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# Panel Autoregressive Distributed Lag Model in Analyzing the Impact of Macroeconomic Variables on Economic Growth in Sub-Saharan African Countries

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## ABSTRACT

This study used a panel ARDL model to analyze the impact of macroeconomic variables on GDP of SSA countries over 33 years (1990 to 2021). It aimed to fit a panel ARDL model for these variables, estimate their long-run impact on GDP, and identify short-run effects. The analysis employed econometric techniques such as panel unit root tests, cointegration analysis, and model estimation. Findings suggested that in the long run, inflation, interest rates, and unemployment had no significant impact on economic growth, while exchange rates negatively affected GDP and export rates positively influenced it. On the hand, the ECT of (-1) indicated that the short run error would attain equilibrium at the speed of 16% annually. Inflation rate, interest rate, unemployment rate and export rate have no significant impact on GDP. However, exchange rate has a negative significant impact on economic growth on the short-run. The study therefore, recommended among others that pursuing trade liberalization policies that reduce barriers to international trade can promote export growth. Removing tariffs, simplifying customs procedures, and addressing non-tariff barriers can enhance the competitiveness of SSA countries in the global market.

**Keywords:** Macroeconomic variables, ARDL, panel data, inflation, interest, exchange export, unemployment, economic growth.

## INTRODUCTION

Sub-Saharan Africa has experienced sluggish economic growth over several decades, with economic crises evident through indicators such as inflation rates, unemployment rates, high interest rates, exchange rates, and export distortions. Inflation defined as an upsurge in the overall level of prices for goods and services, indicates a reduction in a currency's purchasing influence, resulting in an increased cost of living.

Recently, inflation in Sub-Saharan Africa has been on the rise, but this surge is specific to certain nations within the region. Additionally, the challenge of unemployment is distinct and escalating in developing countries, stemming from various economic issues confronting them. Exchange rates show an essential role in influencing a nation's competitiveness in terms of exports and imports, thereby impacting overall economic growth.

Real exchange rate depreciation is an important aspect, but given the rise of the US dollar, competitive currency depreciation may not always convert into a strong pricing advantage in export markets. This complex economic landscape contributes to the ongoing economic challenges faced by many Sub-Saharan African countries. The cost of borrowing is influenced by interest rates, which are one of the most important aspects of the Sub-Saharan African economic system. Borrowing is an essential source of financing businesses and investment, which may lead to economic growth. Additionally, interest rates affect the return on savings. If the interest rate on savings is encouraging, individuals will be willing to save more, which will pave the way

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for loanable funds for investment and eventually lead to economic growth.

Once again, unemployment stands out as a pressing issue, particularly for macroeconomists in Sub-Saharan African nations. It refers to a situation where capable individuals, both men and women, are eager and able to work but cannot secure employment. Unemployment is identified as a significant hindrance to societal advancement. Beyond representing a substantial squandering of a nation's human resources, it leads to a loss in welfare through diminished output, subsequently resulting in lower income and a reduced standard of living, impacting overall economic growth.

On a different note, exports entail the sale of products or services manufactured in one country to another through international trade. While exports offer advantages to global commerce and the nation, concerns arise about potential drawbacks and the apprehension that local industries may suffer from foreign competition. However, evaluating economic performance requires considering a combination of these above discourse indicators and understanding their interrelationships.

Hence, it is essential to examine the connection between these macroeconomic variables and economic growth for a more profound comprehension of the factors influencing or impeding economic development in the region. The panel ARDL model emerges as a fitting econometric methodology for this investigation.

Several previous researches have looked into the connection within macroeconomic variables and economic development. in Nigeria, including works by Uchechi and Iheukwumere (2023), Bashir (2022), Adenomon and Ojo (2020), Idris and Suleiman (2019), Richard (2018), Anidiobu, Okolie, and Oleka (2018), Lyndon and Peter (2016), Hussain, Shabir, and Kashif (2016), Onwachukwu (2015), and Inyiama (2013), to name a few. Notably, all these studies were conducted within the Nigerian context, and the findings from the listed studies exhibited inconsistencies. Furthermore, there were variations in methodologies employed, distinguishing them from the approach adopted in the current study.

Only a limited number of studies have concentrated on Sub-Saharan African countries, with one such example being the research conducted by Adedeji and Ahuru (2016). Their study specifically explored the link within foreign direct investments (FDI) as well as economic development. In this investigation, focus was on ten selected Sub-Saharan African countries, with FDI serving as independent variable in their analysis.

Adejumo and Ogunbunmi (2018) conducted a study that explored the influence of Macroeconomic metrics on the financial health of selected Sub-Saharan African countries between 1990 and 2017. The study considered four major variables: GDP growth rate, inflation rate, monetary policy rate, and exchange rate. They used a panel unit root test with two criteria to assess stationarity, a panel cointegration test to investigate long-run cointegration among the variables, and the Generalized technique of Moment technique of estimation to explore the relationships between the variables. Despite various studies addressing macroeconomic variables and economic growth, the researcher notes a scarcity of studies utilizing panel data in this context. Therefore, this study aims to bridge this gap by applying the panel ARDL model. As a result, the purpose of this study is to bridge this gap by using the panel ARDL approach to examine the impact of macroeconomic indicators on the growth of the economy in Sub-Saharan African Nations.

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## LITERATURE REVIEW

### Concept of Macroeconomic Variables

Macroeconomic indicators are those that concern the movement of economic aggregates such as the nation's gross domestic product (GDP), inflation rates, interest rates, exchange rates, a country's total exports, job opportunities and unemployed people, government spending as well as finances, world trade equilibrium, along with effectiveness (John, Niser & Gareth, 2012). Macroeconomic variables are crucial markers of current economic trends (Hassan, 2015). Because the non-oil sector's activities are aggregated to calculate GDP, the previous behavior of real GDP has clear implications for incremental changes in the volume of activities (Jibril and Yakubu, 2017).

### Inflation Rate

The rates of interest are consistent increases in the general price structure of an economy that affect the value of the local currency (Fatukasi, 2012). It is a long-term increasing fluctuation in prices that affects all commodities and services in the economy as a whole. Several variables contribute to Nigerian price increases.

### Exchange Rate

The exchange rate represents the value of a specific currency as a percentage of another. The rate of exchange is the proportion between a unit of a certain currency and the quantity of another currency that can be exchanged at a given time (Ngerebo- and Ibe, 2013). In other terms, the exchange rate is the price of one currency relative to another, as well as the number of components required to purchase another currency (Mordi 2006).

### Interest rate

The interest rate is the cost of borrowing, this is the costs a borrower pays for currency borrowed for business or other purposes. Shareholders obtain loans from banks along with other financial entities. The reaction to investment expenses fluctuates sharply with an interest percentage, so this is at the forefront of money-making analysis. Acha & Acha (2011).

### Unemployment Rate

Perhaps most significant difficulties facing Sub-Saharan African economies today has become the substantial amount of unemployment, which has been steadily rising over the years. Until the early 1980s, Nigerian policymakers as well as economists have been deeply concerned with the issue of joblessness.

### Export Rate

Exports refer to the exchange of goods or services produced within a country to another nation via international trade. The main focus surrounding exports revolves around their advantages for both international trade and the home country, alongside their disadvantages and the potential threat of foreign competition adversely impacting local industries. When a nation concentrates on producing a particular item that it can manufacture efficiently, these goods become available at competitive prices. This fosters both external and internal economies, leading to heightened employment rates and income levels, thereby facilitating economic growth.

### Concept of Economic growth

Economic growth is commonly understood as a continual rise in a nation's real Gross Domestic Product (GDP). In Sub-Saharan Africa, economic growth was measured at 3.2 percent in 2019 and is projected to increase to 3.6 percent in 2020. This marks an improvement from growth rates of 3.1 percent, 2.7 percent, and 1.3 percent in 2018, 2017, and 2016, respectively.

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## EMPIRICAL REVIEW

Uchechi and Iheukwumere (2023) investigated the correlation between Nigeria's currency rate and economic growth in the country. Their objective was to quantify the degree to which fluctuations in the Naira rate affected economic growth, as well as its impact on inflation within Nigeria, spanning from 1987 to 2018. Employing the Ordinary Least Squares analysis technique, they constructed a regression model to evaluate the underlying hypotheses. However, the results revealed that the Naira rate had an insignificant effect on Nigerian economic growth, though it did exert a notable influence on Naira inflation rates. A notable limitation of the study was the absence of confirmation regarding the unit root test prior to subsequent analyses, raising concerns about the reliability of the data.

Obidike and Nduka (2022) investigate the impact of selected economic indicators on the Nigeria economy. Specifically, the study examines the impact of exchange rate, interest rate, inflation rate, trade openness, foreign direct investment and money supply on the Nigeria in economy. Time series data covering 34 years, from 1987 to 2020 were analyzed with econometric techniques including Descriptive statistics, ADF Tests for Unit Roots, the ARDL and the Diagnostics tests to determine the reliability of the models in the study. The Diagnostics analyses carried out are the Normality Test, Serial Correlation, Multicolinearity Test, Heteroskedasticity, and Ramsey RESET Tests. their findings revealed that inflation rate, trade openness, foreign direct investment and money supply take optimistic and significant effect on real GDP in the short run while exchange rate and interest rate had no significant impact on real GDP in the short run. The study therefore concludes that selected macroeconomic variables have been an effective short run policy instrument that largely affects Nigeria in economy. However, the outcomes of the study are diverse as some having positive outcomes while others having insignificant outcomes hence bound to be unreliable.

Adaramola and Dada (2020) investigated the effects of price increases on economic development spanning from 1980 to 2018. Their analysis incorporated time series data encompassing variables such as inflation, government consumption expenditures, currency rates, money supply, interest rates, degree of openness, and real GDP. Methodologically, they employed the Autoregressive Distributed Lag (ARDL) model along with tests for normality, total amount, heteroscedasticity, and serial correlation LM. Their findings indicated that interest rates and money supply exhibited a positive correlation with economic develoment, while exchange rates and inflation displayed an inverse relationship. However, the procedure adopted is different from the current study, the current utilized panel data approach, their study was conducted pre-SAP and the location was not revealed.

Ukachukwu and Odionye (2020) analyzed the influence of various macroeconomic factors on foreign direct investment (FDI) in Nigeria spanning from 1981 to 2017. Employing ARDL bound cointegration model, they scrutinized the short- and long-term repercussions of these variables on FDI. The cointegration examination revealed a sustained relationship between FDI and the chosen macroeconomic indicators in Nigeria over the long term. According to the ARDL model, foreign exchange rates and crude oil prices exhibited a positive and significant impact on FDI, both in the short and long term. Conversely, inflation exerted a negative and significant influence on FDI across both timeframes. Furthermore, while real GDP

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initially demonstrated a substantial positive effect on FDI, the significance diminished over the long term. The study is limited to Nigeria with mixed findings. Therefore, cannot be generalized to Sub-Saharan African countries.

Omar & Nor (2020) delved into examining the interconnection among macroeconomic variables, namely population, unemployment, and exports, concerning economic growth in Malaysia. This investigation was prompted by the inconsistent findings observed in prior research. Utilizing multiple linear regressions (MLR) analysis on quarterly time series data spanning from 2006 to 2016, the study unveiled a linear relationship among the variables under scrutiny. Specifically, it revealed that population exhibited a significant negative correlation with economic growth, while exports displayed a significant negative impact as well. Contrary to expectations, the study discovered an insignificant relationship between unemployment and economic growth. These findings provide valuable insights for policymakers and the academic community, aiding in a deeper comprehension of the dynamics surrounding the studied variables. The study is limited to Malaysia economy. So, similar study needs in this area to explore macroeconomic variables and its behaviour in Sub-Saharan African countries.

Adenomon et al. (2018) utilized the fully modified ordinary least squares (FMOLS) and error correction model (ECM) methods to analyze the unemployment rate in Nigeria. They gathered annual data from 1981 to 2016 from the Central Bank Statistical Bulletin and the World Bank website on unemployment, interest rates, exchange rates, and inflation rates. The (ADF) test indicated that the economic indicators were stationary at first differences, while the cointegration test affirmed that the variables were cointegrated, with the unemployment rate serving as the dependent variable. The FMOLS model unveiled a significant positive relationship between the exchange rate and population growth with unemployment, while interest rates and inflation rates displayed a negative association. However, only the interest rate was significant in the short run. The ECM analysis revealed a negative and statistically significant coefficient (-1), indicating that the system corrected its previous period disequilibrium at a rate of 48.9% annually. The study concludes that a high exchange rate and population growth could lead to an increase in the unemployment rate in Nigeria. Moreover, it suggests that the government should focus on developing the industrial sector and non-oil segments to stimulate employment generation and enhance exports in Nigeria. The outcome is diverse as some having positive link while others having negative link hence not reliable.

## MATERIALS AND METHODS

The present investigation used a design based on a longitudinal technique. The decision for of this approach relies on the notion that it requires numerous measurements of the exact same parameters across time. In a nutshell, longitudinal investigations are a sort of correlational investigation in which scholars watch and gather data on numerous variables before attempting to change them. The sample size comprised Algeria, Chad, Equatorial Guinea, Gabon, Ghana, Libya Nigeria and Sudan. These countries were chosen based on the fact that they are among top 10 oil exporting countries in Sub-Saharan Africa and the accessibility of secondary data. The variables of the research comprise real GDP. (which served as the dependent variable), and inflation rate, exchange rate, interest rate, unemployment and export rate (which represented the independent or explanatory variables). Data from secondary

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sources spanning the period 1990 to 2021 (33 years) have been gathered through the International Monetary Fund Development Indices and the African Development Bank Measurements.

In this study we used Secondary method of Data collection, as sourced in pursuit to establish the effects of Inflation rate, Interest rate, Exchange rate, Unemployment rate, and Export rate on the GDP of Sub-Saharan African countries was analyzed.

**Model Specification**

The regression model is in the form

GDP= f(INF, EXC,INTR , UNP, EXP) 1

Where GDP = Gross domestic product, INF= Inflation rate, EXC = Exchange rate, INTR= Interest rate, UNP=Unemployment rate and EXP = Export rate respectively. Equation 2 was written as

$$GDP_{it}=\alpha_0 + \alpha_1 \ln INF_1 + \alpha_2 \ln EXC_2 + \alpha_3 \ln INTR_3 + \alpha_4 \ln UNP_4 + \alpha_5 \ln EXP_5 + ui \quad 2$$

$a_o$ is constant and $a_1, a_2, a_3, a_4, a_5$ are the quantities of independent variables to be assessed by means of OLS. Where $u_1$ is stochastic term.

**Panel Unit Root Test**

The first step in this method of estimation is to determine the sequence of how integration occurs in the data. This is significant because estimating an ARDL model requires ensuring that the variables included in the regression have an integration of order zero I(0) or at most integrated of order one I(1). This is due to the fact that when order two I(2) variables are integrated, the method used by ARDL bounds testing fails to produce reliable findings. Thus, the I(2) variables need to be removed from the dataset. To test for unit root in any panel series, the IPS and LLC panel unit root tests will be applied. These tests were proposed by Im, Pesaran, Shin (2003) and Levin, Lin, and Chu (2002), respectively. The baseline:

$$\Delta y_{it} = \gamma_i y_{i,t-1} + \sum_{j=1}^{p} \varphi j \, \Delta y_{i,t-1} \, \varepsilon_{it} \quad 3$$

Where $\gamma_i = p_i - 1$

The two tests compare the null hypothesis of unit root $H_0: \gamma_i = 0$ ($p_i=1$) to the contrast of stationarity $H_1: \gamma_i < 0$. The LLC test assumes that the variables examined are the same across all panels, so $\rho_i = \rho$ for all i nations in the panel.

**Panel Co-integration test**

Upon validating the order of integration, the subsequent phase of the study uses Pedroni's (1999, 2004) panel cointegration tests to look for evidence of long-run cointegration between GDP growth and the independent variables. Other panel cointegration tests include Westerlund (2007). Nevertheless, the test is invalid for the reason of this study because Westerlund himself indicated that such tests are frequently vulnerable to distortions when the T sample size is smaller than 100. The Pedroni (1999, 2004) and Kao (1999) tests use a panel-data model for an I(1) dependent variable y and compare the null hypothesis of no cointegration to the alternative of

cointegration: $y_{it}=x_{it}\,\beta_i + z_{it}\tau_i + \varepsilon_{it}$ 4

when every of the panels i, the variables in $x_it$ are an I(1) series, and both tests require that the covariates not be integrated among themselves. The Kao analysis considers an equal cointegration vector for all nations in the panel, limiting $\beta_I=\beta$. Although both tests

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use the identical null and alternative hypothesis, they differ in significant ways. In fact, the Pedroni test supports panel-specific integrating vectors, which differentiates it against the Kao test.

**Panel ARDL Model**

Upon performing unit root and a cointegration tests, the panel ARDL model will be computed. The ARDL model differentiates between short- and long-run coefficients and can be employed reliably throughout short sample periods. Pesaran and Shin (1998) found that even with a small sample size, the long-run variables are super-consistent and the short-run parameters are √T consistent. Thus, equation (2) is transformed into a panel ARDL (p,q1,q2,q3,q4,q5) equation, with p representing the lags of the dependent variable and q representing the lags of the independent variables. The panel ARDL estimation tests use three estimation methods: pooled mean group (PMG), mean group (MG), and dynamic fixed-effect (DFE). The basic model is formed as follows:

**Panel Estimation**

The PMG predictor is capable of estimating links in short runs, incorporating parameters and adjustments for the long-run equilibrium (speed of adjustment), as well as diverse error variance. The long-run coefficients are required to be consistent across countries. This strategy is appropriate since it is easier to execute and compatible with the presence of long-term relationships. The second method of estimate is Mean Group (MG). According to Pesaran and Smith (1995), it features less restrictive approaches for estimating the diversity of parameters. It can also calculate various coefficients for each country. Both the MG and PMG estimators rely on the Schwarz Bayesian Criterion (SBC) or the Akaike Information Criterion (AIC) to choose appropriate lag durations. The MG estimator produces consistent long-run mean estimations, but it is impractical with homogeneous. Pooled estimation tools are reliable and efficient when long-run homogeneity exists. The third estimator is Dynamic Fixed Effect (DFE). The Hausman tests were then utilized to assess whether model performed well in this study: PMG, MG, or DFE. The MG framework for testing the long-term connection amongst components is given below:

$$\ln GDP_{it}=\Theta_{it} + \beta_{0i}\ln GDP_{I,t-1} + \beta_{1,i}\ln INF_{i,t-1}+\beta_{2,I}\ln EXC_{I,t-1} + \beta_{3,i}\ln INTR_{i,t-1} + \beta_{4,i}\ln UNP_{i,t-1} + \beta_{5,i}\ln EXP_{i,t-1} + \mu i \quad 5$$

Equation 5 shows that the MG estimator with a high order of lag that can estimate long-run average parameters consistently.

The long-run relationship model using the PMG and DFE estimators are as follows:

$$\ln GDP_{it}= \alpha_i + \sum_{j=1}^{p}\lambda_{ij}\ln GDP_{i,t-j} + \sum_{j=0}^{q1}\delta_{1ij}\ln INF_{i,t-j} + \sum_{j=0}^{q2}\delta_{2ij}\ln EXC_{i,t-j} + \sum_{j=0}^{q3}\delta_{3ij}\ln INTR_{3,t-j} + \sum_{j=0}^{q4}\delta_{4ij}\ln UNP_{4,t-j} + \sum_{j=0}^{q5}\delta_{5ij}\ln EXP_{i,t-j} + \mu it \quad 6$$

Where, i represents the number of countries (1, 2, 3...,8), t is the number of years (1990-2021), $(p,q_1,q_2,q_3,q_4,q_5)$ is the optimum time lag, $\alpha_i$ is the countries specific effect, and μit refer to the remainder error terms. The short-run relationship with an error correction model is as follows:

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$$\Delta \ln GDP_{it} = \alpha_i + \phi_i ( \ln GDP_{i,t-1} - \lambda_1 \ln INF_{i,t-1} - \lambda_2 \ln EXC_{i,t-1} - \lambda_3 \ln INFR_{i,t-1} - \lambda_4 \ln UNP_{i,t-1} - \lambda_5 \ln EXP_{i,t-1} ) + \sum_{j=1}^{p} \lambda_{ij} \Delta \ln GDP_{i,t-j} + \sum_{j=0}^{q1} \delta_{1ij} \Delta \ln INF_{i,t-j} + \sum_{j=0}^{q2} \delta_{2ij} \Delta \ln EXC_{i,t-j} + \sum_{j=0}^{q3} \delta_{3ij} \Delta \ln INTR_{i,t-j} + \sum_{j=0}^{q4} \delta_{4ij} \Delta \ln UNP_{i,t-j} + \sum_{j=0}^{q5} \delta_{5ij} \Delta \ln EXP_{i,t-j} + \mu it \quad 7$$

While λi are long-run variables, and ϕi is the variable for the error-correction term, which represents the pace of correction to the long-term equilibrium of lnGDP due to shifts in lnINF, lnEXC, lnINTR, UNP, and lnEXP. ϕi implies the presence of a long-term relationship. The negative and substantial value of ϕi implies a co-integrating connection between lnINF, lnEXC, lnINTR ln,UNP and lnEXP.

### Hausman Specification Test

The Hausman procedure was used to select the most suitable estimator from among the PMG, MG, and DFE estimators. According to Pirotte (1999), the MG estimator assumes parameter independence across groups and ignores group variability.

### Table 1. Variables Measurement

| Variables | Description (1990–2021) | Source |
|---|---|---|
| Gross Domestic Product | GDP is the sum of gross value added by all resident producers in the economy. It is measured in the US dollar. | World Development Indicators, World Bank |
| Inflation | Annual percentage change in the consumer price index | World Development Indicators, World Bank |
| Exchange | An annual average based on monthly averages (local currency units relative to the U.S. dollar). | World Development Indicators, World Bank |
| Interest | Real interest rate is the lending interest rate adjusted for inflation as measured by the GDP deflator | World Development Indicators, World Bank |
| Unemployment | The rate of unemployment calculated by dividing the number of unemployed individuals by the number of individuals employed in the work force | World Bank |
| Export | Exchange rate in US Dollars | World Development Indicators, World Bank |

**Source: Author's compilation of data sources from WDI (2021)**

## RESULTS AND DISCUSSION

Table 2 displayed the descriptive statistic of the economic indicators under reviewed within SSA countries. The mean of GDP of 23.30068 indicates the average annual GDP for SSA countries in the dataset is 23.30 trillion. The mean of inflation rate of 1.749241 indicates the average annual percentage change in the overall price level of products and services of SSA over the stated period is 1.75percent. Mean of exchange rate approximately 3.42% represents the average value of the exchange rate for Sub-Saharan African nations in the dataset. The mean of interest rate of approximately 1.37% represents the average interest rate for SSA countries in the dataset. The mean unemployment rate of approximately 2.74% represents the average unemployment rate for SSA nations in the dataset.

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**Table 2:** Descriptive Statistic

| | LGDP | LINF | LEXC | LINTR | LUNP | LEXP |
|---|---|---|---|---|---|---|
| Mean | 23.30068 | 1.749241 | 3.422789 | 1.371356 | 2.737404 | 3.320465 |
| Median | 23.57869 | 1.735557 | 4.362421 | 1.236222 | 2.860176 | 3.468708 |
| Maximum | 27.07622 | 5.883573 | 6.596323 | 4.876500 | 3.955868 | 4.559623 |
| Minimum | 12.96729 | -4.071629 | -5.403678 | -0.685044 | 0.294906 | -0.777396 |
| Std. Dev. | 2.258086 | 1.504299 | 2.933275 | 0.764540 | 1.068252 | 0.924133 |
| Skewness | -2.047435 | -0.128654 | -0.632381 | 0.585254 | -1.066764 | -2.053368 |
| Kurtosis | 9.355607 | 3.424428 | 2.211805 | 4.157435 | 3.206624 | 8.866312 |
| Jarque-Bera | 604.9615 | 2.607173 | 23.50423 | 28.67813 | 48.62660 | 542.7017 |
| Probability | 0.000000 | 0.271556 | 0.000008 | 0.000001 | 0.000000 | 0.000000 |
| Sum | 5918.372 | 444.3073 | 869.3883 | 348.3244 | 695.3005 | 843.3981 |
| Sum Sq. Dev. | 1290.035 | 572.5174 | 2176.837 | 147.8838 | 288.7139 | 216.0676 |
| Observations | 254 | 254 | 254 | 254 | 254 | 254 |

Source: Researcher's computation 2023

**Panel Unit Root Tests**

To prevent producing false regression results, panel unit root tests were used to study the series of interest and establish the appropriate sequence of integration. To achieve this, two-panel unit root tests were performed. They involve the Levin et al. Unit Root Test along with the Im, Pesaran, and Shi W-Stat Unit Root Test.

**Table 3:** Unit Root Test

| Variables | Levin, Lin, Chu (2002) | Im,Pesaran, Shin (2003) | Augmented Dickey-Fuller | Prob. | Order of integration |
|---|---|---|---|---|---|
| LGDP | -4.40831 | -5.82977 | 67.3017 | 0.0000 | 1st difference |
| LINF | -2.79368 | -3.35528 | 40.2705 | 0.0000 | At level |
| LEXC | -4.98157 | -5.46487 | 63.7455 | 0.0000 | 1st difference |
| LINTR | -7.03019 | -9.34794 | 110.657 | 0.0000 | At level |
| LUNP | 50.2289 | -8.52297 | 80.9759 | 0.0000 | 1st difference |
| LEXP | -2.18092 | -1.97538 | 26.7465 | 0.0026 | At level |

Source: Researcher's Computation 2023.

The table above displayed the variables under review are of different orders.

**Lag Selection Criteria**

**Table 4:** Lag Selection Criteria

| Lag | Logl | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | -2314.999 | NA | 18.09218 | 19.92274 | 20.01161 | 19.95858 |
| 1 | -830.8017 | 2879.216 | 7.23e-05* | 7.491860* | 8.113935* | 7.742708* |
| 2 | -801.6252 | 55.09716* | 7.67e-05 | 7.550431 | 8.705714 | 8.016293 |

Source: Researcher's Computation 2023

With yearly data set, one or two lags are typically sufficient to determine the ideal lag length (Jeffrey, 2012). Table 3 shows the results of determining the ideal lag length from lags one and two, as well as the accompanying Akaike information criterion (AIC), Schwarz Criterion (SC), Hannan-Quinn Criterion values, and selected ARDL models. The decision on the ideal lag length is based on the lag length with the lowest AIC

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value. The ARDL order of one (1) is chosen based on the minimum AIC value of 7.491860*.

**Table 5: Pedroni Panel Cointegration**

H0: No cointegration
Ha: All panels are cointegrated
**Augmented lags: 1**

| | Statistic | p-value |
|---|---|---|
| Modified Phillips–Perron t | 3.3417 | 0.0004 |
| Phillips–Perron t | 3.6433 | 0.0001 |
| Augmented Dickey–Fuller t | 4.4149 | 0.0000 |

Source: Researcher's computation 2023

Table 5 contain statistics and p-values associated with different unit root tests commonly used in time series analysis. Unit root tests are used to determine whether a time series variable is stationary or exhibits a unit root, which implies non-stationarity.

Going by the p-value from the above table its evidence that all panels are cointegrated

**Multicollinearity Test**

Table 6 provides proof that there is no multicollinearity. This is because all of the variables' VIF values are below ten and the tolerance values are more than 0.10 (as a rule of thumb). Furthermore, Gujarati (2003) advises that a VIF value less than 10 is appropriate, with a maximum value of 1.77. The low mean VIF (1.46) also indicates a weak correlation between the regressors. This demonstrates the suitability and fitness of the variables that explain in the framework.

**Table 6:** VIF/TV Test for Multicollinearity

| Variables | VIF | 1/VIF |
|---|---|---|
| Linf | 1.77 | 0.566418 |
| Lexc | 1.71 | 0.583490 |
| Lintr | 1.49 | 0.673067 |
| Lunp | 1.19 | 0.841731 |
| Lexp | 1.13 | 0.886212 |
| **Mean vif** | **1.46** | |

Source: Researcher's computation 2023.

**Panel ARDL Model Estimation**

**Table 7:** PMG Long Run Model

| Variables | Coef. | Std. Error | t-Statistic | Prob.* |
|---|---|---|---|---|
| **Linf** | -.2100637 | .2679733 | 0.78 | 0.433 |
| **Lexc** | -1.030828 | .4746949 | -2.17 | 0.030 |
| **Lintr** | -.8957796 | .4647499 | -1.93 | 0.054 |
| **Lunp** | -.3029636 | 1.84865 | -0.16 | 0.870 |
| **Lexp** | .8380535 | .4252183 | 1.97 | 0.049 |
| **_cons** | 4.773742 | 2.119806 | 2.25 | 0.024 |

Source: Researcher's computation 2023

The coefficient for inflation rate is -0.2100637. This suggests that holding other variables constant, a one-unit increase in the inflation rate is associated with a decrease of approximately 0.21% in GDP in Sub-Saharan African countries. The coefficient for exchange rate is -1.030828, t-statistic of -2.17 and p-value of 0.030. The coefficient for interest rate(lintr) is -0.8957796, with t-statistic value of -2.17 and p-value of 0.054. The coefficient of unemployment rate is -0.3029636. The coefficient for export rate is

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0.8380535, with t-static of 1.97 and the p-value of 0.049. This infers that holding other variables constant, a one-unit increase in the export rate resulted to an increase of approximately 0.84% in GDP of the Sub-Saharan African countries.

**Table 8:** PMG Short Run Model and ECM

| Variables | Coefficient | Std. Error | t-Statistic | Prob.* |
|---|---|---|---|---|
| **ECT** | -.1584123 | .0699154 | -2.27 | 0.023 |
| **linf D1.** | -.1033604 | .1344176 | -0.77 | 0.442 |
| **lexc D1.** | -.7367657 | .3047294 | -2.42 | 0.016 |
| **lintr D1.** | .1720669 | .1269761 | 1.36 | 0.175 |
| **Lunp D1.** | -1.455017 | 1.524282 | -0.95 | 0.340 |
| **lexp D1.** | -.4546283 | .5456911 | -0.83 | 0.405 |
| **_cons** | 4.773742 | 2.119806 | 2.25 | 0.024 |

Source: Researcher's computation 2023

The ECT calculate the speed of adjustment of the dependent variable (economic growth) towards its long-run equilibrium path. A negative ECT suggests that the system corrects deviations from the long-run equilibrium. The coefficient for ECT is -0.1584123. This implies that, on average, the economic growth adjusts by approximately -0.16 units towards its long-run equilibrium for each unit deviation from the equilibrium path in the previous period. The negative sign is expected, indicating that the system corrects disequilibria over time. The coefficient for the first difference of inflation rate (D1. linf) is -0.1033604 and this implies that a one-unit increase in the first difference of inflation rate is associated with a decrease of approximately 0.10% in GDP of SSA. The coefficient for the first difference of the exchange rate (D1.lexc) is -0.7367657. The coefficient for the first difference of the interest rate (D1.lintr) is 0.1720669. This suggests that a one-unit increase in the first difference of the interest rate results to an increase of approximately 0.17% in economic growth of SSA nations. The coefficient for the first difference of the unemployment rate (D1.lunp) is -1.455017. This implies that a one-unit increase in the first difference of the unemployment rate is associated with an increase of approximately 1.46% in economic growth of Sub-Saharan African countries. The coefficient for the first difference of the export rate (D1.lexp) is -0.4546283 and it means that a one-unit increase in the first difference of the export rate will lead to a decrease of approximately 0.45% in GDP of SSA nations.

## CONCLUSION

The study utilised panel ARDL model in determining the influence of macroeconomic indicators on GDP of SSA nations. The study concluded that on the long- run inflation rate is associated with a decrease unit in GDP. This finding is in line with those Adenomon and Ojo (2020), Hussain, Shabir and Kashif (2016) and Inyiama (2013) whose findings showed a negative significant relationship between inflation rate and GDP and this finding disagreed with those of Adaramola and Dada (2020). The study also indicated that exchange has a negative and significant impact on GDP in sub-Saharan African countries, The finding corroborates with those of Obidike and Nduka (2022), and disagreed with that of Vorlak et al. (2019). The study also revealed that interest rate as well has a negative and statistically significant impact on GDP in SSA countries, which means an increase in the interest rate results to a decrease of approximately 0.90 units in GDP in Sub-Saharan African countries. The finding is congruent with those Hussain, Shabir and Kashif (2016). A negative ECT suggests that

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the system corrects deviations from the long-run equilibrium. The coefficient for ECT is -0.1584123. This implies that, on average, the economic growth adjusts by approximately -0.16 units towards its long-run equilibrium for each unit deviation from the equilibrium path in the previous period. The negative sign is expected, indicating that the system corrects disequilibria over time.

**Recommendations**

This study recommends the following:

i. Central banks should adopt effective monetary policy tools to control inflation. This may involve adjusting interest rates to influence money supply and credit conditions. A well-defined and transparent monetary policy framework is essential for managing inflation expectations.

ii. Policymakers may consider adopting exchange rate policies that support the competitiveness of domestic industries in the global market. A competitive exchange rate can boost exports, which, in turn, can contribute to economic growth.

iii. Establishing a clear and transparent monetary policy framework is crucial. Policymakers should carefully consider the impact of interest rate decisions on economic growth and communicate their objectives and strategies to the public.

iv. Pursuing trade liberalization policies that reduce barriers to international trade can promote export growth. Removing tariffs, simplifying customs procedures, and addressing non-tariff barriers can enhance the competitiveness of SSA countries in the global market.

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