# Impacts of Selected Economic Factors on Economic Growth in West African Countries: Panel ARDL Analysis

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**Abstract**
This study used three estimators Pooled Mean Group (PMG), Mean Group (MG) and Dynamic Fixed Effect (DFE) within a panel autoregressive distributed lag (ARDL) model to evaluate both short-run and long- run effects of selected key economic indicators on economic development in West African context. The impact of Trade openness, Foreign direct inflation rate and industrialization on Real gross domestic product per capita as a stand-in for fiscal performance in West African countries between the phase of 1990 to 2022 was investigated with the Panel ARDL modelling approach. The study finds evidence of a cointegrating association between the economic growth in West Africa and the selected variables. It is further observed that trade openness and inflation are found to have a positive significant impact on RGDP in the long run. All the estimated panel ARDL regressions highlight that economic development in West African countries depends significantly on foreign direct investment and the rate of inflation. This study recommends policymakers in the region implement anti-inflationary measures alongside developing robust infrastructure and a conducive environment to attract foreign investors, thereby fostering stable and sustainable economic growth in West African countries.

**Keywords:** Panel ARDL, Pooled Mean Group, Cointegration, Economic factors and West Africa.

**Introduction**
The significance of economic development is immense and cannot be overstated. It is frequently used as a key criterion for determining whether countries are classified as developed or not. Economic development is a key macroeconomic target that countries worldwide continuously strive to achieve (Adewole et al., 2020). However, many West African countries have faced persistent challenges with sluggish output economic growth over several decades, and this has hindered their capacity to achieve notable success in international trade. Fluctuations in crucial macroeconomic indicators such as foreign direct investments, trade openness, inflation rates, industrialization, high interest rates, and exchange rates among others have intensified uncertainty, impeding progress toward achieving sustainable long-term growth goals, thus, the economy of West Africa represents the overall balance in these economic indicators across the continent (Adewole, 2023). West Africa consists of eighteen countries making it the largest regional integration organization in the African continent by population size. In response to the growth trends among West African countries, various initiatives and programs have been launched to enhance fiscal growth in the region. Most findings from past research revealed that the West African States have only witnessed a downward trend in fiscal development over the years despite all the initiated schemes (Ndife, 2017; Younsi et al., 2021; Adewole, 2023; Usmana & Osagie, 2023; Aliu et al., 2024) among others. Foreign capital flows are crucial for enhancing the West African economy, particularly in boosting its capital markets, which are significantly underdeveloped in comparison with sister provinces (Osei, 2005). The difficulties confronted by the states have impeded successive economic segment modifications intended to activate and assign credence to the independent enterprise, which is crucial for fostering investment, growth, and addressing underdevelopment and poverty.

Several previous researchers (Iyoha & Okim 2017; Manamba & William, 2021; Adewole & Amurawaye,2024), have explored the connection between macroeconomic variables and economic development in the context of West Africa but revealing inconsistent findings, the varying results may likely stem from disparities in econometric methodologies, data sources, and coverage. Consequently, further investigation is essential to study

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how macroeconomic situations influence fiscal development in the West Africa region. This study utilizes Panel ARDL modelling tools to estimate and evaluate the empirical relationship across West African country's FDI, Trade openness, inflation rate, industrialization and RGDP. These variables were chosen due to their critical influence on the country's overall economic performance. For instance, in line with (Kamal et al., 2021), FDI, inflation rates and industrial sectors are crucial components of the economic environment. As a key factor in global economic integration, FDI provides financial stability that contributes significantly to a country's economic development. FDI is vital for capital formation, as its inflow and outflow are critical for economic growth (Gochero & Boopen, 2020), it typically involves bringing foreign capital into a country to produce goods for both domestic consumption and export.

Moreover, trade openness promotes economic development by enabling the availability of environmentally friendly products and alleviating barriers to technological progression (Ahmad et al., 2020). Also, Industrialization involves transforming an economy by expanding industrial and manufacturing activities, it can be characterized as an upward projection in the contribution of none non-agricultural and non--service sectors to GDP through various economic processes associated with more efficient value-creation methods (Simandan, 2009).

The main objective of economic policies in many countries is to achieve strong and steady progress in fiscal development while keeping inflation bearable. Inflation often arises from imbalances between supply and demand (Otoakhia, 2024). Additionally, the stability of a nation's foreign exchange rate is crucial in shaping its economic performance. A limited number of studies have concentrated on West Africa's economy encompassing both theoretic and experimental studies, exploring the connection between economic growth and macroeconomic variables in various ways. Key studies in this area include those by Nkoa (2013), Sissoko et al. (2018), Adu-Gyamfi et al. (2020), Wiredu et al. (2020), Emenike (2021), Mkombe et al. (2021) and Ajayi & Akutson (2023) among others. The effect of the aforementioned macroeconomic variables on economic growth in West Africa is still inconclusive, with no clear consensus in the literature about their short-run and long-run impacts. The research seeks to reevaluate the economic science evaluation of the association between key macroeconomic variables and economic fiscal development in West Africa utilizing panel ARDL techniques. This approach enables an examination of analyzing impact of various macroeconomic parameters on economic advancement in both the short run and long run. The Panel ARDL method is advantageous as it instantaneously evaluates both short-term and long-run.

## Materials and Methods
Secondary data sourced from the World Development Indicators (WDI) database provided by the World Bank, ranging from 1990 to 2022 were used for the research. The dataset includes information from 16 West African countries: Benin, Côte d'Ivoire, Gambia, Niger, Nigeria, Mali, Senegal, Sierra Leone, Togo, Burkina Faso, Liberia, Mauritania, Cape Verde, Ghana, Guinea, and Guinea-Bissau. This data will be modelled using panel ARDL data regression. RGDP growth is the endogenous variable while Trade openness, FDI, inflation Rate and Industrialization are the exogenous variables.

## Model Specification
Considering the model specification below;
RGDP= f(TRNSS, FDI, INFRT, INDUSTN)                                           (1)
Where RGDP is the Real Gross domestic product, FDI is the Foreign Direct Investment, INFRT is the Inflation rate, TRNSS signifies trade openness, INDUSTN denotes Industrialization respectively.

Equation (1) can be rewritten as
$$lnRGDP_{it} = \beta_0 + \beta_1 lnTRNSS_1 + \beta_2 lnFDI_2 + \beta_3 lnINFRT_3 + \beta_4 lnINDUSTN_4 + \varepsilon_{it} \qquad (2)$$
$\beta_0$ is constant and $\beta_1$, $\beta_2$, $\beta_3$ and, $\beta_4$ are the quantities of independent variables to be assessed by means of OLS, $\varepsilon_{it}$ is the stochastic term. The macroeconomic variables under study in West African countries are in their natural log form.

Estimation and Preliminary Tests
To ensure a well-specified model, it is crucial to conduct preliminary tests on the variables. In this study, these pre-estimation tests include stationarity tests using the Panel Data Unit Root Test, panel ARDL cointegration tests, Pearson correlation analysis to evaluate correlations among variables, and the determination of the optimal lag length.

Panel ARDL Unit Root Test

Estimating a Panel ARDL model requires that parameters in regression are either integrated of order zero or at most integrated of order one. To accomplish this, the research employed the Im, Pesaran, and Shin (2003) Augmented Dickey-Fuller test and the Levin et al. (2002) unit root test.

Considering testing for the existence of unit roots in the following panel data:

$$y_{it} = \rho_i y_{it-1} + \sum_{j=1}^{p_i} \alpha_{ij} \Delta y_{it-j} + \varphi z_{ij} + \varepsilon_{it} \qquad (3)$$

It tests the following hypothesis;

$$H_0: \rho_i = 1 \text{ for all } i \qquad (4)$$

$$H_1: |\rho_i| < 1 \text{ for at least one } i \qquad (5)$$

The Im etal (2003) is based on an average of the individual Augmented Dickey Fuller test statistics defined as

$$\bar{t} = \frac{1}{N} \sum_{i=1}^{N} t_{\rho_i} \qquad (6)$$

Where $t_{\rho_i}$ is an individual t- statistics for the null hypothesis test.

The Levin et al. (2002) tests of stationarity assume that the parameters examined are consistent across all panels, implying $\rho_i = \rho$ for all countries in the panel.

**Panel ARDL Cointegration Tests**
ADF test, Phillips-Perron test, Pedroni (1999, 2004) panel co-integration tests, and the Westerlund (2007) panel cointegration test were used to analyse the long-term cointegration between RGDP growth and the independent variables, The Pedroni test is particularly useful as it allows for panel-specific cointegrating vectors.

Optimal Lag Length: Selection criteria values for the Panel ARDL series are provided by the following expression;

$$AIC_n = (1 + log2\pi) - \frac{m}{2} log\gamma^2 - N \qquad (7)$$

$$SBC_n = log\gamma^2 + \left(\frac{logm}{m}\right) N \qquad (8)$$

$$HQC = log\gamma + \left(2 \log \frac{logm}{m}\right) N \qquad (9)$$

The best lag is determined using model selection criteria with minimum values of the Akaike Information Criterion (AIC), Schwarz Bayesian Criterion (SBC), and Hannan-Quinn Criterion (HQC).
The panel ARDL equation is denoted as follows:

$$lnRGDP = \beta_0 + \sum_{j=1}^{p} \beta_{1i,j} lnRGDP_{t-j} +$$
$$\sum_{j=0}^{q_1} \beta_{2i,j} lnTRNSS_{t-j} + \sum_{j=0}^{q_2} \beta_{3i,j} lnFDI_{t-j} + \sum_{j=0}^{q_3} \beta_{4i,j} lnINFRT_{t-j} + \sum_{j=0}^{q_4} \beta_{5i,j} lnINDRSTN_{t-j} +$$
$$\varepsilon_{it} \qquad (10)$$

where $i = 1,2,3,\dots N$ and $t = 1,2,3,\dots T$, $\beta_i$ signifies the fixed effects, $\beta_1 - \beta_5$ denotes lagged coefficients of the explanatory variables and the regressors and $\varepsilon_{it}$ is the white noise error term.

**Panel ARDL Model Estimation**.
**Pooled Mean Group (PMG):** The estimation technique as discussed by Pesaran, Shin, and Smith (1999) permits the estimation of links in short runs, factoring in parameters and adjustments for long-run equilibrium (speed of adjustment) and diverse error variance. This approach is suitable due to its ease of execution and compatibility with long-term relationships. Meanwhile, the likelihood-based PMG estimator imposes a constraint by requiring coefficients of long-term effect to be identical through groups. Pooled estimation tools are reliable and efficient when long term homogeneity is present.

**Mean Group (MG):** Pesaran and Smith (1995) describe MG estimator as offering a less restrictive approach for estimating parameter diversity, allowing calculation of various coefficients for each country. The estimator provides reliable mean estimates in the long run, but impractical for cases requiring homogeneity. It assumes heterogeneous slope and intercept coefficients, deriving long-run values by averaging the ARDL long-run values across individual countries.

**Dynamic Fixed Effect (DFE).**
The DFE estimator imposes homogeneous slope coefficients while allowing intercepts to differ throughout states. This approach is identical to the PMG estimator in that it enforces consistency in the long-run cointegration vector across all panels.

The panel ARDL model for both long run and short run for this study is expressed below;

$$\Delta RGDP_{it} = \beta_0 + \beta_1 RGDP_{it-1} + \beta_2 TRNSS_{it-1} + \beta_3 FDI_{it-1} + \beta_4 INFRT_{it-1} + \beta_5 INDRSTN_{it-1} + \sum_{i=1}^{a} \alpha_i \Delta RGDP_{it-1} + \sum_{i=1}^{b} \vartheta_i TRNSS_{it-1} + \sum_{i=1}^{c} \sigma_i FDI_{it-1} + \sum_{i=1}^{d} \gamma_i INFRT_{t-1} + \sum_{i=1}^{e} \varphi_i INDRSTN_{t-1} + \emptyset ECM_{it-1} + \varepsilon_{it}$$ (11)

$\beta_1, \beta_2, \beta_3, \beta_4 \text{ and } \beta_5 \text{ and } \alpha_i, \vartheta_i, \sigma_i, \gamma_i \text{ and } \varphi_i \text{ are}$ long run coefficients and short-run coefficients respectively.

Panel error correction model (PECM) can be expressed below if there exist co integration in equation (11) above.

$$\Delta RGDP_{it} = \alpha_0 + \sum_{i=1}^{a} \alpha_i \Delta RGDP_{it-1} + \sum_{i=1}^{b} \vartheta_i \Delta TRNSS_{it-1} + \sum_{i=1}^{c} \sigma_i \Delta FDI_{it-1} + \sum_{i=1}^{d} \gamma_i \Delta INFRT_{t-1} + \sum_{i=1}^{e} \varphi_i \Delta INDRSTN_{t-1} + \emptyset ECM_{it-1} + \varepsilon_{it}$$ (12)

error correction part is denoted by $ECM_{it-1}$ , $\emptyset$ is the speed of adjustment.
Both MG and PMG estimators rely on optimum selection criterion in selecting appropriate lag durations. The Hausman tests will be used to assess the performance of PMG, MG, and DFE in this work.

Table 1: Description and Source of Variables

| Variables | Description | Source |
|---|---|---|
| Real Gross Domestic Product | Real GDP per capita. It is measured in ratio of the US dollar. | World Development Indicators. |
| Trade Openness | Total import and export in ratio with the GDP | World Development Indicators. |
| Foreign Direct Investment | A substantial lasting investment made by the government into foreign countries. | World Development Indicators. |
| Inflation Rate | A continuing rise in the general price level. | World Development Indicators. |
| Industrialization | Industry (including value added in % of GDP). | World Development Indicators. |

**Results and discussions of results.**

**Table 2: Summary Statistics**

| VARIABLE | Ln RGDP | Ln FDI | Ln Trade Openness | Ln INF RATE | Ln INDUSTLIZTN |
|---|---|---|---|---|---|
| Mean | 17.3180 | 2.1719 | 2.018612 | 1.3722 | 3.0362 |
| Median | 17.2463 | 0.7829 | 21.892252 | 0.1830 | 20.5435 |
| Max. | 21.4599 | 8.0384 | 5.920792 | 0.7295 | 34.2292 |
| Min. | 9.3713 | 0.1969 | 0.549467 | 0.0311 | 4.41072 |
| Standard Dev. | 2.912 | 2.4243 | 1.488334 | 0.4517 | 6.5228 |
| Sum Sq. Dev. | 140.832 | 56.9302 | 69.2749 | 43.0472 | 26.6108 |
| Skewness | -0.8372 | 0.0315 | -0.0273 | 0.0596 | -0.2223 |
| Kurtosis | 3.2147 | 2.0152 | 2.1684 | 3.6652 | 0.2037 |
| Shapiro Test | 0.8910 | 0.9230 | 0.9743 | 0.9043 | 2.3820 |
| Observations | 512 | 512 | 512 | 512 | 512 |

Table 2 presents descriptive statistics of the variables and aggregate averages such as mean, median, the measures of spread and variation. Mean and median of the series consistently falls within range defined by the maximum and minimum values. The variables are symmetrical and leptokurtic with respect to the normal distribution.

**Table 3: Correlation matrix**

| Variables | RGDP | FDI | TRNSS | INF RT | INDLIZN |
|---|---|---|---|---|---|
| RGDP | 1 | | | | |
| FDI | -0.02169 | 1 | | | |
| TR Openness | 0.1847 | 0.3283 | 1 | | |
| Inflation Rate | 0.5505** | 0.0472** | -0.1956** | 1 | |
| INDLIZN | - 0.5212** | -0.0173** | -0.1841** | -0.4825** | 1 |

* and ** designate significant levels at 1% and 5% respectively.

Table 3 shows the association analysis among the macroeconomic variables. The relationship between RGDP and FDI revealed a negative and low level of correlation between the variables but was not statistically significant. However, an averagely significant positive correlation exists between FDI and the Inflation rate, likewise with trade Openness.

Moreover, the correlation that exists between the rate of inflation and RGDP reveals a significant positive relationship; also, there is a negative correlation between the RGDP and industrialization in West Africa.

**Table 4: Panel ARDL Unit Root Test.**

| Variables | Im, Pesaran, Shin (2003) | Levin, Lin, Chu (2002) | Augmented Dickey-Fuller | Prob. | Remark |
|---|---|---|---|---|---|
| RGDP | -0.2130 | 0.2023 | 0.2230 | 0.0000 | I(0) |
| TR NSS | 0.8113 | 0.8293 | 0.8451 | 0.0004 | I(1) |
| FDI | -1.1902 | -1.2034 | -1.1732 | 0.0000 | I(1) |
| INF-RT | 5.3329 | 5.4230 | 5.5302 | 0.0000 | I(0) |
| INDUSRLZTN | 0.7523 | 0.7737 | 0.7193 | 0.0015 | I(1) |

Table 4 revealed that the RGDP and rate of Inflation are stationary at level, while trade openness, foreign direct investment and industrialization are stationary at first difference.

**Table 5:   Best lag Selection Criteria**

| Lag | Log l | LR | FPE | AIC | SIC | HIC |
|---|---|---|---|---|---|---|
| 0 | -57281 | NA | 43.2933 | 44.2562 | 43.4576 | 44.2448 |
| 1 | -311.50 | 365.78 | 41.9927$^*$ | 43.2130* | 42.6246* | 42.1173* |
| 2 | -62892 | 500.91 | 45.3982 | 45.2935 | 45.0993 | 45.6819 |

Table 5 above presents the optimal lag length selection along with their corresponding information criteria; The table also includes the selected ARDL models. The information criterion with an asterisk (*) at lag one was chosen based on the minimum value.

**Table 6:  Panel Cointegration Test.**

| Techniques | Statistic | P-value |
|---|---|---|
| Augmented Dickey Fuller | 2.9836 | 0.0003 |
| Pedroni | 3.0061 | 0.0007 |
| Phillips- Perron t | 3.2145 | 0.0001 |
| Westerlund (2007) | 2.9970 | 0.0009 |
| Variance ratio | | |

Table 6 shows that all the variables in the study are co-integrated at 5% significance level.

**Table 7: VIF test for Multicollinearity**

| Variable | RGDP | FDI | TR OPENESS | INF RT | INDLIZN |
|---|---|---|---|---|---|
| VIF | 1.6306 | 1.6228 | 1.5721 | 1.6934 | 1.4934 |
| R. VIF | 0.6132 | 0.6162 | 0.6360 | 0.5905 | 0.6696 |
| AVE. VIF | 1.6025 | | | | |

Note: VIF symbolize variation inflation factor, R.VIF represent variation inflation factor while AVE. VIF is the average of the variation inflation factor.

In line with Gujarati (2003), Table 7 above shows evidence of no multicollinearity, The highest value in this study is 1.69, the low mean VIF of 1.60 further suggests minimal correlation among the regressors. This confirms the suitability and effectiveness of the variables within the framework.

**Table 8: long Run Result**

| | PMG | | MG | | DFE | |
|---|---|---|---|---|---|---|
| Variable | Coeff. | P-value | Coeff. | P-value | Coeff. | P-value |
| Ln RGDP | 0.1189 | 0.0002** | 0.0628 | 0.0016** | 0.2890 | 0.0031** |
| Ln FDI | -0.0390 | 0.0000** | 0.0548 | 0.0090** | 0.0337 | 0.0003** |
| Ln TR NSS | 0.1161 | 0.0008** | 0.0282 | 0.0006** | 0.2163 | 0.0000 |
| Ln INF RT | 0.34921 | 0.0073** | 0.2090 | 0.0030** | 0.036 | 0.0012** |
| Ln INDLIZN | -0.0331 | 0.2745 | 0.0694 | 0.1539 | 0.0449 | 0.0541 |
| Cons. | 0.3629 | 0.0002 | 0.7123 | 0.0029 | 0.5527 | 0.0049 |

Hausman test: Chi Square, p-value: 0.228

\* and ** designate significant levels at 1% and 5% respectively.

The chi-square value from the Hausman test revealed the efficiency and consistency of the pooled mean group estimator. Table 8 indicates that trade openness has a significant positive association with RGDP, while industrialization shows an insignificant relationship with RGDP per capita. Additionally, results reveal a negative significant relationship between RGDP and FDI in West African states.

The findings indicate that the coefficient value of the inflation rate is 0.34921 with a p-value of 0.0005, suggesting a positive significant impact on real gross domestic product, in the long run. The coefficient for the inflation rate is 0.34921, this suggests that holding other variables constant, a one-unit increase in the inflation rate is associated with a decrease of approximately 0.34 % in GDP in West African countries Similarly, the coefficient value of industrialization is -0.0331with an associated p-value of 0.0019 indicating a negative and insignificant impact on RGDP in selected west Africa countries.

. **Table 9: Short Run Result**

| | PMG | | MG | | DFE | |
|---|---|---|---|---|---|---|
| Variable | Coeff. | P-value | Coeff. | P-value | Coeff. | P-value |
| ECM | -0.1285 | 0.0044** | -0.0338 | 0.0028** | -0.0583 | 0.0007** |
| ΔLn RGDP | 0.8153 | 0.0000** | 0.5902 | 0.0010** | 0.5523 | 0.0000** |
| ΔLn FDI | -0.7825 | 0.0020** | -0.6602 | 0.0001** | -0.6624 | 0.0018** |
| ΔLnTRNSS | -0.4186 | 0.0000** | -0.6298 | 0.0000** | -0.7289 | 0.0005** |
| ΔLnINF RT | 0.3901 | 0.0006* | 0.8392 | 0.0000** | 0.3392 | 0.0000** |
| ΔLn INDLIZN | 0.0926 | 0.0000** | -0.0374 | 0.0059** | -0.0572 | 0.0000** |
| Cons. | 0.5562 | 0.6910 | 0.7732 | 0.0315 | 0.6782 | 0.0281 |

\* and ** indicate the level of significance at 1% and 5% respectively.

Table 9 presents the short-run results of the Error Correction Model, estimated using the PMG, mean Group, and dynamic fixed effect estimators. Based on the PMG estimator chosen by the significance of Hausman test, it revealed a negative significant error correction term (ECM) of -0.1285. Similarly, both the MG and DFE estimators also report negative significant ECM values.

The error correction term estimates the pace at which the dependent variable adjusts its short-run position towards its long-run equilibrium path. A negative Error Correction Term (ECM) indicates that the system corrects deviations from this equilibrium. With an ECT coefficient of --0.128, it suggests that, on average, economic growth adjusts by approximately -0.12 units for each unit deviation from the equilibrium path in the past cycle. PECM results indicate that it takes approximately 0.12 percent of the time for the explanatory variables to revert to equilibrium following a deviation from equilibrium caused by a shock. In the short run, the significance of the inflation rate was at the one percent level and positively correlated with economic development. However, there is a negative effect of trade openness on fiscal growth briefly, though this effect does not persist in the long term, suggesting a temporary contribution. Industrialization also positively affects economic growth in the short run, but this effect differs in the long term. Conversely, Foreign Direct Investment negatively impacts economic development in a lengthy run, with no significant impact in the short run.

**Conclusion**

Study shows that trade openness has a positive significant relationship with RGDP while Industrialization has an insignificant relationship with RGDP in the long run. The study also revealed a negative significant relationship

between the RGDP and foreign direct Investments in West Africa countries. In the short run, inflation has a positive significant effect on fiscal development. In contrast, trade openness negatively affects economic development briefly, indicating that while trade openness may temporarily hinder growth, it does not have a lasting impact. Industrialization similarly has brief consequences on fiscal development, which differs from its long-run impact. FDI negatively affects economic development in the long run and also shows a significant effect in the short run. The short-run results are consistent across all the estimators PMG, MG and DFE confirming the robustness of the outcome of the research.

## Recommendations

1. The study commends that decision-makers in the region must erect anti-inflationary policies accompanied by good infrastructures and an environment that will attract foreign investors to promote stable and viable economic growth in West African countries.
2. The policy implication of this research is that industrialization remains one of the important tools of economic transformation in West African countries and the successful implementation of the industrialization strategies in the countries will contribute to economic development of West African regions.
3. Increased production is frequently necessary in export-oriented industries, which creates jobs. Trade imbalances can be addressed by concentrating on exports. Exports exceeding imports result in a positive trade balance, which promotes economic stability and lessens the need for external borrowing.

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