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## Review of Financial Inclusion and Access to Energy in West Africa

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### Abstract

**Background:** This study examined the relationship between financial inclusion and energy access in West Africa, using panel data from seven countries in the region, namely, Benin, Burkina Faso, Cabo Verde, Ghana, Mali, Nigeria, and Senegal. **Methodology:** The study employed dataset from the World Bank Development Indicators between 2004 and 2019 where Panel Fixed effect were used to estimate the relationship between energy access and financial inclusion. Specifically, the study estimated access to electricity as a function ATM per 100,000 adults, Bank accounts per 1,000 adults, and domestic credit to the private sector. **Findings:** The study did not found a strong evidence to conclude that financial inclusion improves access to energy in West Africa. In particular, of all the variables used to measure financial inclusion only ATM per 100,000 adults proved to have a positive relationship with access to energy while the other variables had no impact on access to energy.

**Key words:** Financial Inclusion, Financial Development, Energy, Energy Access, Energy Poverty

**JEL Classification:** C31, G21, O13, O16, Q43

**Disclaimer:** The views shared in this paper are those of the authors and do not reflect the opinions of the Central Bank of Nigeria

### 1. Introduction

Man's ambition to harness the natural environment for his benefit dates back to the beginning of time, and this endeavour requires some form of energy. Initially, this energy was provided by human strength, followed by the use of animals to cultivate and operate primitive motors for transportation, grinding, and irrigation. Since the first industrial revolution (1760-1840) and the subsequent transformations of nations' economies in Europe and the United States, energy and energy market dynamics have

impacted government decisions and actions (Ahuja and Tatsutani, 2009). Energy is thus an aspect of economic progress and one of the 17 Sustainable Development Goals (United Nations, 2022). Countries with lower power availability record lower GDP per capita and are less developed. Intuitively increased energy access improves healthcare, education, life expectancy, and economic prospects. Increased national productivity is a forerunner to economic development due to these

variables (Nganga, 2016). A significant hindrance to economic growth is the high cost of energy for both households and businesses when determining costs and the general level of pricing in an economy; hence energy availability is a crucial issue that must be addressed.

Energy access is less of a problem in developed nations; however, access to energy is persistent across Africa, particularly Sub-Saharan Africa. Africa's total energy generation capacity (excluding South Africa) is only 28 gigawatts, equal to Argentina's capacity (Nganga, 2016). Five hundred seventy-eight million individuals in Africa did not have access to electricity in 2019, with 174 million in West Africa (International Energy Agency, 2019). The National Bureau of Statistics (2010) reported that two-thirds of families in Nigeria rely on wood from fallen trees as a source of energy, depriving the land of cover and windbreakers, hastening desertification and resource degradation. In many urban places, power rationing is still common, and only 24% of Sub-Saharan Africa has access to electricity as a form of energy.

With expanding population, urbanization, and economic output, the demand for additional power access will only increase. However, low energy access and usage result from the limited installed capacity. Even individuals linked to the electrical grid face 54 days of power loss each year, equating to 15% of the year in darkness (Nganga, 2016). The African commercial sector has been forced to rely on costly generators to compensate for the energy shortage. However, generator power is prohibitively expensive, costing four times as much as grid power on average (Nganga, 2016). Enterprises in Africa have substantially greater operating expenses than counterparts in other continents, which is true not only for power-intensive industries but also for ordinary businesses like banks and supermarkets. For companies in Africa, energy represents a disproportionately high cost (Nganga, 2016).

Financial capital is required to defray the high energy cost and revamp Africa's energy infrastructure (one of which is access to power or electricity). According to the African Development Bank, financial inclusion is critical to Africa's inclusive prosperity. The rise of contemporary methods of delivering financial services has resulted in a massive increase in people who have access to formal

financial services. These financial services are being deployed across Africa in larger numbers than ever before (Ndum, 2021). Therefore, other things being equal, an increase in the size of the financially served population is expected to increase the levels of savings, inducing increments in fixed capital investments, including energy.

This paper will explore the impact of financial inclusion on energy access or the availability in selected African countries: Nigeria, Ghana, Benin, Senegal, Burkina Faso, Cape Verde, and Mali. The choice of these countries is a result of their economic contributions and level of development.

Therefore, the rest of the paper includes section two, which contains conceptual clarifications, a theoretical review, and an empirical review of literature. Sections three and four discuss the methodology, results, and findings, while section five has the conclusion and recommendations.

## 2. Review of Related Literature

### 2.1 Conceptual Literature

#### 2.1.1 Financial Inclusion

Financial inclusion can be defined in various ways; they are all based on criteria associated with widespread access to financial services. These definitions all involve the concept of "universal access" to a "wide range of financial services" at a "reasonable cost" (Bhaskar, 2013). Financial inclusion encompasses all efforts to make formal financial services accessible, affordable, and available to all sectors of the population (AfDB, 2013). This necessitates a particular focus on segments of the people that have historically been excluded from the formal financial system due to their income level and volatility, gender, geographic location, economic activity, or lack of financial literacy.

Nigeria's desire to reduce the number of financially excluded people has yielded excellent results. According to EFINA's (2020) report on the state of financial inclusion in Nigeria, 53% of the adult population was financially excluded in 2008, but that figure dropped to 37% in 2018 and 36% in 2020. Despite this decline in the percentage

of financially excluded people, Nigeria continues to have one of the highest rates in Sub-Saharan Africa. Among the financially included, financial service providers took the form of banks, formal other (non-bank) financial institutions, and informal financial institutions.

**Oumarou and Celestin (2021)** examined the factors of financial inclusion in member countries of the West African Economic and Monetary Union (WAEMU). Financial inclusion was positively correlated with real GDP, mobile phone penetration, and literacy rate. On the other hand, the rural population's weight and interbank credit were inversely associated with financial inclusion. Through the credit channel established by banks with the government, agricultural finance was also shown to likely promote financial inclusion, as did the favorable effect of rural-oriented literacy on financial inclusion.

They observed Benin, Burkina Faso, Cote d'Ivoire, Guinea-Bissau, Mali, Niger, Senegal, and Togo from 2004 to 2017 (14 years). They discovered that the microfinance industry looks to be more inclusive in Togo, Mali, and Niger than the banking sector. The opposite is true for Benin, Senegal, Burkina Faso, Côte d'Ivoire, and Guinea-Bissau. In comparison to other measures, electronic money use is more prevalent in Côte d'Ivoire. Togo is in the opposite scenario, ranking last in terms of electronic money use, although first in access to microfinance and expanded banking.

They used the following metrics: the percentage of adults with accounts at banks, post offices, and the Treasury; the percentage of adults with accounts at the IMF; the percentage of adults with accounts at all providers (banks, SFD, postal services, and Treasury); and the percentage of adults with electronic money accounts at Electronic Money Institutions, e-money issuing banks (in partnership with mobile phone operators), and other financial institutions.

### *2.1.2 Energy Capacity-Country Overview*

Nigeria is blessed with significant oil, gas, hydroelectric, and solar resources. It can generate 12,522 MW of electricity from existing plants. However, it can only distribute approximately 4,000 MW for consumption on most days, which is insufficient for a country with over 200

million. In addition, from this 4,000 MW of electricity transmitted it exports to Benin, Togo, and Niger (**International Trade Administration, 2021**).

Nigeria also has enormous potential of alternative energy sources such as solar and wind, but large areas of the country continue to lack reliable power (**Onyeji, Bazilian and Nusbaumer, 2012**). As of 2019, 62% of the population of 206.1 million had access to electricity, with urban inhabitants having electricity at 91% and rural people at 30%, respectively (**World Bank data, 2020**). Faced with high-energy prices, a significant percentage of household discretionary income and business profits are spent on self-generation of energy via generators that harm the environment and create serious health problems. As a result, substantial investments in the electrical sector will contribute to establishing a reliable 24-hour power supply.

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Benin, a country with 11.5 million people, is another nation in West Africa. It gets 97 per cent of its energy from biomass and imported petroleum products, with electricity accounting for two per cent of net energy use. The country has 343 MW of installed capacity, which includes hydro

(0.51MW), gas (20MW), solar (0.04MW), and other sources (Diesel, HFOs- 323MW). With 1.1 TWh of total yearly consumption and an average peak daily demand of 180 MW, about 33% of Benin's population has access to electricity (USAID, 2021). According to the International Energy Agency, (2019), 32.2 per cent of Benin's population has access to electricity. In metropolitan regions, power is available to 58 per cent of the people, whereas rural areas have only 9 per cent.

Burkina Faso, with a population of about 19.75 million and a GDP of \$14.13 billion, records one of the most expensive energy costs in the region, with production prices ranging from \$0.22 to \$0.25/kWh. The 2016 National Plan for Economic and Social Development aimed to increase Burkina Faso's electricity availability rate from 20% to 80%, double users to one million, and increase installed capacity to 1,000 megawatts (MW). The country's current generation capacity and access are as follows: Total installed capacity of 568 MW: 37 MW of hydropower, 72 MW of Thermal power, 51 MW of solar energy, 149 MW HFOs, Other, 259 MW Diesel (USAID, 2021).

Cape Verde, made up of 10 islands, is a small island archipelago nation off Africa's northwest coast. In 2015, it set itself a bold renewable energy target of 100% of its electricity from renewable resources by 2020. Almost all of the islands' 550,000 residents have electricity, but about one-third still rely on firewood and charcoal for cooking. With a total installed capacity of 70.8MW in renewal energy, wind, and solar, the country generates 932.1Kwh per capita and consumes 696.6Kwh per capita- which is substantially higher than the sub-Saharan Africa average of 488 kWh per person per year (<https://africa-energy-portal.org/country/cape-verde> ).

As of 2019 and according to the international energy agency, approximately 96% of the Cape Verde population have access to electricity. More than 95% of both the urban and rural population have access to electricity.

### 2.1.3 Approaches for measuring energy access

According to Bhatia (2013), energy access is defined in terms that encompass all dimensions of a technology-

neutral approach that is based on usability for obtaining energy services that are reflective of attributes, and that incorporates separate measurement of actual use (including consumption). Measuring energy access is complex, and several obstacles contribute to this. Bhatia (2013) enumerated several of these, they include the following:

- i. Multiple dimensions of energy use for households, productive enterprises, and community institutions
- ii. There are multiple uses or applications in lighting, cooking, refrigeration, entertainment, communication, mechanical loads, etc.
- iii. Multiple sources and/or carriers that consist of Off-Grid/Mini-grid/Grid electricity and Solid/Liquid/ Gaseous fuels.
- iv. What is access? Which addresses the arguments on access to energy sources vs. energy applications (services) vs. actual use (consumption)
- v. Defining minimum standards of access
- vi. Quality of supply and energy attributes comprising of connectivity, availability, quality, convenience, safety, reliability, and affordability.
- vii. Capabilities of the institutional framework while dealing with policies, regulations, and the market
- viii. Constraints in data availability in terms of utility data, project data, and household surveys

Given the difficulties mentioned above in quantifying energy access, this study will view energy access in terms of energy consumption. The study would use the energy consumed by an individual in each country.

## 2.2 Financial Development framework

According to the McKinnon and Shaw (1973) models, financial development is a primary determinant of economic growth. This is a concept that asserts that financial development is critical to economic growth. Advocates argue that a liberal financial system must mobilize greater amounts of financial savings for productive investment, thereby contributing to economic growth (Orji, Jonathan and Anthony-Orji, 2015). Proponents argue that operating in a repressed financial sector constrains development by encouraging low

savings rates, inefficient financial intermediaries, and restrictive financial policies for credit facilities, all of which reduce investment and ultimately reduce economic growth.

**McKinnon (1973)** argued that there is a direct and positive complementarity between financial development and the process of physical capital accumulation; under

certain conditions, that money supply has a first-order effect on economic agents' savings and investment decisions. Among other benefits, financial inclusion expands the banked population, which increases the country's savings level and makes investments more palatable at lower interest rates.

**Table 1:** Approaches for measuring energy access

Methodology	Name	Objective	Author	Date
Single indicator	Energy Poverty Line	Define a threshold point at which households consume a bare minimum level of energy	Barnes	2011
Dashboard of indicators	Energy Indicators for Sustainable Development	The measure of the social, economic, and environmental impact of energy	IAEA	2005
	Energy access situation in developing countries	Penetration rate of modern energy	UNDP/WHO	2009
Composite index	Energy Development Index	Penetration rate of modern energy and levels of energy consumption	IEA	2004
	Multi-dimensional Energy Poverty Index	The measure of deprivation of energy services through ownership of appliances	UNIDO	2011
	Total Energy Access	Minimum access standards for five energy services	Practical Action	2010
Energy Supply Index	The multi-dimensional measure of the quality of energy supply			
Multi-tier	Incremental levels of access to energy services	Level of access to energy services through energy usage (kWh/per capita)	AGECC	2011
	Minimum levels and priorities of access to energy services	Minimum access to basic energy needs in terms of quantity, quality and affordability	EnDev	2011
	Multi-tier standards for cook stoves	Establish standards for cook stoves in terms of efficiency, safety and emissions	GACC/PCIA	2012

Source: **Bhatia (2013)**, SREP Pilot Country Meeting

### 2.3 Empirical Review

**Yilmaz et al. (2021)** examined the impact of financial sector development indicators and access to financial institutions on primary energy use in a sample of European Union transition members over a two-decade period (1996–2017). The study employed panel co-integration and causality tests to account for cross-sectional dependence. The findings indicated that the causal relationship between financial development indicators, access to financial institutions, and primary energy use varied significantly across countries. While the financial development index positively affected primary energy use, private credit had a negligible effect. Additionally, access to financial institutions had a

significant negative impact on primary energy consumption. Coefficients of co-integration at the country level indicated that the financial development index contributed positively to primary energy consumption in Bulgaria, Croatia, Czechia, Hungary, and Slovenia. While private credit also had a favorable effect on primary energy consumption in Bulgaria, the Czech Republic, Estonia, Hungary, Lithuania, Poland, and Slovakia. In comparison to private credit, the financial development index had a greater effect on primary energy use. Additionally, in Croatia, Estonia, Hungary, Poland, and Romania, financial institutions' access had a negative impact on primary energy use. Several policy recommendations are made, including creating an optimal environment conducive to the financial system's

efficient operation and encouraging other economic units to utilize a variety of financial services, thereby increasing the sector's access, depth, and efficiency.

**Koomson and Daquah (2021)** investigated the relationship between financial inclusion and energy poverty in Ghana using two rounds of Ghanaian living standards survey data. They used several multi-dimensional measures to investigate and explore this dynamic. To address the endogeneity problem inherent in financial inclusion, the parameter is instrumented using the distance to the nearest bank. Between 2012/13 and 2016/17, the study discovered that the proportion of energy-insecure households in Ghana decreased slightly, from approximately 81 to 80 percent. According to the estimates, between 1.380 and 1.556 standard deviations of an increase in financial inclusion was associated with a decrease in household energy poverty. The findings were consistent with those obtained using various other quasi-experimental methods. As a result, increased financial inclusion would significantly reduce energy poverty among employed individuals. Financial inclusion may have an effect on energy poverty through consumption poverty and household net income.

**Nussbaumer et al. (2011)** estimated energy poverty incidences and intensities in several African countries, including Nigeria, using a Multidimensional Energy Poverty Index (MEPI) that considered the following dimensions: cooking, lighting, services provided by household appliances, entertainment/education, and communication. Using the Alkire–Foster (AF) methodology, the investigation discovered that the degree of energy poverty varied significantly among the focus African countries considered, ranging from acute energy poverty (MEPI > 0.9 in Ethiopia) to moderate energy poverty (MEPI < 0.6 in Angola, Egypt, Morocco, Namibia, and Senegal). Energy poverty incidence and intensity were estimated to be 81% and 0.75 in Nigeria, respectively.

**Ozdeser et al. (2021)** used the ARDL model to examine the impact of financial development on energy consumption (EC); energy consumption was disaggregated into Fossil Fuel EC and Renewable Energy EC and divided into two equations. The study established that the variables do not have a long-run

relationship but a short-run relationship. For fossil fuel energy consumption, the results indicated a statistically significant negative relationship between real GDP and FFEC. This implies that as real GDP grows, fossil fuel-based energy consumption decreases. Financial development and FFEC have a strong and inverse relationship; as the financial sector developed, fossil fuel consumption declined. Renewable energy consumption indicated a positive relationship between real GDP and REEC. This demonstrates that as real GDP grows, so does renewable energy consumption. The study makes several policy recommendations, including increasing efforts to develop the financial sector within the context of the Nigerian economy and producing goods and services aimed at increasing GDP through the use of energy-efficient technological innovations.

**Gaies et al. (2019)** examined the relationship between financial development and energy consumption in nineteen MENA (the Middle East and North African) countries between 1996 and 2014. Energy consumption was measured in kilograms of oil equivalent per capita and was used as a dependent variable to reflect cross-country energy consumption. Several banking indicators were used to determine financial development in MENA countries. A linear and non-linear dynamic panel model was used to extend **Sadorsky's (2011)** model. The study's findings indicated a positive and statistically significant relationship between the banking system's intermediation capacity and its size and energy consumption. Additionally, the MENA region's financial development-energy demand nexus revealed a non-linear and inverted U-shaped relationship. The economic implications of this study indicated that while financial development initially increases energy consumption, at some point, further financial development results in decline in energy demand.

### 3. Methodology

This study examined the relationship between financial inclusion and energy access in West Africa, using panel data from seven countries in the region, namely, Benin, Burkina Faso, Cabo Verde, Ghana, Mali, Nigeria, and Senegal. The variables examined are access to electricity, which is the dependent variable and ATMs per 100,000 adults, Bank accounts per 1,000

adults and domestic credit to private sector are the independent variables. These variables were used as proxies for the subjects of this study, which are energy access and financial inclusion. The data in annual frequency from 2004 to 2019 was collected from the World Development Indicators of the [World Bank](#) for each cross section. The study used descriptive statistics, pooled ordinary least squares regression and fixed effects and random effects models including the Hausman to examine the relationship among the variables.

The model is therefore implicitly specified as;

$$ACE = f(ATMP, BKAP, CPS, \varepsilon) \dots \dots \dots (1)$$

Equation 3.1 is expressed explicitly as

$$ACE_{it} = ATMP_{it}^{\beta_1} BKAP_{it}^{\beta_2} CPS_{it}^{\beta_3} \varepsilon_{it} \dots \dots \dots (2)$$

The model is expressed after taking the natural logarithm in log - linear form as

$$\ln ACE_{it} = \beta_{0i} + \beta_1 \ln ATMP_{it} + \beta_2 \ln BKAP_{it} + \beta_3 \ln CPS_{it} + \varepsilon_{it} \dots \dots \dots (3)$$

Where,  $\ln ACE_{it}$  represents the natural logarithm of access to electricity of country  $i$  at period  $t$

$\ln ATMP_{it}$  represents the natural logarithm of ATM per 100,000 adults of country  $i$  at period  $t$

$\ln BKAP_{it}$  represents the natural logarithm of bank accounts per 1,000 adults of country  $i$  at period  $t$

$\ln CPS_{it}$  represents the natural logarithm of domestic credit to private sector of country  $i$  at period  $t$

$\beta_{0i}$ ; intercept of the model

$\beta_1 - 3$ ; coefficients of the independent variables.  $it$ ; individual country and time period identifier ( $i = 7, t = 16$ )

### 3.1 Estimation Techniques

#### Pooled Ordinary Least Squares

The panel OLS, also known as the pooled ordinary least squares model, is the same as the basic Ordinary Least Square. It ignores cross-sectional distinguishing features and treats each observation as independent of the others. It also ignores the time factor embedded in the panel. When there is homoscedasticity and no autocorrelation, the pooled model is used based on the assumption that individuals behave similarly. The highest accurate estimates can only be obtained with OLS. The pooled model is based on the same assumptions as a

simple regression model: multicollinearity, exogeneity, homoscedasticity, cross-section, and a normal distribution for the error term ([Greene, 2012](#)).

The panel data models are likewise determined by the assumptions of the common OLS. There is a chance that autocorrelation of disturbances within individuals will arise in research that employs panel data. However, there is a chance that this will result in skewed standard error estimations. There will be underestimating, which will result in overestimated t-statistics. The error should be adjusted, and one method for doing so is to use clustered standard errors. However, the main flaw with this approach is that it does not distinguish the variables depending on their particular characteristics. To put it another way, Pooled OLS mixes them all and ignores their differences. As a result, the model's estimated coefficients may be biased and inconsistent, depending on the situation.

#### Fixed Effect Model

The fixed effects (FE) model aids in the investigation of time-invariant variables' effects. Within an entity, FE investigates the relationship between independent and predicted variables. By allowing each entity to have its own intercept value, the fixed effects model takes into account the heterogeneity that exists across individuals (in this example, each country). The term 'fixed effects' refers to the fact that, while intercepts differ across countries, each individual's intercept does not change over time. It is also assumed that the regressors' slope coefficients do not vary across nations or across time.

Fixed effects model takes this form;

$$Y_{it} = \beta_{0i} + \beta_1 X_{it} + \beta_2 X_{it} + \beta_3 X_{it} + \varepsilon_{it} \quad (4)$$

#### Random Effects Model

In a random effects model, the distinguishing factors across entities are considered to be unrelated to the predictors included in the model and are also random. One of the advantages of random effects is that it allows time invariant variables to be included (i.e. gender). These factors are absorbed by the intercept in the fixed effects model, whereas in the random effects model, individual-specific elements are not regarded as a parameter and are not evaluated. It is instead treated as a random variable with a mean and variation. However, the random effects model is represented thus;

$$\gamma_{it} = \beta_1 X_{it} + \beta_2 X_{it} + \beta_3 X_{it} + \alpha + \mu_{it} + \varepsilon_{it} \quad (5)$$

### Hausman Test

The Hausman test is used to assess which of the Fixed Effects (FE) or Random Effects (RE) techniques is best for this study. The choice of model for a panel analysis utilizing the fixed or random effect model should be based on information about the unique components and exogeneity of the independent variables. Some hypotheses are tested, and the results are utilized to determine the best model to use. The Hausman test determines if a fixed or random-effects model is acceptable by detecting endogeneity in the explanatory variables. When utilized correctly, the random-effects model has the best linear unbiased estimates (BLUE) qualities (Sheytanova, 2015). However, suppose a link exists between the stochastic term of the random effects model and the independent variables. There will be inconsistency in the model's estimations, leading to a preference for the fixed effects model. The dynamic component of a random-effects model may be related to the independent variable at times. When compared to the random effects model estimates, the fixed effects model estimates are invariably consistent but not totally efficient. Because of the features of the panel data model estimates, the Hausman test was used in this investigation.

## 4. RESULTS AND DISCUSSION

### Descriptive Statistics

The descriptive statistics table shown in Table 4.1 shows the summary of the variables used in the analysis of the study. As observed in the table, the dependent and independent variables include access to electricity, ATM per 100,000 adults, bank accounts per 1,000 adults, and domestic credit to the private sector. The natural logarithm of the variables were obtained to mitigate against econometric challenges in the model to be estimated.

Table 4.1 indicated that the variables; access to electricity (ACE), ATM per 100,000 adults (ATMP), bank accounts per 1,000 adults (BKAP), and domestic credit to the private sector (CPS) add up to a total of 105, 65, 93 and 96 observations, respectively. Within the period

under study, the average, minimum and maximum values were obtained. The dependent variable, access to electricity, had its average, minimum and maximum values at 3.69, 2.38, and 4.54, respectively.

Table 4.1: Descriptive Statistics

Variable	ACE	ATMP	BKAP	CPS
Mean	3.69	1.99	5.39	3.02
S.D.	0.58	0.99	1.05	0.48
Min	2.38	-0.39	2.09	2.09
Max	4.54	3.88	3.84	4.19
Observations	105	65	93	96

The independent variables; ATM per 100,000 adults had its average, minimum and maximum values at 1.99, -0.39, and 3.88, respectively, while bank accounts per 1,000 adults had its average, minimum and maximum values at 5.39, 2.09, and 3.84, and domestic credit to the private sector had its average, minimum and maximum values at 3.02, 2.09 and 4.19, respectively.

Table 4.2 reveals the results from the pooled ordinary least squares regression, fixed effects, and random effects model. The results of the pooled ordinary least square regression reveals the coefficient of the estimated variables, r squared and f – statistic. The F-statistic is typically used to explain the comprehensive significance of the model. According to the POLS result shown in Table 4.2, the probability value of the F-statistic is 0.000 which indicates the overall significance of the model. In cross-sectional analysis, r-squared is not usually as that of time series; this explains why the value of r-squared for the POLS is 0.599, as revealed in Table 4.2.

According to the POLS results, the main independent variable ATM per 100,000 adults had a coefficient of 0.385 and a p-value of 0.050, which was statistically significant at five percent. This indicates that a percentage increase in ATMs per 100,000 adults would lead to a 38.5 percent increase in access to electricity; this implies that there is a positive and significant relationship between ATMs per 100,000 adults and access to electricity. The next variable examined bank accounts per 1,000 adults and revealed an estimated coefficient and a p-value of -0.102 and 0.550. This implies that a percentage increase in bank accounts per 1,000 adults would cause a 10.2 percent increase in bank accounts per 1,000 adults. The result of the p-value, however, shows statistical insignificance. Therefore,

bank accounts per 1,000 adults have an insignificant and positive relationship with access to electricity. The last variable, domestic credit to the private sector, had its coefficient and p-value as -0.261 and 0.033. This coefficient value implies that a percent increase in domestic credit to the private sector would result in a 26.1 percent decrease in trade, while the p-value indicates statistical significance at 5 percent. This, therefore, connotes a negative and significant relationship between domestic credit to the private sector and access to electricity. According to the regression results, the constant value, which represents the coefficient of the regression model, was revealed to be 3.287. This implies that one unit increase in any independent variable while holding other variables constant would lead to 3.287 units of increase in access to electricity.

According to the results of the fixed-effects model, the main independent variable ATM per 100,000 adults had a coefficient of 0.173 and a p-value of 0.013, which was statistically significant at five percent. This indicates that a percentage increase in ATMs per 100,000 adults would lead to a 17.3 percent increase in access to electricity; this, therefore, implies a positive and significant relationship between ATMs per 100,000 adults and access to electricity. The next variable examined bank accounts per 1,000 adults and revealed an estimated coefficient and a p-value of 0.012 and 0.886. This implies that a percentage increase in bank accounts per 1,000 adults would cause a 1.2 percent increase in bank accounts per 1,000 adults. The result of the p-value, however, shows statistical insignificance. Therefore, bank accounts per 1,000 adults have an insignificant and positive relationship with access to electricity. The last variable, domestic credit to the private sector, had its coefficient and p-value as 0.096 and 0.187. This coefficient value implies that a percent increase in domestic credit to the private sector would result in a 9.6 percent increase in trade, while the p-value indicates statistical insignificance. This, therefore, connotes a positive and insignificant relationship between domestic credit to the private sector and access to electricity.

Table 4.2: Empirical Results

Estimators	POLS	Fixed Effects	Random Effects
LnATMP	0.385**	0.173*	0.168*

	(0.050)	(0.013)	(0.011)
LnBKAP	0.102	0.012	0.025
	(0.550)	(0.886)	(0.753)
LnCPS	-0.261**	0.096	0.093
	(0.033)	(0.187)	(0.192)
Constant	3.287*	3.111*	3.017*
	(0.000)	(0.000)	(0.000)
R <sup>2</sup>	0.599	0.474	0.485

According to the results, the constant value, which represents the coefficient of the fixed-effect model was revealed to be 3.111. This implies that one unit increase in any independent variable while holding other variables constant would lead to 3.111 units of increase in access to electricity.

According to the results of the random-effects model, the main independent variable ATM per 100,000 adults had a coefficient of 0.168 and a p-value of 0.011, which was statistically significant at five percent. This indicates that a percentage increase in ATMs per 100,000 adults would lead to a 16.8 percent increase in access to electricity; this, therefore, implies a positive and significant relationship between ATMs per 100,000 adults and access to electricity. The next variable examined bank accounts per 1,000 adults and revealed an estimated coefficient and a p-value of 0.025 and 0.753. This implies that a percentage increase in bank accounts per 1,000 adults would cause a 2.5 percent increase in bank accounts per 1,000 adults. The result of the p-value, however, shows statistical insignificance. Therefore, bank accounts per 1,000 adults has an insignificant and positive relationship with access to electricity. The last independent variable, domestic credit to the private sector, had its coefficient and p-value as 0.093 and 0.192. The value of the coefficient implies that a percent increase in domestic credit to the private sector would result in a 9.3 percent increase in trade, while the p-value indicates statistical significance at 5 percent. This, therefore, connotes a positive and insignificant relationship between domestic credit to the private sector and access to electricity. According to the regression results, the constant value, which represents the coefficient of the regression model, was revealed to be 3.017. This implies that one unit increase in any independent variable while holding other variables

constant would lead to 3.017 units of increase in access to electricity.

When it comes to the Hausman test, it is used to determine which of the two models (fixed or random effects) to apply. The normal null and alternative hypotheses are presented for the Hausman test. The null hypothesis is that the random-effects model is the best model to use, whereas the alternative hypothesis is that the fixed effects model is the best model to use. The probability of  $\text{Chi}^2(\text{Prob} > \text{Chi}^2)$  in this Hausman test was 0.7077, which is insignificant, implying that the null hypothesis is accepted and the random effect panel regression results are employed.

### 5. Summary, Conclusion and Recommendation

This paper examined the nexus between financial inclusion and access to energy in a cross-sectional analysis. Using annual data from 2004 to 2019, the paper adopted the POLS, fixed effect, and random effect methodology to investigate the relationship between the variables. Secondary data were sourced from the **World Bank** development indicators. The variables of interest for the study included ATM per 100,000 adults, Bank accounts per 1,000 adults, domestic credit to the private sector, and the percentage of the population with access to energy.

The result of the Hausman test indicated that the random effect model is more appropriate. Therefore, from the study, ATM per 100,000 adults proved to have a positive relationship with access to energy, while other variables- bank accounts per 1000 adults and credit to the private sector had no connection established with the dependent variable.

Based on the findings of this study, it is recommended that in rural areas, financial education, especially on the use of electronic platforms, should be a priority. This would increase the household's access to financial services.

Furthermore, there is a need for legislation/policies to make funds accessible to investors in energy programs. Finally, governments of the discussed countries should invest more in energy infrastructure to improve access to energy resources.

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