

*Testing the Dynamic Affiliation among Financial inclusion, Energy Poverty, Environmental Degradation and Economic Development in the Selected African countries: Evidence of Panel Data Analysis.*

**Testing the Dynamic Affiliation among Financial inclusion, Energy Poverty, Environmental Degradation and Economic Development in the Selected African countries: Evidence of Panel Data Analysis.**

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**Abstract**

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*Energy is necessary for "cooking, lighting, and other business activities" and plays a vital part in daily living, in order to eradicate poverty in developing nations, affordable energy availability is a must. The study investigates the dynamic affiliation among financial inclusion, energy poverty, environmental degradation and economic development in the selected African countries using panel data analysis. The study used panel data for Nigeria, Ghana, Gabon and Niger from 2005 to 2021. The study employed fixed effect model. The panel unit root tests show that real gross domestic product, automated teller machine, depositors with commercial banks, and energy poverty are integrated of order one, while CO<sub>2</sub> emission is integrated of order zero. The fixed effect model shows that automated teller machine, depositors with commercial banks and CO<sub>2</sub> emission have positive and statistically significant effect on the real gross domestic product in Nigeria, Ghana, Gabon and Niger. While Energy poverty has a negative, but statistically significant effect on the real gross domestic product in Nigeria, Ghana and Gabon. The study recommends that in order to reduce energy poverty and environmental degradation in the region, African nation particularly Nigeria, Ghana, Gabon, and Niger should make sure that their citizens have access to affordable, readily available electricity. Policymakers and governments in Africa must create inclusive, well-directed financial policies that take into account the disparities in income, governance, and laws among their nations.*

**Keywords:** Financial inclusion, Energy Poverty, Environmental Degradation, Economic Development

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**1. Introduction**

In a number of recent policy statements, the World Energy Council stated that energy is essential to ending poverty (Pachauri & Spreng, 2004). Furthermore, since energy is necessary for "cooking, lighting, and other business activities" and plays a vital part in daily living, access to affordable energy is a prerequisite for ending poverty in developing countries (Kaasa, 2007). Consequently, it is believed that one of the main causes of poverty in developing countries is the

difficulty to obtain inexpensive, clean energy (Njiru & Letema, 2018). In recent decades, environmental degradation and global warming have emerged as two of the most urgent global challenges. This is explained by the rise in greenhouse gas emissions. Carbon dioxide (CO<sub>2</sub>) emissions are the most dangerous type of greenhouse gas emissions since they negatively affect both the environment and human health. CO<sub>2</sub> emissions are responsible for around 76.7% of all greenhouse gas emissions (Stocker et al., 2014).

The main cause of CO<sub>2</sub> emissions, which are harmful to the environment and public health is the growing use of conventional energy sources like coal, gas, and oil. According to reports, 68% of CO<sub>2</sub> emissions come from sources of pollution (International Energy Agency, 2019). Consequently, policy makers and scholars have focused a great deal of emphasis on CO<sub>2</sub> emission mitigation, since it is crucial that they comprehend the primary causes of CO<sub>2</sub> emissions and environmental damage. The use of renewable energy sources is one of the most practical ways to reduce CO<sub>2</sub> emissions, while preserving a nation's economic prosperity. In order to achieve this, some nations are working to develop energy efficiency and conservation strategies in addition to progressively switching from dirty energy sources (biomass, hydro, geothermal, solar, and wind) to clean ones. As a result, during the past several years, the proportion of renewable energy in both industrialized and emerging nations' overall energy consumption has increased (Alizadeh et al., 2020). Africa's energy systems are distinguished by their high energy intensity, high reliance on biomass, which has an impact on biodiversity, substantial imports of fossil fuels, which have an influence on climate change, and minimal usage of renewable energy (USAID, 2018).

In the informal economy, 792 million Africans largely rely on traditional biomass for cooking, such as firewood, charcoal, and animal dung, accounting for 633 million of the continent's estimated 633 million energy poor people (IEA, 2018). According to Pachauri and Spreng (2004), a number of recent policy statements from reputable organizations—such as the World Bank, the United Nations Development Programme (UNDP), the World Energy Council, and the UK's Department for International Development—have prominently highlighted the relationship between poverty and energy. Energy and poverty are, in fact, closely related. For example, if there is enough energy available to support fast industrialization, this will, all other things being equal, lead to enormous economic growth and a huge number of job opportunities, both of which will significantly reduce poverty. But it's important to remember that energy poverty

can have both causative and effectual relationships with other aspects of poverty. Many parts of the world are currently experiencing energy poverty. Still, Africa appears to be most hit by the problem. As noted by Iwayemi (2010), the majority of African nations are afflicted with energy poverty, which is a account of their low real incomes and overall state of economic underdevelopment. This is true even though Africa is abundantly fund with both renewable and nonrenewable energy sources that much higher its demand deedful for the next century. African academics and policy experts have engaged in stimulating discussions in an attempt to discover a workable solution to the issue of energy poverty in the face of abundance. Enough modern energy sources should be available, as well as access to them, to enable sustainable development.

In general, contemporary energy sources are far friendlier to the environment than older ones. A significant majority of the population in Africa still relies on traditional energy sources, despite the fact that small amount people there have access to advanced energy sources (OECD/IEA, 2010; World Bank, 2012). The majority of Nigeria's population lacks doorway to advanced energy sources, a challenge that the country known as the "giant of Africa" regularly faces. For example, between 2004 and 2010, the majority of households in the nation cooked on firewood (NBS, 2005, 2010). This alone indicates that energy poverty is rife throughout the nation, and its existence has certain consequences for sustainable development. It is significant to note that tackling many of the current development concerns, including poverty, inequality, food security, health, and education, depends on having a sufficient supply and access to modern energy sources. Therefore, the following important problems are raised by the above: To what degree does Nigeria suffer from energy poverty? What factors contribute to the nation's energy poverty? What effects does the nation's energy poverty have on sustainable development? A multidimensional energy poverty index (MEPI), which takes into account a few key aspects of energy requirements, must be used in order to best answer the aforementioned concerns. An index of this kind will make it possible to determine the extent of the energy poverty problem with great accuracy and will open the door to trustworthy evaluations of related concerns.

The main objective of the paper is to investigate the dynamic affiliation among financial inclusion, energy poverty, environmental degradation and economic development in the selected African countries using panel data analysis such as Nigeria, Ghana, Gabon and Niger. Most of the literature reviewed concentrated on the effect of energy poverty on economic growth or financial inclusions on

economic growth except for Li and Qamruzzaman (2023) and Hussain et al (2023) that that combined the effect of energy poverty and financial inclusion on economic growth. In view of the above, this study investigated the dynamic affiliation among financial inclusion, energy poverty, environmental degradation and economic development in the selected African countries using panel data analysis namely Nigeria, Ghana, Gabon and Niger.

## **2. Literature Review**

### **2.1. Concepts of Financial Inclusion and Energy Poverty**

Energy poverty was defined by Ozughalu and Ogwumike (2018) as the inability to obtain clean fuels, a heavy reliance on non-renewable fuels like firewood and biomass, and an inadequate number of high-polluting cooking appliances. When a household cannot afford to provide enough energy for cooking, heating and cooling, appliances, information technology, and other necessities for social and material requirements, it is said to be experiencing energy poverty. Energy poverty is the absence of enough options for acquiring enough fairly priced, dependable, high-quality, safe, and environmentally friendly energy services to support economic and human development. (Reddy, 2000). Energy poverty is the lack of access to modern energy services like power and clean cooking appliances that don't contaminate indoor air. Modern energy sources are generally defined as those that do not rely on biomass fuels. (IEA, 2014).

According to Onaolapo (2015), financial inclusion is the process of ensuring that everyone involved in an economy has easy access to, uses of, and participation in the formal financial system. Mohan (2016) defines Financial Inclusion as the timely and cost-effective delivery of financial services to the impoverished and low-income community. According to the Center for Financial Inclusion (2015) complete financial inclusion is the state in which all individuals who are capable of using financial services have access to a full range of excellent services that are provided conveniently, affordably, and with dignity for the clients. Financial inclusion, often known as access to finance, is the availability of appropriate financial products and services. However, it functions as the standard by which to measure the extent to which financial services are available to the broader population inside the economy. According to the World Bank (2016), there are differences between the ideals of financial inclusion and access to finance. However, not having access to financial services does not automatically entail not using them. Many people may choose not to use financial services even when they are readily available and affordable for other reasons, such as religious

convictions. The same services, however, or regulatory barriers imposed by excessive fees can be available to other people.

## **2.2 Nexus between Financial Inclusion and Poverty**

Through financial inclusion, the impoverished can gain access to financial services and begin saving and investing for the day when they will be able to afford housing, food, and their children's education. This kind of wealth can help people in numerous ways to improve their lives, and it is beneficial to the economy overall. The World Bank projects that poverty would be cut in half if all nations could achieve complete financial inclusion by 2024, when they have established this as their objective. Thus, there would be a decrease in the number of people experiencing extreme poverty worldwide, and those individuals would not be able to afford to buy food for their families instead of using all of their money on drugs or alcohol. Furthermore, by providing access to financial services like savings, credit, payments, and insurance for those who were previously excluded from the formal financial sector, financial inclusion is essential to reducing poverty and inequality. It assists the underprivileged in building assets, obtaining credit and insurance, and gaining access to more reasonably priced goods and services. Furthermore, it lessens inequality by providing economic opportunities to people who would not otherwise be able to engage in the financial system. Additionally, it improves financial capability and literacy, enabling people to make better financial decisions. Finally, by enabling people to access cash for starting enterprises and creating jobs, financial inclusion promotes economic growth. Regarding the relationship between financial inclusion and poverty alleviation, research has shown that financial inclusion has a positive impact on the process (Churchill & Marisetty, 2020).

## **2.3 Theoretical Framework**

According to the theory of the vicious cycle of poverty, people and communities are impoverished because they are caught in a vicious cycle (Todaro & Smith, 2010). A person is impoverished when his income is low, which causes him to consume less, which then results in ill health and low productivity. According to the view, poverty is a systemic issue in society that cannot be resolved without outside help. This theory holds that resource misallocation and the failure of macroeconomic policy are the root causes of poverty. Because there are no incentives for economic growth, productivity, or revenue generation, people live in poverty. According to the theory, macroeconomic policies that promote growth, increasing employment, advancing technology, and bettering institutional

circumstances should be ingrained in the economy in order to reduce poverty. A neoclassical growth model made popular by Solow in 1974 is called optimal growth theory. Economic growth and social welfare are achieved through the efficient combination of energy and other inputs of production, as demonstrated by the optimal growth theory. The idea demonstrates how energy (resource endowment), together with capital, land, and labor, is essential to economic progress. Energy should therefore be taken into account along with other important production parameters (Stern, 1997 and Spreng, 1993). Any economy's growth is fueled by energy (Kaufmann, 1994). According to the notion, energy is a necessary component of production because it is consumed more when output rises.

## **2.4 Empirical literature**

Li and Qamruzzaman (2023) examined the relationships between financial inclusion, the uptake of renewable energy, environmental resilience, and the alleviation of poverty in Sub-Saharan Africa (SSA), Lower-Middle-Income Countries (LMICs), and Low-Income Countries (LICs). The outcome demonstrates that financial inclusion is about providing formal financial services to formerly marginalized or excluded demographic groups. In low-income countries (LICs), lower-middle-income countries (LMICs), and sub-Saharan Africa (SSA), there has been a documented negative correlation between financial inclusion and poverty levels. Furthermore, the use of renewable energy sources is negatively correlated with poverty, suggesting that using renewable energy sources has the ability to stimulate improvements in economic conditions and general welfare. Hussain Akbar, Gul, Shahzad, and Naifar (2023) used the STIRPAT framework to look at the effect of financial inclusion on carbon emissions for 102 countries between 2004 and 2020. Using principal component analysis (PCA) from five financial inclusion proxies, we quantify financial inclusion as a composite index. The study's conclusion recommends, especially for low-income nations, implementing a global environmental strategy that improves financial inclusion through robust and easily accessible financial institutions. Their findings also imply that policymakers and government officials must create inclusive, well-directed financial policies that take into account the disparities in income, governance, and regulation between nations.

Damrah, Satrovic and Shawtari (2022) examined, using annual panel data from 1995 to 2019, the direct effects of information and communication technology (ICT) usage on the environment as well as its moderating role on the association

between financial inclusion and environmental degradation for six oil exporting countries (Canada, the United States, Saudi Arabia, Kuwait, Russia, United Arab Emirates, and Saudi Arabia). The method of Moments Quantile Regression (MMQR) with fixed effects was employed in the investigation. The study discovered that energy use dramatically raises carbon intensity. The empirical findings demonstrated that in the six oil exporting economies, using mobile and internet usage as measures of ICT usage leads to environmental preservation. Furthermore, we note that financial inclusion reduces pollution emissions and hence promotes environmental preservation. In all quantile distributions, the combination of financial inclusion and ICT usage lowers carbon intensity. Habiba and Xinbang (2022) investigated, between 1991 and 2016, the effects of broken-down financial development components on CO<sub>2</sub> emissions while accounting for the complex and varied structure of contemporary financial systems in 46 Sub-Saharan African nations. A system-GMM method is used to estimate the empirical models. According to the report, the growth of the financial markets and all of their constituents—access, depth, and efficiency—have an impact on the region's CO<sub>2</sub> emissions. Similar effects are noted for the development of financial institutions and their sub-measures. On the other hand, compared to the rise of financial institutions, the financial market has fewer negative environmental repercussions. Use of renewable energy also results in significant drops in CO<sub>2</sub> emissions. The financial markets are becoming more and more vital as a supplement to renewable energy in the fight against environmental degradation. The study also shows that, depending on a nation's economy, there are different country-level relationships between these variables and CO<sub>2</sub> emissions.

Barak (2022) examined the effects of per capita income, per capita energy consumption—both renewable and non-renewable—and income inequality on the reduction of poverty in the BRICS (Brazil, Russia, India, China, and South Africa) nations between 1991 and 2019. More accurate results are obtained by using second-generation panel data approaches that account for cross-dependence between nations. The panel's findings revealed that poverty is reduced by growth and per capita consumption of renewable energy, while it is increased by income disparity and per capita use of non-renewable energy. Policymakers should concentrate their efforts on creating a suitable energy strategy that emphasizes the need for an economy powered by energy-saving technologies and pushed by renewable energy, in light of the findings. Koomson and Danquah (2020) investigated, using a variety of multidimensional metrics, how financial inclusion

affected energy poverty. The distance to the closest bank is used to instrument the endogeneity related to financial inclusion. According to the report, between 2012–13 and 2016–17, Ghana's percentage of families experiencing energy poverty decreased marginally from approximately 81% to 80%. According to the estimate, there is a correlation between a standard deviation rise in financial inclusion and a reduction in family energy poverty ranging from 1.380 to 1.556 standard deviations. More consistency is seen in the results for male-headed and rural households. The largest decrease in energy poverty for individuals in the employee category is probably going to come from improvements in financial inclusion. The research additionally recognized consumption poverty and household net income as plausible conduits via which financial inclusion impacts energy poverty.

Kousar, Ahmed, Pervaiz, Zafar, and Abbas (2020) investigated the relationship between energy consumption and poverty in South Asian nations between 1985 and 2018, with a focus on the mediation effect of environmental degradation. The study's variables include population, globalization, poverty, environmental deterioration, and energy use. In order to analyze long-run correlations among the modeled variables, this study used dynamic ordinary least square (DOLS) and fully modified ordinary least square (FMOLS). To verify the mediation, the study used the VAF and the Sobel test. The study's findings show that energy use has a substantial and detrimental effect on poverty. The results showed that, over time, environmental degradation acts as a partial mediator between energy use and poverty. The report suggests that South Asian governments make sure their residents have access to affordable electricity to lower poverty and environmental degradation in South Asian countries. Aigheyisi and Oligbi (2020) Analyzed how the nation's energy poverty has affected development. The resilient least squares estimator's S-estimation approach was utilized to analyze annual time series data from 1990 to 2017. According to the study, the lack of energy has a negative impact on the country's economic growth, suggesting that increased access to electricity would be beneficial for development. It is also discovered that the labor force and domestic investment are essential components of the nation's development. FDI inflows, trade openness, and currency devaluation, on the other hand, are found to have had a negative impact on the growth of the national economy, indicating the (low) level of the nation's preparedness for the unpredictable nature of globalization.



In the same vain Njiru and Letema (2018) analyzed data and trends to investigate the impact of energy poverty in Kenya's Kirinyaga County. According to the study, the region's calorie consumption, life expectancy, living standards, and literacy rates were all adversely impacted by energy poverty. This suggests that there are negative effects of energy poverty on economic growth. Another study conducted by Ogwumike and Ozughalu (2015) bases its estimation and analysis of the prevalence and contributing factors of energy poverty in Nigeria on a straightforward multidimensional energy poverty index that it developed. It also draws attention to the effects of energy poverty on Nigeria's sustainable development. According to estimates, nearly 75% of the population in the nation suffers from energy poverty, indicating how widespread the problem is. Nigerian household size, educational attainment, gender, age, and head of household age are among the factors that determine energy poverty, along with overall poverty, area of residence, and percentage of working members in the home. The issue of energy poverty in Nigeria needs to be effectively addressed. This is one of the main ways to set the nation up for quick and long-term development. Okwanya and Abah, (2018) investigated the relationship between energy use and the decline of poverty in a sample of twelve African nations between 1981 and 2014. The study highlights the significance of energy in reducing poverty in the chosen African countries by demonstrating a long-term negative association between energy consumption and poverty level using the Fully Modified Ordinary Least Square (FMOLS) approach. The outcome also suggests that other elements, such political stability and capital stock, have a major impact on poverty, suggesting that these elements are essential in the fight against poverty. Moreover, a short-run unidirectional connection from energy use to poverty is demonstrated using the Granger causality test. The findings clearly suggest that increasing energy consumption result to a decrease in poverty level. The study therefore recommends that the government in the selected countries should advance infrastructure and maintain political stability in order to maximize the effect of energy consumption on poverty reduction.

Shahbaz, Van Hoang, Mahalik, and Roubaud (2017) examined the asymmetric relationship between economic growth and energy consumption by integrating labor, capital, and finance development into a production function that covered the Indian economy from 1960Q1 to 2015Q4. The asymmetric cointegration between the variables is investigated using the nonlinear autoregressive distributed lag bounds testing method. To investigate the causative relationship between the variables under consideration, an asymmetric causality test is also

utilized. The findings show that when asymmetries are present, there is cointegration between the variables. The findings of asymmetric causality indicate that the only shocks to energy consumption that affect economic development are negative ones. Similarly, the only shocks to financial development that have an effect on economic growth are negative ones. On the other hand, symmetrically, economic growth is caused by capital formation. Lastly, during the course of the investigation, there is a neutral effect between the labor force and economic growth in India.

### **Gap identified from the literature**

Most of the literature reviewed concentrated on the effect of energy poverty on economic growth or financial inclusions on economic growth except for Li and Qamruzzaman (2023) and Hussain et al (2023) that that combined the effect of energy poverty and financial inclusion on economic growth. In view of the above, this study investigated the dynamic affiliation among financial inclusion, energy poverty, environmental degradation and economic development in the selected African countries using panel data analysis namely Nigeria, Ghana, Gabon and Niger.

## **3. Methodology**

### **3.1 Model specification**

This Model is adopted from the work of Li and Qamruzzaman (2023) and Danquah (2020)

The model is specified as

$$GDP = F(FI, EPT, CO2EM) \dots \dots \dots (3.1)$$

The model is modified by using real gross domestic product as a dependent variable and automated teller machine and depositors with commercial banks are used as a proxied to financial inclusion.

$$RGDP = F(ATM, DCB, EPT, CO2EM) \dots \dots \dots (3.2)$$

$$RGDP_{it} = \alpha + \beta_1 ATM_{it} + \beta_2 DCB_{it} + \beta_3 EPT_{it} + \beta_4 CO2EM_{it} + U_i + E_{it} \dots \dots (3.3)$$

Where *RGDP* is the real gross domestic product proxied to economic development and is the dependent variable in the model, *ATM* stand as automated teller machine measured 10,000 per adult, *DCB* is the depositors with commercial

banks measured as depositors with commercial banks measured per 10,000 adults, *EPT* is the energy poverty measured as number of population access to electricity, *CO2 EM* is the CO<sub>2</sub> Emission measured as gaseous fuel consumption.

### 3.2 Fixed and Random effects

In order to achieve our objective, the static of the panel model explored. The study used traditional panel data, because it provides a way to control for unobserved heterogeneity that may be correlated with the explanatory variables and capture dynamic relationship over time and cross entities. Consequently, the Fixed Effect Model (FEM) and Random Effect model (REM) was implemented, where the former is of the following form:

$$Y_{it} = \beta_0 + Z_{it} + \pi_{it} \dots\dots\dots (3.4)$$

Where  $Y_{it}$  is the dependent variable in country  $i$ , and  $Z_{it}$  is the vector of country specific regressors,  $\beta_0$  is the intercept, it is the white noise error term. In addition,

$$\pi_{it} = \lambda + v_{it} \dots\dots\dots (3.5)$$

where it is the typical error term and  $\lambda$  is the unobserved country-specific impact. Random and fixed effects methods of estimation were used to account for these differences because the common constant by pooling model was too restricted and did not include the person specific effect by assuming the endowment and policies across nations. A different approach to model estimation is the random effects model. The way the random effects technique handles the constants for each section is different from the fixed effects approach in that it treats them as random parameters instead of fixed ones. Therefore, the following factors account for the constant's variability for each section.

$$Y_{it} = \alpha + \beta_1 X_{it} + \beta_2 X_{it} + U_i + E_{it} \dots\dots\dots (3.6)$$

The Langrage Multiplier test was utilized in order to determine the suitability of either the pool or random model. The following is the null hypothesis.  $H_0: \delta_2 = 0$ . The random effect model is applicable if the computed probability of the chi-square value is less than the significance thresholds of 0.05, 0.01 or 0.10. In this case, the null hypothesis is rejected. After proving that each individual specific

effect existed in the model, a fixed effect model was required. The fixed effect model is defined as follows: It assumes that the individual specific effects are fixed across entities and that the dummy  $D_i$ , which represents the countries, captures the cross-sectional effect. While the random effect model assumed that each country had a different error term, the fixed effect model assumed that each country had a different intercept term. The Hausman test (1978) was used to determine which of the fixed effect and random models is more appropriate. The alternative hypothesis is that OLS is consistent but GLS is not, and the test is predicated on the null hypothesis of no correlation, which holds that both Ordinary Least Squares (OLS) and Generalized Lease Squares (GLS) are consistent and OLS is inefficient. The Hausman test is specified as follows:

$$H = (\beta^{FE} - \beta^{RE}) [VAR(\beta^{FE}) - VAR(\beta^{RE})]^{-1} (\beta^{FE} - \beta^{RE}) \rightarrow \chi^2(K) \dots\dots\dots (3.7)$$

## 4. Empirical Results and Discussion

### 4.1 Descriptive statistics

**Table 4.1 Descriptive statistics**

Statistics	LRGDP	LATM	LDCB	LEPT	LC02EMM
Mean	10.59033	0.798817	2.331033	1.666775	0.543256
Median	10.31279	1.018894	2.434116	1.753659	0.832855
Maximum	11.75905	1.324899	3.198220	1.966031	1.554829
Minimum	9.641803	-0.167491	1.054230	0.851258	-1.289538
Std. Dev.	0.647093	0.448267	0.527344	0.313554	1.029108
Skewness	0.612033	-0.615475	-0.574548	-1.017103	-0.725608
Kurtosis	1.944601	1.833643	2.573245	2.637697	1.942625
Jarque-Bera	7.401247	8.147616	4.257204	12.09623	9.134857
Probability	0.124708	0.417012	0.119004	0.002362	0.010385
Sum	720.1423	54.31958	158.5102	113.3407	36.94139
Sum Sq. Dev.	28.05483	13.46318	18.63217	6.587200	70.95730
Observations	68	68	68	68	68

**Source:** Researcher computation using E-views 10.

The table 4.1 shows the descriptive statistics of the variables used in the analysis. The mean value of real gross domestic product, automated teller machine, depositors with commercial banks, energy poverty and CO<sub>2</sub> emission are 10.59033, 0.798817, 2.331033, 1.666775 and 0.543256. The Skewness of the distribution in the table shows that all the variables of interest are skewed to the

left and less than one, by implication these variables such as depositors with commercial banks, energy poverty and CO<sub>2</sub> emission are normally distributed except for real gross domestic product. Because all of the variables in question have values less than three, the Kurtosis indicates that the variables are all regularly distributed. Additionally, the normalcy test Jarque-Bera is performed. It demonstrates that every variable used, including the real gross domestic product, automated teller machines, and commercial bank depositors, has a normal distribution because their p-values are greater than 5%, but energy poverty and CO<sub>2</sub> emissions are not normally distributed because their p-values are less than 5%.

#### 4.2 Panel unit root test

**Table 4.2 Levin Lin and Chu, Im Pesaran and Shin and ADF Fisher unit root test**

	Test at Level			Test at first difference		
Variables	LLC PV	IPS PV	ADF - Fisher PV	LLC PV	IPS PV	ADF - Fisher PV
LRGDP	0.0015	0.0931	0.1371	0.0024 <sup>*</sup>	0.0033 <sup>**</sup>	0.0063 <sup>**</sup>
LATM	0.0713	0.0645	0.0252	0.0000 <sup>**</sup>	0.0144 <sup>**</sup>	0.0169 <sup>**</sup>
LDCB	0.0776	0.6851	0.5021	0.0097 <sup>**</sup>	0.0144 <sup>**</sup>	0.0238 <sup>**</sup>
LEPT	0.0600	0.5242	0.6541	0.0000 <sup>**</sup>	0.0000 <sup>**</sup>	0.0000 <sup>**</sup>
LC02EMM	0.0579 <sup>**</sup>	0.0111 <sup>**</sup>	0.0168 <sup>**</sup>	-	-	-

**Source:** Researcher computation using E-views 10, the asterisks <sup>\*</sup>, <sup>\*\*</sup> indicate rejection of the null hypothesis at 10% and 5% level respectively.

The panel unit root tests of Levin Lin and Chu (LLC), Im Pesaran and Shin (IPS), and the ADF - Fisher unit root test are displayed in Table 4.2. The results of these tests demonstrate that, although CO<sub>2</sub> emissions is stationery at level, real gross domestic product, automated teller machines, depositors with commercial banks, and energy poverty are stationery at first difference.

#### 4.3 Panel Cointegration Test

**Table 4.3 Kao panel Cointegration Test**

ADF t-statistic	Probability
-3.324588	0.0004 <sup>*</sup>

**Source:** Researcher computation using E-views 10.

The Kao residual cointegration test result is shown in Table 4.3. The outcome demonstrated that the variables in the model cointegrate, as indicated by the ADF t-statistics probability value, which is significant at 1%. As a result, the current investigation finds evidence of a long-term link and rejects the null hypothesis. This means that the variables employed in the study can be used for the prediction of each other.

#### **4.4 Fixed effect model**

Dependent variable: LRGDP **Table 4.4 Fixed effect model**

<b>Variables</b>	<b>Coefficients</b>	<b>Standard Error</b>	<b>T-statistics</b>	<b>P-Value</b>
LATM	0.072197	0.050989	1.415932	0.0020
LDCB	0.215936	0.104519	2.066006	0.0432
LEPT	-0.190067	0.262725	-4.529708	0.0000
LC02EMM	0.071071	0.117878	0.602916	0.5488
F-statistics	652.4908			
Prob > F	0.000000			
Hausman test	0.0000			

**Source:** *Researcher computation using E-views 10*

Table 4.4 depicts the fixed effects model estimated in the study, the result shows that automated teller machine has a positive and statistically significant effect on the real gross domestic product in Nigeria, Ghana, Gabon and Niger, this simply means that a single digit increase in automated teller machine will result 7% increase in the real gross domestic product in Nigeria, Ghana, Gabon and Niger. Depositors with commercial banks indicates positive and statistically significant effect on the real gross domestic product in Nigeria, Ghana, Gabon and Niger, by implication N1 increase in depositors with commercial banks will bring about 21% increase in the real gross domestic product in Nigeria, Ghana, Gabon and Niger. Variable energy poverty shows negative but statistically significant effect on the real gross domestic product in Nigeria, Ghana, Gabon and Niger, this means that a single digit increase in energy poverty will result into 19% decrease in the real gross domestic product in Nigeria, Ghana, Gabon and Niger. CO<sub>2</sub> emission indicates positive and statistically insignificant effect on the real gross domestic product in Nigeria, Ghana, Gabon and Niger. The p-value of f-statistics indicates (0.000000), this means that automated teller machine, depositors with commercial bank, energy poverty and CO<sub>2</sub> emission have 100% significance influence on the real gross domestic product in Nigeria, Ghana, Gabon and Niger. The Hausman test which chooses the appropriate model for the study, shows that

the probability value of the chi-square is less than 5%, this necessitates the study to adopt the fixed effect model. Fixed effect model allows the researcher to control for unobserved heterogeneity, address endogeneity and capture time invariant effect and also provide efficient estimation in panel data analysis.

#### **4.5 Discussion of the result**

The result shows that automated teller machine has a positive and statistically significant effect on the economic growth in Nigeria, Ghana, Gabon and Niger. This simply means that a single digit increase in automated teller machine will result to 7% increase in the economic growth in Nigeria, Ghana, Gabon and Niger. The positive findings are in line with the economic apriori expectation which assumed a positive relationship between automated teller machine and economic growth. Depositors with commercial banks indicates positive and statistically significant effect on the economic growth in Nigeria, Ghana, Gabon and Niger, by implication N1 increase in depositors with commercial banks will bring about 21% increase in the economic growth in Nigeria, Ghana, Gabon and Niger. The positive finding is in line with the economic apriori expectation which established a positive relationship between depositors with commercial banks and economic growth, by implication when depositors with commercial banks increase economic growth also increase all things being equal. energy poverty shows negative but statistically significant effect on the real gross domestic product in Nigeria, Ghana, Gabon and Niger, this means that a single digit increase in energy poverty will result 19% decrease in the economic growth in Nigeria, Ghana, Gabon and Niger. This simply means if the inability of human being to have access to electricity increase the economic growth will decrease all things being equal. CO<sub>2</sub> emission indicates positive and statistically insignificant effect on the economic growth in Nigeria, Ghana, Gabon and Niger. By implication a single digit increase in energy consumption will result an increase in economic growth in Nigeria, Ghana, Gabon and Niger.

#### **5. Conclusion and Recommendations**

The study investigates the dynamic affiliation among financial inclusion, energy poverty, environmental degradation and economic development in the selected African countries using panel data analysis namely Nigeria, Ghana, Gabon and Niger. The panel unit root tests show that real gross domestic product, automated teller machine, depositors with commercial banks, and energy poverty are integrated of order one while CO<sub>2</sub> emission is integrated of order zero. The fixed effect model shows that automated teller machine has a positive and statistically

significant effect on the real gross domestic product in Nigeria, Ghana, Gabon and Niger. Depositors with commercial banks indicate positive and statistically significant effect on the real gross domestic product in Nigeria, Ghana, Gabon and Niger. Energy poverty shows negative but statistically significant effect on the real gross domestic product in Nigeria, Ghana, Gabon and Niger. CO<sub>2</sub> emission indicates positive and statistically insignificant effect on the real gross domestic product in Nigeria, Ghana, Gabon and Niger. The study conclude that financial inclusion has a significant effect on economic development of African countries, energy poverty retard economic development of African countries and environmental degradation influence economic development of African countries. The study recommends that African Countries especially Nigeria, Ghana, Gabon and Niger should ensure the availability of cheap and accessible energy for citizens to in order to lower the energy poverty and environmental degradation in the region. African Countries and policymakers need to develop well-directed and inclusive financial policies that consider the varying levels of governance, regulations, and income across countries.

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