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# DO EXCHANGE RATE FLUCTUATIONS EFFECT ECONOMIC GROWTH IN NIGERIA? EMPIRICAL EVIDENCE*

## *NİJERYA'DA DÖVİZ KURU DALGALANMALARI EKONOMİK BÜYÜMEYİ ETKİLİYOR MU? AMPİRİK KANITLAR*

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**Öz**

**Amaç:** Bu çalışma, döviz kurunun Nijerya'nın ekonomik büyümesi üzerindeki etkisini pozitif ve negatif bileşenlerine ayırarak değerlendirmeyi amaçlamıştır.

**Yöntem:** Döviz kurunun Döviz kurunun ekonomik büyüme üzerindeki etkisini ayrıştırmak için doğrusal olmayan bir ARDL modeli kullanılmıştır. Ayrıca, naira değerindeki değişikliklerin etkilerini ölçmek için asimetrik etkiler testi kullanılmıştır.

**Bulgular:** Kısa vadede, Naira ABD doları karşısında değer kaybettiğinde ekonomik büyüme düşme eğilimi gösterirken, değer kazandığında ekonomik büyüme artma eğilimi göstermektedir. Uzun vadede ise bu etkiler ters yönde işlemektedir. Buna ek olarak, asimetrik etkiler için yapılan test, Naira'nın değer kazanmasının ekonomik büyümeyi etkileme şeklinin değer kaybetmesinden önemli ölçüde farklı olduğunu göstermektedir.

**Sonuçlar:** Bu bulgulardan çıkan genel sonuç, Nijerya'da döviz kurunun ekonomik büyüme üzerindeki etkisinin doğrusal olmadığıdır. Sonuçlardan ayrıca, bilgi stokunun Nijerya ekonomisinin büyümesine fazla katkıda bulunmadığı da anlaşılmaktadır. Nijerya'daki düşük eğitim finansmanı ve kayıt oranı göz önüne alındığında bu şaşırtıcı değildir. Dolayısıyla, bu araştırmada toplanan kanıtlar, Nijerya'nın ekonomik büyümesini önemli ölçüde desteklemek için sermaye stokunu yeterince kullanmıyor olabileceğini göstermektedir.

**Anahtar Kelimeler:** Döviz kuru, Nijerya, Ekonomik büyüme, ARDL modeli

**Abstract**

**Aim:** This study aimed at assessing the impact of exchange rate on Nigeria's economic growth by decomposing it into positive and negative components.

**Method:** A non-linear ARDL model was used to decompose the effect of exchange rate on economic growth. Also, asymmetric effects test was used to measure the effects of changes in the value of the naira.

**Findings:** In the short run, when the Naira depreciates against the US dollar, economic growth tends to decline, while when it appreciates, economic growth tends to increase. In the long run, these effects work in the opposite direction. In addition, the test for asymmetric effects shows that the way in which the appreciation of the naira affects economic growth differs significantly from that of its depreciation

**Conclusions:** The general conclusion from these findings is that the effect of exchange rate on economic growth in Nigeria is non-linear. It is also clear from the results that the stock of knowledge does not contribute much to the growth of the Nigerian economy. This is not surprising given the low education financing and enrolment rate in Nigeria. Therefore, the evidence gathered in this research suggests that Nigeria may be underutilising its capital stock to significantly support its economic growth.

**Keywords:** Exchange rate, Nigeria, Economic growth, ARDL model

* This study is derived from Ayodeji Mubarak Olayiwola's master's thesis titled "The impact of exchance fluctuations on economic growth in Nigeria" (Advisor: Prof. Dr. Ilhan Eroglu)

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## I. Introduction

**Background:** An examination of the macroeconomic literature shows economic growth to be an issue that has been of serious concern to researchers in economics and to policymakers alike. In addition, economists closely associate economic growth to the attainment of key macroeconomic objectives such as reducing poverty, stabilizing debt, employment growth and infrastructural provision. The sustained economic growth can then lead to poverty reduction particularly in countries such as Nigeria, where the poverty incidence is high (Orji et al., 2020).

The objective of Nigeria's trade policy is to promote and diversify its exports by strengthening national competitiveness. Nigeria's foreign trade accounts for 23% of its GDP (World Bank-WB). According to the National Bureau of Statistics-NBS; Nigeria's exports are mainly based on petroleum oils and petroleum gas (90% of total exports), while imports are dominated by mineral products (40%). The largest export partners are India (12.6% of total exports), Spain (12%), the Netherlands (9.6%), the United States (6.8%) and France (5.8%), while Nigeria's import partners are China (22.7% of total imports), the Netherlands (10.4%), India (7.9%), the United States (5.6%) and France (2.6%) (URL 1,2023).

Moreover, it is not surprising that economic growth continues to remain in the front burner of macroeconomic discourse, leading to a great deal of interest in factors which may influence it. Among such factors, one that has received considerable attention in past studies is exchange rate (e.g., Rapetti et al., 2012; Owoundi, 2016; Yan et al., 2016; Habib et al., 2017; Anaya and Hansenclever, 2018; Wesseh and Lin, 2019) and it continues to do so, even in the recent and emerging literature (e.g., Gabriel et al., 2020; Ribeiro et al., 2020; Barguellil, 2021; Ko, 2022). The main idea behind the concerns on the exchange rate effect on economic growth is that a country's currency value influences is external trade, a critical component of aggregate demand which determines output, and thus, economic growth. A movement in exchange rates is said to lead invariably to favourable or unfavourable changes to economic growth, depending on the prevailing conditions in both the domestic economy and that of its trading partners (Rapetti et al., 2012).

Since the traded sectors are the engine of international technology spill overs, positive knowledge externalities and learning-by-exporting (Grossman and Helpman, 1991; Araújo and Salerno, 2015; Tse et al., 2015; Hu et al., 2016; Ma and Muendler, 2021), the domestic economy tends to benefit when the currency depreciates, leading to an increase in exports, aggregate demand and economic growth.

Evidently, the evolution and dynamics of exchange rates have serious growth implications for a developing country such that well aligned exchange rate movements have desirable results, whereas, misalignments could be potentially disastrous. Given these concerns, several developing countries, Nigeria inclusive, have made efforts to manage their exchange rate values in attempt to instigate greater economic growth. In Nigeria for instance, different governments have implemented several exchange rate policies with the broad aim of maintaining external balance and achieving sustained economic growth since the country gained independence in 1960. For example, the exchange rate policies during the periods between independence and the Structural Adjustment Programme (SAP) mostly favoured direct control of the Naira's value with the aim of maintaining external balance (i.e., trade and payments) and stabilizing the Naira's value relative to those of the major currencies (Obaseki, 1991).

Indeed, there has been inconsistent trend in Nigeria's economic growth since the periods before SAP and until now, that raises the question of whether the lack of sustained economic growth in Nigeria is not, at least in part, tied to exchange fluctuations experienced in the country thus far. This question forms the central theme of the present study, which re-examines the role of exchange rate fluctuations on economic growth in Nigeria.

**Research Objectives and Hypotheses:** The main objective of this study is to assess the impact of exchange rate fluctuations on Nigeria's economic growth. In this context, the objective of the study can be summarized in three sub-objectives; i) ii) To analyze the impact of Naira depreciation relative to the US dollar on Nigeria's economic growth. iii) To test the asymmetry between the impact of Naira depreciation and appreciation on Nigeria's economic growth. Research Hypotheses; In line with the research objective, the research hypotheses are as follows.

$H_1$: Exchange rate depreciation does not significantly affect Nigeria's economic growth.
$H_2$: Exchange rate appreciation has insignificant effect on Nigeria's economic growth.
$H_3$: The impact of exchange rate appreciation on Nigeria's economic growth is no different from that of exchange rate depreciation.

**Justification of the Study:** To differentiate from past Nigerian studies, this research implements the Nonlinear ARDL (NARDL) technique suggested by Shin et al. (2014) to decompose the influence of exchange rate on Nigeria's economic growth into their positive and negative components. Because of the decomposition, the NARDL could offer greater insight on how Nigeria's economy has responded to exchange rate fluctuations thus far, helping to shed light on the appropriate policy measure that would improve the use exchange rate as a tool for achieving sustained economic growth.

## II. Theoretical Framework

### 2.1. Theoretical Framework

Studies of the Nigerian economy have focused on finding solutions to shrinking economic growth. Accordingly, the Nigerian federal government has been pursuing different policies in different periods to improve economic growth. In these policies, it is of particular importance to reveal the factors that are effective in the growth of the Nigerian economy. In previous studies, the answer to the question of what determines economic growth has been attributed to a wide range of causes ranging from economic, social, political and institutional reasons, making it difficult to reach a consensus on the determinants of growth. Consequently, the number of possible determinants of economic growth has naturally increased. A study by Nyoni and Bongo (2018), which analyzed 27 studies on what determines economic growth in Nigeria, emphasizes the public's belief that a change in government administration will contribute positively to economic growth. In addition, the study concluded that in order to achieve economic growth, the focus should be on population growth rather than inflation, foreign direct investment, interest rates, exports, public and private investment.

In the historical process, it is seen that the determinants of growth have different levels of impact and importance on growth. This issue has been handled in different dimensions in growth theories. In this context, the historical process that started with Mercantilism and Physiocrats continued with the Classics, Shumpeter, Keynesians, Robert Solow's Exogenous growth theory for Neoclassical theory and endogenous growth theories. While the Mercantilists first considered precious metals and coins as economic power, later the total amount of goods produced was taken as a measure of wealth. The Physiocrats, who replaced the Mercantilists, took land and production on land as a measure of wealth. (Sharipov, 2015).

While classical economics attributed the determinants of economic growth to the increase in investment and productive capacity, Schumpeter later emphasized risk-taking as a determinant of growth, seeing the driving force of growth in entrepreneurship, innovation, creativity and foresight.

Adam Smith, David Ricardo, Thomas Maltus and Jean-Baptiste Say, as the leading representatives of the classics, based the determinants of growth on the "Law of Markets". Although Karl Marx, like the classics, saw production as the determinant of growth, he emphasized the fact that the occurrence of production crises in the capitalist economic model did not always create demand, contrary to what Say claimed. On the other hand, Alfred Marshall made a distinction between endogenous economies and exogenous economies in terms of growth and revealed the existence of exogenous economies as well as

productivity with the development of firms on the one hand and industry on the other hand by reducing production costs thanks to exogenous economies (Piętak, 2014).

While classical thought explained growth from the supply side, Keynes claimed that the role of demand in growth is more decisive. Keynes stated that contrary to the 'natural equilibrium' claim of the classics, the economy is generally 'prone to imbalance and unemployment' due to the nature of the economy. In his studies, Keynes saw investment as a determinant of growth in short-run and static models. However, on the grounds that this situation did not explain long-term and dynamic relations, he drew attention to issues such as labor force, capital, natural resource increase and technological development as determinants of growth in the model that Harrod and Domar discussed together and called the Harrod- Domar Model (Keynes, 1936; Harrod, 1939; Domar, 1947). Neoclassical economics, as a later trend, saw land, capital and labor as the determinants of growth. While this approach was generally accepted, Robert M. Solow pointed out in his 1957 study that technological progress is an important determinant of growth (Solow, 1957)

Growth models have shown different developments from past to present. The differentiation of growth models may be possible with different perspectives. Common assumptions also contribute to the classification of growth models. Models that assume that the productivity of the factors in the production function decreases and models that assume that the productivity of the factors of production is constant. The first of these models is known as exogenous models and is referred to as exogenous models in the literature. The second one is known as endogenous models and is also referred to as endogenous models in the literature. On the other hand, Neoclassical models, which are classified as exogenous models, assume that countries converge to each other. Accordingly, poor countries grow faster and converge to rich countries. The reason for the emergence of endogenous growth models against exogenous growth models is that the issues that cannot be explained by the exogenous growth model can be explained by the endogenous growth model. These issues can be summarized as the ability of countries to produce more than a century ago, the role of human capital in economic growth and the reasons for the differentiation of countries. Endogenous models use a production function that refers to a linear function of technology and the most typical example of this is the AK Production Function (Rebello, 1991). The leading endogenous growth models can be listed as follows (Piętak, 2014);

-Adding exogenous factors to the model (Marvin Frankel),
-Learning by doing (Kenneth Arrow),
-Adding capital externalities to the neoclassical production function (Paul Romer),
-Consideration of human capital in addition to physical capital (Robert Lucas),
-Internalization of technological progress as a result of R&D activities- increasing the supply of intermediate goods (Paul Romer) and improving the quality of existing goods (Aghion - Howitt)
This study's theoretical framework derives from the endogenous growth theory. The endogenous growth theory is an off-shoot of the classical growth theories like the Solow, Harrod-Domar and RCK models. These classical theories originally propose that capital accumulation (through savings) is responsible for economic growth, their analysis break down in the long-run horizon with neither savings nor capital accumulation are unable to sustain economic growth. In fact, as the long-run analyses of the models reveal, only knowledge accumulation remains valid for sustaining economic growth. The endogenous growth theory presents an alternative explanation that factors in other variables are different from capital accumulation and labour force as explanations for long-run economic growth. The main difference between endogenous and classical growth theories is that the variable responsible for long-run economic growth in the classical models (i.e., knowledge) is endogenized by providing an explanation for it within the model. This study's theoretical framework assumes that long-run growth is influenced by knowledge, capital accumulation, price level and exchange rate through the so-called J-curve hypothesis.

## III. Method

### 3.1. Model Specification

Building on the study's theoretical framework, the determinants of economic growth ($eg$) include, exchange rate ($ex$), capital stock ($cs$), knowledge stock ($ks$) and inflation rate ($ir$). Other than exchange rate, the choice of capital stock derives from the long-standing economic growth literature that claims capital accumulation is essential for growth because it influences a country's production capacity. Knowledge stock contributes to growth through its ability to improve the quality of human capital and labour productivity whereas, microeconomic theory suggests, firms are incentivized to produce more output when prices rise. Given the foregoing, the functional form of the economic growth model estimated in this study is expressed as follows.

$$eg = f(ex, cs, ks, ir) \qquad (1)$$

One way to express equation (18) is to assume that all the independent variables influence economic growth in a linear fashion such that a change in one direction influences economic growth with the same magnitude as a change in another direction. Such assumption limits the analysis because it does not allow the decomposition of an independent variables effect on the dependent variable into positive and negative effects. An alternative approach is the non-linear ARDL (NARDL) model suggested by Shin et al. (2014) which has been used extensively to capture asymmetry in the effect of one variable on another (see for instance, Ahmed et al., 2021, Onodje et al., 2021). The NARDL model in this case is given as follows.

$$d(eg_t) = \beta_0 + \beta_1 eg_{t-1} + \beta_2^+ ex_{t-1}^- + \beta_2^- ex_{t-1}^- + \beta_3 cs_{t-1} + \beta_4 ks_{t-1} + \beta_5 ir_{t-1} + \sum_{i=1}^{m} \theta_{1_i} d(eg_{t-i}) +$$
$$\sum_{i=0}^{n} \theta_{2_i}^+ d(ex_{t-i}) + \sum_{i=0}^{n} \theta_{2_i}^- d(ex_{t-i}) + \sum_{i=1}^{q} \theta_{3_i} d(cs_{t-i}) + \sum_{i=1}^{q} \theta_{4_i} d(ks_{t-i}) + \sum_{i=1}^{q} \theta_{5_i} d(ir_{t-i}) + \mu_t \qquad (2)$$

$$-\frac{\beta_2}{\beta_1} = -\frac{\beta_3}{\beta_1}$$

Such that, $\mu_t$ represents the error term of the regression and $d$, the difference operator. In equation (19), $ex_t^+$ represents a positive change or an increase in exchange rate (i.e., a naira depreciation vis-à-vis the US$) whereas $ex_t^-$ implies a negative change or decrease in exchange rate (i.e., a naira appreciation vis-à-vis the US$). Several approaches can be used to decompose the effect of the independent variables, but previous studies that specified the NARDL model (e.g., Ahmed et al., 2021; Nuru and Gereziher, 2021; Onodje et al., 2021) have relied on the Mork (1989) procedure which is now utilized in the present study as follows.

$$ex_t^+ = \sum_{i=1}^{t} d(ex_t^+) = \sum_{i=1}^{t} \max\{d(ex), 0\} \qquad (3)$$

$$ex_t^- = \sum_{i=1}^{t} d(ex_t^-) = \sum_{i=1}^{t} \min\{d(ex), 0\} \qquad (4)$$

Hence, $ex_t^+$ is the cumulative sum of positive exchange rate changes up to period $t$ while $ex_t^-$ represents the cumulative sum of negative exchange rate changes up to period $t$. As with the conventional ARDL model, long-run effects of the exchange rate and the control variables in equations (18) are calculated as follows.

$$-\frac{\beta_i}{\beta_1} \; \forall \; i \in \{2, \ldots, 5\} \qquad (5)$$

Given the long-run coefficients, the null hypothesis for the NARDL bounds test of the output growth model would assume the following form.

$$\frac{\beta_2^+}{\beta_1} = \frac{\beta_2^-}{\beta_1} = \frac{\beta_3}{\beta_1} = \frac{\beta_4}{\beta_1} = \frac{\beta_5}{\beta_1} = 0 \qquad (6)$$

### 3.2. Data Measurement and Sources

Data used for this study is annual time series data on the variables from 1981 to 2020. With the exception of knowledge stock, which was sourced from the WDI database, all other variables are sourced from the CBN statistical bulletin. In terms of measurement, all the variables are expressed in natural logs. summarizes the description and measurement of the variables are provided in Table 1.

**Table 1. Variables' Measurement**

| Variable | Symbol | Measurement | Source |
|---|---|---|---|
| Economic growth | $eg$ | Natural logs | CBN |
| Exchange rate (Nominal) | $ex$ | Natural logs | CBN |
| Capital stock | $cs$ | Percentage of GDP (%) | CBN |
| Knowledge stock (secondary school enrolment ) | $ks$ | Percentages (%) | WDI |
| Inflation rate | $ir$ | Percentage CPI changes (%) | CBN |

**Source:** CBN statistical bulletin.

### 3.3. Presentation of the Data

Starting with the time plots of the variables used for analyses (see Graphic 1.), economic growth, measured as GDP (in trillions of naira) seems to have trended upwards for most of the periods under consideration. However, a slight dip in the variable is observable around the 1983 – 1985 period which coincides with the Structural Adjustment Programme (SAP).

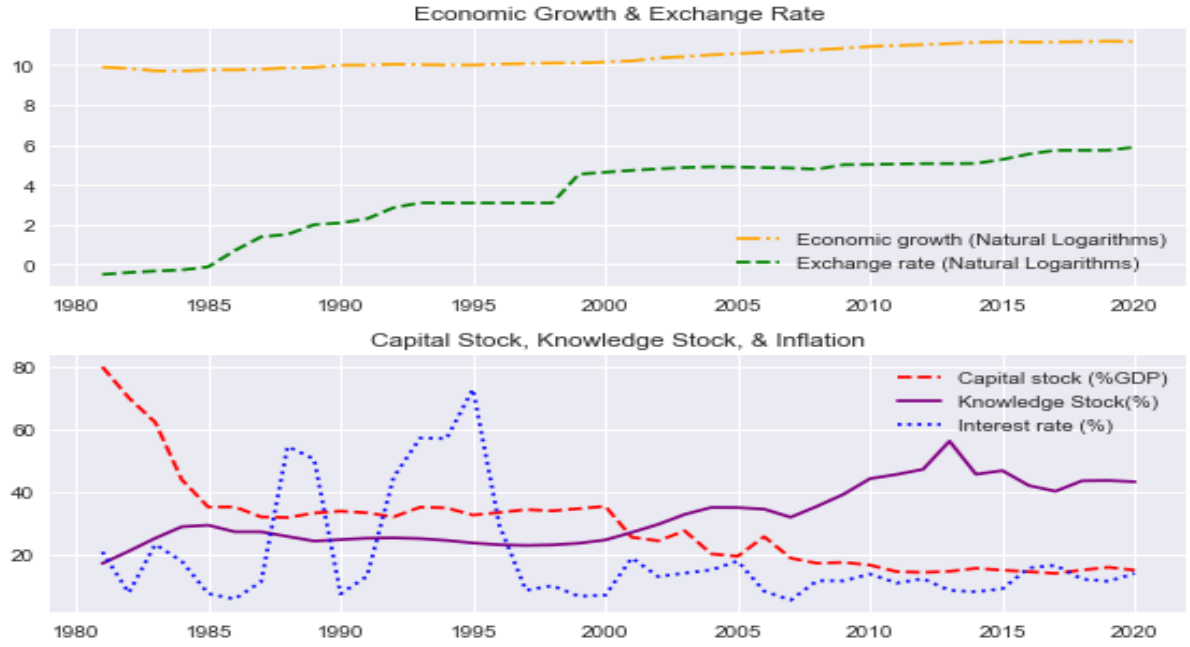


**Figure 1. Time Plots of Series (1981- 2020)**

**Source**: Prepared by the Authors.

This period is generally associated with decline in several macroeconomic indicators like manufacturing growth, employment and gross output in addition to rising inflation levels (Chete et al., 2017; Chete and Adenikinju, 2002; Onodje and Onodje, 2022). Moreover, between 1990 and 2000, Nigeria's GDP seems to have witnessed minimal growth as seen by the relative flatness of its graph during those periods relative to other periods. It can also be seen that GDP exhibits a sharp increase relative to trend starting from the year 2000. This coincides with the beginning of the current democratic dispensation which has

been associated with unprecedented inflow of FDI as well as several government policies to alleviate poverty and revitalize the ailing economy. Turing to the US$/naira nominal exchange rate , there seems to be consistent depreciation in the naira when compared to the US$ throughout the analysis period. The period of 1995 to 2000 that was associated with minimal real GDP increase is associated with the sharpest consistent increase in the US dollar value relative to the naira. There seems to be greater fluctuations in the other variables, especially inflation rate and which peaked at more than 70% in 1995. Capital stock (as a % of GDP) decreases consistently whereas, knowledge stock (secondary school enrolment) seems to have increased steadily from 2000. variables used in the model ***i)*** Economic growth(ln) : Refers to a value in terms of real gross domestic product. ***ii)*** Exchange rate (Nominal- ln): Measures the value of one Naira in nominal terms against 1 US dollar in nominal terms. ***iii)*** Capital stock(%): a percentage measure of the ratio of the total amount of physical capital owned by the country to GDP. ***iv)*** **K**nowledge stock (%): Secondary school enrollment. **v)** Inflation rate (%): A measure of the % change in the consumer price index.

### 3.3. Ethical Considerations

Ethics committee approval was not obtained because secondary data were used in the study. However, while preparing the article, academic ethical rules were followed.

## IV. Empirical Analysis and Findings

### 4.1. Descriptive Statistics

The descriptive statistics of the variables summarised in Table 2 show their statistical properties.

**Table 2. Summary of Descriptive Statistics**

| Statistic | EG | EX | CS | KS | IR |
|---|---|---|---|---|---|
| Mean | 10.388 | 3.541 | 28.929 | 32.244 | 18.991 |
| Std. | 0.525 | 1.992 | 14.992 | 9.433 | 16.874 |
| Min. | 9.693 | -0.494 | 13.917 | 17.106 | 5.380 |
| Max. | 11.186 | 5.883 | 79.954 | 56.205 | 72.840 |
| JB | 4.198 | 4.918 | 31.669 | 3.337 | 29.911 |
| p. > JB | 0.123 | 0.086 | 0.000 | 0.189 | 0.000 |
| Kurtosis | -1.458 | -0.644 | 2.943 | -0.671 | 2.157 |
| Skewness | 0.313 | -0.796 | 1.608 | 0.623 | 1.823 |
| Years | 40 | 40 | 40 | 40 | 40 |

**Source:** Authors' calculations

We observe that economic growth and knowledge stock (KS) have insignificant Jarque-Bera (JB) statistics which seems to support normality in their distributions. Exchange can also be said to have a normal distribution at least, at 5% significance level. On the other hand, variables like capital stock and interest rates clearly have non-normal distributions judging by the p-values of their JB statistics. Further evidence of relative normality in the distributions of economic growth, capital stock and knowledge stock is shown in their kurtosis values which are close to 0 for exchange rate and capital stock especially. Overall, the variables exhibit minimal skew with exchange rate showing slight negative skew whereas, the other variables show slight positive skew with interest rate taking the lead. The implication of these statistical properties is the nature of the error term's distribution from a regression equation involving these variables (Gujarati et al., 2012). Given that the JB test suggests normality of most variables, especially economic growth, it is reasonable to expect a normal distribution error terms in a regression involving the set of variables used.

### 4.2. Correlation Analysis

A visual summary of the correlations is provided in Figure 1 using a heatmap. Correlations that are closer to the red spectrum of the correlation matrix show high negative association between variables whereas, those closer to the purple end of the colour spectrum indicate high positive correlation. Values within the dimmer regions of the spectrum indicate weaker correlations.

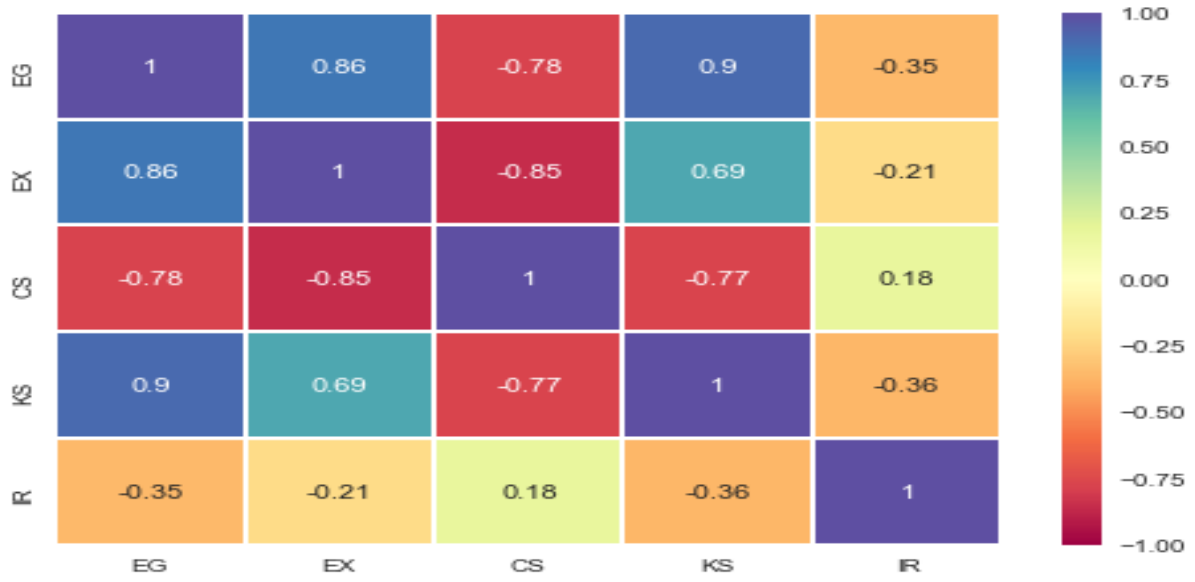


**Figure 2. Heatmap of Correlation Matrix**

**Source:** Prepared by the Authors

As expected, the diagonal elements are all "1" and highlighted in purple. This shows the correlation of each variable with itself. Conversely, the off diagonals are more diverse in colours. Given the deepness of most cells along the economic growth (EG) row, it can be inferred that economic growth has strong correlations with most of the variables. For variables like exchange rate (EX) and knowledge stock (KS), the correlation with economic growth is strong and positive whereas, for capital stock (CS), it is strong and negative. Other than with economic growth, exchange rate is also strongly correlated with capital stock and knowledge stock, with the latter being positive whereas, the former is negative. Interest rate exhibits a weak correlation with inflation rate. In fact, inflation seems to be weakly correlated with all the variables. It correlates strongest with economic growth and knowledge stock in an inverse manner. This seems to suggest that higher inflation may decrease both output and the ability to afford schooling in the country. We also find weak positive correlation between inflation and capital stock. It is surprising that capital stock has negative correlation with capital stock. This might underscore the scarcity of resources for investing in both physical and human capital such that there is a trade-off between the two.

### 4.3. Unit Root Test

Unit root tests were also performed on the variables to determine their stationarity status. Gujarati and Porter (2003) say that stationarity tests are indispensable when working with time series data because they help to avoid spurious regression and determine the appropriate technique to use. First, the tests were performed on the variables at their levels and then was repeated again for their first differences for those that were found non-stationary initially. The results reveal that many of the variables are not stationary at all levels. Among these are economic growth, exchange rate and knowledge stock. Capital stock and inflation rate both happen to be levels-stationary series. Once the tests were repeated on the variables at their first difference states, the evidence showed resoundingly that the previously non-stationary series became stationary. Thus, economic growth exchange rate and inflation rate are all stationary at their first differences.

**Table 3. ADF Unit Root Test**

| Test/Series | Stat. | p-val. | Sig. |
|---|---|---|---|
| Test at Levels | | | |
| EG | -1.768 | 0.720 | |
| EX | -1.365 | 0.871 | |
| CS | -3.830 | 0.015 | ** |
| KS | -1.907 | 0.651 | |
| IR | -4.057 | 0.007 | *** |
| Test at First Difference | | | |
| EG | -3.566 | 0.033 | ** |
| EX | -5.678 | 0.000 | *** |
| CS | -4.242 | 0.004 | *** |
| KS | -6.294 | 0.000 | *** |
| IR | -5.691 | 0.000 | *** |

**Note:** **, and *** mean significance at 5% & 10% respectively

**Source:** Authors' estimations

### 4.4. Bounds Test of Cointegration

Given the result of the stationarity tests revealed in the previous section, it becomes desirable to estimate the Non-linear ARDL model. However, another precondition for such a model is that there should be compelling evidence of cointegration among the variables. It is possible to apply the bounds test regardless of whether the variables to be used in the model are I(0) or I(1). Therefore, there is no need to determine the stationarity of the variables before applying the bounds test. However, since the critical values in Pesaran et al. (2001) are tabulated according to whether the variables are I(0) or I(1), the variables should be tested against the possibility of being I(2). In this context The bounds test of Pesaran et al. (2001) provide a useful way to test for stationarity when the model being considered is made up of both levels-stationary and first-difference stationary variables The bounds test of Pesaran et al. (2001) provide a useful way to test for stationarity when the model being considered is made up of both levels-stationary and first-difference stationary variables. Table 4 shows the result. According to Pesaran and his colleagues, the null hypothesis that there is no stationarity among the variables can be rejected as soon as the calculated F-statistic of the test is above the tabulated "upper" bound at most, at 5%. Looking at the result, we see that the calculated F (9.883) is higher than the upper bounds value at 1% (4.150). Thus, the conclusion is that the economic growth has a significant long-run relationship with the proposed determinants.

**Table 4. Bounds Test Result**

| Significance | Bounds | |
|---|---|---|
| | *Lower* | *Upper* |
| 10% | 2.080 | 3.000 |
| 5% | 2.390 | 3.380 |
| 2.50% | 2.700 | 3.730 |
| 1% | 3.060 | 4.150 |
| F-stat | DF | |
| 9.883 | 5 | |

**Source:** Prepared by the Authors

### 4.5. Short Run Effect of Exchange Rate on Economic Growth

Once there was evidence of cointegration and mixed order integration among the variables, it became possible to present the result of the estimated ARDL model as shown in Table 5 What is immediately apparent is that all the independent variables have significant short run influences on economic growth. It is equally clear that the signs of exchange rate depreciation variable ($EX^+$) are different from that of the exchange rate appreciation variable ($EX^-$). Capital stock has mixed short run effects, but it is easy to see that the overall effect is positive by summing up the individual short run coefficients of the variables.

Likewise, interest rate's effect is positive overall though its effect is smaller compared to the other variables. It is possible to make inference about the convergence of the ARDL model by looking at the value and sign of the ECT (Error Correction Term). The conditions for convergence require that the ECT should not only be negative, but it also has to be less than one in absolute terms. Moreover, it is essential that the ECT be less significant (Pesaran et al., 2001). Looking at the estimated ECT, it is clear that all the conditions for convergence have been satisfied. The actual ECT value can equally give the adjustment speed towards long-run equilibrium when there is a shock to the model (Gujarati and Porter, 2003). In the current model, 33.9% of the divergence from equilibrium is corrected per year.

**Table 5. Estimated Short Run Model**

| Variable | Coeff. | S. E. | t-val. | p-val. |
|---|---|---|---|---|
| D(EG(-1)) | -0.278 | 0.116 | -2.394 | 0.028 |
| D($EX^+$) | -0.072 | 0.012 | -6.148 | 0.000 |
| D($EX^+$(-1)) | -0.072 | 0.016 | -4.462 | 0.000 |
| D($EX^+$(-2)) | -0.046 | 0.012 | -3.798 | 0.001 |
| D($EX^-$) | 0.669 | 0.278 | 2.403 | 0.027 |
| D(CS) | -0.002 | 0.001 | -2.080 | 0.052 |
| D(CS(-1)) | 0.002 | 0.001 | 2.869 | 0.010 |
| D(CS(-2)) | 0.003 | 0.001 | 3.893 | 0.001 |
| D(IR) | -0.001 | 0.000 | -5.315 | 0.000 |
| D(IR(-1)) | 0.002 | 0.000 | 7.320 | 0.000 |
| D(IR(-2)) | 0.001 | 0.000 | 4.107 | 0.001 |
| ECT(-1) | -0.339 | 0.035 | -9.604 | 0.000 |
| R-sq. | 0.870 | | | |
| Adj. R-sq. | 0.811 | | | |
| F-stat. | 1491.529 | | | |
| P.> F. | 0.000 | | | |

**Note:** standard errors are corrected for autocorrelation using the Huber-White method

**Source:** Prepared by the Authors

### 4.6. Long Run Effect of Exchange Rate on Economic Growth

The long run model is shown in Table 6 As with the long run model, there is evidence of significance for most of the variables in the model. However, we see that the signs of the exchange rate variables have been swapped with depreciation now decreasing growth rate whereas, depreciation supports growth in the short run. Moreover, the sign of capital stock is now possible whereas, that of inflation is now negative. Knowledge stock does not have a significant effect.

**Table 6. Estimated Long Run Model**

| Variable | Coeff. | S. E. | t-val. | p-val. |
|---|---|---|---|---|
| EG | 0.051 | 0.014 | 3.742 | 0.002 |
| $EX^-$ | -1.394 | 0.453 | -3.075 | 0.007 |
| CS | -0.025 | 0.006 | -4.323 | 0.000 |
| KS | 0.001 | 0.003 | 0.203 | 0.841 |
| IR | -0.011 | 0.003 | -3.844 | 0.001 |
| C | 11.236 | 0.252 | 44.621 | 0.000 |

**Note:** standard errors are corrected for autocorrelation using the Huber-White method

**Source:** Author's estimation

These results show that a one-unit increase in the exchange rate (i.e. a depreciation) has a significant impact on economic growth both in the short run and in the long run. Likewise, a one-unit decrease in the exchange rate (i.e. an appreciation) also has a significant impact on economic growth both in the short run and in the long run.. Hence, both 1.$H_O$ and 2.$H_O$ can be rejected.

### 4.7. Test of Asymmetry

To test if exchange rate appreciation has a different effect on economic growth than exchange rate depreciation, Wald tests were used as suggested by Shin et al. (2014). The tests, which covered both long and short run effects of exchange rate on economic growth have been reported in Table 7 According to the results, there is evidence of asymmetry in both the long run and long run as the p-values of the F-tests are significant in both cases. To put it differently, a naira appreciation affects economic growth differently than a naira depreciation.

**Table 7. Result of Asymmetry Tests**

| Hypothesis | F-stat. | p-val. | Decision | Effect |
|---|---|---|---|---|
| *Long run* | | | | |
| $-\beta_2^+/\beta_1 = -\beta_2^-/\beta_1$ | 5.955 | 0.025 | Reject | Asymmetric |
| *Short run* | | | | |
| $\sum\theta_2^+ = \sum\theta_2^-$ | 4.858 | 0.041 | Reject | Asymmetric |

**Source:** Prepared by the Authors

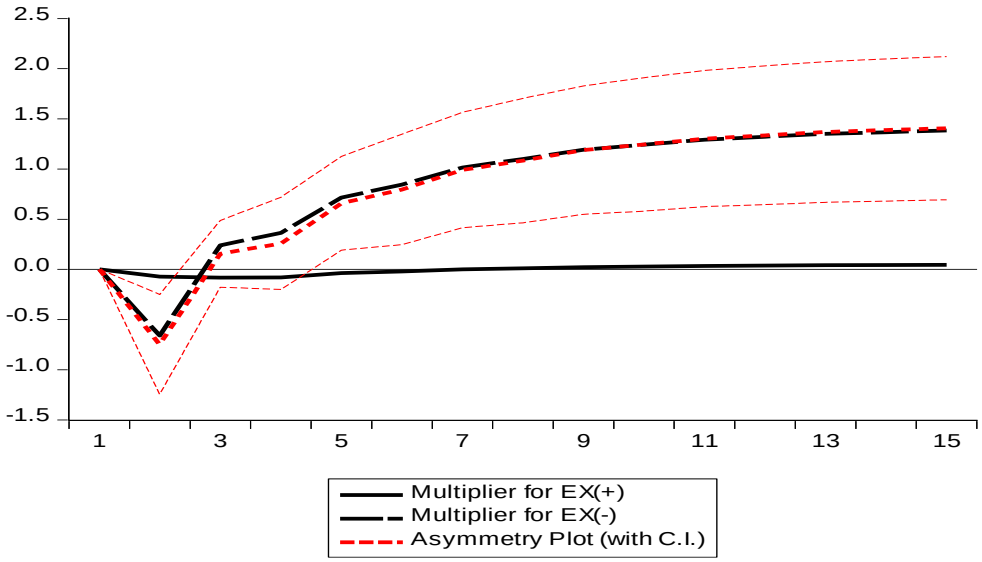


**Figure 3. NARDL Multiplier Plot**

**Source:** Prepared by the Authors

The dynamic multipliers of the asymmetric impacts are plotted is reported in Graphic 2 which shows the cumulative effects of a positive or negative shock from exchange rate to economic growth as it traverses along the horizon. The dashed black line represents the effect of a positive shock to exchange rate appreciation while the solid black line represents the effect of exchange depreciation on economic growth. Likewise, the solid red line is the asymmetry line whereas, the dashed red lines are 5% confidence intervals. Since the asymmetry line lies within the 95% confidence bands, there is indeed, evidence that exchange rate has asymmetric effects on Nigeria's economic growth.

Based on these results, the **3.H**$_0$ is rejected. Hence, it can be concluded that the influence of an increase in exchange rate on Nigeria's economic growth is different from that of a decrease in exchange rate.

### 4.8. Post-estimation Diagnostics

To ascertain whether the estimated NARDL model satisfies the requirements of the underlying classical linear regression model, the usual tests of autocorrelation, heteroskedasticity and normality of regression errors as shown in (Table 8). In the case of the autocorrelation test, the null hypothesis that the errors are autocorrelated is rejected. While the presence of autocorrelation could hamper the relevance of the estimated coefficients, this problem has been accounted for with the aid of Huber-White

Heteroskedasticity and Autocorrelation Corrected (HAC) standard errors. Looking at the heteroskedasticity tests, we see that the null hypothesis of homoscedastic errors can be accepted, meaning that the errors do not exhibit heteroskedasticity. In terms of normality test, the Jarque-Bera test was applied on the regression errors. The result shows that the errors are indeed normally distributed.

**Table 8. Summary of Diagnostic Tests**

| Test | Hypothesis | Chi-sq. | p-val. | Decision |
|---|---|---|---|---|
| Autocorrelation | *Errors are not autocorrelated* | 10.676 | 0.014 | Reject |
| Heteroskedasticity | *Errors are homoskedastic* | 16.962 | 0.457 | Accept |
| Normality | *Errors are normal* | 0.006 | 0.997 | Accept |

**Source:** Prepared by the Authors

In addition to the post-estimation tests, the CUSUM (Cumulative Sum) and Cumulative Sum of Squares (CUSUM of Squares) tests were conducted to determine whether the estimated coefficients are stable. The CUSUM test shows whether the coefficients are dynamically stable whereas, the CUSUM of squares test shows whether they don't change suddenly. If the blue CUSUM plots are within the red 5% confidence bands, the coefficients are considered stable. Looking at the estimated plots in Figure 3, it can be seen that in both cases, the CUSUM plots are actually within the required bands. Hence, it can be concluded that the coefficients are stable.

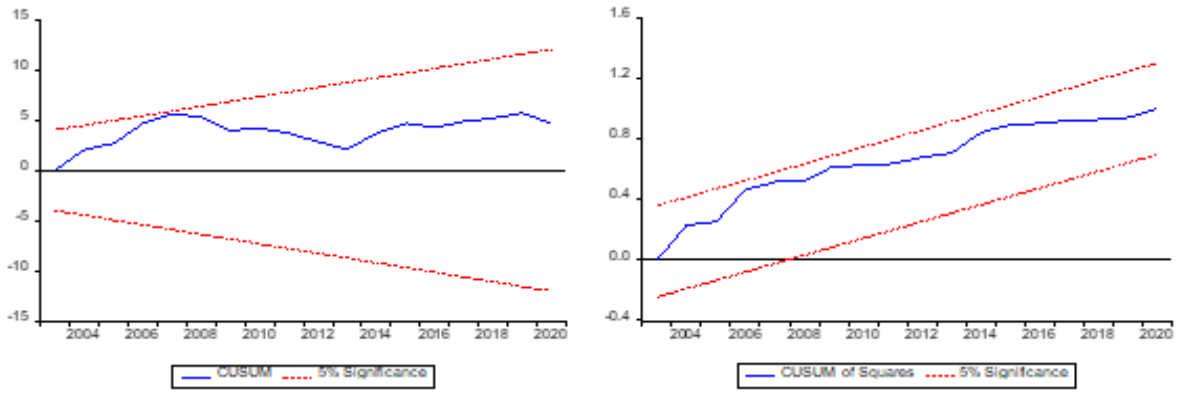


**Figure 4. CUSUM & CUSUM of Square Graphs**

**Source:** Prepared by the Authors

### 4.9. Discussion of Results

The results with respect to exchange rate shows that economic growth responds differently to an appreciation and a depreciation. Moreover, this response seems to differ in the short run and in the long run. Starting with the short run the result shows that a depreciation in exchange rate (i.e., $EX^{+}$) tends to decrease economic growth whereas, an appreciation in exchange rate (i.e., $EX^{-}$) tends to increase economic growth. For instance, we see that when exchange rate depreciates by 1%, what follows is a decrease in economic growth by around 0.07% within the same year that the depreciation occurred and by the same amount a year later. Moreover, a further decrease in economic growth of about 0.05% is also discernible after two years. On the other hand, we see that an appreciation in the naira vis-à-vis the US dollar results in a stronger positive effect on short run economic growth in the country. With a 1% gain in the naira's value relative to that of the US$ in any given period, we see that economic growth should increase by around 0.7% approximately on average within the same period. Therefore, naira appreciation tends to benefit the Nigerian economy in the short run whereas, depreciation appears detrimental.

One possible scenario responsible for these results can be explained looking at the demand side of the economy. A depreciation could hurt the economy in the short run as it increases prices for consumers that depend on imported goods. The higher living costs could impact then transmit to the economy

through lower demand of both domestic and foreign goods. The result is a decrease in production and economic activities which then leads to a decrease in economic growth. Conversely, an appreciation of the naira makes it cheaper to import and this could lead to substantial savings in consumer import demand which are then used to increase the purchase of domestic goods. The effect is an increase in production and economic activities which then cause positive economic growth. There are some notable studies that have discovered similar results in different contexts. An example of this are the studies by Barguellil, Ben-Salha and Zmami (2018) for developing countries in which those with flexible regimes exhibit weaker short run economic growth response compared to countries with more rigid regimes. The findings by Missio et al. (2015) also establishes similar results for countries in Latin America where only moderate devaluation tends to help short run economic growth.

As per the long run results, the reverse seems to be the case. Unlike in the short run, an increase in exchange rate (i.e., a deprecation of naira's value compared to that of the US$) leads to positive effects on Nigeria's economic growth. On the other hand, an appreciation of the currency (i.e., a decrease in the US$/naira rate) seems to hurt Nigeria's economic growth. Moreover, the effect of an appreciation appears to be stronger than their short run effects. In the case of a depreciation, we see that a 1% increase in increases in exchange rate would, on an average, cause long run economic growth to expand by 0.05%. In the case of an appreciation, it can be deemed that a 1% decrease in exchange rate leads to around 1.4% contraction in long run economic growth for Nigeria. Intuitively, the fact that the signs of an appreciation versus a depreciation change the way they are observed to do between the short run and the long run point to support for the J-curve hypothesis. That is, a depreciation appears to be detrimental in the short run whereas it becomes beneficial to long run economic growth. This shows clearly that whatever benefits that come from devaluation is only visible in the long run. This typically occurs as a result of short run rigidities like fixed production plans, fixed scale of production and set wages and prices that prevent them to change immediately even when foreign demand for domestic goods increases immediately as a result of the devaluation (Bahmani-Oskooee and Karamelikli, 2021). In the long run, these rigidities ease out – prices become more flexible, production plans change, production scales can be expanded and so on. At this point, the economy is now in the position to avail itself of the benefits of lower prices of its goods internationally. Thus, long run economic growth should increase following a devaluation or a currency depreciation (Bahmani-Oskooee and Nasir, 2019). This scenario appears to have played out in the case of Nigeria during the period under study. These findings are in support of diverse other evidence elsewhere. Some notable evidence can be found in the works of scholars like Nusair (2016) for transition economies in Europe, Bahmani-Oskooee and Nasir (2019) for trade between the UK and the US, and Upadhyaya et al., (2022) for the trade between China and the US.

Other than exchange rate, the effects of the control variables included are also noteworthy. The short run effect of capitals stock seems to be negative initially but becomes positive afterwards. From the coefficients, it can be gleaned that a percentage point increase in capital stock as a percentage of real GDP would initially cause economic growth to decrease by 0.2% in the same year that capital stock increased.[4] Subsequently, the initial negative effect is wiped off in the following year and economic growth rises further by 0.3% in two years later. Thus, capital stock has a net positive effect on short-run economic growth. Yet, its long run effect is peculiarly negative. This is counterintuitive. One could possibly blame this anomaly on excessive bureaucratic bottlenecks and perhaps corruption. The initial short run impact may be due to the boost to demand that initially occurs when contracts are awarded out for capital investments. These are subsequently wiped off when the projects stall from inconsistent cash flow or embezzlement that is not uncommon the Nigerian society (Adeleke et al., 2021; Gholami and Salihu, 2019; Igiebor, 2019).

As per knowledge stock, the parsimonious ARDL model estimated based on (Akaike Information Criteria) AIC has eliminated the variable's short run economic growth impact. Nevertheless, the estimated long-run effect is seen to be positive, implying that knowledge accumulation could contribute to Nigeria's economic growth. Still the long run impact is not statistically significance. The absence of a

short run impact could be explained by the fact that investment in education only yields long run returns and not necessarily short run returns. This is due to the time taken for the knowledge to translate into skills and capabilities that are then channelled into research and development to boost economic performance (Çakar et al., 2021; Jayasooriya, 2020). Moreover, the poor allocation of resources to the education sector in Nigeria is well-known (Bello, 2020; Ezeani, 2018). This could thus account for the lack of a short run impact and the insignificant positive impact of knowledge stock on Nigeria's economic growth.

Finally, inflation rate has economic growth effects that are akin to the so-called Phillips curve hypothesis. Notably, inflation is supposed to have a positive growth effect initially when the economy is still operating below full capacity. This is characteristic of the short run. As time goes on, the country inevitably achieves close to full capacity making it more and more difficult for additional output to be associated with higher inflation. This is characteristic of the long run. The foregoing illustration seems to have played out in the case of Nigeria during the periods under study. Inflation has a net positive short run effect which, after netting out the negative effect, amounts to a 0.2% economic growth increase when there is a one percentage point increase in inflation. The long-run impact is stronger, indicating around 1.01% economic growth increase for a percentage point inflation increase.

**V. Conclusion and Recommendations**

This study utilized annual time series data from 1981 to 2020 on real GDP as a measure of economic growth and the US$ to naira exchange rate as a measure of exchange rate. It also includes other independent variables that have been known to affect economic growth such as capital stock, knowledge stock and inflation rate. To achieve the study's objectives, unit root tests were conducted which showed the proposed empirical model to contain both levels-stationary variables (capital stock and inflation) and difference-stationary variables (economic growth, exchange rate and knowledge growth) which permitted the application of the bounds test of cointegration. The study thus estimated a Nonlinear ARDL model based on the cointegration results. First, the effect of appreciation and depreciation of the naira compared to the dollar had different short run and long run effects. In the short run, economic growth tends to decrease with a depreciation of the naira whereas, it increases when the naira appreciates against the US$. The long run effects are reversed. Economic growth was found to respond positively to a naira depreciation and negatively to a naira appreciation in the long run. The test of asymmetric effects revealed that indeed, how an appreciation in the naira affects economic growth is significantly different (in both magnitude and direction) from how a depreciation affects economic growth in the case of Nigeria. This asymmetric effect is consistent for both the short and the long run. Among the control variables, capital stock has a net positive short run effect, but a negative long run impact. Likewise, inflation rate has a significant net positive short run effect, but a significant negative long run effect on Nigeria's economic growth. Lastly, Knowledge stock has no short run impact on economic growth and its positive long run impact is statistically insignificant.

Conclusion: The findings of the study shows that the effect of an appreciation in the naira relative to the US$ impacts economic growth differently from the effect of its depreciation. Moreover, the fact that the sign of an increase in exchange rate (i.e., a depreciation) switches from negative in the short run to positive in the long run while the sign of a decrease (i.e., an appreciation) switches from positive in the short run to negative in the long run is indicative of the J-curve. The overall conclusion from these findings is that exchange rate's effect on economic growth is nonlinear in Nigeria. It is also clear from the results that knowledge stock has not contributed much to the growth of Nigeria's economy. This is no surprise given the low level of education funding and rate of enrolment into schools in Nigeria.Therefore, the evidence gathered in this research suggests that Nigeria may be underutilising capital stock to significantly propel its economic growth.

Contrary to the results here, knowledge is generally seen as an engine of growth. However, in line with the findings of this study, the literature supports this conclusion with findings that the structure of the economy is more of a determinant of growth than the stock of knowledge (Britz et al., 2006, Okorafor, 2010; Janoski et al., 2014). On the other hand, Shobande and Asongu's study also found results contrary to the conclusions reached here. In the study, it is observed that for Nigeria, knowledge causes growth through unidirectional Granger causality. The study also found evidence that for Nigeria, knowledge can help the country to achieve its targeted growth trajectory (Shobande and Asongu, 2021)

**Recommendations:** Policymakers will find following suggestions useful.

1) There is need to use devaluation policy with caution. Policymakers should be alert about the negative short run impacts of such a policy that could affect aggregate demand and economic growth in the short run even though there are likely long run economic benefits. Policies that cushion the short run effect of the devaluation can be pursued to mitigate the negative impact. This could be in form of tax concessions for domestic industrial concerns to boost domestic production and provide good quality substitutes for essential household goods that are mostly imported.
2) The findings show that more needs to be done in the education sector. There should be genuine commitment on the part of government to gradually increase budget allocation to the education sector to meet the 26% benchmark stipulated by UNESCO. It is also suggested that priority should be given to capital investments in academic infrastructure and more funding be scheduled towards research and development in the country to boost its long run economic growth.
3) The issue of bureaucratic bottlenecks and corruption have to be tackled in the aspect of project allocation and implementation. Genuine efforts to decrease frictional processes and curb embezzlement on the part of government is direly needed to improve capital accumulation and its reverse the trend of negative long run impact documented in this study.
4) Coordinated policy actions to tackle inflation are necessary to prevent its negative impact on real sector activities in the country. Therefore, more efficient management of money supply is highly essential. Government must tackle the issue of cost push inflation given the consistently rising price levels in order to protect real output growth in Nigeria.

**Limitation and Future Research:** While the US$ is widely accepted as an international currency of exchange, Nigeria transacts business with other major world economies with equally strong currencies which this study has not accounted for. An alternative could be to use the effective exchange rate which is a weighted average of major world currencies so that it possible gives a more holistic measure of exchange rate. It is possible that such a measure could further shed light on the connection between exchange rate and economic growth which would be useful for policy purposes. Future research should, therefore, explore this possibility using similar decomposition techniques used in this study.

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