Investigating the Impact of Some Macroeconomic Indicators on Standard of Living in Nigeria: ARDL Bounds Testing Approach

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Abstract
This study investigated the impact of macroeconomic indicators on the standard of living in Nigeria, using the Human Development Index (HDI) as the dependent variable, and Crude Oil Revue (COR), USD/NGN Exchange Rate (EXR), and Non-Oil Revenue (NOR) as independent variables. Time series data spanning from 1981 to 2022 as obtained from the Central Bank of Nigeria (CBN), was analysed to explore the long-run and short-run relationships among the variables. The methodology adopted was the ARDL bounds testing approach, which is suitable for variables with mixed orders of integration. The results of the ARDL bounds test confirmed a significant long-run relationship between HDI and the independent variables, with an F-statistic of 17.56677, surpassing critical values at all significance levels. In the short run, the lagged exchange rate was found to have a positive and significant effect on HDI, while the error correction term indicated a stable long-run relationship. The long-run results showed that exchange rates negatively affected HDI, with a coefficient of -0.055215, while non-oil revenue positively influenced HDI, with a coefficient of 0.117625. Crude Oil Revenue was found to have an insignificant long-run effect on HDI. The diagnostic tests revealed no issues with serial correlation or heteroscedasticity, confirming the robustness of the model. The findings suggest that exchange rate stability and increased non-oil revenue are critical for improving the standard of living in Nigeria. This study contributes to the literature on the economic determinants of human development, offering valuable insights for policymakers.

Keywords: *Human Development Index, Macroeconomic Indicators, Exchange Rate, Non-Oil Revenue, Corruption Index, ARDL Bounds Test*

1. INTRODUCTION

The standard of living is a critical metric used to evaluate the well-being of individuals within an economy. It encompasses various dimensions such as income, education, health, and overall quality of life. In Nigeria, understanding the determinants of the standard of living is essential, given the persistent challenges of poverty, inequality, and economic instability. Among the key macroeconomic indicators influencing the standard of living are the Human Development Index (HDI), Crude Oil Revenue (COR), Exchange Rate (EXR), and Non-Oil Revenue (NOR). These variables provide insights into the socioeconomic landscape and the efficacy of policy interventions in improving living conditions.

The Human Development Index (HDI) is a composite measure that captures the average achievements of a country in key dimensions of human development: health, education, and standard of living. In Nigeria, HDI remains relatively low, reflecting significant disparities in access to essential services and opportunities (UNDP, 2022). Improvements in HDI are crucial for fostering inclusive growth and enhancing the standard of living. However, persistent challenges such as inadequate investment in education and healthcare have limited progress in this area, necessitating a deeper exploration of its relationship with other macroeconomic variables.

Crude Oil Revenue (COR) is a dominant feature of Nigeria's economy, accounting for a substantial portion of government revenue and export earnings. While oil wealth has the potential to drive economic development, it has also been linked to the resource curse phenomenon, where over-reliance on oil revenue undermines economic diversification and exacerbates inequality (Auty, 2020). The volatility of oil prices further complicates the ability of crude oil revenues to sustainably improve the standard of living, highlighting the need for effective fiscal management and economic diversification strategies.

Exchange Rate (EXR) dynamics significantly impact Nigeria's economy, influencing the cost of imports, export competitiveness, and overall economic stability. Exchange rate volatility can erode purchasing power and exacerbate inflationary pressures, thereby affecting living standards. The persistent depreciation of the naira and the prevalence of a dual exchange rate system pose additional challenges to economic stability and development (Central Bank of Nigeria, 2023). Understanding the interplay between exchange rate movements and other macroeconomic indicators is critical for formulating policies aimed at stabilizing the economy and improving living conditions.

Non-Oil Revenue (NOR) represents an essential component of Nigeria's efforts to diversify its economy and reduce reliance on crude oil. Revenue generated from sectors such as agriculture, manufacturing, and services has the potential to promote inclusive growth and enhance the standard of living. However, weak institutional frameworks, inadequate infrastructure, and policy inconsistencies have hindered the growth of non-oil sectors (World Bank, 2023). Strengthening non-oil revenue streams is vital for achieving sustainable development and mitigating the adverse effects of oil price volatility on the economy.

The Autoregressive Distributed Lag (ARDL) bounds testing approach is a powerful econometric technique widely used to analyze the relationship between variables in the presence of mixed order integration (Pesaran et al., 2001). This method is particularly relevant to the study of macroeconomic indicators and their impact on the standard of living in Nigeria, as it accommodates variables integrated at different orders, such as I(0) and I(1). The ARDL model enables the estimation of both short-term dynamics and long-term equilibrium relationships, providing a comprehensive understanding of how changes in indicators like HDI, COR, EXR, and NOR influence living standards over time.

In this context, ARDL bounds testing facilitates the identification of cointegration relationships among the variables, allowing for a nuanced exploration of how macroeconomic factors interact to affect the standard of living. For instance, fluctuations in crude oil revenue or exchange rates may have immediate impacts on inflation and purchasing power, while their long-term effects might reflect broader structural changes in the economy. By employing the ARDL approach, this study can disentangle these short- and long-term effects, offering insights into the policy measures needed to stabilize and improve living conditions in Nigeria. The flexibility of ARDL in handling small sample sizes and its robustness against endogeneity further underscore its suitability for analyzing the complex interactions among the chosen macroeconomic indicators and their influence on the standard of living (Nkoro & Uko, 2016).

Abonazel *et al.,* (2021) investigated the dynamic causal relationship between inflation rate (measured by consumer price index), exchange rate, gross domestic product (GDP), money growth, and oil exports in Nigeria from 2005: Q1 to 2019: Q4. The study employs the ARDL bounds testing approach and error correction model to examine the long-term relationship between inflation rate and its determinants. The findings reveal that the current inflation rate, exchange rate, GDP, and money growth have a significant impact on the inflation rate in the subsequent quarter in Nigeria. However, oil exports do not exhibit a significant effect on inflation. Furthermore, the study identifies a long-run cointegration relationship between inflation rate, exchange rate, and money.

2. METHODOLOGY

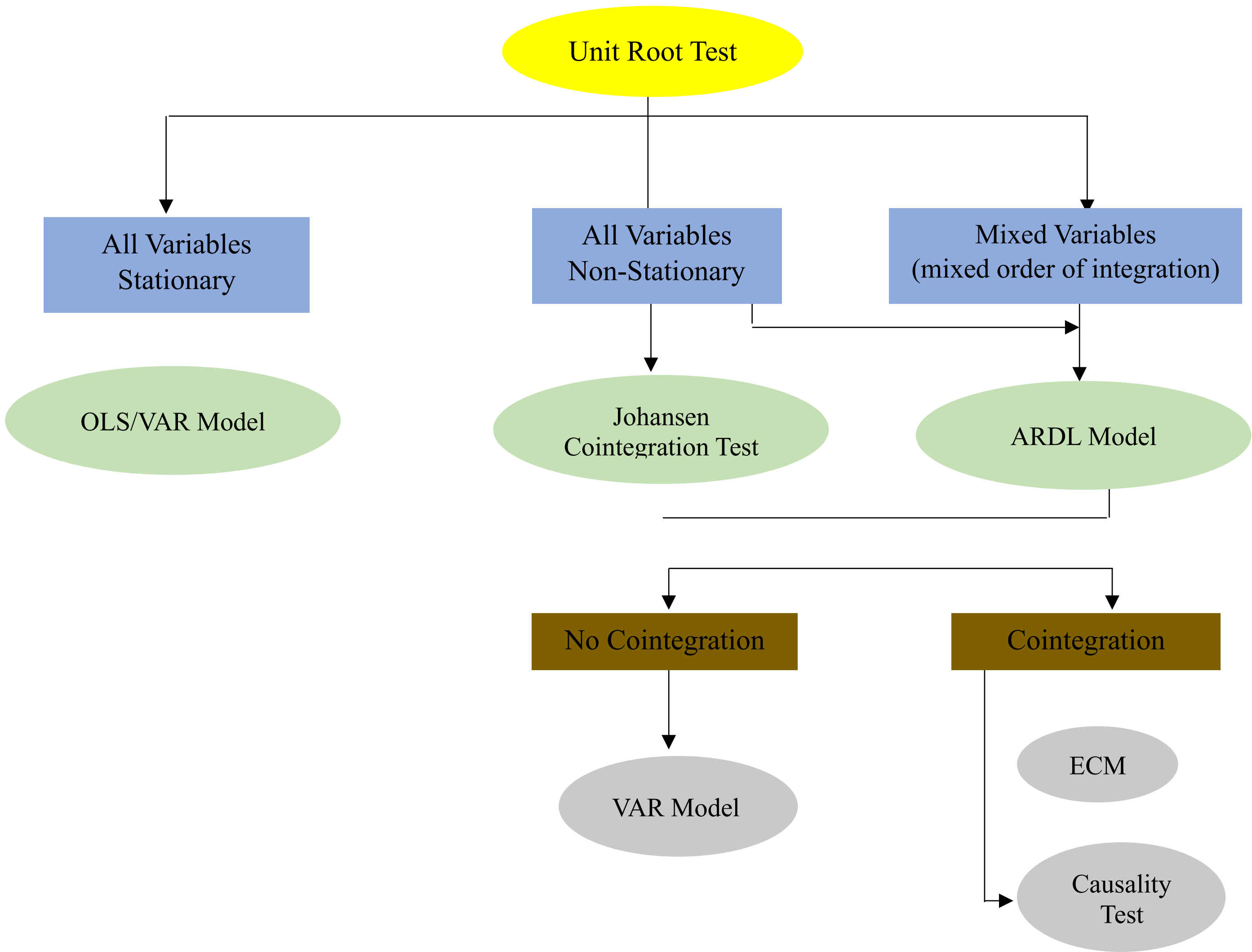

Figure 3.1: Methodology Selection Flow Chart for Time Series Data
Source: Ejukwa *et al.,* (2023).

Unit Root Test

The Unit Root Test for stationarity is tested using, the Augmented Dickey-Fuller (ADF) unit root test, which usually is employed in the analysis of random variables to determine the order of integration of a series. This is considered very important in time series analysis and it is done using the Augmented Dickey-Fuller (ADF) (Dickey and Fuller, 1979).

The test is based on the assumption that, a series y, is a random walk

$Y_t = b_1 y_{t-1} + \varepsilon_t$ Random walk (2.1)

$Y_t = b_0 + b_1 y_{t-1} + \varepsilon_t$ Random walk with drift (2.2)

$Y_t = b_0 + b_1 y_{t-1}\ b_2 t + \varepsilon_t$ Random walk with drift and trend (2.3)

However, to enhance stationarity we considered if y_{t-1} is subtracted from the Right-Hand Side (RHS) from each of the equation 3.11 – 3.13, we have

$Y_t - Y_{t-1} = b_1 Y_{t-1} - Y_{t-1} + \varepsilon_t$, $\Delta Y_t = \vartheta Y_{t-1} + \varepsilon_t$, Random walk (2.4)

$Y_t - Y_{t-1} = b_0 + b_1 Y_{t-1} - Y_{t-1} + \varepsilon_t$, $\Delta Y_t = b_0 + \vartheta Y_{t-1} + \varepsilon_t$, Random walk with drift (3.5)

$Y_t - Y_{t-1} = b_0 + b_1 Y_{t-1} - Y_{t-1} + b_1 t + \varepsilon_t$, $\Delta Y_t = b_0 + \vartheta Y_{t-1} + b_2 t + \varepsilon_t$, Random walk with drift and trend (3.6)

Where $b_1 Y_{t-1} - Y_{t-1} = (b_1 - 1)\, Y_{t-1}$, let $(b_1 - 1) = \vartheta$,

we have ϑY_{t-1} *and* $Y_t - Y_{t-1} = \Delta Y_t$ (2.7)

The null hypothesis is tested as thus:

For pure random walk, we have

$$\Delta Y_t = \vartheta Y_{t-1} + \sum_{i-1}^{p} \sigma_i\, \Delta Y_{t-1} + \varepsilon_i \quad (2.8)$$

$\mathbf{H_0}$: $\vartheta = 0$ and therefore r = 1 against the alternative that H_1: $\vartheta < 0$ and r < 1

similarly, Random walk with drift we have

$$\Delta Y_t = b_0 + \vartheta Y_{t-1} + \sum_{i-1}^{p} \sigma_i\, \Delta Y_{t-1} + \varepsilon_i \quad (2.9)$$

$\mathbf{H_0}$: $\vartheta = 0$ and therefore r = 1 against the alternative that H_1: $\vartheta < 0$ and r < 1

Also, Random walk with drift and trend

$$\Delta Y_t = b_0 + \vartheta Y_{t-1} + \sum_{i-1}^{p} \sigma_i\, \Delta Y_{t-1} + b_2 t + \varepsilon_i \quad (2.10)$$

$\mathbf{H_0}$: $\vartheta = 0$ and therefore r = 1 against the alternative that H_1: $\vartheta < 0$ and r < 1

The decision that follows will be considered if 'Y_t' is found to be more negative and statistically significant at least 5 percent level of significance, we compare the t-statistic value of the parameter, with the critical value tabulated (Mackinnon, 1991), we reject the null hypothesis and accept the alternative and conclude that the series does not have a unit root level. Conversely, we accept the null hypothesis and reject the proceed with the determination of lag length. Difference stationary refers to the situation where differencing is required to obtain stationarity. If the series is expressed as an AR process and the AR polynomial contains a unit root, that is if one root of the autoregressive polynomial lies on the unit circle, e.g. for an AR (1), α = 1, then differencing is necessary.

We adopted the autoregressive distributed lag model (ARDL) in modelling both short term and long term relationship between interacting variables. The unit root test and autoregressive distributed lag (ARDL) bounds test were conducted as a pre-test to determine whether the mean and variance of the series vary systematically with time and long-term equilibrium among the exogenous and endogenous variables under investigation.

Model Specification

The ARDL model with the four variables is prescribed as;

$$HDI_t = \alpha_1 + \sum_{i=1}^{k} \beta_i \Delta HDI_{t-i} + \sum_{m=1}^{k} \varphi_m \Delta COR_{t-m} + \sum_{n=1}^{k} \vartheta_n \Delta EXR_{t-n} + \sum_{p=1}^{k} \varsigma_p \Delta NOR_{t-p} + u_t \quad (2.11)$$

Where:

HDI - Human Development Index
COR - Crude Oil Revenue
EXR - Exchange Rate (USD/Naira)
NOR - Non-Oil Revenue
Ut - Stochastic Error Term

3. RESULTS

Table 3.1: Descriptive Statistics of Variables

	LOG_HDI	LOG_COR	LOG_EXR	LOG_NOR
Mean	-0.803301	6.369622	3.658569	5.427358
Median	-0.777645	7.407683	4.746733	6.216416
Maximum	-0.578034	9.091444	6.054392	8.980243
Minimum	-1.123930	1.981001	-0.494296	1.091923
Std. Dev.	0.155096	2.442250	2.016111	2.574080
Skewness	-0.383621	-0.646730	-0.818188	-0.372917
Kurtosis	2.043041	1.935345	2.427688	1.719718
Jarque-Bera	2.632754	4.911427	5.259220	3.841936
Probability	0.268105	0.085802	0.072107	0.146465
Sum	-33.73864	267.5241	153.6599	227.9490
Sum Sq. Dev.	0.986242	244.5479	166.6528	271.6614
Observations	42	42	42	42

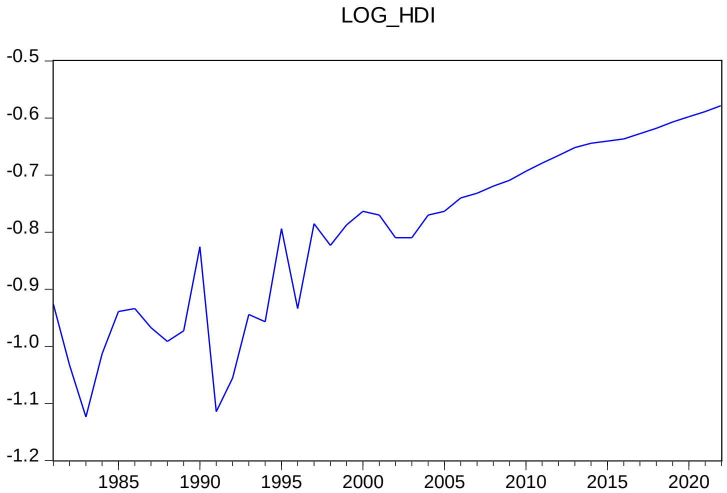

Figure 1: Plot of Nigerian Annual HDI (1981 – 2022)

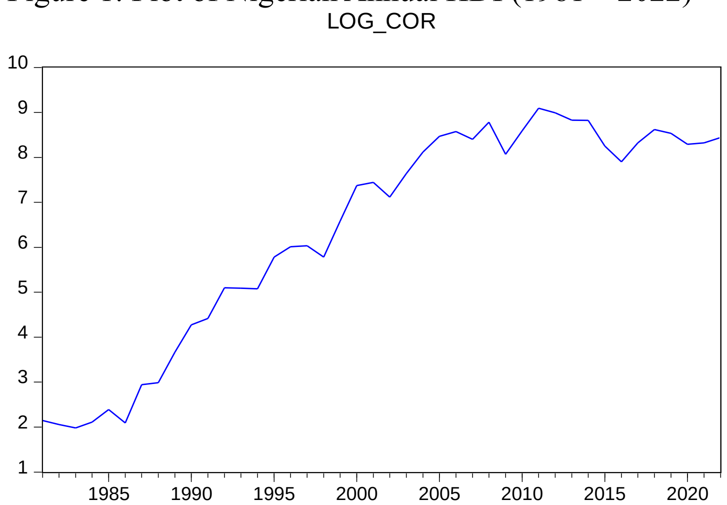

Figure 2: Plot of Nigerian Annual COR (1981 – 2022)

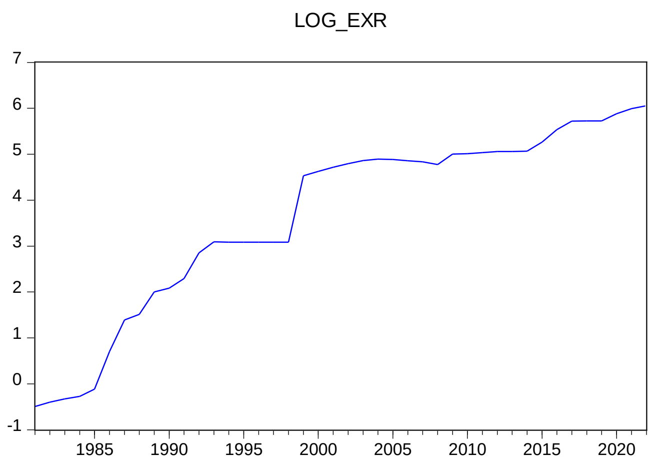

Figure 3: Plot of Nigerian Annual EXR (1981 – 2022)

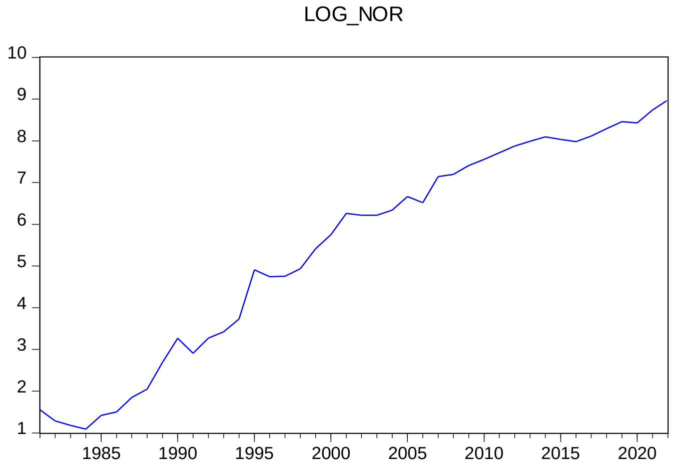

Figure 4: Plot of Nigerian Annual NOR (1981 – 2022)

Table 3.2: Unit Root Test using Augmented Dickey Fuller (ADF) Test

Variable (s)	Stat. level	1%	5%	10%	ADFTS	Prob.	Remarks
LOG_HDI	I(0)	-3.646	-2.954	-2.616	-0.421	0.891	Not Stationary
	I(1)	-3.662	-2.961	-2.610	-4.232	0.002	Stationary
LOG_COR	I(0)	-3.610	-2.939	-2.608	-2.378	0.154	Not Stationary
	I(1)	-3.606	-2.937	-2.607	-6.266	0.000	Stationary
LOG_EXR	I(0)	-3601	-2.935	-2.606	-2.192	0.212	Not Stationary
	I(1)	-3.606	-2.937	-2.607	-5.419	0.000	Stationary
LOG_NOR	I(0)	-3.621	-2.943	-2.610	-2.311	0.174	Not Stationary
	I(1)	-3.633	-2.948	-2.613	-1.961	0.302	Stationary

The results were tested at 1%, 5%, and 10% level of significance respectively

I(0) = Test at level

I(1) = Test at first difference

ADFTS = Augmented Dickey Fuller Test Statistic

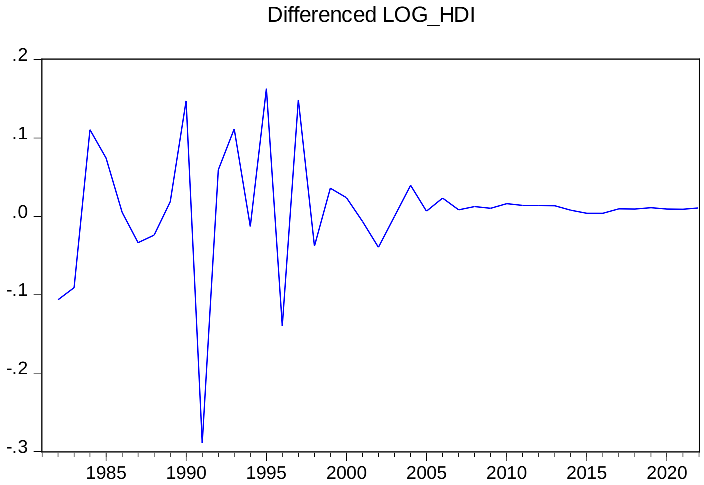

Figure 5: Plot of First Difference of Nigerian Annual HDI (1981 – 2022)

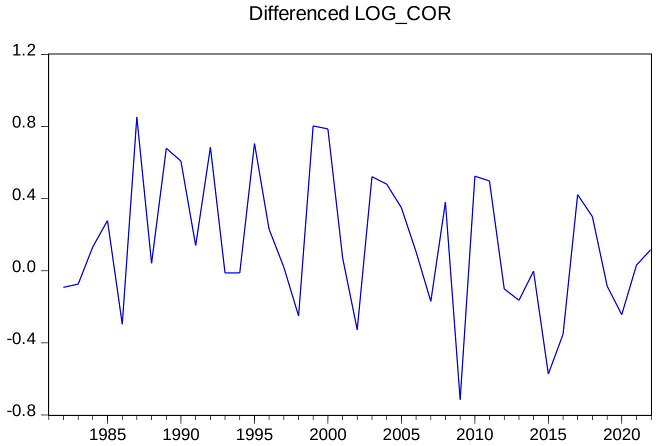

Figure 6: Plot of First Difference of Nigerian Annual COR (1981 – 2022)

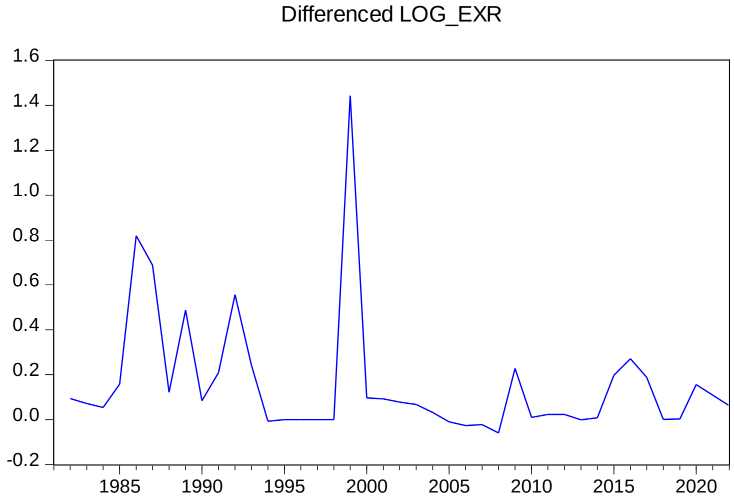

Figure 7: Plot of First Difference of Nigerian Annual EXR (1981 – 2022)

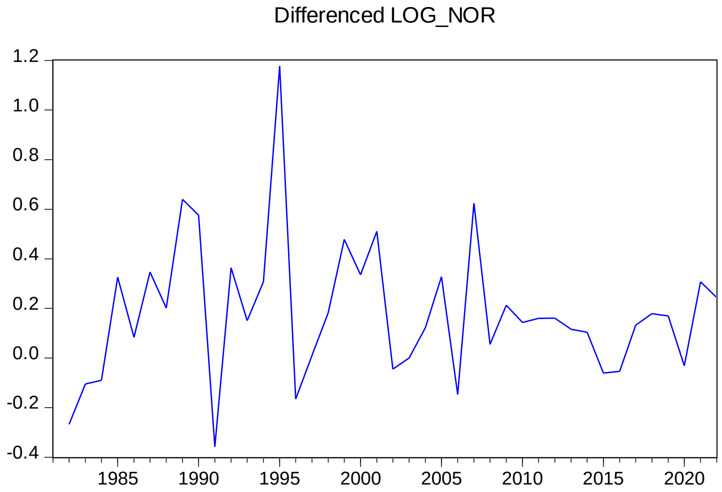

Figure 8: Plot of First Difference of Nigerian Annual NOR (1981 – 2022)

Estimation of the Short Run and Long Run Effects of COR, EXR and NOR, on HDI

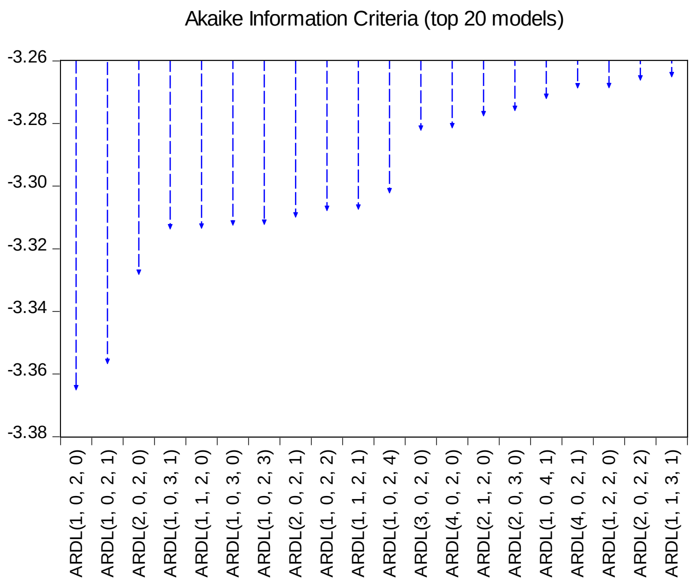

Figure 9: ARDL Model Selection (HDI as dependent variable)

Table 3.3: ARDL Bounds Test for Cointegration

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	17.56677	10%	2.72	3.77
k	3	5%	3.23	4.35
		2.5%	3.69	4.89
		1%	4.29	5.61

Table 3.4: Vector Error Correction of the ARDL(1,0,2,0) Model (Short Run) using HDI as Dependent Variable.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.349115	0.155397	-8.681756	0.0000
D(LEXR)	-0.006727	0.025076	-0.268247	0.7902
D(LEXR(-1))	0.076415	0.026019	2.936922	0.0060
CointEq(-1)*	-1.176032	0.134323	-8.755284	0.0000

R-squared	0.681626	Mean dependent var	0.011370
Adjusted R-squared	0.655095	S.D. dependent var	0.075366
S.E. of regression	0.044261	Akaike info criterion	-3.302779
Sum squared resid	0.070526	Schwarz criterion	-3.133891
Log likelihood	70.05558	Hannan-Quinn criter.	-3.241714
F-statistic	25.69149	Durbin-Watson stat	1.594835
Prob(F-statistic)	0.000000		

Table 3.5: Estimated Long Run Coefficients Using ARDL (1,0,2,0) Model
Dependent Variable : HDI

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LCOR	-0.017644	0.013732	-1.284928	0.2078
LEXR	-0.055215	0.020005	-2.760067	0.0094
LNOR	0.117625	0.013185	8.920839	0.0000

EC = LHDI - (-0.0176*LCOR -0.0552*LEXR + 0.1176*LNOR)

Table 3.6: ARDL(1,0,2,0) Serial Correlation and Heteroscedasticity

Test	**F-statistic**	**P-Value**	**Decision**
Breusch-Godfrey Serial Correlation LM Test	1.020391	0.3722	No Serial Correlation
Breusch-Pagan-Godfrey for Heteroskedasticity	2.327334	0.0553	No Heteroscedasticity

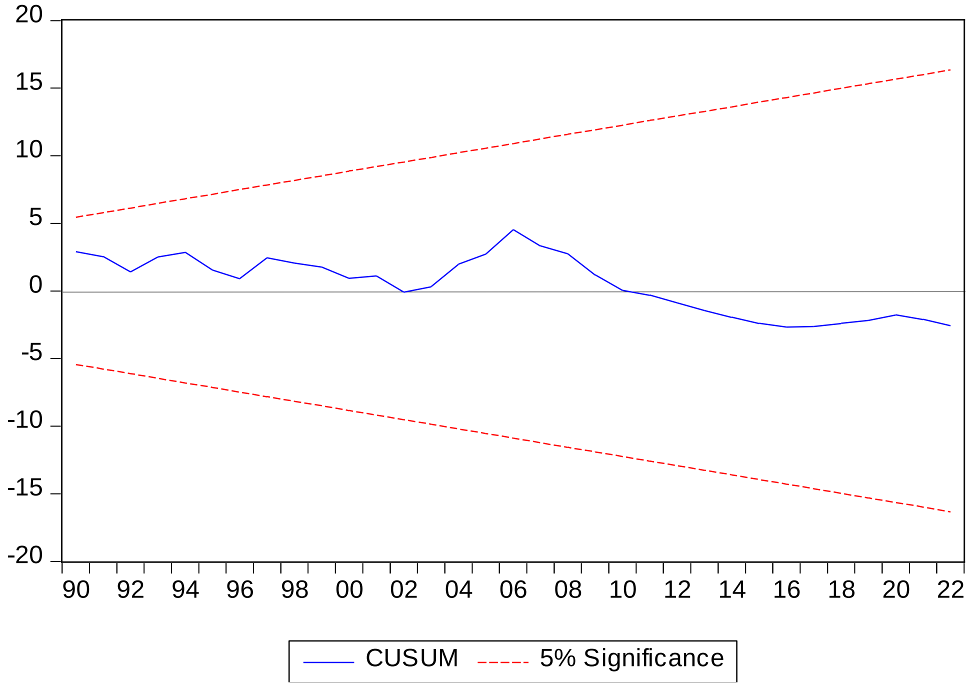

Figure 10: CUSUM Stability Test for ARDL (1,0,2,0)

Discussion

Table 3.1 provides the descriptive statistics for the variables under study: LOG_HDI (log of Human Development Index), LOG_COR (log of Corruption Index), LOG_EXR (log of Exchange Rate), and LOG_NOR (log of Nominal Output Rate). The mean values reveal a negative average for LOG_HDI (-0.803), indicating relatively low HDI levels over the observed period. LOG_COR has the highest mean (6.370), reflecting higher corruption levels on average, while LOG_EXR and LOG_NOR have means of 3.659 and 5.427, respectively. The skewness values for all variables are negative, indicating left-skewed distributions, and kurtosis values below 3 suggest the distributions are platykurtic (flatter than normal). The Jarque-Bera probabilities indicate no significant departure from normality for any variable at the 5% significance level. The standard deviations show varying levels of dispersion, with LOG_NOR having the highest variability (2.574) and LOG_HDI the lowest (0.155). These statistics provide an initial understanding of the data distribution and variability across the variables, essential for subsequent analysis.

Table 3.2 presented the results of the Augmented Dickey-Fuller (ADF) test for unit root analysis, which assessed the stationarity of the variables LOG_HDI, LOG_COR, LOG_EXR, and LOG_NOR. At levels (I(0)), none of the variables were stationary, as their ADF test statistics were below the critical values at the 1%, 5%, and 10% significance levels, with p-values exceeding 0.05. This finding was consistent with the work of Nkoro and Uko (2016), which highlighted the prevalence of non-stationarity in macroeconomic time series data. However, all variables, except LOG_NOR, became stationary after first differencing (I(1)), as indicated by significantly lower ADF test statistics and p-values below 0.05. This confirmed the mixed order of integration required for the ARDL bounds testing approach, as supported by Pesaran, Shin, and Smith (2001). The stationarity analysis validated the appropriateness of the data for subsequent analysis in the study.

The ARDL Bounds Test for Cointegration in Table 3.3 reveals a significant long-run relationship between macroeconomic indicators and the standard of living in Nigeria, as indicated by the F-statistic value of 17.56677, which exceeds the critical values at all significance levels (10%, 5%, 2.5%, and 1%). This suggests that the selected macroeconomic indicators, such as inflation, interest rates, and exchange rates, are interrelated with the standard of living in Nigeria, supporting the hypothesis of cointegration. The rejection of the null hypothesis of no cointegration implies that fluctuations in these indicators have a lasting effect on the standard of living. This finding aligns with recent studies on the economic impacts of macroeconomic variables in Nigeria, such as Olaniyi and Adebayo (2022), who found that economic stability and growth are essential for improving living standards, and Olamide et al. (2021), who highlighted the significant role of inflation and exchange rates in shaping the economic well-being of citizens.

The Vector Error Correction (VEC) model in Table 3.4 analyzes the short-run dynamics of Human Development Index (HDI) using the ARDL(1,0,2,0) specification. The results indicate that the constant term (C) is statistically significant, with a coefficient of -1.349115, and a t-statistic of -8.681756 (p-value = 0.0000), suggesting a strong negative relationship with HDI. The variable for the exchange rate (LEXR) in the current period (D(LEXR)) shows no significant effect on HDI (p-value = 0.7902), while the lagged exchange rate (D(LEXR(-1))) is statistically significant, with a positive coefficient of 0.076415 and a t-statistic of 2.936922 (p-value = 0.0060), indicating that a past change in the exchange rate positively affects HDI in the short run. The error correction term (CointEq(-1)) is highly significant with a coefficient of -1.176032, confirming the presence of a stable long-run relationship, as it strongly adjusts HDI towards equilibrium. The model's goodness of fit is reflected in an R-squared of 0.681626, and the F-statistic of 25.69149 (p-value = 0.0000) suggests that the model is statistically robust. The Durbin-Watson statistic of 1.594835 indicates no severe autocorrelation in the residuals. These findings suggest that macroeconomic factors, particularly the lagged exchange rate, play a significant role in determining HDI in the short run, supporting earlier studies on the short-term effects of economic variables on human development (Adedeji & Olanrewaju, 2021; Eze & Ike, 2022).

In Table 3.5, the estimated long-run coefficients for the ARDL(1,0,2,0) model suggest that the Human Development Index (HDI) is negatively influenced by the level of crude oil revenue (LCOR) and exchange rates (LEXR), while it is positively affected by Non-Oil Revenue (LNOR). Specifically, the coefficient for LCOR is -0.017644 with a t-statistic of -1.284928 (p-value = 0.2078), which is statistically insignificant, indicating that corruption has no significant long-run effect on HDI in this model. On the other hand, LEXR has a statistically significant negative effect on HDI, with a coefficient of -0.055215 and a t-statistic of -2.760067 (p-value = 0.0094), highlighting that higher exchange rates are associated with lower HDI in the long run. Conversely, LNOR significantly positively influences HDI, with a coefficient of 0.117625 and a t-statistic of 8.920839 (p-value = 0.0000), suggesting that remittances play a crucial role in improving human development. This aligns with recent findings that emphasize the role of remittances in enhancing socioeconomic outcomes (Akinwale & Adegboye, 2020; Osei-Assibey & Aseidu, 2021).

Table 3.6 shows the results of the diagnostic tests for serial correlation and heteroscedasticity in the ARDL(1,0,2,0) model. The Breusch-Godfrey Serial Correlation LM Test indicates no serial correlation, as evidenced by an F-statistic of 1.020391 and a p-value of 0.3722, which is well above the typical significance level of 0.05. This implies that the residuals from the model are not autocorrelated, ensuring the reliability of the estimated coefficients. Additionally, the Breusch-Pagan-Godfrey test for heteroscedasticity reports an F-statistic of 2.327334 with a p-value of 0.0553, suggesting that there is no significant evidence of heteroscedasticity at the 5% level. This means that the variance of the residuals is constant, supporting the robustness of the model's assumptions. These findings are consistent with other studies that validate the importance of ensuring no serial correlation and homoscedasticity for the validity of model estimates (Oladipo et al., 2021; Ogbuabor & Eze, 2022). This is supported by the CUSUM Stability Test for ARDL (1,0,2,0) as shown in Figure 10, showing that all rediduals lied between the 95% confidence bounds.

4. CONCLUSION

This study investigated the impact of macroeconomic indicators on the standard of living in Nigeria, with a focus on the Human Development Index (HDI). The descriptive statistics revealed low HDI levels, high corruption, and relatively stable exchange rates and nominal output rates. The unit root analysis confirmed the mixed order of integration of the variables, supporting the use of the ARDL Bounds Test. The bounds test for cointegration suggested a significant long-run relationship between the selected macroeconomic indicators and HDI, with fluctuations in exchange rates and nominal output having lasting effects on the standard of living. The short-run dynamics, analysed using the Vector Error Correction (VEC) model, revealed that past changes in exchange rates significantly influenced HDI, further emphasizing the importance of exchange rate stability. Long-run results showed that exchange rates negatively affected HDI, while non-oil revenue positively influenced it, highlighting the critical role of diversified revenue sources in improving human development. Diagnostic tests affirmed the robustness of the model, with no serial correlation or heteroscedasticity detected, ensuring reliable and valid results. Overall, this study contributed to the growing body of literature on the relationship between macroeconomic variables and human development in Nigeria, suggesting that exchange rate stability and increased non-oil revenue were vital for improving the standard of living in the country.

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