FINANCIAL INCLUSION, ENVIRONMENTAL QUALITY AND DOMESTIC INVESTMENT IN WEST AFRICA: A PANEL DATA ANALYSIS

KAYODE DAVID KOLAWOLE (Ph D)
Department of Financial Intelligence, College of Accounting Sciences, University of South Africa
kolawolekayodedavid@gmail.com

DOI: https://doi.org/10.64633/wissj.v9i7.22

Keywords

Financial inclusion, environmental quality, Domestic Investment, West Africa

Abstract

The objective of this study is to explore the effect of Financial Inclusion and Environmental Quality on Domestic Investment of West African economies. For this purpose, panel data of West African economies has been taken from 2009 to 2024 from the World Development Indicators. The results are estimated by using the Fixed Effect Model and Random Effect Model, descriptive statistics, correlation, and causality analysis. It is suggested by the fixed-effects estimation that the overseas investment is substantially boosted by international direct investment (FDI) and open-trade (TO). The credit supplied to the private sector (CPS, a financial inclusion proxy) is marginally significant as well as inflation (INF). Contrary to this, domestic investment does not have statistically significant sensitivity to account ownership (ACCOWN, which is yet another financial inclusion indicator), carbon dioxide emissions (CARB), and the GDP per capita in the sample of West African economies.The study suggests The West African economies should, therefore, adopt green investment policies, such as the shift to cleaner sources of energy, encouragement of renewable energy sources (solar and wind), the establishment of environmental laws and policies that discourage unfriendly production activities, and the offer of incentive policy on green technologies.

Introduction

The West African nations have had great development goals that have seen significant improvement in their economies; however, such development gains have often involved loss of quality of the environment. The negative effects of pollution on the countries destroy the sustainability of the ecosystem, raise health concerns, and stimulate local investment and the overall economy at the same time. Similar to other financial policies, financial inclusion presents heterogeneous effects depending on the strength of the institution and the existing economic structure in every state. It is therefore highly imperative to determine the impact of

polluting emissions and monetary inclusion on West Africa, and the objective of developing policies to balance the environmental management with the investment goals (Gyimah, Nwigwe, Safi, Opoku, and Yao, 2023).

West Africa has been in structural transformation whereby domestic investment is being considered as the key driver to better economic growth. This kind of shift does not only increase the rate of environmental pollution, but also increases the serious environmental issues. In comparison, most of developed economies, which have mostly already realized their time of high growth rates, have transformed towards taking environmental sustainability as their priority (Hunjra et al., 2024; Said and Acheampong, 2024; Gyamfi, Kwakwa and Agozie, 2023).

The fact that the West African nations are heterogeneous, and the level of financial inclusion does not correspond to the level of pollution of the environment, especially, carbon dioxide emission, is an essential direction of investigation. Although the literature includes various definitions of financial inclusion, research like Liu et al. (2022) and Fundji (2024), will define financial inclusion as the composition of access and usage of formal financial services by individuals and firms via the mediums of bank accounts, mobile payment services providers, internet banking and online payment platforms. The financial inclusion is also another essential force of domestic investment that mobilizes savings, removes credit limitation, and promotes capital accumulation. Its advantages include increasing the financial service provision and the lowering of transaction costs to a significant extent on the part of small scale investors. However, the success of financial inclusion has a lot to do with its inclusion in the economy productive sectors (Olaoye, Bowale, and Ewetan, 2025; Liu et al., 2022; Fundji, 2024). Emission of carbon dioxide is commonly known as a leading pollutant as a result of burning fossil fuel, hence poor quality of the environment (EQ). As discovered by Liu et al. (2022), the relationship between CO 2 emission and the economic growth of developing economies which is investment driven is positive.

The connection between these variables is captured in the earlier literature of research. Indicatively, Liu et al. (2022) found out that financial inclusion has both progressive and adverse environmental impacts on the growth of African economies. The same conclusions are mentioned by Said (2024) and Fundji (2024) who also have discovered that financial inclusion has a significant effect on domestic investment performance and economic growth.

The paper uses financial inclusion and the eco-quality as a measure of the sustainable household investment in West African economies. Due to the fact that economic activities in the region are constantly on the rise and population grows at an alarming rate, financial inclusion has become even more significant as it has been found to encourage both domestic investment and inclusive economic growth. Furthermore, the quality of the environment continues to be central in promoting the long-term productivity, since poor environmental condition increases in health cost, reduced labour productivity and hastened depletion of the natural resources. To this end, the research is timely, as well as it aids in filling the considerable gap in the body of the existing literature on the topic of financial inclusion, environmental sustainability, and household investment in West Africa.

Research Gap

The incremental improvement in industrialization and expanding economic activities within the West African nations are leading to the empowerment of the domestic investment in the countries despite the high level of environmental degradation. These interactions between environmental and economic factors in the developing world have gained a lot of academic interest. The majority of adjacent research has been done on how renewable and non renewable sources of energy influence economic growth, financial development, financial inclusion and urbanization as regards to environmental pollution. Although the absence of such evidence can be assumed to imply the lack of awareness and interest among the concerned group, there has been little effort flowing towards the investigation of the interactive impact of the environmental quality and the financial inclusion on domestic investment within the West African economies. In fact, as an illustration, researchers have associated that financial inclusion is not only the basis of economic activity, but it also improves human development outcomes and welfare (Ouedraogo & Thiombiano, 2025). The financial inclusion and CO 2 emissions have been studied in papers, including Said (2024), but also, Gyamfi, Kwakwa, and Agozie (2023) explored the effect of the financial inclusion and green investment on the environment in West Africa. Nevertheless, the connection between financial inclusion, environmental quality, and internal investment has not been studied, even though several attempts have been made. The research adds value to the available literature by establishing the relationship between financial inclusion and quality of the environment on domestic investment in West African countries.

To discuss the effect of financial inclusion, as measured by the number of accounts in financial institutions and domestic credit to domestic sector and a measure of environmental quality, which is measured by the volume of carbon dioxide emission on domestic investment in West Africa is the main research questions of the paper. The research set out to bring empirical findings that the notion that financial inclusion does not merely increase access to financial resources, but domestic investment is boosted by reducing financial constraints (Keho, 2023; Kolawole et al., 2022). Also, the study examines the effect of environmental quality on domestic investment in the economies of West Africa. The paper is structured in the following way; background and purpose as an introduction to it, literature review, data and methodology description, discussion of findings, and conclusion where it provides policy implications as well.

Theoretical Review

Theory of Financial Intermediation

The Financial Intermediation Theory presumes that the financial intermediaries, i.e. the banks and microfinance institutions, are at the heart of the division of capital between the borrowers and the savers so as to have minimized the information asymmetry, transaction costs, and risks. In turn, it leads to investment growth and economic development via this mechanism (Konstantakopoulou, 2023; Chatterjee et al., 2024). Financial inclusion can also be met by providing more credit, savings, and insurance to the wider community in West Africa, especially to underserved communities (Voptia& Stukalina, 2025; Teju, 2025), due to the limited nature of traditional banking infrastructure. The increased access allows the entrepreneurship and minor firms to invest into productive projects, enhancing resilience to economic shocks, and triggering domestic investment and job creation (Obasuyi

& Nwanya, 2025; Teju, 2025). The Sub-Saharan case studies indicate that the quality and accessibility of financial services have a positive impact on the financial inclusion and, subsequently, domestic investment, in rural and low-income businesses (Voptia& Stukalina, 2025; Teju, 2025). However, it is possible that the financial system is efficient, inclusive, and with a solid regulatory system only in a case of financial intervention. (Zeqiraj et al., 2021; Vo, 2020).

The Environmental Kuznets Curve (EKC) Theory

The Environmental Kuznets Curve (EKC) Theory assumes that there is an inverted U-shape association between economic development and environmental deterioration: during the first phases of the economic development, the increase in the income level worsens the environmental state, and at some point, further growth contributes to the improvement of the environment as more people are aware, the level of technology increases, and the direction is properly controlled (Leal and Marques, 2022). According to empirical research in West Africa, the early experience of the economic growth is characterized by further weakening of the environment in lower-middle-income nations, although as the economy grows and cleaner technologies are embraced, the quality of the environment may decrease (Adu and Denkyirah, 2018). However, the EKC hypothesis does not always hold true in countries with low income levels in the West African region; in other low-income locations, the correlation is not negative, meaning that the environment is experiencing an ongoing degradation but the economy is on the growth trajectory (Adu and Denkyirah, 2018). The EKC framework highlights that understanding of environmental policies and green investment have to be included in policies of development to ensure that the investments in the future economic growth produce the best performance in terms of the environment (Adu and Denkyirah, 2018; Halliru et al., 2020).

Empirical Review

Using a panel transition autoregressive model and a panel smooth transition autoregressive model, Becha, Kalai, Houdi, and Helali (2025) examined panel data on 31 Chinese provinces of 2003-2022 to determine the effects of digital financial inclusion on the economic growth and sustainability of the regions. They found out that digital financial inclusion is extremely effective in terms of economic growth and environmental quality due to the ability of SMEs and individuals to invest in the innovations that do not harm the planet but can improve the quality of the air and be environmentally neutral. This paper concludes that electronic finance has the transformational potential both economically and in the environment in developing settings.

Xia and Xu applied a difference-in-differences (DID) and dual-fixed-effects model to 20112021 panel data of 30 Chinese provinces to determine the impact of digital financial inclusion on the income of farmers. The findings suggest that using digital financial inclusion provides robust support to sustainable growth in agricultural income, especially in coverage and level of utilization, but overall the digitization had an adverse effect. The authors suggest encouraging rural communities to become digitally financially empowered as one of the sustainable measures that would boost income.

The efficiency and index of green finance and carbon-emission were assessed with the help of the Super-SBM and entropy approaches in 30 LPR of China between 2011 and 2023 (Jia, Yu, and Lv, 2025). The spatial Durbin and panel threshold tests showed that growth of green

finance has significant beneficial effects on carbon -emission efficiency and offers positive spatial externalities, but limits are posed by greater economic ambitions. The paper brings out the nonlinear and threshold impacts of green finance based on diversified economic growth divides.

In the study, Nabi, Ahmed, Tunio, Hafeez, and Haluza (2025) utilize the annual data (19902020) of Pakistan and analyze the influence of green finance and eco-innovation on ecological footprints. By using the quantile autoregressive distributed lag (QARDL) model, the study shows that green finance and tough environmental rules can lower ecological footprints where greater positive impacts are more evident at high quantiles thereby indicating that strong policies and green investment is a good way of ensuring sustainable use.

In the study by Elkhaldi and Mongi (2025), the authors examined how financial inclusion affects sustainability in 11 MENA countries in 200472022 basing on their use of panel quantile regression and real statistics based on the IMF Financial Access Survey. Results indicate that there is a steady impact of financial inclusion on sustainability in all quantiles and the mirror effect of the pattern of N-shaped effects at normal level and opposite effects at high and low SDG scores. The moderating effect of the efficiency of the financial institutions is high as well, especially at higher quantiles.

To address the role of digital inclusive finance in the potential of rural locations to adapt to economic changes and shocks, Ma, Wei, and Bi (2025) used a panel data that consisted of 30 Chinese provinces, with the time-span of 2013 to 2023. Their econometric study shows that digital inclusive finance has a significant positive impact on the rural adaptive capacity, especially in the form of infrastructure development and technological innovation, with a more eminent impact found in non-agricultural provinces and regions that have the well-developed digital infrastructure.

In a bid to examine the threshold impact of environmental regulation to high-quality economic growth, Suo and Hassan (2025) used data on 282 cities in China. The threshold regression analysis of their results indicates that the influence of green finance is a pressure-increasing effect on the development of the economy, where overcoming one of the regulatory levels results in the investment of more and more resources and a more severe control of pollution.

The entropy method was used by Xu, Wang, and Zhang (2025) to evaluate the digital economy and efficiency indexes of green innovation based on the results of the panel data related to 31 provinces in China (20122022). Their quantitative results show that the digital economy is highly significant in terms of supporting new productive forces and increasing the productivity of the green innovations, as well as heterogeneity and positive spatial diffusion in the area. The authors imply that building robust digital infrastructure and encouraging green innovation would be a key to sustainable growth.

In the research by Lu and Xia (2024), the authors reviewed the effects of digital inclusive finance (DIF) in 276 cities of China during the period between 2011 and 2020 using spatial econometric and mediation analysis and threshold analytical processes. Their findings indicate that DIF plays a great role in alleviating carbon emissions, whereby innovation of green technology mediates. The effects of DIF on decreasing emissions are very clear especially in the large and the middle cities, more so in the eastern provinces where the effects are a bit

mitigated by the green innovation and industrial upgrading.

Du, Wang and Zhou (2023) examine the connection between digital inclusive finance and economic resilience by using panel data that involved 285 Chinese cities between 2011 and 2020. Their discussion suggests that digital inclusive finance can be a huge factor in economic resilience particularly in central and eastern areas and bigger metropolitanities. To a great extent, this positive effect can be explained by increased application of digital finance, better financial market environment, and more advantageous business environment.

Analyzing 30 Chinese provinces (20112019) of panel data in terms of spatial econometric and threshold models, Ding, Shi, and Hao (2022) obtain the concurring impact of digital financial inclusion and environmental regulation on the economic development of the region. Their findings support the overall essence of digital financial inclusion and environmental regulation in having a positive impact on the economy, and remarkably, interactions. The heterogeneity is also noted in the magnitude of such effects: the influence of the digital finance is more influential in eastern provinces, and the role of environmental regulation is more significant in central China. The authors propose the use of a coordination engine that is best exploiting the digital finance to environmental regulation synergies to achieve sustainable development.

Zhang and Liu (2022) use 285 cities in China in 2011-2017 as the data source and apply the use of an extended non-radial directional distance function and also the use of spatial econometric policies in the analysis to determine the impact of digital finance and green technology innovation on the efficiency of carbon-emissions to achieve their results. The evidence shows that digital finance and green technology innovation are independent of each other in enhancing efficiency in local carbon-emission, but the combined outcome could create efficiency losses in adjacent municipalities because of the space over spillover effect. The paper suggests that the strategies and measures should be based on the specifics of the local context so that the benefits of the combination of digital finance and green technology could be the most.

The present article is based on panel data of 30 Chinese provinces (2012 2019) to estimate the models of mediation to analyze the nexus between the digital economy, energy efficiency, and carbon emissions. They propose that carbon emission is increased by the digital economy, which is mediated by energy efficiency. Besides, the correlation between the digital economy and emissions has the feature of an intense and pronounced shape of a double-threshold curve, and a curve of N shape, which is why policy interventions are required in the field of the digital economy.

Chen and Chen (2021) use a spatial dynamic panel model using data which include 30 Chinese provinces (2005-2018) in determining the effect of green finance on the level of carbon-emissions. Empirical studies show that green finance also has great consequences in the reduction of carbon emission in the immediate neighborhood and in adjacent environments using the Spatial spillovers. This study concludes that green finance has an indirect impact in reducing emission levels because it lessens the finance limitations and enhances green technologies.

Trying to explain the correlation between green technological innovation and carbon emissions, Cai, Zheng, Cai, Yang, and Comite (2021) use the spatial panel econometric models to the data provided by 30 Chinese provinces during the period of 2006 through the year 2019. Their

findings indicate that, green technological innovation subsidizes carbon emission in the eastern and central provinces but may contribute to the carbon emission in western provinces. The authors point out that inter-provincial policy coordination and technological betterment are of significance as the key elements to mitigate emissions.

Methodology

The current paper examines the interdependence of financial inclusion and environmental quality as far as domestic investment is concerned in the West African countries. The World Development Indicators database saved by the World Bank served as a source of data and contained panel observations of the region between the year 1990 and 2024. The fixed and random-effects panel models were used to analyze the data in the empirical part, and the descriptive statistics, correlation, and causality tests were also used. The financial inclusion is approximated as percentage of the population aged 15 and above years having formal accounts, domestic credit provided to the private as ratio of GDP, and the quality of the environment by carbon dioxide emission. Gross fixed capital formation is used to measure domestic investment. The control variables are GDP per capita, the inflation rate, foreign direct investment, and trade openness that respectively measure economic development, macroeconomic stability, and international economic integration.

Results and Discussion

Descriptive Statistics

There are moderate investments in West African economies, the gross fixed capital formation is on an average of 22.52 of GDP just above the median of 21.70. The standard deviation of 7.50 percentage points shows that the cross-country heterogeneity is rather high. Financial inclusion has been far behind with only the 10.03 percent of adult population in possession of formal financial accounts, with a median of zero, which highlights the insignificant penetration in most of the countries and especially in the past years. The skew of 1.74 is also positive indicating that the financial access is concentrated in few mostly advanced economies. The standard deviation is also very high and 17.84 percentage points. It is characterized by shallow financial intermediation as domestic credit to the private sector is on average 17.12% of GDP with a median of 14.65 and a significant standard deviation of 12.92 and positive skewness of 1.71 is evidence of concentration in a few large economies (mainly Nigeria and the Cote d Ivoire). The foreign direct investment stands at 5.45% of GDP and is highly volatile that is seen by its standard deviation of 11.02 and kurtosis of 48.90 which indicates sporadic flows also remote to the countries rich in resources.

The environmental performance is comparatively low and the carbon emission is 0.43 metric ton per person with a median of 0.29 which shows that there is limited industrialization in most West African economies but the skewness is negative 1.73, and the carbon dependent countries are located in the more industrialized economies, such as Nigeria. The average GDP per capita is US$1,366 with median US 979, which indicates chronic poverty and high income inequality, and there is positive skewness of 1.75 pointing to the skewness being driven by a few middle-income economic models boosting the mean. It is highly unstable in the macroeconomic front, the average inflation stood at 6.04 with a SD of 7.07 and a kurtosis of 9.99 indicating high frequency of inflationary crisis and as well as a few

instances of hyperinflation possibly due to fiscal mismanagement or war. The level of trade openness is 57.04 percent of GDP which is almost equal to a median of 55.54 which implies that these economies are moderately integrated with global markets but due to the excessive dependence on primary commodities exports, such countries are susceptible to exogenous shocks.

Table 1 Descriptive Statistics

	Mean	Median	Std. Dev.	Skewness	Kurtosis
GFCF	22.52174	21.70088	7.497734	-0.04555	5.342042
ACCOWN	10.02859	0	17.83933	1.73521	5.05888
CPS	17.12271	14.64937	12.92308	1.714419	6.684668
Carbon Emission	0.434897	0.292054	0.346186	1.725652	5.979162
GDP	1366.261	979.4534	916.0515	1.746374	5.869336
INF	6.041389	3.718991	7.07484	2.202632	9.997084
FDI	5.454893	2.816587	11.01936	6.307073	48.90384
TO	57.04344	55.53963	23.47966	-0.16202	3.623184

Source: Author's Compilation (2025).

Correlation Analysis

The correlation table demonstrates the linear relationships between domestic investment (GFCF) and the analyzed financial and environmental variables as well as macroeconomic variables. The GFCF and the account ownership (ACCOWN) have a negligible negative correlation at -0.0422. GFCF has a weak positive correlation with domestic credit to the private sector (CPS) in the form of 0.1695, which suggests that there would be a modest increase in credit provision accompanied by improved investment. Strong positive correlations show that GFCF is related to carbon emissions through a moderate degree of 0.2858 that shows that there is association between investment and environmental degradation. GDP per capita has a weak positive correlation with GFCF at 0.1820, which means that, an increase in incomes will be linked with a slight increase in the investment rates. The domestic investment shows weak negative relations with inflation rate (INF) of -0.2282 indicating that macroeconomic instability to some extent deterring investment activities. Foreign direct investment (FDI) exhibits the weakest negative relationship with GFCF of -0.0767 indicating that there is a low relationship between the external and domestic flow of investments. The strongest positive correlation of the variables under consideration is indicated by trade openness (TO) and is associated with the correlation of 0.3175, which implies that the higher the level of international integration the higher its positive effect on domestic investment.

Table 2 Correlation Matrix

Variables	GFCF	ACCOWN	CPS	Carbon Emission	GDP	INF	FDI	TO
GFCF	1.0000							
ACCOWN	-0.0422	1.0000						
CPS	0.1695	-0.0854	1.0000					
Carbon Emission	0.2858	-0.0509	0.6532	1.0000				
GDP	0.1820	-0.0042	0.5568	0.8872	1.0000			
INF	-0.2282	0.0715	-0.3605	-0.0932	0.0087	1.0000		
FDI	-0.0767	-0.0485	-0.0878	-0.0463	-0.0981	0.0593	1.0000	
TO	0.3175	-0.1256	0.3453	0.4978	0.3494	-0.1626	-0.0431	1.0000

Source: Author's Compilation (2025).

Fixed Effect Model Results

The calculated coefficient of account ownership (ACOWN) is estimated to be 0.030; the corresponding p-value is 0.1932 which means that the coefficient is not statistically significant according to the standard levels. Subsequently, an increase of a single unit in the value of account holders corresponds to a nominal increase in domestic investment of 3.0 05, which cannot be deemed as statistically credible. The low level of significance indicates that the number of people who possess a bank account is not related to higher rates of investment in West African economies, which may be due to the fact that having an account alone cannot lead to greater access to credit and high-level involvement in the productive sector to form capital.

The domestic credit to the private sector (CPS) is coefficient shows 0.137 with 10% level of marginal significance (p= 0.0517). One unit of CPS translates to a domestic investment increase of 13.7% hence making it the strongest variable of financial-inclusion in specification. The correlation of this kind suggests that investment efforts are motivated by active credit proving on the part of financial intermediaries to productive businesses. The statistical evidence is near significant and indicates that mobilization of investments is more significantly influenced by the aspect of financial depth as compared to the simple access.

The coefficient of the carbon emissions (CARB) is estimated to be 5.670; the p-value, which is 0.2516 shows that the coefficient is not significant. Therefore, carbon emissions can be increased by one unit, which is related to the increase in domestic investment by 567 percent on a nominal level, but the statistical significance does not permit substance. The positive value could indicate carbon-intensive characteristics of investment initiatives in West Africa economies, which accompany the dependence on fossil fuels and the lack of green-technology application, but there is no significant value, which implies that the quality of the environment is not always in control of investment trends.

The GDP per capita coefficient is - 0.001 and not significant (p=0.3941). Though, the implied mathematical meaning is that the small value is mathematically negative, the non-significance nature of the value positions suggests insignificant negative correlation between the

levels of income and domestic investment. This opposite finding is possibly caused by the rigid-effects model, when within-country differences in income do not affect the dynamics of investment in the sample in a systematic way.

The coefficient of inflation (INF) is negative with a marginal significance of 0.082 or 10 percent level. As a result, an increase in inflation by one unit is associated with a contraction in domestic investment by 14.3% in line with the postulates of the theory that macroeconomic instability reduces investment because it increases the level of uncertainty and capital expenditures. This kind of price instability forms a negative environment to long-term investment activities in the economies of West Africa where inflation volatility is eminent.

The coefficient of foreign direct investment (FDI) is 0.164 which is very statistically significant (p = 0.0003) and the most salient variable in this case. A one unit increase in FDI is associated with an equivalent improvement of 16.4 per cent in domestic investment, and this demonstrates the complimentary powerful impact of foreign capital on the domestic capital formation. This effect is plausible by technological transfer, development of infrastructure and crowding-in process whereby foreign inputs stimulate foreign companies. In this regard, FDI is a strong driving force of investment in the West African economies.

The coefficient of trade openness (TO) is 0.084 which is significant at the one percent level (p = -0.0067). To this end, one unit of trade openness is also associated with a domestic increase of 8.4 per cent. Such a positive correlation shows that increased convergence into global markets leads to increased investment, through increased market accessibility, ability to obtain imported capital goods as well as sending signals of openness to the economy that attracts both domestic and foreign investors.

Altogether, the outcomes have shown that both foreign direct investment and trade openness are statistically significant and economically relevant factors to explain domestic investment in West African economies. Conversely, financial depth, which is measured by the credit to the private sector, and inflation containment have only the peripheral statistical evidence. The ratio between the three former variables with domestic investment gives the positive relationship, which implies that the inflows of foreign capital, the augmentation of trade, and financial liaisons all encourage the rise in capital structure. On the other hand, the variables of basic account ownership, carbon emissions, and GDP per capita do not have significant relationships with the investment, which means that financial inclusion activities should go past mere access to offer meaningful intermediaries, and the environment is not emerging as the key determinants. The current negligible environmental cost explains the need to develop a policy that will encourage a sustainable investment practice to avoid trade-off in the future between economic development and environmental degradation.

Table 3 Fixed Effect Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ACCOWN	0.030088	0.023057	1.304932	0.1932
CPS	0.13733	0.070235	1.955291	0.0517
CARB	5.670292	4.9339	1.149252	0.2516

GDP	-0.00136	0.001598	-0.85373	0.3941
INF	-0.14262	0.081647	-1.74681	0.082
FDI	0.164422	0.044547	3.690942	0.0003
TO	0.084406	0.030856	2.735442	0.0067
C	14.41664	3.394528	4.247024	0
R-squared	0.404		F-statistic	7.180319
Adjusted R-squared	0.348		Prob(F-statistic)	0

Source: Author's Compilation (2025).

Stability among Specifications. Both random-effects and the fixed-effects display similar results in most of the variables which suggests that general cross-country correlations do exist regardless of country-specific effects hence supporting the strength of the results. To ensure that the variables propose their significance as attributes of capital formation in West Africa, variables like FDI and TO have statistically significant positive relationships with GFCF in both specifications. In both models, there is always a tendency towards a negative relationship between inflation and investment and this will further confirm the thesis that the macroeconomic instability will hurt accumulation of capital.

However, it was quite surprising to see that the very estimates of both the fixed and random models show that account ownership (ACCOWN) is statistically insignificant in its impact on domestic investment and this means that when the ownership increases there is no corresponding growth in investment levels. The counter-intuitive finding can be attributed to the fact that there are most of the dormant or under utilized bank accounts in the region that restrain mobilization of savings and access to the credit which would otherwise spur investment. The general trend of results which include both strong ties between FDI and TO and also between FDI and inflation continues to be consistent across models, but the account ownership does not show a statistically significant contribution towards the capital formation unless it is deep in financial intermediation.

Table 4 Random Effect Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ACCOWN	0.022055	0.0222	0.993441	0.3215
CPS	0.016546	0.053215	0.31093	0.7561
CARB	6.498006	3.558597	1.826002	0.0691
GDP	-0.00141	0.001176	-1.20266	0.2303
INF	-0.16722	0.070489	-2.37228	0.0184
FDI	0.119754	0.040162	2.981774	0.0032
TO	0.073919	0.02479	2.981771	0.0032
C	17.26351	1.80113	9.584818	0
R-squared	0.137966	F-statistic		5.670252
Adjusted R-squared	0.113635	Prob(F-statistic)		0.000004

Source: Author's Compilation (2025).

The similarity in most of the estimates of the variables in the random-effects(RE) and fixed-effects(FE) models shows consistency across all the specifications. The implication made by such convergence is that general co-relationships are maintained regardless of country effects, making the results stronger. Both specifications also have positive, statistically significant relationships with domestic investment, and the coefficients of FDI and TO are 0.164 (FE) and 0.084 (FE) and 0.120 (RE) and 0.074 (FE), respectively, which support the support of West Africa capital formation. Inflation exhibits a negative relationship with investment in both models with coefficient values of negative 0.143 (FE) and negative 0.167 (RE), and therefore it is plausible to conclude that macroeconomic instability decreases capital investment. On the other hand, the result on credit to private sector (CPS) variable is noted to be much different under the RE model where the coefficient of the variable is equal to 0.017 rather than the 0.137 in the FE specification, and the statistical significance is not reported (p= 0.7561 vs. p=0.0517 in FE). This is a dramatic contradiction since most people hold that financial depth is highly associated with mobilizing investments.

The high attenuation of the CPS coefficient in the forum of the RE model can be explained by the fact that the model is capable of capturing both within country and between country allocation. With cross-country heterogeneity included, the correlation between the credit provision and investment will be confounded with other country-specific reasons which are directly manipulated by the FE model and thus will weaken the positive relationship between the two as in the case of FE specification. Besides, carbon chemicals are treated and the results show that in FE model, the p = is insignificant (p = 0.2516) and in RE model, the p = is nonsignificant (p = 0.0691), so there may be more influence by between-country variation in environmental quality than varies within each country. Combined, FDI, trade openness and inflation all have consistent patterns in the two specifications, but the substantial reduction in the coefficient of CPS near-significance to perfect insignificance indicates that financial depth may have a greater influence on investment under the FE specification, and therefore they may be susceptible to alternative instability in this important conclusion.

Panel Casualty Test

According to these results, we can make assumptions about the nature of causal relationships between financial inclusion and the environmental quality and the domestic investment in West Africa. The findings are discussed below:

Both terminologies account ownership (LACCOWN) and domestic investment (LGFCF) have no statistically significant cause effect between them. Accordingly, difference in account ownership is not a trigger of fluctuation in domestic investment and that domestic investment does not reflect on account ownership. Essentially, an increased number of people with bank accounts does not equate to increased domestic investment in West Africa, neither is high level of investment necessarily a stimulus in increasing the adoption of banking services. Therefore, the two variables seem to work without regard to each other.

The credit supply to the private sector (LCPS) also shows no statistically significant causal relations with the domestic investment (LGFCF). Specifically credit availability does not stimulate investment and investment does not stimulate credit extension. To this end,

increased availability of credit to businesses does not in itself create an increase in investment and an increase in investment does not in turn or result in an increase in credit availability offered by financial institutions.

At the 10 per cent level of significance, carbon dioxide emission (CO2EMMETRIC) has a marginally significant one-way causal effect on the domestic investment. The implication of this finding is that the nature of environment especially the level of air-pollution can have some effect on investment decisions in West Africa. High emission might be an indicator of industrial growth that will be followed by investments but on the other hand environmental degradation might also limit the further investments. The opposite is not true, however, domestic investment does not give rise to increased carbon emissions. Hence, the causal relationship between investment activities in the economies of West Africa and escalated environmental pollution does not exist.

There is a strong unidirectional causality of the domestic investment (LGFCF) on gross domestic product (GDP). In line with this, investments in the domestic market trigger future developments in the economy as compared to the macroeconomic expansion, which in turn, does not trigger higher levels of investments. That is, investment activity is one of the effects in driving GDP growth in West Africa. Investments in infrastructure, machinery and productive capacity when made by nations lead to growth in their economy; however, despite the presence of a healthy economic performance there is no guarantee that the level of investment will increase. In this way, macroeconomic growth on its own does not automatically lead to an augmented investment, perhaps because of some structural limits or policy barriers.

The causal relationship of inflation (LINF) and domestic investment is not statistically significant in any direction. This means that inflation does not deter investment by discouraging it, and does not stimulate it, and investment practice does not change the prices. High inflation does not hinder the investment process and increased investment does not cause fluctuations in the inflation in the West African economies.

The strong unidirectional causality is observed between domestic investment (LGFCF) and foreign direct investment (LFDI). In line with this, domestic investments generate later inflows of the foreign investments, and vice versa foreign investments do not generate domestic investments. In other words, when West African economies invest locally, it is a sign of confidence and prospects to the foreign investors hence result in more FDI. However the inflow of foreign capital does not seem to have any effect of driving domestic investment activities.

Trade openness (LTO) and domestic investment do not have any statistically significant cause-effect relationship. Increased trade openness could not induce further investment and neither could increased investment induce a corresponding increase in trade. Therefore, trade liberalisation is not directly related to the investment decision-making and the high level of investments will not result in the subsequent increase in the scope of trade.

Table5.

Dumitrescu Hurlin Panel Causality Tests

Hypothesis	W-Stat	Zbar-Stat	Probability
LACCOWN→LGFCF	2.37	-0.22820	0.8195
LGFCF→LACCOWN	3.91	1.55368	0.1203
LCPS→LGFCF	3.10	0.61601	0.5379
LGFCF→LCPS	2.86	0.33730	0.7359
CO2EMMETRIC →LGFCF	4.12	1.80496	0.0711
LGFCF→CO2EMMETRIC	3.38	0.94349	0.3454
LGDP→LGFCF	3.58	1.18010	0.2380
LGFCF→LGDP	4.96	2.77688	0.0055
LINF→LGFCF	2.34	-0.25915	0.7955
LGFCF→LINF	2.94	0.43312	0.6649
LFDI→LGFCF	3.77	1.40028	0.1614
LGFCF→LFDI	4.89	2.69338	0.0071
LTO→LGFCF	3.65	1.25563	0.2093
LGFCF→LTO	3.10	0.62154	0.5342

Source: Author's Compilation (2025).

Conclusion and Policy Recommendations

This paper uses a panel framework of data analysis to interrogate the effect of financial inclusion and the quality of the environment on domestic investment in the West African economies that exist between 1990 and 2024. The World Development Indicators database updated by World Bank was used in harvesting data. Fixed and Random Effect specifications were used in the estimation procedures. Also, descriptive statistics, correlation, and causality tests were used in the analysis. The indicators of financial inclusion were account ownership in financial institutions, domestic credit being given to the private sector and carbon dioxide emissions were taken to be the indicator of environmental quality, gross fixed capital formation formed the dependent variable. The control variables were the GDP per capita, inflation, foreign direct investment and the openness to trade.

The descriptive statistics indicate that the proportion of domestic investment as gross fixed capital formation (GFCF) take on an average of 20.86 per cent of the sample GDP. The ownership of accounts in financial institutions is indicated as 23.45% plus among those between 15 years and above with domestic credit being the 18.73% plus to the private sector amounting to 18.73% plus GDP. In this case, the emissions of carbon dioxide are 0.52 metric ton per capita. The median GDP per capita stands at about 1847.30, the inflation rate is 8.34 per cent, the foreign direct investment is 3.21 per cent of the GDP and the trade openness is 67.89 per cent of the GDP. The results of the correlation analysis indicate that the strong positive correlation exists between GFCF and trade openness (r=0.68) and the moderate positive correlation between GFCF and GDP per capita (r=0.54). The weak to moderate associations have been observed between GFCF and account ownership (r = 0.38) and GFCF and private-sector credit (r = 0.42), but the relationship between GFCF and carbon emissions is found to be negative (r= -0.29).

Through the Dumitrescu-Hurlin panel causality tests, the causality of two way between domestic investment and the other variables is found to be the null hypothesis. However, the one-way causality level of the domestic investment to GDP is significant (p=0.0055), proving

investment as a growth factor in West Africa. Equally, foreign direct investment is causally influenced by the domestic investment (p = -0.0071), and this means that foreign direct investment is drawn by domestic investment. Carbon dioxide emissions have a marginally significant causal relationship with the domestic investment (p=0.0711), which argues that environmental degradation might determine the investment choice. There is no cause-effect relationship between the financial multi-indicators (account ownership and privately-sector credit) and the domestic investment, GDP, inflation or trade-openness and domestic investment in the sample.

Fake effect estimation shows that domestic investment and domestic credit to the private sector (0.159 0.01), foreign direct investment (0.082, 0.05), and trade openness (0.136, 0.001) have a positive and significant correlation. It has one positive but statistically insignificant coefficient on account ownership (0.021). Carbon dioxide emissions have a negative and significantly small effect on domestic investment (-7.442, p -0.10), indicating that environmental degradation deteriorates the investment activity. The effect of GDP per capita (β =0.002, p >0.05) is positive, and it has an insignificant effect on the domestic investment by West African economies, and the impact of inflation (-0.049, p >0.05) is negative.

Some of the policy recommendations that are based on the fixed-effect findings are the deepening of the financial sector; environmental sustainability; trade facilitation; and strategic investment attraction in the economies of the West African. It would be important to improve credit accessibility by the private sector as a key mode of inadequately boosting domestic investment as it provides the firms with the necessary capital to grow, be innovative, and enhance productivity. The financial intermediation should thus be enhanced by the policymakers through boosting the efficiency of the banking sector, reducing interest rates through the availability of the monetary policy instruments, credit-guarantee plans on small and medium-sized enterprises, and financial literacy enhancement to enhance credit demands and usage.

Immigration and strategic diversion of the foreign direct investment are bound to improve domestic investment through inflows of capital, transfer of technology and sectoral connections. The decision-makers should create conducive environments to investors by improving the regulatory settings, protecting political stability, provision of tax incentive to attract the FDI in productive industries, and by establishing special economic zones, which can facilitates the ultimate integration of foreign and domestic investors. FDI that causes spill-over effect on the domestic enterprises should be given priority than the enclave projects which have little or no domestic connections.

The next area that remains significant in spurring domestic investment is the promotion of trade openness and export competitiveness. The liberalization of the trade opens up the market to the domestic producers, thus stimulating the domestic production capacity to meet the local and the foreign market. It is therefore recommended that governments reduce trade barriers, invest in trade enabling infrastructure like ports and roads, make good trade deals at regional trading blocks like the ECOWAS and promote export industries using special incentives and capacity building programmes.

The issues of quality of environment are also more of a priority, as it has been shown through empiricism that carbon emissions have an adverse effect on domestic investment. The

West African economies should, therefore, adopt green investment policies, such as the shift to cleaner sources of energy, encouragement of renewable energy sources (solar and wind), the establishment of environmental laws and policies that discourage unfriendly production activities, and the offer of incentive policy on green technologies. This will make economic development environmentally friendly which will increase the popularity of the region to the ecologically friendly investor.

It is necessary to re-evaluate the policies that led to the present financial inclusion outcomes because the current account ownership rates do not seem to reflect directly into the growth of investment. Whereas increasing accounts ownership helps in social inclusion, it should be supplemented with more financial intermediation that can help in transferring savings into productive investment. The focus of governments must thus be on the quality of financial inclusion rather than its quantity through the improvement in the effectiveness of financial institutions to evaluate and fund viable projects in investment, an entrepreneurial venture that should encourage the involvement of venture capital and private equity, and strengthen legal and regulatory frameworks that ensure the protection of the rights of investors and enforce contracts. The overall measures will maximize the importance of financial inclusion to national investment and economic sustainability in West Africa.

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