ASSESSING THE ENVIRONMENTAL IMPACTS OF FINANCIAL SECTOR DEVELOPMENT: EVIDENCE FROM CREDIT ALLOCATION AND MONETARY EXPANSION IN SUB-SAHARAN AFRICA

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Abstract

This study investigates the impact of financial sector development on environmental degradation in selected Sub-Saharan African countries, with a specific focus on the roles of credit to the private sector and broad money supply. Drawing on the Environmental Kuznets Curve (EKC) and Environmental Transition Theory (ETT), the research examines whether financial deepening exacerbates or mitigates ecological harm. The study utilizes a balanced panel dataset covering seven countries—Côte d'Ivoire, Ghana, Kenya, Mauritius, Namibia, Nigeria, and South Africa—over the period 1993 to 2021. Employing the Panel Autoregressive Distributed Lag (P-ARDL) framework as proposed by Pesaran, Shin, and Smith (1999), the analysis captures both short-run dynamics and long-run equilibrium relationships, while panel Granger causality tests are used to explore directionality between variables. The findings reveal that in the short run, broad money supply significantly reduces CO_2 emissions, while credit to the private sector has no immediate effect. In the long run, however, credit allocation contributes positively to ecological footprint per capita but reduces the broader ecological footprint index, suggesting mixed environmental implications depending on credit allocation and institutional context. The study also identifies bidirectional causality between financial development and CO_2 emissions, underscoring the feedback loop between economic activity and environmental pressure. Country-level heterogeneity further highlights the need for tailored financial-environmental strategies. Based on these results, the study recommends the implementation of targeted green finance policies, strengthened regulatory frameworks for credit allocation, and enhanced environmental governance mechanisms to ensure that financial development supports environmental sustainability across diverse African economies.

Keywords: Credit to the private sector, Ecological footprint EKC Hypothesis, Environmental degradation, Financial sector development

JEL Classification: 013, 04

1. INTRODUCTION

The contemporary global development discourse emphasizes two critical, yet often conflicting, objectives: sustaining economic growth and preserving environmental integrity. The challenge of reconciling these dual imperatives has gained increased prominence in the 21st century, largely due to the accelerating effects of climate change driven by anthropogenic greenhouse gas (GHG) emissions. Among these gases, carbon dioxide (CO_2) is the most significant, contributing approximately 60% of the enhanced greenhouse effect, thereby posing substantial risks to both ecological systems and human well-being (Acaravci & Ozturk, 2010).

In recent decades, the expansion of financial systems has played a crucial role in facilitating economic activities across countries. However, its implications for environmental sustainability remain deeply contested. Financial development, measured by indicators such as credit to the private sector and broad money supply to GDP, has the potential to either mitigate or exacerbate environmental degradation. On one hand, access to finance may stimulate investments in cleaner technologies and energy efficiency, thereby reducing environmental harm (Sadorsky, 2011; Shahbaz, Khan & Tahir, 2013). On the other hand, increased financial intermediation may facilitate greater consumption and industrial activities, leading to increased energy use and CO_2 emissions (Mahalik & Mallick, 2014; Al-Mulali, Saboori & Ozturk, 2015).

This debate is particularly relevant in the context of Sub-Saharan Africa (SSA), where countries are undergoing rapid financial and economic transformation amidst pressing environmental challenges. The region remains a vital part of the global agenda to mitigate carbon emissions, particularly as signatories to the United Nations Framework Convention on Climate Change (UNFCCC), which aims to limit global temperature rise to 2°C above pre-industrial levels (United Nations DESA, 2019). Despite their relatively low per capita emissions, SSA countries are highly vulnerable to climate-related risks and, therefore, must align their financial development pathways with environmental sustainability.

Notably, while a growing body of literature has explored the relationship between financial development and environmental degradation, empirical findings remain inconclusive. Some studies affirm that financial sector expansion leads to environmental improvements by enabling green investments (Tamazian, Chousa & Vadlamannati, 2009; Sehrawat, Giri & Mohapatra, 2015), while others argue that financial development exacerbates environmental harm due to increased energy consumption (Aslan, Destek & Okumus, 2018; Le, Le & Taghizadeh-Hesary, 2020). These inconsistencies are further compounded by variations in financial structures, methodological limitations, and country-specific factors such as institutional quality and regulatory frameworks.

A particular limitation in the existing literature is the narrow focus on single proxies of environmental degradation most commonly, CO_2 emissions. However,

CO_2 emissions represent only one facet of environmental damage. Scholars such as Al-Mulali et al. (2015) have advocated for broader indicators, such as the ecological footprint, to more comprehensively assess environmental outcomes. To address these gaps, this study investigates the relationship between financial development proxied by credit to the private sector and broad money supply to GDP and environmental degradation in selected Sub-Saharan African countries. By integrating multiple financial indicators and employing robust econometric techniques, including the Mean Group (MG) and Pooled Mean Group (PMG) estimators developed by Pesaran, Shin, and Smith (1999), the study provides robust insights into the long-run and short-run dynamics of finance-environment interactions. These techniques help to mitigate the problem of parameter heterogeneity and offer more reliable inferences for policy formulation.

The remainder of the paper is structured as follows. Section 2 presents the literature review. Section 3 outlines the methodology and model specification. Section 4 discusses the empirical results, and Section 5 concludes with conclusion and recommendations.

2. LITERATURE REVIEW

2.1 THE CONCEPT OF ENVIRONMENTAL DEGRADATION

Environmental degradation constitutes one of the most pressing and persistent challenges in contemporary economic, social, and ecological discourses. It is broadly defined as the deterioration in the quality of the natural environment, primarily because of anthropogenic activities. These activities include, but are not limited to, pollution, deforestation, desertification, biodiversity loss, climate change, and the depletion of air, water, and soil resources (Brown et al., 1987; Tian et al., 2004). Environmental degradation is thus understood not merely as a physical transformation of the earth's surface, but as a systemic breakdown of ecological integrity, often spurred by human consumption patterns, industrialization, urban expansion, and resource overexploitation (Johnson et al., 1997; Malcolm & Pitelka, 2000; Maurya et al., 2020).

According to the Intergovernmental Panel on Climate Change (IPCC, 2014), one of the central causes of environmental degradation is the accumulation of greenhouse gases in the earth's atmosphere, primarily resulting from fossil fuel combustion, deforestation, and other forms of land-use change. Among these greenhouse gases, carbon dioxide (CO_2) is the most abundant and is considered responsible for more than 60 percent of the global warming effect (Acaravci and Ozturk, 2010). In addition, the degradation process often includes the destruction of ecosystems and habitats, extinction of species, and significant reductions in air and water quality. These outcomes have extensive implications not only for the sustainability of ecological systems but also for economic development, human health, and long-term national security (Conserve Energy Future, 2020; Gasser & Luderer, 2018).

Environmental degradation is thus multi-dimensional in its manifestation and impact, necessitating a careful and integrative approach to measuring and understanding its causes, consequences, and control mechanisms. The selection of appropriate indicators is critical in this regard, as it influences the scope and depth of analysis.

2.2 INDICATORS OF ENVIRONMENTAL DEGRADATION

In academic and policy literature, numerous indicators are used to evaluate the extent of environmental degradation. However, in the context of empirical analysis, carbon dioxide emissions and ecological footprint are the most widely accepted and applied indicators.

Carbon Dioxide (CO_2) Emissions

Carbon dioxide is a colorless, odorless, and non-toxic gas that is naturally present in the atmosphere. However, its concentration has significantly increased due to human activities, particularly the burning of fossil fuels such as coal, oil, and natural gas, and through industrial processes like cement production (World Bank, 2018). CO_2 emissions are often measured in metric tons per capita and serve as a reliable proxy for the level of industrialization and energy consumption in a given economy. According to Eurostat (2017), carbon emissions comprise all emissions from the consumption of solid, liquid, and gaseous fuels, as well as gas flaring.

The importance of CO_2 as a metric system from its dominance among anthropogenic greenhouse gases. Brander (2012) notes that while there is other greenhouse gases regulated under the Kyoto Protocol—such as methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6)—CO_2 accounts for most global emissions. The term "carbon dioxide equivalent" (CO_2e) is often used to standardize different greenhouse gases by converting their impact into the equivalent amount of CO_2, thus allowing comparative analysis across emissions types.

Ecological Footprint

The ecological footprint extends the analysis of environmental degradation beyond the narrow lens of CO_2 emissions. It captures the biologically productive land and water area required to produce the resources consumed and to assimilate the wastes generated by a given population using prevailing technology (Wackernagel and Rees, 1996). The ecological footprint includes six components: cropland, grazing land, forest land, fishing grounds, built-up land, and carbon footprint. It is measured in global hectares (GHA) per capita and provides a more comprehensive understanding of human impact on the environment (Charfeddine & Mrabet, 2017; Katircioglu et al., 2018).

Al-Mulali and Sheau-Ting (2014) argue that ecological footprint serves as a more reliable measure of environmental degradation because it incorporates multiple dimensions of environmental stress, including carbon emissions, land use, and natural resource consumption. The use of this indicator allows researchers and policymakers to capture the broader and long-term ecological consequences of economic and financial activities. Majeed and Mazhar (2019) emphasize that ecological footprint provides a more holistic view of sustainability challenges, particularly in developing countries where traditional metrics may not fully reflect environmental realities.

2.3 FINANCIAL DEVELOPMENT

Financial development refers to the improvement in the quantity, quality, and efficiency of financial intermediary services. This includes the functioning of banks, financial markets, and other institutions involved in mobilizing savings, allocating capital, facilitating transactions, and managing risk (Levine, 2004; World Bank, 2016). A developed financial system is characterized by deep markets, a broad range of financial instruments, efficient payment mechanisms, and strong regulatory frameworks.

The relationship between financial development and environmental degradation is inherently ambiguous and has attracted considerable scholarly debate. On one hand, financial development can enhance environmental quality by mobilizing resources for investment in green technologies, improving energy efficiency, and encouraging corporate social responsibility (Tamazian et al., 2009; Shahbaz et al., 2013). Financial institutions, by offering favorable loan terms and credit incentives, can stimulate investment in renewable energy projects and cleaner production processes (Hamdan et al., 2018).

On the other hand, financial development may contribute to environmental deterioration by increasing access to capital, thereby promoting industrial expansion, urbanization, and consumption. This phenomenon, sometimes referred to as the "scale effect", suggests that as more credit becomes available, firms and households increase their use of fossil fuels and other environmentally harmful practices (Mahalik & Mallick, 2014; Al-Mulali et al., 2015). The result is an increase in CO_2 emissions and ecological degradation.

2.4 INDICATORS OF FINANCIAL DEVELOPMENT

To empirically assess the relationship between financial development and environmental degradation, researchers commonly rely on a set of quantifiable indicators. Among these, credit to the private sector and broad money supply to GDP are the most pertinent to understanding the financial-environmental nexus in Sub-Saharan Africa.

Credit to the Private Sector

This indicator reflects the extent to which commercial banks and other financial institutions allocate financial resources to the private sector. It is calculated as the ratio of domestic credit provided to the private sector to gross domestic product (GDP) (World Bank, 2009). Beck et al. (2000) argue that this measure is superior to others because it excludes credit to the public sector and thus more accurately reflects market-driven financial intermediation.

The role of private sector credit in environmental outcomes is twofold. When directed towards environmentally friendly investments, such as clean energy or sustainable agriculture, it can lead to environmental improvements. Conversely, if channeled into resource-intensive and polluting industries, it may worsen environmental degradation. Thus, the environmental impact of this indicator largely depends on the sectoral distribution of credit and the regulatory frameworks guiding financial allocations (Beck and Levine, 2004; Majeed and Mazhar, 2019).

Broad Money Supply to GDP (M2/GDP)

Broad money supply, commonly referred to as M2, encompasses currency in circulation along with demand deposits and other liquid assets. When expressed as a ratio to GDP, it serves as a measure of financial depth and liquidity in the economy (World Bank, 2009). This indicator reflects the capacity of the financial system to provide financial services and absorb shocks, and it is closely associated with the degree of monetization in the economy.

In terms of environmental implications, an increase in M2/GDP may indicate greater financial intermediation and capital availability, which could either be utilized for sustainable investments or for environmentally detrimental activities. Therefore, just like private sector credit, the effect of broad money supply on environmental degradation is context-specific and contingent upon regulatory and institutional environments.

2.5 THEORETICAL PERSPECTIVES

Environmental Kuznets Curve (EKC) Hypothesis

The Environmental Kuznets Curve (EKC) hypothesis represents a pivotal theoretical model in environmental economics. The hypothesis, popularized by Grossman and Krueger (1991, 1993, 1995) and formalized by Panayotou (1995), posits that the relationship between economic growth and environmental degradation follows an inverted U-shaped curve. This relationship suggests that at the initial stages of economic development, environmental degradation intensifies due to the proliferation of industrial activities, deforestation, fossil fuel consumption, and unregulated resource extraction—phenomena often driven by rapid urbanization and industrialization.

However, as income levels rise and countries reach a specific threshold (referred to as the **turning point**), a structural transition tends to occur. Economies shift from agriculture and heavy manufacturing to services and high-technology industries. This structural change is accompanied by increased environmental awareness, better regulatory enforcement, cleaner production techniques, and greater public demand for environmental protection, all of which collectively contribute to a gradual decline in environmental degradation (Grossman and Krueger, 1995; Hussen, 2005).

The EKC framework is underpinned by three fundamental effects:

1. **Scale Effect**: As economies grow, the scale of production and energy consumption increases, leading to higher levels of pollution and natural resource depletion.
2. **Composition Effect**: Over time, the economic structure evolves, with a transition from pollution-intensive industries to cleaner sectors, such as services and technology-based production.
3. **Technique Effect**: Technological advancement and regulatory improvements lead to more efficient and cleaner production processes, reducing pollution intensity per unit of output.

Empirical support for the EKC is mixed. While studies like Narayan and Narayan (2010), Shahbaz, Lean, and Shabbir (2012), and Sinha and Shahbaz (2018) confirm its validity in some contexts, other analyses—particularly those focused on developing and low-income countries—fail to find evidence of the inverted U-shaped relationship. Dasuki and Olubusoye (2020), in their comprehensive study of 43 African countries, found that only 21 percent of the countries demonstrated EKC consistency, whereas 79 percent showed monotonically increasing carbon emissions with economic growth. This suggests that without supportive institutional frameworks, adequate technological capacity, and effective environmental regulation, economic growth may not necessarily translate into environmental sustainability.

Environmental Transition Theory

The Environmental Transition Theory (ETT) complements the EKC and EMT by focusing on the stages of environmental change during economic transformation. ETT suggests that environmental degradation is not uniform across all stages of development. In the early phases of urbanization and industrialization, rapid expansion in energy consumption and infrastructure development leads to significant environmental stress. However, as economies mature and achieve higher levels of per capita income, they become more capable of investing in sustainable practices and enforcing environmental regulations (Majeed & Mazhar, 2019; Li et al., 2021).

ETT emphasizes the adaptive capacity of societies to transition from environmentally harmful to environmentally sustainable practices. The role of the financial system in this process is pivotal, as it provides the capital and incentives required for both technological adoption and structural shifts toward greener industries. ETT is particularly pertinent in the Sub-Saharan African context where many economies are in early-to-intermediate stages of this transition and thus face critical decisions on how to balance economic growth with environmental sustainability.

2.6 EMPIRICAL LITERATURE

Global Evidence

Majeed and Mazhar (2019) conducted one of the most comprehensive studies using panel data from 131 countries over the period 1971 to 2017. They employed several econometric techniques including system GMM and Driscoll-Kraay standard errors, and found that financial development, especially through private sector credit, significantly reduced ecological footprint. Their findings underscore the importance of green financial intermediation in improving environmental quality.

Similarly, Shahbaz et al. (2018) examined the French economy and found that financial development had a statistically significant negative impact on CO_2 emissions. This outcome was attributed to the advanced nature of the French financial system, its regulatory frameworks, and investment in energy research and innovations. Piñeiro-Chousa et al. (2017), studying BRIC countries, also reported that financial development reduced CO_2 emissions in the long run.

Contrarily, Shahbaz et al. (2020), focusing on the United Arab Emirates, reported a positive relationship between financial development and environmental degradation. Their results suggest that in the absence of robust environmental regulations and enforcement mechanisms, financial development may finance energy-intensive industries that contribute to pollution. Likewise, Hamdan et al. (2018) found that in ASEAN-5 countries, financial indicators such as private domestic credit and market capitalization positively affected CO_2 emissions, highlighting the potential negative externalities of unregulated financial expansion.

These mixed outcomes point to the need for disaggregated analysis, particularly in developing regions, where institutional and financial dynamics differ substantially from those in advanced economies.

Evidence from Sub-Saharan Africa

Majeed and Mazhar (2019) found that in Sub-Saharan Africa, domestic credit to the private sector had a negative impact on ecological footprint, suggesting that financial development in the region could support environmental sustainability if well-directed. Musa et al. (2021), examining Nigeria from 1981 to 2019, reported that financial development had a statistically significant negative impact on CO_2 emissions in both the short and long run, thus supporting the notion of green financial intermediation.

Conversely, Longe et al. (2020) reported that financial development in Nigeria increased carbon emissions in the short term, although it had a mitigating effect in the long run. Their study emphasized the role of sectoral allocation of credit and the maturity of financial institutions in influencing environmental outcomes. Dasuki and Olubusoye (2020), in a study of 43 African countries, found that the EKC hypothesis held in only a minority of cases, further highlighting the divergence between economic growth and environmental improvement in the region.

Kwakwa and Alhassan (2018) tested the EKC hypothesis in Tunisia and found its validation only for certain sources of emissions. These results suggest that in countries with weak institutional capacities and limited technological adoption, financial development may not automatically translate into environmental improvements.

3. METHODOLOGY

This study adopts a longitudinal panel data design, which is well suited for investigating the dynamic interaction between financial sector development and environmental degradation across countries and over time. Panel data analysis is preferred for its superior econometric properties, including its capacity to control unobserved heterogeneity, capture temporal dynamics, and improve estimation efficiency through increased degrees of freedom (Baltagi, 2008). Specifically, this design enables the examination of both short-run and long-run effects, aligning with the objectives of assessing Environmental Kuznets Curve (EKC) dynamics and the environmental impacts of financial development.

The empirical investigation focuses on seven Sub-Saharan African (SSA) countries: Côte d'Ivoire, Ghana, Kenya, Mauritius, Namibia, Nigeria, and South Africa. These countries are selected based on three criteria: (i) data availability from 1993 to 2021, (ii) relatively advanced financial systems, and (iii) geographic and economic representativeness within SSA. This purposive sampling approach ensures the inclusion of nations at different stages of financial and environmental transition, which is critical for testing the EKC hypothesis and analyzing cross-country heterogeneity.

3.1 DATA SOURCES AND PERIOD

Data is sourced from two internationally recognized databases:

- **World Bank's World Development Indicators (WDI, 2021)**, which provides indicators on financial development, economic performance, and macroeconomic control variables.
- **Global Footprint Network (2021)**, which supplies data on ecological footprint, a comprehensive measure of biocapacity demand.

The study covers a 29-year period (1993–2021), ensuring adequate temporal variation for robust panel regression analysis.

3.1 MODEL ESTIMATION

Following the structure proposed by Pesaran, Shin, and Smith (1999), the study estimates a Panel Autoregressive Distributed Lag (P-ARDL) model. This technique accommodates mixed order integration of regressors (I(0) and I(1)) and allows for both long-run equilibrium and short-run dynamics to be simultaneously modeled. The general P-ARDL specification is presented as:

$$\Delta \ln Y_{it} = \alpha_i + \phi_i(\ln Y_{it-1} - \theta_i' \ln X_{it-1}) + \sum_{j=1}^{p-1} \gamma_{ij} \Delta \ln Y_{it-j} + \sum_{j=0}^{q-1} \delta_{ij} \Delta \ln X_{it-j} + \varepsilon_{it}$$

Where:

- Y_{it}: Environmental degradation (CO_2 or EFP).
- X_{it}: Vector of independent variables (CPS, LLR, GDPPC, ENC, URB, FDI, SER).
- ϕ_i: Speed of adjustment to long-run equilibrium.
- θ_i : Long-run parameters.
- α_i : Country-specific intercept.
- ε_{it} : White noise error term.

Causality Analysis

To assess the directionality of the relationship between financial development, economic growth, and environmental degradation, the study employs **Granger causality testing** in a panel framework. The causality model tests whether lagged values of a variable X significantly explain the current values of another variable Y, over and above the past values of Y alone (Granger, 1969). The panel Granger causality approach accounts for heterogeneity across countries and is specified as follows:

$$Y_{it} = \beta_0 + \sum_{j=1}^{p} \beta_j Y_{it-j} + \sum_{j=1}^{q} \alpha_j X_{it-j} + u_{it}$$

$$X_{it} = \gamma_0 + \sum_{j=1}^{p} \delta_j X_{it-j} + \sum_{j=1}^{q} \phi_j Y_{it-j} + \vartheta_{it}$$

Bidirectional causality exists if both α_j and ϕ_j are jointly significant.

3.2 VARIABLE MEASUREMENT AND EXPECTED EFFECTS

Variable	Definition	Expected Sign	Source
CO_2 Emissions (CO_2)	Metric tons per capita	Dependent	World Bank (2021)
Ecological Footprint (EFP)	Global hectares per capita	Dependent	Global Footprint Network (2021)
Credit to Private Sector	% of GDP	+ or −	Hasan et al. (2021)
Broad Money Supply (LLR)	M2/GDP	+ or −	Nyarkoa & Kaya (2021)
Energy Consumption (ENC)	Primary energy uses per capita	+	Longe et al. (2020)

Urbanization (URB)	% of population in urban areas	+	Kwakwa & Alhassan (2020)
FDI Inflows (FDI)	% of GDP	+	Isiksal et al. (2019)
School Enrollment (SER)	% gross secondary enrollment	−	Kwakwa & Alhassan (2020)

Author's Compilation (2025)

The expected signs are based on extant literature, recognizing that financial development can either enhance or harm environmental quality depending on the type of investments and institutional context (Shahbaz et al., 2018; Zhang & Zhang, 2018).

3.2 ESTIMATION PROCEDURE

To ensure the validity and robustness of the empirical results, this study employs several preliminary econometric tests and estimation techniques. First, the Im, Pesaran, and Shin (IPS) panel unit root test is conducted to examine the stationarity properties of the variables, allowing for heterogeneity in autoregressive parameters across countries and testing the null hypothesis that all panels contain a unit root. Upon establishing the order of integration, the Pedroni (1999, 2001) residual-based panel cointegration test is applied to determine whether a long-run equilibrium relationship exists among the study variables, accounting for heterogeneity in the cointegrating vectors. For estimation, both the Mean Group (MG) and Pooled Mean Group (PMG) estimators are utilized within the Autoregressive Distributed Lag (ARDL) framework to capture both short-run and long-run dynamics. The choice between MG and PMG estimators is guided by the Hausman test, which assesses their relative efficiency and consistency. All statistical computations and estimations are performed using EViews 9.0 software.

4. RESULTS AND DISCUSSIONS

This section presents the empirical results of the study using several statistical tools, including trend analysis, descriptive statistics, unit root tests, correlation analysis, cointegration tests, the ARDL model for long- and short-run estimates, and Granger causality tests.

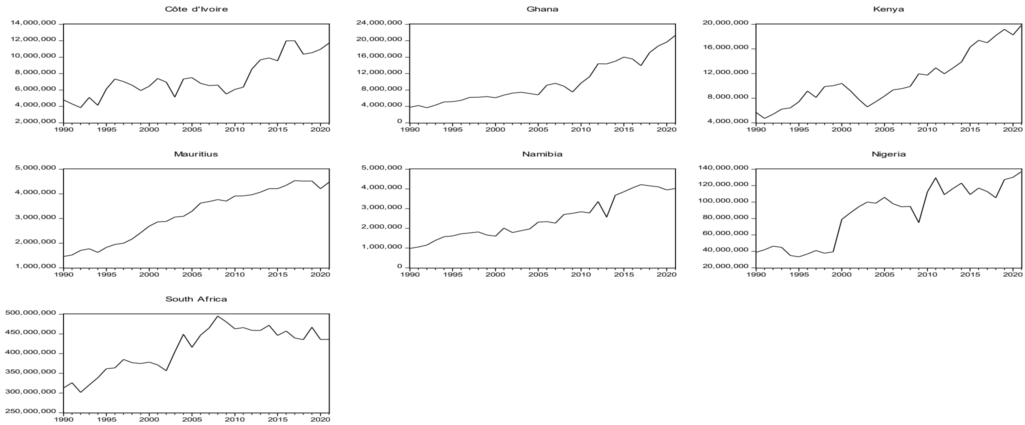

Figure 1a. *Trends in CO_2 Emissions and Ecological Footprint*
Source: Author's computation (2025) with the aid of E-view 9.0 econometric software

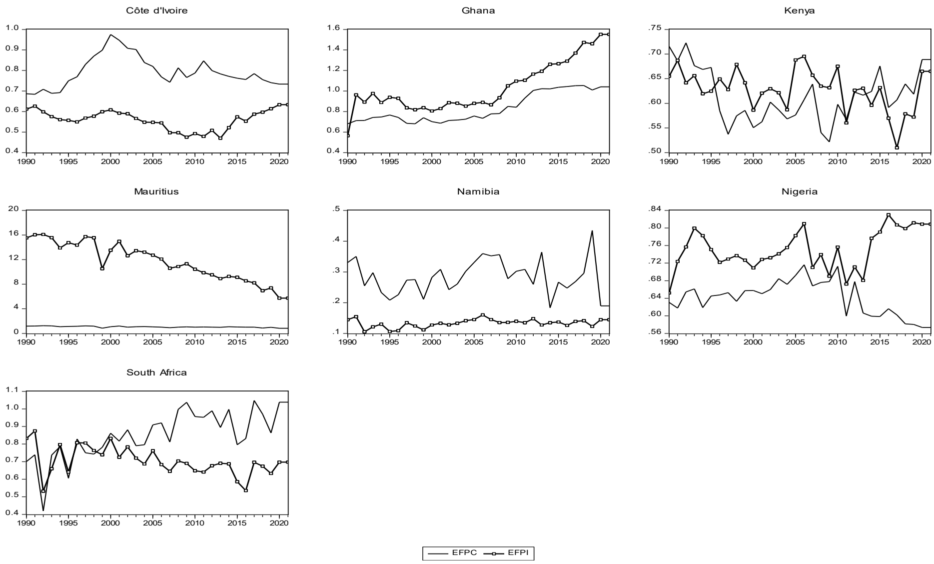

Figure 1b. *Trends in Ecological Footprint*
Source: Author's computation (2025) with the aid of E-view 9.0 econometric software

Figure 1 illustrates a consistent upward trend in total CO_2 emissions across all the Sub-Saharan African countries included in the study, indicating a rising contribution to global environmental degradation despite comparatively lower absolute emission levels than advanced economies. Notably, emissions in Côte d'Ivoire increased from 4 million tons in 1990 to over 10 million tons in 2022, while Nigeria's emissions surged from 40 million to 120 million tons over the same period. Figure 2 presents the trends in ecological footprint per capita, disaggregated into cropland (EFPC) and built-up land (EFPI). The patterns reveal country-specific differences, with EFPC being more prominent in Côte d'Ivoire, Namibia, and South

Africa, whereas EFPI is notably higher in Ghana, Nigeria, and Mauritius. Except for Mauritius, where ecological footprints show a declining trend, most countries exhibit either stable or increasing trajectories, suggesting a gradual intensification of environmental pressure.

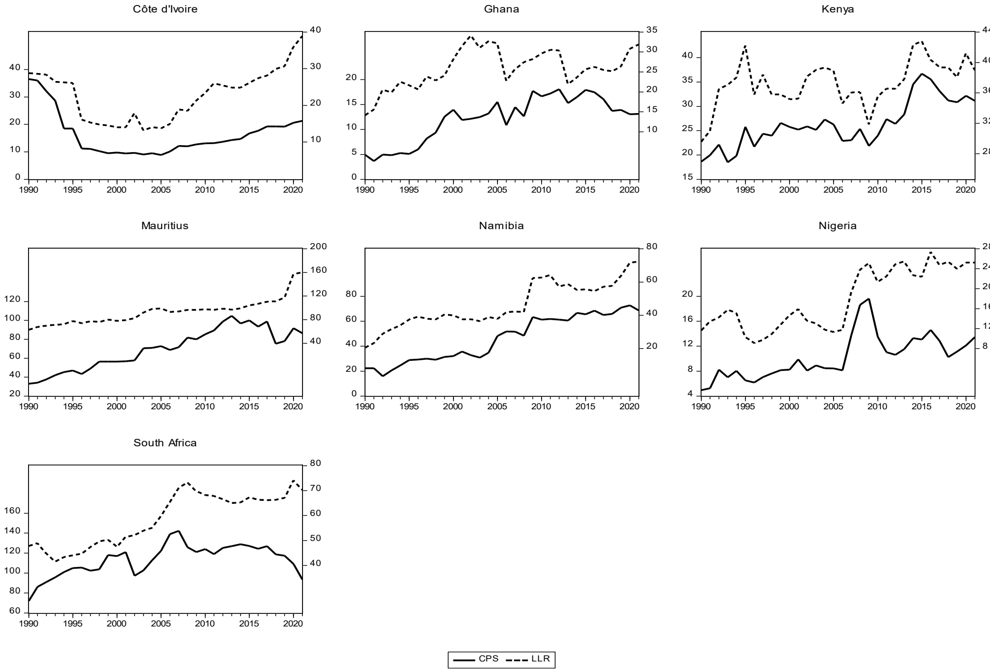

***Figure 2**: Trends in Credit and Financial Liquidity*
Source: Author's computation (2025) with the aid of E-view 9.0 econometric software

The trends in financial development indicators across the selected Sub-Saharan African countries reveal a general expansion of the financial sector since the 1990s, particularly in money markets, as evidenced by the upward movement in both financial liquidity (M2/GDP) and credit-to-GDP ratios. Figure 2 shows that financial liquidity consistently exceeds credit ratios across all countries, indicating stronger monetary depth relative to credit intermediation. However, these trends are not uniform over time: Côte d'Ivoire experienced a prolonged decline in both indicators from 1995 to the late 2010s, suggesting systemic financial distress; Nigeria witnessed a sharp rise in credit between 2005 and 2008, followed by a steep drop in 2009; and South Africa has faced a notable decline in credit ratios since 2017.

***Table 1:** Descriptive Statistics for Panel Data*

Variable	Mean	Max.	Min.	Std. Dev.	Skew.	Kurt.	J-B	Prob.
GCO2	4.51	99.11	-26.23	13.39	2.12	14.71	1402.96	0.00
EFPC	0.73	1.24	0.18	0.25	-0.28	2.68	3.83	0.15
EFPI	2.20	16.08	0.11	4.00	2.35	7.05	348.42	0.00

CPS	42.46	142.42	3.66	37.82	1.03	2.74	38.99	0.00
LLR	43.54	160.06	9.06	27.08	1.37	5.17	111.04	0.00
FDI	2.23	10.66	-1.42	2.25	1.58	5.19	133.22	0.00
URB	42.46	67.85	17.04	11.83	-0.19	2.64	2.47	0.29
SER	2.05	4.01	1.24	0.42	0.65	5.84	88.52	0.00
GENC	2.83	187.03	-31.43	18.01	6.48	62.24	33248.26	0.00

Source: *Author's computation (2025) with the aid of E-view 9.0 econometric software*

The descriptive statistics in Table 1 provide a preliminary overview of the central tendencies and distributional characteristics of the variables used in the panel dataset. The mean values of key environmental indicators—CO_2 emissions growth (GCO2) and ecological footprint per capita (EFPC)—are 4.51% and 0.73 global hectares, respectively, indicating moderate environmental pressure on average across the sampled countries. However, the extremely high standard deviation of GCO2 (13.39) and EFPI (4.00), along with their high maximum values (99.11 and 16.08, respectively), reflect substantial variability and potential outliers. The high skewness (2.12 for GCO2 and 2.35 for EFPI) and kurtosis values, particularly for GCO2 (14.71) and general energy consumption growth (GENC, kurtosis of 62.24), suggest the presence of non-normality and heavy tails, which is statistically confirmed by the Jarque-Bera (J-B) tests with p-values of 0.00, rejecting the null hypothesis of normal distribution for most variables. Only EFPC and URB display approximately normal distributions (p-values of 0.15 and 0.29, respectively). Variables such as credit to the private sector (CPS) and broad money supply (LLR) also show significant dispersion and positive skewness, indicating uneven financial development among countries. Notably, the negative minimum values for GCO2 and FDI indicate periods of contraction or capital outflows in some countries.

Table 2: *Descriptive Statistics for Individual Countries*

COUNTRY	GCO2	EFPC	EFPI	CPS	LLR
Côte d'Ivoire	4.32	0.79	0.56	16.20	22.70
Ghana	6.39	0.84	1.04	12.15	25.85
Kenya	4.72	0.62	0.63	26.30	37.30
Mauritius	3.79	1.06	11.66	69.75	93.52
Namibia	5.30	0.28	0.13	46.02	46.18
Nigeria	5.85	0.64	0.75	10.27	17.95
South Africa	1.21	0.85	0.70	113.25	58.49

Source: *Author's computation (2025) with the aid of E-view 9.0 econometric software*

Table 2 presents country-level descriptive statistics, highlighting significant variation in environmental and financial indicators across the selected Sub-Saharan African economies. South Africa exhibits the highest level of financial development, with a credit-to-private sector (CPS) ratio of 113.25% of GDP and a relatively high liquidity ratio (LLR) of 58.49%, though it records the lowest CO_2 emissions growth

(GCO2) at 1.21%. In contrast, Mauritius, while also financially advanced (CPS: 69.75%, LLR: 93.52%), shows a markedly higher ecological footprint index (EFPI) of 11.66, suggesting considerable environmental stress. Nigeria and Ghana report moderate GCO_2 levels but lower CPS and LLR values, indicating underdeveloped financial sectors. Namibia, despite modest environmental indicators, displays relatively high financial depth compared to most peers.

Table 3: *Correlation Matrix*

Variable	CO2	EFPC	EFPI	CPS	LLR	FDI	ENC	URB	SER
CO2	1								
EFPC	0.21 (0.00)	1							
EFPI	-0.19 (0.00)	0.61 (0.00)	1						
CPS	0.72 (0.00)	0.24 (0.00)	0.23 (0.00)	1					
LLR	0.17 0.01	0.34 0.00	0.64 0.00	0.64 0.00	1				
FDI	-0.16 (0.02)	-0.11 0.12	-0.07 (0.30)	-0.01 0.85	0.04 0.53	1			
ENC	0.82 0.00	0.19 0.00	0.09 (0.20)	0.68 (0.00)	0.58 0.00	0.00 (0.94)	1		
URB	0.63 0.00	0.41 0.00	0.02 (0.73)	0.51 0.00	0.21 0.00	0.13 0.06	0.61 (0.00)	1	
SER	0.35 (0.00)	0.27 (0.00)	0.27 (0.00)	0.62 (0.00)	0.67 (0.00)	0.24 (0.00)	0.54 (0.00)	0.37 (0.00)	1

Source: Author's computation (2025) with the aid of E-view 9.0 econometric software

The correlation matrix in Table 3 reveals several statistically significant relationships among the variables, offering preliminary insights into the interplay between environmental degradation, financial development, and socio-economic factors in Sub-Saharan Africa. CO_2 emissions show a strong and positive correlation with energy consumption (ENC) ($r = 0.82$, $p < 0.01$), affirming the dominant role of energy use in driving emissions. Similarly, CO_2 emissions are positively associated with credit to the private sector (CPS) ($r = 0.72$) and urbanization (URB) ($r = 0.63$), suggesting that financial deepening and urban growth may exacerbate environmental pressures. Interestingly, CO_2 emissions are only weakly correlated with broad money supply (LLR) ($r = 0.17$), indicating a less direct link between overall liquidity and emissions. The ecological footprint per capita (EFPC) is positively correlated with urbanization (r = 0.41), which supports the idea that urban expansion is associated with greater ecological stress. In contrast, the ecological footprint index (EFPI) is negatively correlated with CO_2 (r = -0.19), suggesting that the broader ecological dimension may capture environmental impacts beyond carbon emissions alone. School enrollment (SER) shows positive correlations with both financial variables (CPS: r = 0.62; LLR: r = 0.67) and environmental indicators, indicating that human capital development coexists with rising environmental and financial activity. Notably, foreign direct investment (FDI) exhibits weak and mostly insignificant correlations with environmental indicators, pointing to a potentially limited direct environmental effect in this context.

***Table 4a**: Panel Data Unit Root Tests Results in Levels*

Variables	*Common unit process*	*individual unit root process*		
	LLC	**IPS**	**ADF**	**PP-Fisher**
LCO2	-2.63**	0.37	10.31	9.72
EFPC	0.21	-0.52	17.31	33.82*
EFPI	2.06**	-0.60	28.41*	43.53*
LLR	0.96	1.21	14.37	14.69
CPS	-2.58**	-1.38	21.19	17.33
ENC	-0.93	1.39	8.11	6.53
FDI	-2.25**	-3.56**	36.96**	52.69**
URB	0.07	3.60	4.61	27.41
SER	-1.80	5.72	4.87	0.64

Source: Estimated by the Author. *Note: ** and * indicate significant at 1% and 5 % levels respectively; IPS = Im, Pesaran & Shin; LLC = Levin, Lin & Chu*

***Table 4b**: Panel Data Unit Root Tests Results in First Differences*

Variables	*Common unit process*	*individual unit root process*		
	LLC	**IPS**	**ADF**	**PP-Fisher**
LCO2	-7.60**	-8.61**	93.85**	176.2**
EFPC	-10.51**	-12.77**	132.8**	186.4**
EFPI	-7.13**	-13.28**	138.8**	209.4**
LLR	-5.98**	-6.84**	74.92**	156.2**
CPS	-5.04**	-5.84**	61.65**	125.7**
ENC	-6.67**	-6.79*	72.29**	165.7**
FDI	-7.49**	-10.75**	120.0**	189.4**
SER	4.03*	1.63	7.618	45.62**
URB	3.86*	3.56*	5.673	6.83

Source: Estimated by the Author. *Note: ** and * indicate significant at 1% and 5 % levels respectively; IPS = Im, Pesaran & Shin; LLC = Levin, Lin & Chu*

The unit root test results in Tables 4a and 4b confirm that most variables in the dataset are non-stationary at levels but become stationary after first differencing, indicating they are integrated of order one, I(1). In Table 4a, variables such as CO_2 emissions (LCO2), credit to the private sector (CPS), and foreign direct investment (FDI) are stationary at levels under the LLC test, while EFPI and EFPC show mixed results, being significant under some individual unit root tests. However, variables like urbanization (URB), and broad money supply (LLR) fail to reject the null of non-stationarity across most tests. In contrast, Table 4b shows that all variables, except for urbanization and school enrollment (SER), are significantly stationary in first differences at the 1% or 5% levels across all tests, including LLC, IPS, ADF, and PP-Fisher. These findings validate the appropriateness of applying ARDL.

Table 5: *Cross-section Dependence Test Results*

Equation series tested	Pesaran CD	P-value	Abs corr
CO2	0.635	0.516	0.144
EFC	1.123	0.239	0.195
EFPI	-0.692	0.488	0.170

Source: Author's computations (2025)

Table 5 presents the results of the cross-section dependence (CD) tests for the key environmental variables—CO_2 emissions (CO2), ecological footprint per capita (EFC), and ecological footprint index (EFPI)—using the Pesaran CD statistic. The p-values for all three variables exceed the 0.05 significance threshold (CO2: $p = 0.516$; EFC: $p = 0.239$; EFPI: $p = 0.488$), indicating a failure to reject the null hypothesis of cross-sectional independence. This implies that the environmental indicators across the sampled Sub-Saharan African countries do not exhibit significant contemporaneous correlation, suggesting limited common shocks or interdependence in environmental dynamics.

Table 6: *Results of Bounds Test of Cointegration*

Country	F-statistic	I(0)	I(1)
Côte d'Ivoire	54.86	2.04	2.08
Ghana	3.72	2.04	2.08
Kenya	82.93	2.04	2.08
Mauritius	11.34	2.04	2.08
Namibia	13.44	2.04	2.08
Nigeria	5.12	2.04	2.08
South Africa	2.12	2.04	2.08

Source: Author's computation (2025)

The results of the Bounds Test for cointegration in Table 6 indicate evidence of long-run relationships between the variables in most of the selected countries. The computed F-statistics for Côte d'Ivoire (54.86), Kenya (82.93), Mauritius (11.34), Namibia (13.44), and Nigeria (5.12) all exceed the upper critical bound value at the 5% significance level (I(1) = 2.08), confirming the presence of cointegration. Ghana's F-statistic (3.72) is also above the critical bounds, though marginally, suggesting a weaker but still valid long-run relationship. In contrast, South Africa's F-statistic (2.12) barely exceeds the lower bound (I(0) = 2.04) and falls close to the inconclusive region, indicating weak or no evidence of cointegration. These findings imply that, for most countries, economic and financial variables move together with environmental indicators in the long run, justifying the use of long-run estimation techniques in subsequent analysis.

Table 7: *Short Run PMG Estimates- Regression Results for the Effects of Financial Development on Environmental Degradation*

Variable	*LCO2*			*EFPC*			*EFPI*		
	Coeff.	**t-ratio**	**prob.**	**Coeff.**	**t-ratio**	**prob.**	**Coeff.**	**t-ratio**	**prob.**
Constant	3.172	2.934	0.00	0.030	0.140	0.89	0.510	0.423	0.67
ΔCPS	0.006	0.886	0.38	-0.003	-1.641	0.11	-0.006	-1.629	0.11
$ΔCPS_{t-1}$	-0.003	-0.677	0.50	-0.003	-1.519	0.13	-0.004	-0.445	0.66
ΔLLR	-0.012	-2.118	0.04	0.002	0.654	0.52	0.019	1.019	0.31
$ΔLLR_{t-1}$	-0.001	-0.349	0.73	-0.003	-0.579	0.56	-0.014	-2.031	0.05
ΔLENC	0.330	1.236	0.22	-0.270	-1.156	0.25	-0.624	-1.213	0.23
$ΔLENC_{t-1}$	0.277	1.491	0.14	-0.279	-1.068	0.29	0.152	0.164	0.87
ΔURB	3.655	1.501	0.14	0.678	1.241	0.22	-6.678	-1.009	0.32
$ΔURB_{t-1}$	-3.518	-1.450	0.15	-1.508	-2.048	0.04	-0.769	-0.729	0.47
ΔFDI	0.007	0.549	0.58	-0.011	-1.479	0.14	-0.039	-1.376	0.17
$ΔFDI_{t-1}$	0.000	0.020	0.98	-0.004	-0.925	0.36	0.027	0.774	0.44
ΔSER	3.688	1.238	0.22	3.774	0.998	0.32	27.358	1.100	0.27
$ΔSER_{t-1}$	4.828	0.990	0.33	-1.148	-0.299	0.77	-48.494	-1.109	0.27
ECM_{t-1}	-0.511	-2.882	0.01	-0.659	-4.042	0.00	-0.010	-0.153	0.88
S.E. of reg.	0.088			0.000			-0.047		
Mean dep. Var.	0.038			0.049			0.401		

Source: Author's computation (2025)

The short-run Panel Mean Group (PMG) estimates in Table 7 offer nuanced insights into the dynamic effects of financial development on environmental degradation across Sub-Saharan African countries. The results show that in the short run, broad money supply (ΔLLR) significantly reduces CO_2 emissions (coefficient = -0.012, p = 0.04), suggesting that financial liquidity—when effectively mobilized—may support environmentally beneficial activities such as investments in energy efficiency or green technology. However, this effect is not consistent across all environmental indicators, as LLR's influence on ecological footprint per capita (EFPC) and ecological footprint index (EFPI) is statistically insignificant in the current period but becomes significant and negative for EFPI at lagged levels ($p = 0.05$). This lagged effect implies that the environmental benefits of financial deepening may materialize over time. These findings align with the argument of Tamazian et al. (2009) and Shahbaz et al. (2013), who contend that financial development can contribute positively to environmental sustainability when channeled toward clean technologies and well-regulated sectors. On the contrary, credit to the private sector (CPS) shows no significant short-run effect on CO_2 emissions or EFPI, and only a marginally negative but insignificant effect on EFPC, which may reflect weak environmental targeting in credit allocation, a concern echoed by Majeed and Mazhar (2019) for many developing economies.

Moreover, the error correction terms (ECMt-1) are negative and statistically significant for both CO_2 emissions (–0.511, $p = 0.01$) and EFPC (–0.659, $p < 0.01$), confirming the presence of long-run equilibrium relationships and indicating that deviations from the long-run path are corrected over time. However, the error correction term for EFPI is insignificant, suggesting no meaningful long-run adjustment in that dimension. These results align with the Environmental Kuznets Curve (EKC) and Environmental Transition Theory (ETT), both of which predict that environmental degradation may decrease over time with rising institutional maturity and financial development, provided effective policy and technological mechanisms are in place (Grossman & Krueger, 1995; Majeed & Mazhar, 2019; Li et al., 2021). Overall, the findings reinforce the argument that financial development's impact on environmental degradation in Sub-Saharan Africa is heterogeneous, both across indicators and over time, and highlight the critical importance of sector-specific financial governance and targeted green financing to realize sustainable development outcomes.

***Table 8a**: Long Run PMG Estimates*

Variable	*LCO2*			*EFPC*			*EFPI*		
	Coeff.	**t-ratio**	**prob.**	**Coeff.**	**t-ratio**	**prob.**	**Coeff.**	**t-ratio**	**prob.**
CPS	0.002	0.572	0.57	0.003	3.016	0.00	-0.051	-2.453	0.02
LLR	-0.017	-4.133	0.00	0.001	1.059	0.29	-0.063	-2.330	0.02
LENC	0.178	3.025	0.00	0.080	2.244	0.03	-4.659	-2.661	0.01
URB	0.076	4.063	0.00	0.028	8.209	0.00	0.142	1.595	0.11
FDI	0.004	0.389	0.70	0.003	2.220	0.03	-0.235	-2.759	0.01
SER	-0.417	-0.716	0.48	-0.687	-8.770	0.00	-10.572	-2.372	0.02

Source: Author's computation (2025)

The long-run PMG estimates in Table 8a reveal significant and varied effects of financial development on environmental degradation indicators across Sub-Saharan African countries. Credit to the private sector (CPS) has a statistically significant positive effect on ecological footprint per capita (EFPC) ($p < 0.01$), suggesting that increased private sector credit contributes to environmental stress through higher resource consumption—consistent with the scale effect posited in the EKC literature (Grossman & Krueger, 1995; Mahalik & Mallick, 2014). However, CPS exerts a negative effect on the ecological footprint index (EFPI) ($p = 0.02$), implying that, when credit is channeled toward sustainable sectors, it may mitigate broader ecological pressures, a finding that aligns with Majeed and Mazhar's (2019) argument on green financial intermediation. Similarly, broad money supply (LLR) significantly reduces both CO_2 emissions (LCO2) and EFPI, supporting Shahbaz et al. (2013) and Tamazian et al. (2009) who argue that financial deepening can improve environmental quality when financial systems support clean investment.

Table 8b: *Individual Country Long Run Results*

Variable	*Cote d'Ivoire*		*Ghana*		*Kenya*		*Mauritius*		*Namibia*		*Nigeria*		*South Africa*	
	Coeff.	**Prob.**	**Coeff.**	**Prob.**	**Coeff.**	**Prob.**	**Coeff.**	**Prob.**	**Coeff.**	**Prob.**	**Coeff.**	**Prob.**	**Coeff.**	**Prob.**
CPS	0.082	0.022	-0.132	0.039	-0.057	0.021	-0.022	0.000	0.074	0.012	-0.019	0.020	0.001	0.719
LLR	-0.079	0.038	0.097	0.026	0.034	0.115	-0.004	0.442	-0.048	0.016	0.004	0.617	-0.005	0.046
LENC	0.798	0.323	-0.747	0.535	-3.227	0.010	0.612	0.027	-0.050	0.744	1.030	0.001	1.719	0.036
FDI	0.348	0.053	-0.171	0.006	0.081	0.031	0.001	0.933	-0.073	0.043	0.006	0.735	0.010	0.282
URB	0.335	0.258	0.850	0.001	2.143	0.016	-5.698	0.001	-0.032	0.395	-0.035	0.509	0.562	0.175
SER	0.717	0.937	-26.90	0.002	-15.003	0.027	-16.42	0.013	4.381	0.092	1.776	0.275	-0.071	0.565
Constant	16.869	0.069	1.048	0.893	17.428	0.155	341.2	0.007	17.095	0.047	16.09	0.000	-0.252	0.200

Source: Author's computation (2025)

The individual country long-run estimates in Table 8b reveal significant heterogeneity in the relationship between financial development and environmental degradation across the selected Sub-Saharan African countries, reinforcing the context-specific nature of the financial–environmental nexus discussed in the literature. Credit to the private sector (CPS) exhibits both positive and negative effects: it increases environmental degradation in Côte d'Ivoire and Namibia, consistent with the scale effect (Mahalik & Mallick, 2014), while it significantly reduces it in Ghana, Kenya, Mauritius, and Nigeria, aligning with the findings of Majeed and Mazhar (2019) and Musa et al. (2021) that financial intermediation can support environmental sustainability when credit is well-directed. Broad money supply (LLR) mostly shows negative effects—especially in Côte d'Ivoire, Namibia, and South Africa—indicating that greater liquidity may enhance green financing opportunities, consistent with Tamazian et al. (2009).

Table 9: *Causality Test Result*

Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.
CPS does not homogeneously cause LCO2	5.996	3.917	0.000
LCO2 does not homogeneously cause CPS	7.069	5.460	0.000
LLR does not homogeneously cause LCO2	4.175	2.002	0.041
LCO2 does not homogeneously cause LLR	5.130	3.298	0.001
CPS does not homogeneously cause EFPC	5.470	3.676	0.000
EFPC does not homogeneously cause CPS	1.067	-1.234	0.217
LLR does not homogeneously cause EFPC	6.781	5.139	0.000
EFPC does not homogeneously cause LLR	2.183	0.010	0.992
LCO2 does not homogeneously cause LGDPPC	3.427	1.398	0.162
LGDPPC does not homogeneously cause LCO2	6.513	4.840	0.000
EFPC does not homogeneously cause LGDPPC	2.740	0.631	0.528
LGDPPC does not homogeneously cause EFPC	8.331	6.868	0.000
EFPI does not homogeneously cause LGDPPC	3.061	0.990	0.322
LGDPPC does not homogeneously cause EFPI	12.161	11.140	0.000

Source: Author's computation (2025)

The causality test results in Table 9 reveal bidirectional and unidirectional causal relationships between financial development indicators and environmental degradation, providing critical empirical support to the dynamic interactions suggested by prior literature. Notably, a bidirectional causality exists between credit to the private sector (CPS) and CO_2 emissions (LCO2) ($p = 0.000$), indicating a feedback mechanism whereby increased private credit contributes to emissions—likely through industrial and consumption expansion—while rising emissions, in turn, influence financial sector behavior, possibly via environmental risk exposure or regulatory adaptation. This aligns with the findings of Shahbaz et al. (2020) and Hamdan et al. (2018), which suggest that without strong environmental oversight, financial development can exacerbate ecological degradation. Similarly, broad money supply (LLR) also shows bidirectional causality with CO_2 emissions ($p < 0.05$), underscoring its role as both a driver and consequence of environmental pressures, a pattern echoed in the work of Tamazian et al. (2009).

For ecological footprint per capita (EFPC), unidirectional causality is observed from CPS and LLR to EFPC, with no reverse causation, suggesting that financial variables exert a direct influence on broader ecological outcomes, consistent with Al-Mulali and Sheau-Ting's (2014) assertion that financial expansion can alter land use and resource demand patterns. In contrast, GDP per capita (LGDPPC) displays strong unidirectional causality toward all environmental indicators (LCO2, EFPC, EFPI), but not vice versa, reinforcing the scale effect from the Environmental Kuznets Curve (EKC) framework (Grossman & Krueger, 1995; Dasuki & Olubusoye, 2020).

5. Conclusion and Recommendations

This study provides robust empirical evidence on the dynamic relationship between financial sector development and environmental degradation in selected Sub-Saharan African countries from 1993 to 2021. The findings underscore that financial development, through both credit allocation and monetary expansion, exerts heterogeneous effects on environmental quality. In the short run, broad money supply significantly reduces CO_2 emissions, suggesting that financial liquidity can support environmentally sustainable investments when properly channeled. However, private sector credit does not yield immediate environmental benefits, reflecting potentially weak environmental targeting in credit allocation. Long-run estimates reveal that financial deepening especially when accompanied by effective institutional and regulatory frameworks can mitigate environmental degradation, as demonstrated by the negative impact of financial indicators on CO_2 emissions and the ecological footprint index in several countries. The causality analysis further validates the bidirectional relationship between financial development and carbon emissions, while also confirming the unidirectional influence of economic growth on environmental degradation. These results reaffirm the relevance of the Environmental Kuznets Curve and Environmental Transition Theory in the Sub-Saharan African context, while also highlighting the critical role of financial systems in shaping sustainable development pathways.

First, policymakers should strengthen the alignment between financial sector development and environmental sustainability objectives. This can be achieved through the implementation of green finance frameworks that incentivize investments in renewable energy, sustainable infrastructure, and resource-efficient technologies. Regulatory measures such as green credit guidelines, environmental risk assessments in loan portfolios, and interest rate subsidies for clean technology projects could enhance the environmental orientation of private credit. Central banks and financial supervisory authorities in Sub-Saharan Africa should also play an active role in mainstreaming environmental considerations into financial sector operations, drawing on best practices from regions where financial development has demonstrably improved environmental outcomes (e.g., France and BRIC economies, as highlighted by Shahbaz et al., 2018; Piñeiro-Chousa et al., 2017).

Second, country-specific strategies are necessary due to the significant heterogeneity observed across nations. For example, while Ghana and Kenya benefit environmentally from credit expansion, countries like Côte d'Ivoire and Namibia experience adverse effects, implying that institutional quality, sectoral credit distribution, and the maturity of financial systems mediate environmental outcomes. Governments should thus invest in capacity building for financial institutions to conduct environmental due diligence and monitor the ecological impacts of financed projects. Additionally, enhancing environmental education and promoting public awareness as evidenced by the negative long-run effect of school enrollment on ecological degradation can serve as a complementary strategy. Future research should further disaggregate financial flows by sector and incorporate metrics of institutional governance to better understand the conditions under which financial development contributes to or detracts from environmental sustainability in the African context.

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