Energy Transition in West African Monetary Zone (WAMZ): Does Financial Development Matter?

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ABSTRACT

This study provides valuable insights into the nexus between financial development and energy transition in the West African Monetary Zone (WAMZ), focusing on Nigeria, Ghana, Sierra Leone, Liberia, and Guinea. While financial development was measured using financial access, depth, and efficiency indexes, energy transition was measured by the share of the population with access to clean fuels for cooking and heating. For the data analysis, descriptive statistics, Levin, Lin, and Chu's (LLC) panel unit root test, and a one-way error component random effects model were employed. The LLC panel unit root test results showed that all the variables are stationary, integrated with order zero, I(0). Specifically, the random effects results showed evidence of a positive and significant effect of financial service access on access to clean fuels for cooking and heating. This finding highlights the strategic role of financial access in driving the energy transition process in the WAMZ. Similarly, evidence of a positive and significant effect of financial depth on access to clean fuels for cooking and heating was established from the results. This finding is impressive as it explains that an increase in the depth of the financial system is critical to fostering energy transition in the WAMZ. The effect of financial efficiency on access to clean fuels for cooking and heating is positive. The causality test results established evidence of a joint causality from financial access, depth, and efficiency indexes to energy transition measure (share of the population with access to clean fuels for cooking and heating). Given the findings, this study recommends that policymakers should prioritize the expansion of credit availability and microfinance initiatives to deepen the financial system and synergize their efforts for greater financial efficiency to empower households and businesses to adopt renewable energy technologies and create more opportunities for transition to sustainable energy sources in the WAMZ.

Keywords: Financial development, energy transition, financial access, financial depth, households and WAMZ

INTRODUCTION

The West African Monetary Zone (WAMZ) faces unique challenges and opportunities as it navigates the path towards sustainable development. Transitioning to sustainable energy sources is critical for economic growth, environmental sustainability, and social equity in the region. Smil (2010) posits that economies are under more pressure to update their energy infrastructure in a way that is environmentally sustainable due to the global push for an energy transition, which is a long-term structural change in the pattern of energy use that includes a shift from traditional sources like fuelwood and coal to more contemporary forms like oil, natural gas, and renewable energy. It is documented in extant literature that financial development can effectively strengthen energy transition in developing economies. By making credit and other financial services more accessible, financial development makes it possible to invest in clean energy technology and infrastructure (Sadorsky, 2010).

It is also believed that better resources for research and development (R&D) may be available through financial development, which could lead to technological breakthroughs in sustainable energy solutions. Kutan,

Samargandi & Sohag (2017) assert that this could support the adoption of renewable energy technologies and reduce dependence on fossil fuels. More so, households' dependency on traditional energy sources like biomass can be decreased by improving access to financial services, which can help them purchase cleaner energy options. This makes financial development critical for a sustainable transition to clean and modern energy. Furthermore, financial development is critical for mobilizing capital to fund energy infrastructure, especially renewable energy projects. However, financial markets in West Africa are generally described as underdeveloped making it difficult for countries to secure funding for large-scale energy projects. This has increased the call for policies that enhance financial inclusion and improve access to credit which could facilitate the energy transition in WAMZ (Asongu & Odhiambo, 2020). Financial development is expected to contribute positively to renewable energy investments as well as energy efficiency improvements in the region. Khan *et al.* (2021) argue that countries with more developed financial systems tend to have better access to green financing options such as green bonds and environmental funds which are essential for the energy transition.

Promoting renewable energy sources (RES) has become a key energy policy for most economies to dissipate ecological instability (Hojnik *et al*., 2021). Prior studies (Ojekemi et al., 2022; Zakari and Khan, 2022) suggest that energy structure is categorized into two main sources namely non-renewable energy and renewable energy. As highlighted in the World Meteorological Organization (2022) report, by 2050, solar energy sources will account for most of the globe's electricity demands, which will continue to expand as electrification becomes an integral approach for achieving net zero agenda. African economies can tap into exciting opportunities and become dominant forces in the energy market. Transitioning from non-renewable energy to renewable energy has become an unsettling proposition for WAMZ. For example, Adeleye *et al*. (2023) revealed that the form of energy most African countries rely on for their household and industrial activities causes enormous environmental issues.

Given Africa's increasing reliance on non-renewable energy sources of energy, such as wood and coal, the situation may worsen in the coming decades. Additionally, other ecological concerns including water pollution, air pollution, waste and solid disposal and terminal issues are problems these countries are more likely to face (Djoukouo, 2021). Despite having abundant renewable energy resources such as solar, wind, and hydro, the lack of adequate financing impedes project development, technology adoption, and infrastructure development for a successful energy transition. As access to financing for energy transition remains limited, particularly for households and businesses, the goal of transitioning to cleaner and sustainable energy has remained a major challenge. In this light, this study examines how financial development has shaped the process of energy transition in the WAMZ. Following the introduction in Section 1, the rest of this paper is organised as follows: Section 2 provides the review of related literature. Sections 3 and 4 embody the methodology and results respectively whereas Section 5 concludes the paper.

LITERATURE REVIEW

Theoretical Literature

The financial repression hypothesis, proposed by Shaw (1973) and McKinnon (1973), suggests that restrictions on financial markets, such as interest rate controls and high reserve requirements, can lead to financial repression, which hinders financial development and economic growth. This theory highlights the importance of liberalizing financial markets to promote financial development and economic growth (Daud, 2023). The Financial Repression Hypothesis is a theory that posits that government policies can lead to the suppression of financial markets and hinder economic growth. This theory has been used to explain the relationship between financial inclusion, financial development, and economic growth in Nigeria and other developing countries. According to the financial repression hypothesis, government interventions in financial markets, such as interest rate controls, credit allocation policies, and directed lending, can distort market signals and lead to inefficient allocation of resources. One of the key arguments of the financial repression hypothesis is that government policies that limit the freedom of financial institutions to operate can hinder financial development and undermine the process of energy transition.

In addition, the political economy of energy transition emphasizes the role of politics and economic interest in shaping energy transitions. The theory assumes that governments play a vital role in investing in and guiding new energy technologies while emphasizing the need for public sector leadership in energy transition. This theory has been used to understand the relationship between political power and energy transition in developing countries including the WAMZ countries. The political economy of energy transition emphasizes how economic power, state policies, social equity and global politics shape, facilitate or hinder energy transition. The theory has been critiqued from various perspectives. For instance, Grubb (2015) argues that while political and economic factors and vital, the theory does not fully address how technological breakthroughs and innovation processes influence energy transition.

Concept of Financial Development

Financial development refers to the evolution of financial institutions, markets, and instruments to enhance the allocation of resources, promote economic growth, and strengthen overall financial stability in a country. It encompasses a broad range of aspects, including the depth, efficiency, stability and accessibility of financial systems. Financial depth is concerned with the level of financial activity in the economy, often measured by the ratio of private sector credit to GDP while financial access defines the extent to which individuals and businesses can access financial services, measured by the number of bank branches, interest rates, account onwership and credit to economic agents, among others. In addition, while financial efficiency defines how effectively financial services are provided, often measured by indicators such as interest rate spreads or transaction costs, financial stability encompasses the ability of the financial system to withstand shocks and avoid crises, which is crucial for supporting sustainable economic growth.

According to Güngör, Çiftçioğlu, and Balcilar (2014), financial development is concerned with the increase in the quality and quantity of financial services with lower transaction costs. Improvements in the effectiveness and operation of markets and financial institutions that result in better resource allocation within the economy also define financial development (Levine, 1997). This embodies the growth and expansion of financial systems, including institutions, markets, capital markets and instruments, which enhance the financial depth efficiency, stability and access to financial services.

Empirical Literature

Asongu & Odhiambo (2020) in their study employed the Autoregressive Distributed Lag (ARDL) model to analyze the short- and long-term relationship between financial development and energy consumption in sub-Saharan Africa from 1980–2016. The model accounted for varying levels of integration among the variables. The study reveals that financial development was associated with higher energy consumption in the long run, suggesting that as financial sectors grew, they facilitated greater access to energy. However, the type of energy consumed was not always sustainable, as investments also went into traditional energy projects. The study recommends that financial policies should incentivize investments in clean and renewable energy sources, alongside strengthening environmental regulations. In particular, there is a need to align financial sector growth with sustainable energy policies to ensure a positive impact on the energy transition.

Shahbaz *et al.* (2018) examined the dynamic relationship between financial development, economic growth, and energy consumption for the period 1975-2015 focusing on developing economies in sub-Saharan Africa. By using the vector error correction model (VECM), the model captured both short-run adjustments and long-term equilibrium relationships among the variables. The findings indicated that while financial development initially led to increased energy consumption due to higher economic activity, it could support energy transition in the long term, especially in countries that implemented strong renewable energy policies. The study recommended that financial and energy policies be aligned to accelerate the adoption of clean energy technologies. Similarly, Mensah *et al.* (2023) studied the impact of financial development on access to clean fuels and energy efficiency across WAMZ countries from 2000 to 2010 using a dynamic panel data model. The model considered variations across regions and different financial development indicators. The study

concluded that financial development improved access to clean cooking fuels in countries with more advanced financial sectors within WAMZ.

Shahbaz *et al.* (2021) explored the impact of financial development on renewable energy use in 34 upper-middle-income developing countries between 1994 and 2015. The study employed Pedroni and Kao cointegration tests to examine the long-term relationship between variables. In addition, the long-run effect of financial development on renewable energy consumption was investigated using the Fully-Modified Ordinary Least Squares (FMOLS) estimation method. The Pedroni and Kao cointegration test results showed evidence of a long-run relationship between financial development and renewable energy use. The estimated FMOLS showed that financial development contributed positively to the growth of renewable energy use. Based on the findings, the study recommends that policymakers implement incentives and tax policies that increase the demand of enterprises for renewable energy resources.

METHODOLOGY

Research Design

This study employed a quasi-experimental research design. The motivation for this research design followed the use of secondary data for the analysis which is devoid of manipulations.

Data Collection Methods and Sources

This study utilized time series spanning from 1990 to 2022. The datasets were obtained from the World Bank and the World Health Organization - Global Health Observatory.

Model Specification

The model set up for this study closely followed the works of Asongu and Odhiambo (2020), Mensah et al. (2023), and Shahbaz *et al.* (2021), but with modifications following the decomposition of financial development into financial access, depth, and efficiency indexes. The pooled ordinary least squares (POLS), fixed effects (FE), and random effects (RE) models are specified as follows:

i. Pooled OLS model

$$ACF_{it} = \beta_0 + \beta_1 FAS_{it} + \beta_2 FDE_{it} + \beta_3 FEF_{it} + \varepsilon_{it} \quad (1)$$

Where: ACF = access to clean fuels for cooking and heating, FAS = Financial access index, FDE = financial depth index, FEF = financial efficiency, β_i– β_3 = slope parameters to be estimated, ε_{it}= error term, *i = 1, . . ., N. t = 1, . . ., T,,* i = cross-sectional units including the five selected countries, t = time dimensions (1990 to 2022),

ii. Fixed Effects Model

$$ACF_{it} = \beta_0 + \beta_1 FAS_{it} + \beta_2 FDE_{it} + \beta_3 FEF_{it} + Ui + \varepsilon it \quad (2)$$

Where: = Fixed effect (individual effect), εit = Error Term

iii. Random Effects Model

$$ACF_{it} = \beta_0 + \beta_1 FAS_{it} + \beta_2 FDE_{it} + \beta_3 FEF_{it} + Ui + vit \quad (3)$$

Where: U_i= Random effects (individual effects), v_i = Remainder disturbance term

Method of Data Analysis

Descriptive statistics was employed to analyze the distribution of each of the variables over the study period in terms of their respective mean, standard, minimum, and maximum values. This study employed the Levin, Lin, and Chu (LLC, 2002) unit root test to test for stationarity among the time series. Essentially, the LLC test assumes that the errors are independent and identically distributed across the panels, and it assumes that the individual time series share a common unit root process. The generic specification of the LLC panel unit root test model is formalized as follows:

$$\Delta Y_t = \propto_0 + \propto_1 Y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta Y_{t-i} + \lambda_t \quad (4)$$

Where: Y_t = variable for investigation, $\propto_1$ and β_i = parameter estimates and p = lag length

The pooled regression model was estimated for the panel datasets using the Ordinary Least Squares (OLS) method. This is predicated on the assumption that the intercept and slope coefficients will be homogeneous over time and among the study's various groups. In contrast, the fixed effects model was estimated using the within-regression estimator. The measurement of fixed effects, namely the one-way error component model, adhered to the ideas of Mundlak (1961), according to which there are heterogeneous intercept coefficients due to individual units but homogenous slope coefficients. Furthermore, in line with the proposal of Balestra and Nerlove (1966), the random effects model was estimated using the maximum likelihood (ML) estimator. Nonetheless, the Hausman (1978) test was used to determine which of the two competing models was preferred.

RESULTS AND DISCUSSION

Descriptive Statistics

The focus of the descriptive statistics is the mean distribution and standard deviation as well as the minimum and maximum values of each of the variables. The results are presented in Table 1.

Table 1: Summary of descriptive statistics

Variable	Observation	Mean	Std. Dev.	Minimum	Maximum
ACF	165	3.677	6.674	0	30.3
FAS	165	.12204	.17902	.0073	.5075
FDE	165	.0655	.0755	.0056	.24176
FEF	165	.4744	.1087	.2126	.8500

Source: STATA output (2024)

The descriptive statistics showed that the population with access to clean fuels for cooking and heating averaged 3.677% with minimum and maximum values of 0 and 30.3 respectively. This highlights the poor transition to clean and modern energy. The results showed that the financial service access index, financial depth index, and financial efficiency index averaged 0.12204, 0.0655, and 0.4744 respectively. This suggests that the extent of financial efficiency partly exceeded that of financial access and depth in the study area. The financial efficiency index is associated with the minimum and maximum values of 0.2126 and 0.8500 respectively. The standard deviation showed that the observations for the financial efficiency index clustered around its mean while that of the other variables did not cluster around their respective mean values.

Panel Unit Root Test

Levin, Lin & Chu (LLC, 2002) unit root test was employed in this study to test for stationarity in each of the series at the 5% level. The results are presented in Table 2.

Table 2: Summary of LLC unit root test results

Variable	LLC test results at levels	LLC test results at 1st diff.	Order of integration
ACF	2.0775*** (0.0189)	-	I(0)
FAS	-2.9375*** (0.0017)	-	I(0)
FDE	-3.7294*** (0.0001)	-	I(0)
FEF	-7.2163*** (0.0000)	-	I(0)

Source: STATA output (2024)

Note: *** p<0.01, ** p<0.05, * p<0.1 denote significant at 1%, 5% and l0% level respectively

The unit root test results showed that access to clean fuels for cooking and heating is stationary at the 5% significance level given that the corresponding probability value of the test statistics is less than 0.05. This necessitated the rejection of the null hypothesis of unit root. Thus, the variable is integrated of order zero. At the same time, the results showed that all the financial development indicators (financial access, depth, and efficiency indexes) are stationary at the 5% significance level. This is based on the fact that the probability values of their test statistics are less than 0.05. Hence, it followed from the results that financial access, depth, and efficiency indexes are integrated of order zero.

Model Estimation

The estimation of pool regression, fixed and random effects results followed the stationarity of all the series. The results are presented in Table 3.

Table 3: Summary of the panel regression results

Dependent variable: ACF	(1)	(2)	(3)
Variable	POLS	FE	RE
FAS	4.456	55.36***	50.07***
	(2.926)	(8.414)	(7.899)
FDE	2.519	29.62**	32.15***
	(6.911)	(12.75)	(12.30)
FEF	13.93***	1.055	1.189
	(5.055)	(3.285)	(3.302)
Constant	-3.610	-5.534***	-5.134
	(2.598)	(1.815)	(4.467)
Observations	165	165	165
R-squared	0.3735	0.538	0.5377
F-test	4.26		
Prob.(F-stat.)	0.0063		
Number of crossid		5	5
F-test(u_i=0)		26.76	

Prob.>F-(u_i=0)		0.0000	
Chi-square(var(u_i=0))			74.74
Prob.> chi2(var(u_i=0))			0.0000
Hausman test results	Chi2(4) = 6.33		Prob>chi2 = 0.0964

Source: STATA output (2024)

Note: *** p<0.01, ** p<0.05, * p<0.1 denote significant at 1%, 5% and l0% level respectively

The Hausman test result formed the basis for deciding the preferred results between the fixed effects and random effects results. As observed from the Hausman test results, the probability value (0.0964) of the Chi-square statistic (6.33) is greater than 0.05. This indicates that the null hypothesis that the random effects result is appropriate is accepted at the 5% significance level. Consequently, the discussion of findings is based on the random effects results. Specifically, the random effects results showed that the financial access index significantly increased population access on access to clean fuels for cooking and heating. This finding highlights the significant positive contribution of financial service access to energy transition in the WAMZ. This implies that improved access to financial services can help households afford cleaner energy solutions, thus reducing reliance on traditional energy for cooking and heating. This finding corroborates the results of Asongu and Odhiambo (2020), Mensah et al. (2023) and Bento and Moutinho (2016) who reported evidence of a positive contribution of financial development to the growth of cleaner energy use. The results also showed that financial depth has a positive effect on access to clean fuels for cooking and heating. This finding is significant at the 5% level, indicating that an increased depth of the financial system is an enabler of energy transition in the WAMZ. This suggests that greater financial depth has the potential to foster technological advancements in clean energy solutions in the WAMZ. The significant positive contribution of financial depth to is consistent with the findings of Shahbaz *et al.* (2021) and Ozturk and Bilgili (2015) who found evidence to justify the claim that financial development increased the growth of renewable energy use.

Additionally, it is established from the random effects results that the financial efficiency index has a positive effect on access to clean fuels for cooking and heating. Although this finding is not significant at the 5% level, it suggests that a financially efficient system that allows for optimal allocation of financial resources and minimizes transaction costs is imperative for the transition to cleaner and modern energy resources. The estimated random effects model is associated with an R-squared of 0.5377. This implies that financial development indicators (financial access, depth, and efficiency indexes) jointly explained 53.77% of the total variations in energy transition during the study period. It is also evident from the results that the probability value (0.0000) of the Chi-square statistic (74.74) is less than 0.05. This finding indicates that financial access, depth, and efficiency indexes are jointly significant in explaining changes in energy transition during the study period. This further attests to the statistical reliability of the estimated random effects model for policy formulation and forecast

Causality Test

The causality test showed the interaction between financial development indicators and energy transition. The direction of causality is presented in Table 4.

Table 4: Summary of causality test results

Null hypothesis (H_0): No causality				
Direction of causality	DF	Chi-square stat.	Prob. value	Decision
FAS → ACF	1	6.859***	0.0088	Reject H_0
ACF → FAS	1	0.3137	0.5754	Accept H_0
FDE → ACF	1	0.0068	0.9339	Accept H_0

ACF → FDE	1	0.0265	0.8705	Accept H_0
FEF → ACF	1	1.6392	0.2004	Accept H_0
ACF → FEF	1	2.4148	0.1202	Accept H_0
FAS, FDE, and FEF → ACF	3	10.4474***	0.0151	Reject H_0

Source: E-views output (2024)

Note: *** p<0.01, ** p<0.05, * p<0.1 denote significant at 1%, 5% and l0% level respectively

The causality test results showed evidence of unidirectional causality from financial service access to access on access to clean fuels for cooking and heating. For this reason, the null hypothesis is rejected. This finding indicates that access to financial services has a predicting ability for changes in the energy transition in the study. The results further showed no evidence of unidirectional or bidirectional causality between financial depth and access on access to clean fuels for cooking and heating as well as between financial efficiency and access to clean fuels for cooking and heating. This is based on the fact the probability values of their test statistics are greater than 0.05. Consequently, the hypotheses of causality cannot be rejected at the 5% significance level. More importantly, the results showed evidence of joint causality from financial access, depth, and efficiency indexes to access to access on access to clean fuels for cooking and heating. This finding is impressive as it suggests that financial development can be relied upon to predict changes in the energy transition in the WAMZ.

CONCLUSION AND RECOMMENDATIONS

This study provides insights into the financial development implications for energy transition in the WAMZ. This follows the widespread recognition of the role of financial development in promoting increased access to credits, greater financial efficiency, and the deepening of the financial sector for increased households' access to cleaner energy solutions and investments in sustainable energy infrastructure. The findings showed that financial service access significantly increased the share of the population with access to cleaner energy for cooking and heating. This is interesting as it indicates that greater access to credit is associated with a higher transition to cleaner energy. The results equally showed that financial depth contributed positively to energy transition. This suggests that an increased size of financial institutions relative to the GDP fosters efficient allocation of financial resources for clean energy initiatives by both households and businesses. Again, the financial efficiency index affected access to cleaner energy for cooking and heating positively. This is a pointer that a financially efficient system that allows for better capital allocation can facilitate energy transition. Given the findings, this study concludes that financial development that promotes financial service access and financial institutions depth is pivotal for the transition from traditional, fossil-fuel-based energy sources to cleaner and sustainable energy alternatives. Thus, this study recommends that policymakers should prioritize the expansion of credit availability and microfinance initiatives to empower low-income households and businesses to adopt renewable energy technologies, thus facilitating the transition to sustainable energy sources in the WAMZ. Monetary authorities in the WAMZ should strive to deepen the financial system by increasing the size of financial institutions relative to GDP to enhance the availability of resources for investments in cleaner energy solutions. It is also recommended that policymakers synergize their efforts for greater financial efficiency to increase funding for renewable energy projects while reducing the costs associated with renewable energy technologies for sustainable energy transition in the WAMZ.

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