growth. In a similar vein, Using VECM and granger causality test Oluwaseyi (2017) reveal a negative relationship between capital flight, interest rates differential, political instability, and Nigeria's economic growth between 1980 and 2014. However, Adedayo and Ayodele (2016) show that increase in capital flow into the economy has the tendency of increasing economic growth.  Ajilore (2010) and Bakare (2011) focus on the causes, highlighting trade faking and external debt as significant factors influencing capital flight from Nigeria. Despite the majority of studies concentrating on short-term effects, a critical gap exists in considering the long-run impact, often employing less robust methodologies like ordinary least square (OLS) and Linear Autoregressive Distributed Lag (ARDL). Recognizing these limitations, this study aims to address these gaps by utilizing a more robust methodology, Nonlinear Autoregressive Distributed Lag (NARDL), providing a thorough analysis of the intricate relationship between capital flight and economic growth in Nigeria.

## 3. Empirical Model

### 3.1 Model Specification

The model for this study is based on the Hadjimichael (1994) model, which originates from the theoretical framework of the endogenous growth theory of aggregate production function. By incorporating additional factors deemed relevant in the literature on the nexus between capital flight and economic growth, the empirical model for this study can be derived as follows:

$$Y_t = \alpha_t + \gamma CFL_{t-1} + \beta X_t + \varepsilon_t \qquad 1$$

where:

- $Y_t$ is the per capita growth of GDP,
- $CFL_{t-1}$ is the lagged value of the proxy for capital flight,
- $X_t$ represents the set of control variables (capital formation (investment), remittances, inflation, interest rate, exchange rate, population growth),
- $\varepsilon_t$ is the error term,
- $\alpha_t$ is the constant term, and
- $\beta$ denotes the coefficients of the model.

All variables are expressed in natural logarithm form to avoid heteroscedasticity and induce stationarity in the variance-covariance matrix (Narayan and Smyth, 2005). The capital flight variable enters the model with a lag for two reasons: first, intuitively, money that flees the economy in one year will impact economic growth in the subsequent period; second, lagging the capital flight variable helps to avoid endogeneity problems between GDP per capita and capital flight in our empirical analysis.

### 3.2 Estimation Procedure

To examine the growth effect of capital flight, this study applies the Non-linear Auto Regressive Distributed Lag (NARDL) approach by Shin et al. (2014) alongside other diagnostic tests to estimate the impacts of capital flight on growth. The NARDL is an asymmetric extension of the well-known ARDL model by Pesaran and Shin (1999) and Pesaran, Shin, and Smith (2001), which is often used to capture both long-run and short-run asymmetries in the variable of interest. According to Hoang, Lahiani, and Heller (2016), this approach offers several advantages: it allows for modeling the cointegration relation between dependent and independent variables, permits testing both linear and nonlinear cointegration, and distinguishes between the short- and long-run effects of the independent variable on the dependent variable. Additionally, unlike other error correction models that require the same order of integration for the time series, the NARDL model relaxes this restriction, allowing for the combination of data series with different integration orders.

To exploit more useful dynamics of the model, we use the NARDL model of Shin et al. (2014), which takes the following general form:

$$\begin{aligned}\Delta InGDP_t =& \alpha_0 + \alpha_1 InGDP_{t-1} + \alpha_2 InCFL^{+}_{t-1} + \alpha_3 InCFL^{-}_{t-1} + \alpha_4 InINV_{t-1} + \alpha_5 InREM_{t-1} + \alpha_6 InINF_{t-1} + \alpha_7 InINT_{t-1} \\ & + \alpha_8 InEXC_{t-1} + \alpha_9 InPOG_{t-1} + \sum_{j=1}^{p} \lambda_j \Delta InGDP_{t-j} + \sum_{j=1}^{q} (\gamma_j \Delta InCFL^{+}_{t-j} + \gamma_j \Delta InCFL^{-}_{t-j}) + \sum_{j=1}^{r} \varphi_j \Delta InINV_{t-j} \\ & + \sum_{j=1}^{s} \xi_j \Delta InREM_{t-j} + \sum_{j=1}^{t} \vartheta_j \Delta InINF_{t-j} + \sum_{j=1}^{u} \eta_j \Delta InINR_{t-j} + \sum_{j=1}^{v} \varpi_j \Delta InEXC_{t-j} + \sum_{j=1}^{w} \psi_j \Delta InPG_{t-j} + \varepsilon_t \end{aligned} \quad (2)$$

The decomposition of $CFL_t$ into its positive $\Delta CFL_t^{+}$ and negative $\Delta CFL_t^{-}$ partial sums for increases and decreases follows the approach proposed by Shin *et al.* (2014) in order to accommodate the potential short- and long-run at time t. The $CFL_t^{+}$ and $CFL_t^{-}$ are defined theoretically as:

$$CFL_t^{+} = \sum_{j=1}^{t} \Delta CFL_t^{+} = \sum_{j=1}^{t} max(\Delta p_j, 0)$$

$$CFL_t^{+} = \sum_{j=1}^{t} \Delta CFL_t^{+} = \sum_{j=1}^{t} max(\Delta p_j, 0)$$

$$CFL_t^{-} = \sum_{j=1}^{t} \Delta CFL_t^{-} = \sum_{j=1}^{t} \min(\Delta p_j, 0)$$

The asymmetric error correction term is thus shown in equation 3:

$$\begin{aligned}\Delta GDP_t =& \tau\xi_{t-1} + \sum_{j=1}^{p} \lambda_j \Delta InGDP_{t-j} + \sum_{j=1}^{q} (\gamma_j \Delta InCFL^{+}_{t-j} + \gamma_j \Delta InCFL^{-}_{t-j}) + \sum_{j=1}^{r} \varphi_j \Delta InINV_{t-j} + \sum_{j=1}^{s} \xi_j \Delta InREM_{t-j} \\ & + \sum_{j=1}^{t} \vartheta_j \Delta InINF_{t-j} + \sum_{j=1}^{u} \eta_j \Delta InINR_{t-j} + \sum_{j=1}^{v} \varpi_j \Delta InEXC_{t-j} + \sum_{j=1}^{w} \psi_j \Delta InPG_{t-j} + \lambda ect_{t-1} + \varepsilon_t \end{aligned} \quad (3)$$

In equation (3), the error-correction term is denoted by $ect_{t-1}$ and $\lambda$ represents the speed of adjustment of model to the long run equilibrium in the NARDL. The long-run coefficients with respect to the negative and positive changes of the independent variables can be computed as $L^{+} = -\alpha_2^{+} / \alpha_1$ and $L^{-} = -\alpha_3^{-} / \alpha_2$. These coefficients measure the relationship between capital flight and economic growth at the long-run equilibrium. The long-run symmetry can be tested by using a Wald test of the null hypothesis that $\alpha_2^+ = \alpha_3^-$. Similarly, the short-run adjustment of economic growth ($GDP_t$) to a positive or negative variation of capital flight ($CFL_t$) is captured by the parameters $\gamma_j^+$ and $\gamma_j^-$, respectively. The short run symmetry can be tested by using a standard Wald test of the null hypothesis that $\gamma_j^+ = \gamma_j^-$, for all j =0, …, r. Hence, in this setting, in addition to the asymmetric long run relation, the NARDL captures the asymmetric short-run influences of capital flight on output.

To implement our empirical application of the nonlinear ARDL approach, we follow a series of steps. Initially, we conduct pre-tests to determine the order of integration for the variables using the ADF and PP unit root tests, ensuring no I(2) series are present, as the ARDL approach accommodates series that are I(0) or I(1). Following this, we estimate equation (6) using the standard OLS method, selecting the lag length based on the SIC information criterion or a general-to-specific procedure to refine the NARDL model by eliminating insignificant lags. Next, we perform bounds testing for cointegration, as outlined by Pesaran et al. (2001) and Shin et al. (2014), within an unrestricted error correction model to test for long-term relationships among variables in both linear and nonlinear specifications, using F-statistics to evaluate the joint significance of the coefficients of the lagged levels of the variables. Finally, upon confirming the existence of a long-run equilibrium relationship among the variables, we estimate the long-run asymmetric impact of capital flight on economic growth, capturing the asymmetric responses of the dependent variable to positive and negative variations of the independent variable through the positive and negative dynamic multipliers associated with a one percent change in $CFL_t^+$ and $CFL_t^-$ as follows:

$$m_h^+ = \sum_{j=0}^{h} \frac{\partial GDP_{t-1}}{\partial CFL_{t-1}^+}; \ m_h^- = \sum_{j=0}^{h} \frac{\partial GDP_{t-1}}{\partial CFL_{t-1}^-}, \ h = 0,1,2,...$$

Note that as $h \to \infty$, $m_h^+ \to L^+$ and $m_h^- \to L^-$ by construction (with $L^+ = -\alpha_3^+ / \alpha_2$ and $L^- = -\alpha_3^- / \alpha_2$ as the long run coefficients explained above)

Following a change in the system's parameters, one can see dynamic modifications from the initial equilibrium to the new equilibrium between the system variables based on the estimated multipliers. Where $\Delta$ is a difference operator, residuals, $\mu_i$ are independently and normally distributed (i.i.d) with zero mean and constant variance and $ect_{i-1}$is the error correction term resulting from the long-run equilibrium relationship via ARDL model and $\alpha$ and $\beta$ are parameters to be estimated. $\delta$ is a parameter indicating the speed of adjustment to the equilibrium level after a shock. The F statistics or Wald test on the lagged explanatory variables of the *ect* indicates the significance of the short-run causal effects. The $ect_{t-1}$ variable will be excluded from that model if the variables are not cointegrated. The optimal lag length *p* is determined by the Akaike's Information Criterion (AIC) because of its superior performance in small sample (Lütkepohl, 2005). Next, we apply the Likelihood Ratio (LR) statistics to ascertain the direction of Granger causality between the variables of interest.

### 3.2.3 Variable Definitions and Data Source

This study focuses on Nigeria, utilizing time series data from 1980 to 2022. The primary data source for capital flight measures, capital formation (investment), GDP per capita, inflation, exchange rate, and population growth is the World Development Indicators (WDI) 2021 edition. The Central Bank of Nigeria Statistical Bulletin provides data on interest rates (91-day treasury bills). The variables are defined as follows:

- Capital Flight: Various methods exist to estimate capital flight, depending on its definition. This study uses the World Bank (1985) residual method to calculate capital flight for Nigeria from 1980 to 2022, chosen due to data availability constraints. This method defines capital flight as the difference between the change in external debt and net foreign investment inflows, adjusted for the current account deficit and stock of official foreign reserves.

$$CFL = \left[\Delta external\ debt + FDI(net)\right] - \left[\Delta CA\ deficit + \Delta reserve\right]$$

- Total value of gross fixed capital formation, reflecting the investment in physical assets like machinery, buildings, and infrastructure.
- Remittances: Personal remittances received from residents abroad, representing the transfer of money by foreign workers to their home country.
- Inflation (INF): Rate at which the general level of prices for goods and services is rising, reflecting the decrease in purchasing power of a currency.
- Interest Rates (INT): The cost of borrowing money, typically represented by the 91-day Treasury bill rate.
- Exchange Rate: The rate at which one currency is exchanged for another, affecting trade and money movement between countries, with a potentially positive or negative impact on GDP growth.
- Population Growth: The annual increase in the number of people living in a country, typically expressed as a percentage.

## 4. Results

### 4.1 Descriptive Statistics

Table 1 presents descriptive statistics for key variables in the dataset, including GDP, capital flight (CFL), investment (INV), remittances (REM), inflation (INF), interest rates (INT), exchange rates (EXCH), and population growth (POPG). Notably, variables like GDP exhibit relatively low variability with a mean of 7.819 and a standard deviation of 0.315, while CFL demonstrates a left-skewed distribution with a skewness of -0.889 and heavy-tailed distribution with a kurtosis of 12.396.

**Table 1: Descriptive Statistics**

| | GDP | CFL | INV | REM | *INF* | INT | EXCH | POPG |
|---|---|---|---|---|---|---|---|---|
| Mean | 7.819 | 24.992 | 24.539 | 21.402 | 3.032 | 17.348 | 3.786 | 2.629 |
| Median | 7.783 | 24.907 | 24.574 | 21.556 | 3.112 | 17.227 | 3.814 | 2.618 |
| Maximum | 8.152 | 25.271 | 25.771 | 24.117 | 6.102 | 32.114 | 6.092 | 3.142 |
| Minimum | 7.22 | 23.562 | 23.112 | 15.321 | -1.102 | 8.002 | -0.687 | 2.341 |
| Std. Dev. | 0.315 | 0.389 | 0.719 | 3.401 | 2.319 | 4.685 | 2.198 | 0.172 |
| Skewness | -0.889 | -1.921 | 0.051 | -0.384 | -0.428 | 0.321 | -0.795 | 0.905 |
| Kurtosis | 1.454 | 12.396 | 1.811 | 1.677 | 1.852 | 3.595 | 2.411 | 3.921 |
| Jarque-Bera | 5.134 | 211.369 | 2.751 | 4.487 | 4.211 | 1.163 | 5.778 | 6.921 |
| Probability | 0.079 | 0 | 0.258 | 0.108 | 0.125 | 0.607 | 0.06 | 0.03 |
| Observations | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |

*Source: Computed by the author*

The distribution's form is inferred from skewness and kurtosis, which highlight asymmetry and tail thickness. While the majority of the skewness values are modest, several variables exhibit asymmetry and large tails, supporting normality. With the exception of capital flight, interest rates, and population growth rate, kurtosis figures for GDP, investment, remittances, inflation, and exchange rate are mostly below 3, indicating a flat and platykurtic (fat or short-tailed) distribution. By identifying deviations from a normal distribution, the Jarque-Bera test also assesses the normality of the data distribution. The importance of these deviations is indicated by the related probabilities. Taken as a whole, these statistics provide information on the central trends and distributional properties of the variables, directing further investigation and interpretation.

### 4.2 Correlation Matrix

Examining how the correlations between the variables have changed over time is essential before diving into the study's main findings. Table 2 gives an estimate of the correlation matrix's strength of linkages, giving a thorough rundown of the various degrees of links between many variables. A greater GDP is thought to be linked to lower interest rates and capital flight, as seen by the pairwise correlation matrix, which shows a negative association between GDP and CFL and INT. On the other hand, increases in GDP are correlated favourably with variables like INV, REM, INF, EXCH, and POPG, suggesting that greater GDP levels are associated with these variables' higher values. It is important to remember that these associations cannot be definitively shown using just empirical data; instead, a more trustworthy econometric method, such the non-autoregressive distributed lag, must be used. Furthermore, the correlation matrix emphasizes that there are no multicollinearity concerns in the data since every correlation is within the permissible range for identifying multicollinearity problems.

**Table 2: Pairwise correlations Matrix**

| | *GDP* | *CFL* | *INV* | *REM* | *INF* | *INT* | *EXCH* | *POPG* |
|---|---|---|---|---|---|---|---|---|
| *GDP* | 1.000 | | | | | | | |
| *CFL* | -0.029 | 1.000 | | | | | | |
| *INV* | 0.688 | 0.046 | 1.000 | | | | | |
| *REM* | 0.551 | -0.201 | 0.405 | 1.000 | | | | |
| *INF* | 0.403 | -0.097 | 0.327 | 0.739 | 1.000 | | | |
| *INT* | -0.211 | -0.105 | -0.677 | 0.171 | 0.221 | 1.000 | | |
| *EXCH* | 0.618 | -0.141 | 0.183 | 0.697 | 0.751 | 0.421 | 1.000 | |
| *POPG* | 0.084 | -0.224 | 0.207 | -0.171 | -0.343 | -0.199 | -0.309 | 1.000 |

*Source: Computed by the author*

#### 4.3 Unit root Tests

The empirical analysis requires determining the integration order of each time series in the model. To avoid spurious results. Tables 3 and 4 display the results of the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests, respectively. These tests assess the stationarity of each time series in the dataset to determine their integration order. The results indicate that all variables are stationary at their first differences, except for capital flight (CFL) and population growth (POPG), which are stationary at their levels. Specifically, for the ADF test, GDP, investment (INV), remittances (REM), inflation (INF), interest rate (INT), and exchange rate (EXCH) are non-stationary at levels but become stationary after first differencing, indicated by significant test statistics at the first differences. For the PP test, a similar pattern is observed, confirming the stationarity at first differences for these variables.

This implies that the null hypothesis of non-stationarity is rejected for all variables at their respective levels or first differences. Ensuring that the variables are integrated of order one at most (I(1)) allows for subsequent analysis to determine potential long-run relationships among the variables, avoiding spurious regression results. This confirmation of the integration order is crucial for the validity of further econometric analyses, such as cointegration tests and error correction models, which rely on the stationarity properties of the data.

**Table 3: Unit Root Test (augmented dickey–fuller test)**

| | With Constant | Without constant | With Constant | Without constant | Decision |
|---|---|---|---|---|---|
| *GDP* | -1.251 | -2.103 | -3.364** | -2.976 | I(1) |
| *CFL* | -3.837*** | -3.748** | -5.690*** | -5.659*** | I(0) |
| *INV* | -0.726 | -2.030 | -4.396*** | -5.275*** | I(1) |
| *REM* | -0.809 | -1.765 | -6.638*** | -6.573*** | I(1) |
| *INF* | -2.414 | -0.615 | -2.874* | -4.190** | I(1) |
| *INT* | -2.311 | -2.130 | -5.513*** | -5.944*** | I(1) |
| *EXCH* | -2.140 | -1.125 | -6.104*** | -6.633*** | I(1) |
| *POPG* | -3.933*** | -2.458 | -5.545*** | -5.199** | I(0) |

*Source: Computed by the author*

**Table 4: Unit Root Test (Phillip-Perron test)**

| | With Constant | Without constant | With Constant | Without constant | Decision |
|---|---|---|---|---|---|
| *GDP* | -0.995 | -3.871** | -4.529*** | -4.231*** | I(0) |
| *CFL* | -2.537 | -2.484 | -7.397*** | -8.776*** | I(1) |
| *INV* | -1.06 | -2.099 | -4.396*** | -5.327*** | I(1) |
| *REM* | -0.809 | -1.964 | -6.638*** | -6.573*** | I(1) |
| *INF* | -1.951 | -0.633 | -2.771* | -2.947* | I(1) |
| *INT* | -2.323 | -2.035 | -7.095*** | -7.413*** | I(1) |
| *EXCH* | -2.247 | -1.074 | -6.104*** | -6.712*** | I(1) |
| *POPG* | -2.786* | -2.726 | -5.487*** | -5.472*** | I(0) |

*Source: Computed by the Author*

#### 4.4. Results of bounds test for co-integration

To determine the existence of long-run cointegration among the variables, a bounds test for cointegration is conducted, as shown in Table 5. The F-test value is compared to the lower and upper bounds, following the methodology of Pesaran et al. (2001). If the calculated F-value exceeds the upper bound, the null hypothesis is rejected in favor of the alternative. The results confirm the presence of a long-run association and a non-linear relationship between capital flight and economic growth, as the critical F-statistics value surpasses both the lower bounds I(0) and upper bounds I(1). This validates the use of the Non-Autoregressive Distributed Lag (NARDL) modeling approach in this study.

**Table 5: ARDL bounds test for the cointegrating relationship.**

| T | T-Statistics | Significance | Lower value I(0) | Upper value I(1) |
|---|---|---|---|---|
| 8 | F-Statistics =4.859 | 10% | 1.95 | 3.06 |
| | | 5% | 2.22 | 3.39 |
| | | 2.5% | 2.48 | 3.70 |
| | | 1% | 2.79 | 4.10 |

*Source: Computed by the author*

### 4.5. Results from asymmetry test (i.e. wald test)

In addition to the F-statistics, the Wald test is conducted to further validate cointegration among the variables, as shown in Table 6. The Wald test results in Table 6 demonstrate significant asymmetry in the effects of capital flight on economic growth. The long-run F-statistic of 15.782 with a p-value of 0.0001 and the short-run F-statistic of 45.234 with a p-value of 0.0000 both indicate that changes in capital flight—whether positive or negative—significantly impact economic growth. This asymmetry suggests that the effects of capital flight on economic growth are not uniform and can vary depending on the nature of the change (positive or negative). The findings also highlight the complex dynamics between capital flight and economic growth, justifying the use of the Non-Autoregressive Distributed Lag (NARDL) modeling approach in this study.

**Table 6. Long- and Short-run symmetry Tests.**

| | Long-run | | Short-run | |
|---|---|---|---|---|
| | F-Statistic | P-value | F-Statistic | P-value |
| ***CFL (capital flight)*** | 15.782 | 0.000 | 45.234 | 0.000 |

*Computed by the author*

### 4.6 Results of the asymmetric relationship between capital flight and economic growth

Next, the existence of asymmetric cointegration in the model is established and the order of integration of the variables is corroborated using the NARDL model for capital flight-economic growth model. In this case, the link between capital flight and economic growth is assessed using the long-run, short-run dynamic, and ECM models. The NARDL model indicates that variations in capital flight and economic progress are not correlated. The fluctuations in economic development may be distinguished by examining both positive and negative shifts in capital flight.

#### *4.6.1. NARDL Estimation of Long-run NARDL Coefficients*

The NARDL model estimation results, presented in Table 7, provide insights into the long-run asymmetry between capital flight and economic growth. The model estimates coefficients for both positive (ΔCFL(+)) and negative (ΔCFL(-)) changes in capital flight, reflecting the asymmetric effect of capital flight on economic growth over the long run. The results reveal a significant positive long-run relationship between positive changes in capital flight and economic growth, as indicated by the p-value of 0.004, below the 5% significance level. Conversely, negative changes in capital flight exhibit a significant negative long-run relationship with economic growth, with a p-value of 0.021. This suggests that capital flight adversely affects economic growth. Specifically, a 1% increase in capital flight leads to a 12.8% decrease in economic growth in the long run, while a 1% decrease in capital flight results in a 23.6% increase in economic growth. These findings align with the findings by Lawal et al., 2017; Bredino et al., 2018; Orji et al., 2020, indicating that capital flight adversely impacts economic growth. Additionally, the results show that other control variables such as investment, remittances, and interest rates also significantly affect economic growth, with population growth exerting a substantial positive impact.

**Table 7: Long-run NARDL coefficients estimation results**

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| $CFL^{+}$ | -0.128 | 0.054 | 2.412 | 0.021 |
| $CFL^{-}$ | 0.236 | 0.069 | -3.264 | 0.004 |
| *INV* | -0.142 | 0.080 | -1.775 | 0.087 |
| *REM* | -0.078 | 0.034 | -2.090 | 0.049 |
| *INF* | 0.026 | 0.074 | 0.351 | 0.743 |
| *INT* | 0.022 | 0.011 | 2.045 | 0.039 |
| *EXCH* | 0.018 | 0.065 | 0.276 | 0.785 |
| *POPG* | 1.293 | 0.312 | 4.142 | 0.000 |
| *C* | 8.390 | 1.802 | 4.658 | 0.000 |

*Computed by the author*

With regards to the long run effect of other control variables, the results indicate that while economic growth is negatively and significantly affected b***y*** investment, proxied with gross capital formation, interest rate and population growth exert significant positive impact on economic growth.

#### *4.6.2. NARDL Short-run and ECM Test result*

Table 8 presents the short-run coefficients estimates and ECM results, shedding light on the dynamic relationship between capital flight, control variables, and economic growth in Nigeria. The Error Correction Term (ECT) being significant at a 1% level indicates that the model can correct

28.5% of short-run disequilibrium to the long run, elucidating the relationship between positive and negative changes in capital flight and economic growth. The high R-square of 88.1% signifies a robust fit, indicating the model's ability to explain a significant portion of the variation in economic growth based on capital flight and control variables. In the short-run NARDL output, an asymmetrical relationship between capital flight and economic growth is evident. Both positive and negative changes in capital flight are statistically significant, impacting economic growth in the short run. Specifically, a 1% increase in positive change in capital flight (capital outflows) reduces economic growth by 0.042% in the short run, while a 1% increase in negative change in capital flight (capital inflows) increases economic growth by 0.070% in the short run. Furthermore, control variables such as remittances, inflation, exchange rate, and population growth demonstrate significant effects on economic growth in the short run, with investment exerting a positive influence.

**Table 8. Short-run coefficients estimates and ECM results**

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| **C** | 0.001 | 0.007 | 0.149 | 0.881 |
| $\Delta CFL^{+}$ | 0.042 | 0.018 | 2.333 | 0.050 |
| $\Delta CFL^{-}$ | -0.070 | 0.021 | -3.333 | 0.003 |
| $\Delta INV$ | 0.018 | 0.020 | 0.900 | 0.371 |
| $\Delta REM$ | -0.025 | 0.007 | -3.571 | 0.001 |
| $\Delta INF$ | -0.097 | 0.031 | -3.129 | 0.004 |
| $\Delta INF(-1)$ | -0.085 | 0.032 | -2.660 | 0.012 |
| $\Delta INT$ | 0.007 | 0.002 | 4.500 | 0.000 |
| $\Delta EXCH$ | -0.038 | 0.010 | -3.800 | 0.002 |
| $\Delta EXCH(-1)$ | -0.032 | 0.011 | -2.909 | 0.007 |
| $\Delta POPG$ | 0.325 | 0.038 | 8.553 | 0.000 |
| $\Delta POPG(-1)$ | -0.198 | 0.045 | -4.400 | 0.000 |
| ***ECT(-1)*** | -0.285 | 0.032 | -8.984 | 0.000 |
| ***R-Square*** | 0.881 | - | - | - |
| ***Adjusted R-Square*** | 0.835 | - | - | - |
| ***S.E of Regression*** | 0.020 | - | - | - |
| ***Sum Squared Resid*** | 0.012 | - | - | - |
| ***Prob(F-Statistic)*** | 120.491 | - | - | - |

*Computed by the author*

### *4.7. Diagnostics tests*

Table 9 provides a summary of the testing regression assumptions conducted to ensure the validity of the regression model. The tests include normal distribution, LM test for serial correlation, ARCH test, and Ramsey RESET test. The F-statistics and associated p-values are presented for each test. The normal distribution test assesses if the residuals of the regression model follow a normal distribution. With an F-statistic of 0.292 and a p-value of 0.874, there is no evidence to reject the null hypothesis of normality, indicating that the residuals are normally distributed. The LM test for serial correlation evaluates the presence of autocorrelation in the residuals. A low F-statistic of 0.567 and a high p-value of 0.537 suggest that there is no significant serial correlation in the residuals. The ARCH test checks for the presence of heteroscedasticity, indicating whether the variance of the residuals is constant. With an F-statistic of 0.548 and a p-value of 0.506, there is no evidence of heteroscedasticity in the residuals. Finally, the Ramsey RESET test examines the functional form of the regression model. A small F-statistic of 0.004 and a high p-value of 0.956 indicate that the model specification is appropriate and there is no evidence to reject the null hypothesis of correct model specification.

**Table 9. Summary of testing regression assumption**

| Type of Tests | F-Statistics | P-value |
|---|---|---|
| Normal Distribution | 0.292 | 0.874 |
| LM Test (Serial Correlation ) | 0.567 | 0.537 |
| ARCH | 0.548 | 0.506 |
| Ramsey RESET | 0.004 | 0.956 |

*Computed by the author*

The cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) tests are used to evaluate the model's stability. The estimated lines in figures 1 and 2, which displays the findings, falls within the upper and lower limits, indicating that the model's parameters are stable.

**Figure 1.** ***Plots of cumulative Sum of Recursive Residuals***

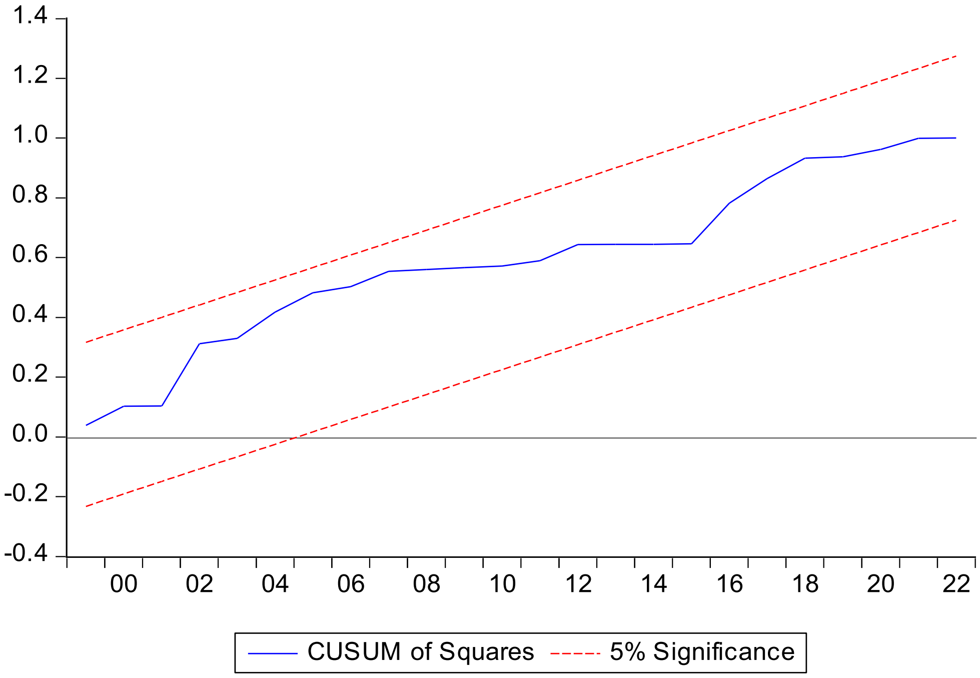
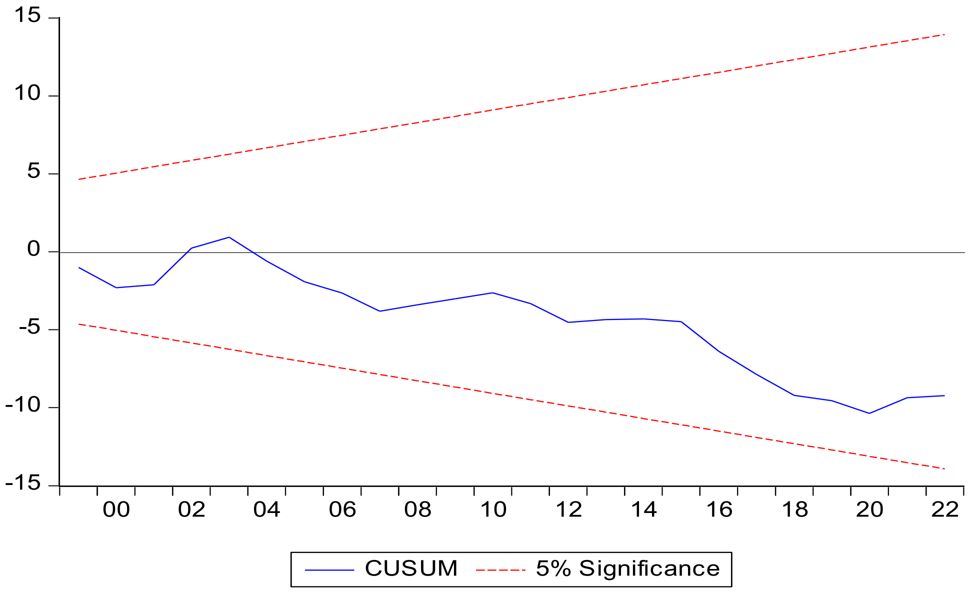


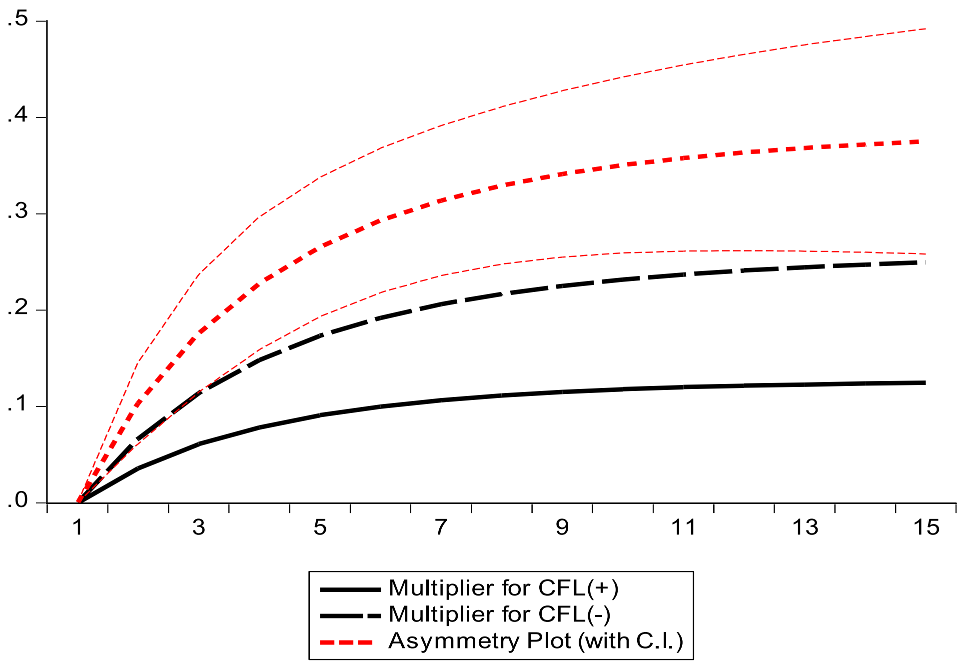

**Figure 2.** ***Plots of cumulative Sum of Squares of Recursive Residuals***



*4.8. Dynamic multiplier graph*

The Dynamic Multiplier Graph (DMG) provides a method to assess the adjustment asymmetry in long-run equilibrium resulting from positive and negative changes or shocks in capital flight. In Figure 3, the dynamic effects of economic growth in response to positive and negative changes revealed that there exists an asymmetry in the adjustment process of economic growth to positive and negative changes or shocks in capital flight. The graph demonstrates that capital flight reacts more swiftly to an increase in economic growth compared to a decline. Specifically, when there's a positive change or shock in capital flight, economic growth responds more rapidly (represented by the black dashed line), whereas its adjustment to a negative change or shock in capital flight is slower (shown by the black line below). The dynamic multiplier of positive and negative changes in capital flight (represented by the small red dashed line) further illustrates this asymmetry. The red line, encompassing the upper and lower bounds of the 95% confidence intervals, highlights that GDP responds more positively to a positive shock than to a negative shock of capital flight, indicating an asymmetrical relationship between capital flight and economic growth dynamics.

**Figure 3: Dynamic Multiplier**



**5. Conclusion and policy implications**

This study investigates the relationship between capital flight, economic growth, and various independent factors influencing Nigeria's economic dynamics from 1980 to 2023. Utilizing the nonlinear and asymmetric ARDL cointegration method proposed by Shin et al. (2014) within the nonlinear Autoregressive Distributed Lag (NARDL) framework, the findings reveal an intricate connection between capital flight and economic growth in both the long and short run. The negative significance of the error correction term at the 5% level implies the short-run model's convergence to long-run equilibrium over time. NARDL estimates uncover a robust long-term positive association between capital flight and economic growth, coupled with a significant negative correlation between economic growth and the negative change in capital flight over the long run. This trend is mirrored in the short run with the error correction results. Specifically, an increase in capital flight hampers economic growth in both time horizons, while a decline in capital flight corresponds to increased economic growth. Additionally, the study employs dynamic multipliers to illustrate the pattern of after-shock changes, highlighting asymmetries in adjustment dynamics. Importantly, positive changes in capital flight elicit a faster response in economic growth than negative changes.

Addressing the asymmetric impact of capital flight on economic growth necessitates a multifaceted policy approach. Immediate actions to curb capital flight through tightening regulations, enhancing institutional integrity, and strengthening anti-corruption measures are crucial, given the urgency implied by the faster impact of positive changes in capital flight on economic growth. Additionally, policymakers should focus on boosting investor confidence through clear and consistent policies, fostering international cooperation to combat illicit financial activities, and conducting public awareness campaigns to mobilize support for policy interventions. Long-term structural reforms aimed at improving the business environment, promoting diversification, and investing in human capital and infrastructure are also essential to address underlying factors driving capital flight and foster sustainable economic development.

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