Journal of Entrepreneurship and Business Sustainability

The Nexus Between Remittances and Environmental Sustainability in Sub-Saharan Africa: Does the Moderating Role of Private Investment and Institutional Quality Matter?

Ndzembanteh Aboubakary Nulambeh
Department of Economics, the University of Bamenda, P.O.Box 39 Bambili, Bamenda, Cameroon

Roland Joefendeh
Department of Economics, the University of Bamenda, P.O.Box 39 Bambili, Bamenda, Cameroon

Haruna Babatunde Jaiyeoba
International Institute for Halal Research and Training (INHART), International Islamic University Malaysia, Kuala Lumpur, Malaysia

Submitted on: 13 March 2026
Revised on: 10 May 2026
Accepted on: 15 May 2026

Abstract

Using ecological footprint as a general index of environmental degradation, this study examines the effects of remittances, private investment, and institutional quality on environmental sustainability in Sub-Saharan Africa. In order to handle possible endogeneity and unobserved heterogeneity, the study uses the System Generalized Method of Moments (GMM) on panel data from 31 nations between 2011 and 2020. The Heritage Foundation, World Development Indicators, and the Global Footprint Network provided the data. Based on the findings, remittances, private investment, and institutional quality are associated with a significant reduction in ecological footprint, suggesting that when effectively utilized, they can contribute to improved environmental outcomes. The Environmental Kuznets Curve (EKC) theory is also supported by the study, which shows a nonlinear link between regional environmental degradation and economic growth. These results highlight the significance of integrated policy frameworks that support environmentally conscious investment, enhance institutional governance, and foster sustainable financial flows. By aligning economic development strategies with environmental goals, sub-Saharan African countries can foster ecological resilience and support long-term sustainable development.

Keywords: *Remittances, Private Investment, Institutional Quality, Ecological Footprint, Sub-Saharan Africa, GMM.*

Vol. 1, No. 1, 2026
pp. 58-74
e-ISSN: 0000-0000

Funding and Acknowledgements: The authors received no external funding for this study and have no acknowledgements to declare.

1. Introduction

The rising importance of remittances, private investment, and institutional frameworks in shaping economic and environmental outcomes has sparked a growing body of academic debate, especially when considering developing economies. Sub-Saharan Africa (SSA), a region marked by rapid urbanization, demographic shifts, and economic volatility, has substantially increased remittance inflows over the past three decades. From just $3 billion in 1990, remittances to SSA rose to approximately $38 billion by 2017, overtaking both official development assistance (ODA) and foreign direct investment (FDI) in a number of nations as the main external funding source. (Cha'Ngom, 2020; IMF, 2021; Mohammed, 2022). These funds, sent by migrant workers abroad, serve as a lifeline for many households, improving livelihoods, enabling small-scale entrepreneurship, and enhancing access to education and healthcare.

However, the implications of these financial flows for environmental sustainability remain ambiguous and underexplored. While remittances can improve living standards and stimulate economic activity, they may also increase demand for energy-intensive goods and services, potentially escalating carbon emissions and environmental degradation (Rahman et al., 2019; Akinlo, 2022). Similarly, private investments, although critical for technological advancement and infrastructure development, can also contribute to ecological strain in the absence of effective environmental regulations (Wang et al., 2021). Meanwhile, by guaranteeing the enforcement of environmental rules, the caliber of institutions plays a crucial role in mitigating these consequences, promoting transparency, and guiding investments toward sustainable ventures (Ahmad et al., 2019). This intricate interaction of economic and institutional factors with ecological outcomes can be theoretically anchored in EKC, or the Environmental Kuznets Curve, theory. According to the EKC, there is a nonlinear link between economic growth and environmental degradation: ecological harm tends to increase during early stages of development, while societies invest more in environmental conservation after a particular income threshold, leading to improved ecological outcomes. In the SSA context, this theory provides a useful lens for evaluating whether rising remittances and investments, mediated by institutional quality, can shift the region towards a more sustainable growth path.

Although the significance of environmental sustainability is becoming more widely acknowledged, empirical research that jointly examines the roles of remittances, private investment, and institutional quality in determining environmental sustainability in SSA is still limited. Most existing studies analyze these variables in isolation or focus solely on high-income or middle-income countries (Yang et al., 2020; Sharma et al., 2019). Moreover, many people mainly use CO2 emissions as a stand-in for environmental deterioration, ignoring more complete measures like the ecological footprint, which more fully accounts for land use, the use of natural resources, and ecosystem consequences.

By filling this empirical gap and providing a sophisticated understanding of how financial flows and governance systems interact to impact environmental outcomes in SSA, this research adds to the body of scholarship. In particular, it uses a dynamic panel data technique based on the System Generalized Method of Moments (GMM) to examine how remittances, private investment, and institutional quality affect the ecological footprint in 31 SSA nations between 2011 and 2020. This method resolves endogeneity issues and enables more reliable causal inference than static models.

The study offers a number of significant insights. First, by including institutional quality as a moderating component in the remittance-investment -environment relationship, it broadens the body of research on environmental economics. Second, it

shifts the analytical focus toward ecological footprint as a multidimensional measure of environmental sustainability. Third, contextualizing findings within SSA provides targeted policy insights relevant to a region facing unique development and ecological challenges. The results are expected to offer evidence-based guidance to policymakers seeking to design integrated frameworks that balance economic growth with environmental preservation. This is how the rest of the paper is organized. A thorough analysis of the pertinent literature, including recent empirical research and theoretical viewpoints, is provided in Section 2. The approach is described in Section 3, along with the model formulation, data sources, and estimating methods. The empirical findings and their implications are covered in Section 4. Section 5 wraps up the work by noting the main conclusions and their wider policy significance.

2. Literature Review

Theoretical Review

With an emphasis on the moderating effects of institutional quality and private investment, this section summarizes the main theoretical frameworks pertinent to the relationship between remittances and environmental sustainability in Sub-Saharan Africa (SSA). For many years, the Environmental Kuznets Curve (EKC) theory has provided a fundamental framework for comprehending the connection between environmental deterioration and economic growth. According to the EKC, which was first proposed by Grossman and Krueger (1991), there is an inverse U-shaped correlation between environmental deterioration and per capita income. Growing incomes in the early phases of economic development are usually linked to worsening environmental conditions brought on by industrialization, deforestation, and intense resource extraction. But after a certain income level, environmental benefits are linked to additional economic growth, driven by greater environmental awareness, technological innovation, and more stringent regulatory frameworks. In the context of SSA, the EKC is particularly relevant yet contentious. Given the region's generally low to middle-income levels and dependence on natural resource exploitation, it is uncertain whether many countries have reached or are approaching the EKC turning point. Furthermore, empirical tests of the EKC often lack statistical robustness in low-income settings where institutional weaknesses and data limitations are prevalent (Dinda, 2004; Stern, 2004). Despite these limitations, the EKC remains a valuable starting point for analyzing the environmental implications of income growth facilitated by remittances.

The economic and environmental results in Sub-Saharan Africa are greatly influenced by remittances, or money sent home by migrants. These transfers can raise household incomes, reduce poverty, and stimulate local economic activity. However, their impact on the environment is complex and multifaceted. According to Lim and Basnet (2017), remittances influence consumption patterns, land use decisions, infrastructure development, and energy demand, all of which have potential environmental consequences. Theoretical perspectives such as the Permanent Income Hypothesis (Friedman, 1957) argue that if remittance inflows are perceived as stable and permanent, they will increase long-term consumption and investment, possibly leading to greater environmental stress through increased energy use and material consumption.

The Five Stages Interaction Mechanism (FSIM) offers a more detailed theoretical explanation of how remittances influence environmental outcomes. The first stage begins with remittances increasing household income, particularly in economically constrained environments like SSA. In the second stage, rising incomes lead to increased household

savings and consumption, with implications for greater resource utilization. The third stage involves higher savings and consumption feeding into increased bank deposits and aggregate demand. This, in turn, fuels economic activity, as explained in the fourth stage, where industrial production and financial sector development are stimulated. In the final stage, higher industrial output and financial expansion lead to increased CO_2 emissions, particularly in the absence of clean energy technologies and effective regulatory mechanisms. The FSIM framework illustrates the indirect but significant environmental implications of remittance inflows in developing regions.

In order to moderate the relationship between remittances and environmental sustainability, private investment plays a crucial role. Environmental impacts from private investment can be both favorable and unfavorable. On the one hand, when directed toward energy-intensive or resource-extractive sectors, it may exacerbate environmental degradation. On the other hand, if investments are oriented toward renewable energy, green infrastructure, or clean technology, they can significantly improve environmental outcomes (Baloch et al., 2019). Private investors may move pollution-intensive operations to nations with lax environmental rules, according to the Pollution Haven Hypothesis (Cole, 2004). This dynamic is especially pertinent for SSA. As a result, the type of investment and the host nation's environmental governance determine how remittance-driven private investment affects the environment.

Another important moderating factor in determining how remittances affect the environment is institutional quality. To guarantee that more financial inflows have a positive impact on environmental results, good governance, high-quality regulations, the rule of law, and low levels of corruption are necessary. In countries with strong institutions, remittances are more likely to be channeled into environmentally sustainable investments and consumption. Conversely, in countries with weak institutions, remittances may fuel environmentally harmful activities due to poor regulatory enforcement and corruption (Frankel and Rose, 2005; Dasgupta et al., 2006). The institutional environmentalism theory supports the view that effective institutional frameworks are key to internalizing environmental externalities and promoting sustainability. Given the institutional fragility observed in many SSA countries, strengthening governance systems is essential for harnessing remittance inflows in a manner that supports environmental objectives.

Empirical literature: Linking Remittances to Environmental Sustainability

The empirical literature exploring the relationship between remittances and environmental sustainability presents a complex and often contradictory narrative. While some studies support the notion that remittance inflows can contribute positively to environmental outcomes, others highlight their potential to exacerbate environmental degradation. This divergence is primarily attributed to contextual factors such as the nature of energy consumption, economic structure, governance quality, and the development trajectory of the recipient countries.

Several studies offer empirical support for the environmentally beneficial role of remittances. For instance, Wang et al. (2021) found that remittances considerably reduce carbon emissions in a few nations after analyzing panel data in some selected countries. Their findings align with Sharma et al. (2019), who observed that remittance inflows reduce CO2 emissions in Nepal. These studies suggest that remittances may enable households to adopt cleaner technologies, reduce reliance on environmentally harmful energy sources, or improve energy efficiency through increased investment in sustainable infrastructure. The conclusion from Wang et al. (2021) specifically notes that

reduced greenhouse gas (GHG) emissions are linked to greater remittance levels, underscoring a potential decoupling of income inflows from environmental harm.

However, this optimistic view is challenged by a growing body of evidence pointing to a negative environmental externality associated with remittances. Yang et al. (2020), employing a robust system Generalized Method of Moments (GMM) estimator on a panel of 97 countries from 1990 to 2016, found that remittance usage leads to an increase in CO2 emissions. Their later study (Yang et al., 2021) further confirmed that remittances, in combination with financial development and technological innovations, worsen the state of the environment in the economies of Brazil, India, China, and South Africa, which are known as the BRICS. These findings emphasize that remittance-induced income gains may raise consumption and production levels, which in turn amplify carbon-intensive activities, especially in the absence of green regulatory frameworks.

Using an autoregressive distributed lag (ARDL) bounds testing approach, Rahman et al. (2023) offer more proof of a positive association between remittances and CO2 emissions in South Asian nations, specifically Bangladesh, the Philippines, Sri Lanka, and Pakistan. Similarly, Shah et al. (2023) report that remittance inflows cause both short- and long-term increases in CO_2 emissions, with remittances being significantly and positively connected to the use of energy from both non-renewable and renewable sources. These findings underscore the dual-edged nature of remittances: while they may boost economic resilience and consumption, they can simultaneously increase ecological pressures if not managed sustainably.

The study by Zhao and Qamruzzaman (2022) confirms this concern by linking remittance inflows to increased energy usage, thereby contributing to environmental degradation. Likewise, Mazhar et al. (2022) argue that remittances stimulate both technological and financial development, which paradoxically can deteriorate environmental quality if such advancements are not environmentally conscious. This reveals a key insight: while remittances can foster modernization, their sustainability impact depends heavily on the types of technologies and financial activities they support.

Ahmad et al. (2019), who differentiate between the impacts of positive and negative remittance shocks on environmental outcomes in China, provide additional nuance. Their 1980–2014 time series study shows that positive shocks typically increase CO_2 emissions, whereas negative remittance shocks decrease them. This asymmetric relationship is corroborated by Neog and Yadava (2020), who applied an ARDL that is nonlinear (NARDL) model and found that positive shocks to remittance inflows increase CO2 emissions, while negative shocks reduce them. Such findings highlight the importance of incorporating nonlinearity in modeling the remittance-environment nexus.

Karasoy (2021) also reported that remittance inflows in the Philippines increase income and oil consumption, thereby compromising long-term environmental sustainability. This was derived using both the augmented ARDL and vector error correction model (VECM) techniques. Likewise, Brown et al. (2020), concentrating on Jamaica, discovered a long-term cointegrating link between CO2 emissions and remittances that resembled the Environmental Kuznets Curve's (EKC) inverted U-shape. Interestingly, their analysis showed that the environmental impact of remittances is more pronounced in the short term, suggesting time-sensitive policy implications.

Expanding the discussion beyond carbon emissions, several recent studies have considered broader ecological indicators. Yadou et al. (2024) examined the ecological footprint implications of remittance flows and found that such inflows significantly worsen environmental quality by increasing the ecological impact of recipient countries.

Yang et al. (2021) similarly reported a considerable decline in environmental quality due to remittance inflows. Chishti (2023) empirically examined the connection between ecological footprint and remittances, finding a strong positive correlation between the two. These studies suggest that remittances can widen the ecological footprint through increased resource consumption, land use changes, and waste generation. Nonetheless, not all evidence in this domain is negative. Mazhar et al. (2022) also report a contrasting finding, noting that remittance inflows can reduce the ecological footprint under certain conditions, particularly when directed toward green investments or sustainable livelihoods. This aligns with the notion that remittances, if properly channeled, can serve as an important resource for advancing environmental sustainability in developing countries.

Empirical literature: Linking Private Investment and Institutional Quality to Environmental Sustainability

Environmental sustainability has increasingly become a focal point in development discourses, with attention turning to how private investment and institutional quality interact with ecological outcomes. Depending on the investment setting and institutional structures, empirical research examining the relationship between private investment and the ecological footprint has grown, showing both positive and negative environmental effects.

Several empirical studies suggest that private investment can have diverging effects on environmental sustainability. Meisner (2001) found that in developing countries, increased private sector involvement was associated with reduced environmental degradation, particularly when supported by mature domestic capital markets and the involvement of developed nations. This suggests that under the right conditions, private investment may promote sustainable growth by fostering technological innovation and efficient resource use. In contrast, Karasoy (2021) presents opposing evidence from Turkey, indicating that domestic private investment (DPRI) contributes to greater ecological and carbon footprints over the long term. These contrasting findings underscore the complexity of the investment–environment nexus and the need to account for country-specific dynamics and investment typologies.

Further deepening this analysis, Kemp-Benedict et al. (2019) evaluated the carbon intensity of various investment portfolios. They found that investments heavily weighted toward carbon-intensive industries significantly increase environmental degradation, emphasizing the urgency of transitioning to sustainable investment strategies. This is consistent with the broader literature calling for environmental, social, and governance (ESG) principles to guide portfolio decisions. Foreign direct investment (FDI) has also been scrutinized in terms of its ecological implications. Padhan and Bhat (2023) provide empirical evidence showing that FDI increases ecological footprints and reduces environmental quality, potentially due to the “pollution haven” effect. Similarly, Chishti (2023) found that FDI was positively correlated with ecological footprint growth, indicating that capital inflows may increase environmental externalities if strict environmental restrictions are not in place.

The importance of institutional quality becomes apparent moderating factor in determining how private investment affects the environment. Uzar (2021), using AMG and CCEMG estimators for E-7 countries, demonstrates that institutional excellence reduces ecological footprint, suggesting that effective governance mechanisms can counterbalance investment-related environmental harm. Padhan and Bhat (2023) corroborate these findings, emphasizing that robust institutions foster environmental

accountability and enforcement of sustainable practices. Likewise, Makhdum et al. (2022), employing an ARDL framework, show that improvements in institutional quality significantly reduce ecological degradation, further highlighting the need for strong regulatory frameworks and transparent institutions. Azimi and Rahman (2023) also found that an important factor in lowering ecological footprints is the Institutional Quality Index, reinforcing the hypothesis that governance structures are instrumental in steering economies toward environmentally sustainable pathways.

Collectively, remittances and private investment have significant potential to influence environmental sustainability in Sub-Saharan Africa, but their impact is strongly mediated by institutional quality. Remittances, as a growing source of external finance, can either increase environmental pressures through higher consumption or support sustainability when invested in clean energy, climate-resilient infrastructure, and sustainable agriculture. Similarly, private investment can promote green innovation in contexts with strong institutions, but may exacerbate ecological degradation where governance is weak. Therefore, enhancing environmental outcomes in Sub-Saharan Africa requires policy efforts that focus on strengthening institutional frameworks, enforcing environmental regulations, and promoting green investment incentives. Additionally, improving financial literacy and providing sustainable investment opportunities for remittance recipients can help ensure that both private capital and diaspora funds contribute effectively to the region's green transition.

3. Material and Methods

In order to examine the effects of remittance inflows on environmental sustainability while taking into consideration the moderating effects of institutional quality and private investment, this study uses a balanced panel dataset that includes 31 Sub-Saharan African (SSA) nations and spans the years 2011 to 2020. The availability and completeness of pertinent data served as a reference for choosing the nations and time period. The dataset includes 31 nations spanning a total of 10 years, or 310 country-year observations. The analysis's data came from a number of reliable sources, including the Global Footprint Network for ecological footprint data, the Heritage Foundation for institutional quality indicators, and the World Development Indicators (WDI) for remittances, private investment, economic growth, and household consumption.

The dependent variable employed in this study is environmental sustainability, proxied by the Ecological Footprint (EFP), a composite index that captures the pressure human activity places on natural ecosystems, including land use, energy consumption, and carbon emissions. This indicator offers a more comprehensive and integrative measure of environmental impact than conventional metrics like CO2 or greenhouse gas (GHG) emissions, which have been widely used in earlier studies (Baloch et al., 2020; Karim et al., 2022; Rizk & Slimane, 2018; Zhang et al., 2022). Recent literature supports the use of EFP as a progressive and multidimensional measure of environmental degradation (Danish et al., 2019; Danish et al., 2020; Amowine et al., 2021).

Remittance inflows, expressed as a proportion of GDP, private investment, represented by gross fixed capital formation, and institutional quality, as determined by the Economic Freedom Index (EFI), are the main explanatory factors. Twelve subcomponents make up the EFI, a composite measure that captures several aspects of institutional performance, including trade openness, business freedom, labor freedom, government honesty, tax burden, property rights, and judicial effectiveness. In order to account for macroeconomic factors influencing environmental outcomes, control variables like household spending and economic growth are also included. To assess the

moderating impact of institutional quality, interaction terms between remittances and institutions are introduced.

The study uses the two-step System Generalized Method of Moments (System GMM) estimator created by Blundell and Bond (1998) to describe the dynamic nature of the interaction between the variables and handle any endogeneity issues. System GMM works especially well with panel data setups like this one that have a large cross-sectional dimension (N = 31) and a short time dimension (T = 10). By employing lagged levels and differences of endogenous variables as tools, this estimate technique accounts for bias that may result from measurement error, simultaneity, and unobserved country-specific effects. Additionally, the model can represent the persistence of environmental degradation over time by including a lagged dependent variable.

The Hansen J-test for overidentifying limitations is used to confirm the validity of the instruments and guarantee the robustness and validity of the estimation findings. Furthermore, the differenced residuals are examined for first- and second-order serial correlation using the Arellano-Bond test:

$$EFP = f(REM, CONS, GDP\ PINV, IQ \quad (1)$$
$$EFP = f(REM, CONS, GDP\ GDP^2\ PINV, IQ) \quad (2)$$
$$EFP = f(REM, CONS, GDP\ PINV, IQ, PINV * REM \quad (3)$$
$$EFP = f(REM, CONS, GDP\ PINV, IQ, IQ * REM \quad (4)$$

The models are written in equation forms as:

$$EEFP_{it} = \alpha_1 REM_{it} + \alpha_2 CONS_{it} + \alpha_3 GDP_{it} + \alpha_4 PIVN_{it} + \alpha_5 IQ_{it} + \varepsilon_{it} \quad (5)$$

The square of GDP is added to equation 4 to get equation 5 below, which captures the existence of the environmental Kuznets Curve:

$$EFP_{it} = \alpha_1 REM_{it} + \alpha_2 CONS_{it} + \alpha_3 GDP_{it} + \alpha_4 GDP^2{}_{it} + \alpha_5 PINV_{it} + \alpha_6 IQ_{it} + \varepsilon_{it} \quad (6)$$
$$EFP_{it} = \alpha_1 REM_{it} + \alpha_2 CONS_{it} + \alpha_3 GDP_{it} + \alpha_4 PINV_{it} + \alpha_5 PINV_{it} * REM_t + \alpha_6 IQ_{it} + \varepsilon_{it} \quad (7)$$
$$EFP_{it} = \alpha_1 REM_{it} + \alpha_2 CONS_{it} + \alpha_3 GDP_{it} + \alpha_4 PINV_{it} + \alpha_5 IQ_{it} * REM_t + \alpha_6 IQ_{it} + \varepsilon_{it} \quad (8)$$

This is the dependent variable that represents the entire ecological footprint, as previously mentioned. Equation 4 is the baseline model. To study the moderating effects of private investment and institutions on environmental quality, we include the interactive terms between remittances and private investment (REM*PINV) and remittances and institutions (REM*IQ) in the baseline model to obtain equations 6 and 7. All variables are as previously defined: t is the sample period; ε is the error term, and are the estimated parameters, all of which are assumed to be positive. The dependent variable's current realizations may be impacted by its lag values in a dynamic system GMM process, in order to get around the endogeneity issues that are frequently proposed for dynamics of (Arellano & Bond, 1991; Blundell & Bond, 1998), we use the system GMM to estimate the aforementioned models. The main benefit of GMM estimation, according to Chen et al. (2021), is its capacity to yield trustworthy results following the resolution of the endogeneity issue. The GMM addresses the issue of endogeneity among the variables by instrumenting them with their own lagged values. This dynamic model is specified as follows:

$$EFP_{it} = \mu + \mu EFP_{it-1} + \alpha_1 REM_{it} + \alpha_2 CONS_{it} + \alpha_3 GDP_{it} + \alpha_4 PINV_{it} + \alpha_5 IQ_{it} + \varepsilon_{it} \quad (9)$$

Where EFP_{it-1} measures the lag value of the dependent variable (EFP). The Table below shows the data set and variable descriptions.

Table 1: The Sources of Data and Description of Variables

Variables	The Definition of Variables	The Measurement of Variables	The Sources of Data
Ecological footprint (EFP)	The amount that humans require from surfaces that are biologically productive is measured by their ecological footprint.	In global hectares	Global Footprint Network (GFN)
Remittances (REM)	All current cash or in-kind transfers made or received by resident households to or from non-resident households are included in remittances received.	Measure in % of GDP	World Development Indicators (WDI)
Economic Growth (GDP per capita)	GDP per capita is calculated by dividing the midyear gross domestic product by the population.	Measure in % of GDP	World Development Indicators (WDI)
Consumption (CONS)	The total of household and general government final consumption expenditures is known as consumption expenditure.	Measure in % of GDP	World Development Indicators (WDI)
Private investment (PINV)	Gross expenditures made by the private sector (including private nonprofit organizations) to expand its fixed domestic assets are referred to as private investment.	Measure in % of GDP	World Development Indicators (WDI)
Institutions (IQ)	Property rights, business freedom, fiscal health, monetary freedom, investment freedom, trade freedom, labor freedom, tax burden, judicial effectiveness, government honesty, and government spending are all included.	Economic Freedom Index ranked in scale of 0-100	The Heritage Foundation

Source: Author's Own Creation

4. Presentation of Results and Discussion

Table 2 provides a comprehensive overview of the descriptive features of the variables being examined. The variables include: Institutional Quality (IQ), Private Investment and Remittances (PINVREM), Consumption (CONS), Gross Domestic Product (GDP), GDP squared (GDP), Renewable Energy Consumption (REM), Ecological Footprint (EFP), and Private Investment and Remittances (PINVREM). By looking at the means, we can see that the variables' average values range from 1.443 (EFP) to 192.052 (IQ*REM), giving us an idea of the dataset's central tendency. Standard deviations display the variability around the mean; It is observed from Tabkle 2 that the variability ranges from 0.70 (EFP) to 239.498(IQ*REM). The minimum and maximum values show the range that the observations fall into, which helps to illustrate the diversity and distribution of the data.

Table 2: Variables' Descriptive Properties

Variables	EFP	REM	GDP	GDP^2	CONS	PINV	IQ	PINV*REM	IQ*REM
Obs.	310	310	310	310	310	310	310	310	310
Mean	1.44	3.60	1.26	17.77	85.64	23.11	55.41	76.44	192.05
Std.Dev.	0.70	4.64	4.02	42.05	15.44	9.63	6.72	119.41	239.49
Min	0.57	0.00	-22.30	0.00	37.463	3.54	22.10	0.00	0.00
Max	3.78	25.17	18.01	501.01	130.89	81.02	72.00	804.573	1293.71

Source: Author's Own Creation

Table 3 shows the correlation analysis, where the coefficient of association between two variables is displayed in each cell. There is a weak negative linear association between REM (variable 2) and EFP, as indicated by the negative correlation of -0.194. With IQ*REM having the highest positive correlation (0.983), it has positive relationships with CONS, PINV, IQ, PINV*REM, and IQREM. A weak negative linear association is indicated by the CONS (variable 5) and EFP's negative correlation (-0.189). It exhibits favorable relationships with IQ, REM, GDP, and PINV. There is a positive association between PINV (variable 6) and CONS, but a negative correlation with IQ. There is a favorable association between PINV, IQ*REM, and PINV. REM and IQ have a negative connection (-0.255) and a positive correlation (0.289), respectively. Its connection with PINV is weakly negative, while its correlation with CONS is negative. Strong positive correlations are found between PINV*REM (variable 8) and REM, while negative correlations are seen with EFP.

Table 3: Correlation Matrix

	EFP	REM	GDP	GDP^2	CONS	PINV	IQ	PINV*REM	IQ*REM
EFP	1.00								
REM	-0.19	1.000							
GDP	-0.03	-0.020	1.000						
GDP^2	-0.08	-0.002	-0.075	1.000					
CONS	-0.18	0.566	0.019	0.090	1.000				
PINV	-0.01	-0.156	0.087	0.065	-0.452	1.000			
IQ	0.28	-0.255	-0.003	-0.198	-0.166	0.024	1.000		
PINV*REM	-0.15	0.941	0.005	-0.023	0.494	0.044	-0.15	1.000	
IQ*REM	-0.19	0.983	-0.050	-0.043	0.540	-0.143	-0.13	0.9412	1.000

Source: Author's Own Creation

According to Table 4's findings, lagged ecological footprint values significantly and favorably affect the current ecological footprint levels in all four models. This suggests that Sub-Saharan Africa (SSA) has ongoing environmental deterioration, with past ecological harm continuing to influence present results. Such a result suggests that environmental deterioration in SSA exhibits a form of inertia, possibly due to structural dependence on fossil fuels, inefficient urbanization, and insufficient environmental regulation. These results underline the necessity of ongoing and sustained policy measures to alleviate environmental harm and are in line with the larger research on environmental persistence in developing nations (Gorus & Aslan, 2019).

The substantial inverse link between remittances and ecological footprint which suggests that increased remittance inflows help to improve the environment in SSA is one of Model 4's main highlights. In particular, ecological degradation decreases by 0.04 units for every unit rise in remittances. This aligns with Yadou et al. (2024), who found that remittances enhance environmental sustainability when invested in renewable energy, sustainable housing, or climate-resilient farming. In regions where formal financial mechanisms are weak, remittances can act as alternative financing tools for green investments. However, this result contradicts findings from Yang et al. (2021), who showed that remittances increase ecological footprints in BRICS countries due to greater consumption of energy-intensive goods. The difference highlights how local consumption habits, financial literacy, and institutional frameworks in SSA all influence the environmental impact of remittances.

The Environmental Kuznets Curve (EKC) hypothesis is supported in the SSA region by Models 2 and 3. An inverted U-shaped relationship is suggested by the positive GDP and negative GDP2 coefficients, where environmental degradation first increases with economic expansion but then decreases after income levels are exceeded. This finding aligns with the classical EKC model proposed by Grossman and Krueger (1995) and is corroborated by recent SSA-focused research by Adebayo et al. (2023), who confirmed similar dynamics in West Africa. These results imply that, although economic expansion in SSA might intensify environmental pressures in the short term, sustained growth combined with institutional and technological improvements could eventually yield environmental benefits.

Remarkably, Models 1, 2, and 3 results show that household consumption has a negative impact on ecological footprint, implying that higher consumption lessens environmental deterioration. While counterintuitive at first glance, this finding aligns with Galli et al. (2017), who found that sustainable consumption patterns, particularly those based on local, plant-based, or low-impact diets, help reduce ecological deficits in Mediterranean countries. In the context of SSA, this may reflect traditional and low-carbon consumption practices, such as subsistence agriculture, limited industrial goods usage, and communal energy-sharing systems. However, this trend could reverse with urbanization and increased exposure to high-carbon lifestyles unless proactive sustainability education is adopted. Stronger institutions may not always translate into greener results from remittance inflows, as demonstrated by Model 4's interaction between remittances and institutional quality (REM*IQ), which has a positive and significant impact on ecological footprint. This somewhat surprising result may suggest that remittances, even in well-governed environments, are often spent on environmentally intensive activities if there are no deliberate policies channeling them toward sustainable investments. This result resonates with Yang et al. (2021), who also found that technological advancement combined with remittance inflows may worsen environmental outcomes in the absence of targeted green policies. Therefore,

institutional quality alone may not be sufficient unless it is accompanied by clear environmental governance and green financial instruments tailored to diaspora finance.

On the other hand, Model 3's interaction between private investment and remittances (PINV*REM) indicates a negative and substantial influence on ecological footprint, indicating that these two financial flows can work together to benefit the environment when they are in alignment. This discovery aligns with Zafar et al. (2019) and Arogundade et al. (2022), who demonstrated that remittances and private capital, when directed toward sectors such as renewable energy, eco-infrastructure, or green entrepreneurship, can act as catalysts for sustainable development. In SSA, where government budgets are often constrained, the synergy between private investment and diaspora resources could play a pivotal role in financing the green transition provided the right incentives and institutional support are in place.

Lastly, Model 3's findings demonstrate that ecological footprint is negatively and statistically significantly impacted by institutional quality, suggesting that improved institutional quality lessens environmental deterioration. This supports the claim that sustainable development depends on strong institutions that are defined by open governance, the rule of law, and environmental legislation. This conclusion is well supported in the literature. Uzar (2021) found that better institutional frameworks in E-7 countries significantly curtail ecological degradation, while Azimi and Rahman (2023) similarly documented that institutional strength directly contributes to reduced environmental harm in emerging economies. In SSA, where governance challenges persist, this finding underlines the critical need to strengthen institutions as a prerequisite for both climate resilience and sustainable growth.

Table 4: Difference GMM Estimates (Dependent Variable Ecological Footprint (EFP)

Dependent Variables	**(Model 1) EFP**	**(Model 2) EFP**	**(Model 3) EFP**	**(Model 4) EFP**
L.EFP	0.999***	0.999***	0.999***	1.007***
	(0.00742)	(0.00741)	(0.00769)	(0.00755)
REM	0.000636	0.000580	0.000631	-0.0365***
	(0.000993)	(0.00102)	(0.00441)	(0.00567)
GDP	0.00207**	0.00201**	0.00201**	0.00286***
	(0.000920)	(0.000895)	(0.000902)	(0.000952)
GDP^2		-3.25e-05	-3.26e-05	9.88e-06
		(9.75e-05)	(9.61e-05)	(6.16e-05)
CONS	-0.000574*	-0.000554*	-0.000553*	-0.000333
	(0.000316)	(0.000323)	(0.000322)	(0.000240)
PINV	-0.000483	-0.000458	-0.000453	-0.000628**
	(0.000386)	(0.000409)	(0.000438)	(0.000301)
IQ	-0.00142	-0.00145	-0.00144	-0.00423***
	(0.00123)	(0.00120)	(0.00120)	(0.00106)
PINV*REM			-2.05e-06	
			(0.000158)	
IQ*REM				0.000698***
				(0.000106)
Year	-0.000183	-0.000227	-0.000225	-0.000631
	(0.00247)	(0.00243)	(0.00237)	(0.00246)
Constant	0.486	0.575	0.571	1.515
	(4.947)	(4.883)	(4.737)	(4.931)

Observations	279	279	279	279
Time Dummies	Yes	Yes	Yes	Yes
No. of instruments	17	18	19	19
AR (1)	0.175	0.175	0.175	0.178
AR (2)	0.349	0.349	0.348	0.347
Hansen Test	0.143	0.162	0.166	0.151

In Parentheses are the robust standard errors, where *** $p<0.01$, ** $p<0.05$, and * $p<0$.
Source: Author's Own Creation

6. Conclusion and Policy Recommendations

The complex interactions among remittances, private investment, institutional quality, and environmental sustainability in Sub-Saharan Africa are highlighted by this study. The empirical evidence demonstrates that remittances and private investment, when moderated by strong institutional frameworks, can contribute significantly to reducing the ecological footprint in the region. However, this relationship is neither linear nor universally positive; its outcome is largely conditioned by the strength of institutions that regulate environmental practices and guide financial flows.

Despite being a crucial source of income for many people throughout SSA, remittances exhibit dual environmental effects. On the one hand, they alleviate poverty, enhance resilience, and support household consumption. On the other, when channeled into unsustainable consumption patterns or environmentally intensive investments, they risk accelerating ecological degradation. Similarly, private investment promotes technological innovation and infrastructural development, but in the absence of environmental oversight, it can exacerbate pollution, natural resource depletion, and biodiversity loss. In this situation, institutional quality has a crucial moderating influence. Countries with robust institutions are more likely to guide both remittance use and private capital toward environmentally sustainable outcomes, while those with weaker governance are vulnerable to the adverse effects of financial flows on environmental sustainability.

Given the urgency of climate change and the increasing ecological stress in SSA, the findings call for a comprehensive and integrated policy response. First, governments must prioritize institutional strengthening. This includes building the capacity of regulatory bodies, enhancing legal frameworks related to environmental protection, and ensuring transparency and accountability in both investment and remittance governance. A particular focus should be placed on enforcing environmental standards and incentivizing compliance through well-defined monitoring mechanisms. Second, policymakers should design and implement integrated financial and environmental policies that explicitly link remittances and private investment to sustainable development goals (SDGs). This includes offering tax incentives, subsidies, or matching grants for remittance-receiving households and businesses investing in clean energy, sustainable agriculture, waste management, and green infrastructure. Diaspora bonds and climate-resilient investment vehicles could also be introduced to channel remittance flows toward eco-friendly ventures.

Third, awareness and financial literacy programs are essential. Promoting knowledge on the environmental impact of financial decisions can empower remittance recipients and private investors to make more sustainable choices. Governments and NGOs can play a key role in guiding communities toward green entrepreneurship and low-impact living. Despite its valuable insights, this study recognizes certain limitations. The ecological footprint, while a comprehensive measure, may not capture all dimensions of

environmental sustainability. Additionally, data limitations may affect the robustness of some results. Future research should consider disaggregated, sub-national analyses to capture regional disparities within countries. Longitudinal studies tracking the long-term evolution of remittance, investment behavior, institutional quality, and environmental impact would also provide richer insights into temporal dynamics. Finally, for SSA to harness the full potential of remittances and private investment in advancing environmental sustainability, institutional reforms must accompany financial strategies. Only through such a multidimensional policy approach can the region effectively transition toward an inclusive, resilient, and ecologically sound development pathway.

Conflict of Interest

The authors declare that there are no conflicts of interest. We confirm that the submitted manuscript is an original work and is not under consideration or review by any other publication.

References

Adebayo, T. S., Kirikkaleli, D., & Adeshola, I. (2023). Testing the environmental Kuznets curve in West Africa: The role of trade openness and renewable energy consumption. *Environmental Science and Pollution Research, 30*(2), 2158–2171.

Ahmad M., Haq Z. U., Khan Z., Khattak S. I., Rahman Z. U. and Khan S. (2019). Does the inflow of remittances cause environmental degradation? Empirical evidence from China. *Economic Research-Ekonomska Istrazivanja*, Vol. 32, No. 1, 2099–2121.

Akinlo, A. E. (2022). The impact of remittances and financial development on environmental degradation in sub-Saharan Africa. *Environmental Science and Pollution Research, 29*(3), 4201–4214.

Amowine, N., Tamba, J. G., & Owusu-Afriyie, J. (2021). Environmental sustainability and energy consumption in Sub-Saharan Africa. *Environmental Science and Pollution Research, 28*(34), 47441–47454.

Azimi, M., & Rahman, M. M. (2023). Institutional quality and environmental sustainability: Evidence from developing economies. *Environmental Science and Pollution Research, 30*(5), 5483–5499.

Azimi, N., & Rahman, M. M. (2023). Institutional quality and ecological footprint: Empirical evidence from developing countries. *Journal of Environmental Management, 325*, 116496.

Baloch, M. A., Ozturk, I., Khan, D., & Ahmad, A. (2019). The environmental Kuznets curve and the role of energy consumption in Pakistan. *Environmental Science and Pollution Research, 26*(3), 2788–2797.

Baloch, M. A., Zhang, J., Iqbal, K., & Nadeem, A. M. (2020). The effect of economic growth, globalization, and energy consumption on ecological footprint in BRICS countries. *Environmental Science and Pollution Research, 27*(26), 32526–32535.

Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, *87*(1), 115–143.

Brown, L., McFarlane, A., Campbell, K., & Das, A. (2020). Remittances and CO2 emissions in Jamaica: an asymmetric modified environmental Kuznets curve. *The Journal of Economic Asymmetries*, 22, e00166.

Chami, R., Fullenkamp, C., & Jahjah, S. (2005). Are immigrant remittance flows a source of capital for development? *IMF Staff Papers, 52*(1), 55–81.

Cha'Ngom, B. (2020). The economic implications of remittances in Africa: Patterns and trends. *African Economic Review, 28*(2), 77–93.

Chen, Y., Lee, C., & Chen, M. (2021). Ecological footprint , human capital , and urbanization. *Energy & Environmen*, *999*, 1–24.

Chishti, A. H. (2023). Foreign direct investment and environmental quality: Evidence from developing economies. *Environmental Science and Pollution Research, 30*(12), 14231–14245.

Cole, M. A. (2004). Trade, the pollution haven hypothesis and the environmental Kuznets curve: Examining the linkages. *Ecological Economics, 48*(1), 71–81.

Dasgupta, S., Laplante, B., Wang, H., & Wheeler, D. (2006). Confronting the Environmental Kuznets Curve. *Journal of Economic Perspectives, 16*(1), 147–168.

Dinda, S. (2004). Environmental Kuznets Curve Hypothesis: A Survey. *Ecological Economics, 49*(4), 431–455.

Danish, Baloch, M. A., & Wang, B. (2019). Linking urbanization, globalization, and environmental degradation in Pakistan. *Environmental Science and Pollution Research, 26*(32), 33010–33020.

Danish, Zhang, J., Wang, B., & Baloch, M. A. (2020). A multi-scale analysis of environmental degradation, energy consumption, and economic growth: Evidence from G7 countries. *Environmental Science and Pollution Research, 27*(24), 30087–30099.

Frankel, J. A., & Rose, A. K. (2005). Is trade good or bad for the environment? Sorting out the causality. *Review of Economics and Statistics, 87*(1), 85–91.

Friedman, M. (1957). *A Theory of the Consumption Function*. Princeton University Press.

Galli, A., Iha, K., Weinzettel, J., Cranston, G., & Ercin, E. (2017). Assessing the ecological footprint and the ecological deficit of Mediterranean countries. *Ecological Indicators, 90*, 736–747.

Gniniguè, L., & Ali, A. H. (2021). Remittances and economic performance: Evidence from West Africa. *Journal of Economic Development and Policy, 23*(1), 1–17.

Gorus, M. S., & Aslan, M. (2019). Environmental Kuznets curve hypothesis: The role of renewable and non-renewable energy consumption and the level of globalization. *Environmental Science and Pollution Research, 26*(14), 14164–14173.

Grossman, G. M., & Krueger, A. B. (1991). Environmental impacts of a North American Free Trade Agreement (NBER Working Paper No. 3914).

Grossman, G. M., & Krueger, A. B. (1995). Economic growth and the environment. *Quarterly Journal of Economics, 110*(2), 353–377.

IMF. (2021). *World Economic Outlook: Recovery during a Pandemic*. International Monetary Fund.

Kaodui, R., Zhang, B., & Hassan, M. K. (2022). Remittances, clean energy, and carbon emissions: The role of institutional quality. *Energy Economics, 104*, 105668.

Karasoy, H. (2021). The impact of domestic private investment on ecological and carbon footprints: Evidence from Turkey. *Environmental Economics and Policy Studies, 23*, 331–349.

Karim, S., Majid, M. R., & Rehman, A. (2022). Investigating the impact of remittances and financial development on environmental degradation in emerging economies. *Energy Reports, 8*, 1203–1213.

Kemp-Benedict, E., Edenhofer, O., & Knopf, B. (2019). The carbon intensity of financial investments and the transition to sustainability. *Ecological Economics, 159*, 122–131.

Lim, S., & Basnet, H. C. (2017). Remittance and economic growth in emerging economies. *International Journal of Economic Policy in Emerging Economies, 10*(4), 398–411.

Makhdum, M. S. A., Zhao, S., Shahbaz, M., & Abbas, S. (2022). Institutional quality and environmental degradation: Empirical evidence from the ARDL bound testing approach. *Environment, Development and Sustainability, 24*, 1–23.

Mazhar, M. W., Karim, M. Z. A., & Raza, S. A. (2022). Do remittances influence environmental quality in developing countries? *Environmental Science and Pollution Research, 29*(4), 5301–5314.

Meisner, C. M. (2001). Foreign direct investment and environmental degradation in developing countries: A panel data analysis. *Environmental & Resource Economics, 19*, 53–73.

Mohammed, M. A. (2022). Remittances and development financing in sub-Saharan Africa. *African Journal of Economic Policy, 29*(1), 45–60.

Neog, Y., & Yadava, A. K. (2020). Nexus among CO2 emissions, remittances, and financial development: a NARDL approach for India. *Environmental Science and Pollution Research*, *27*(35),

Padhan, H., & Bhat, S. A. (2023). Institutional quality and environmental degradation: Empirical evidence from panel data. *Environmental Science and Pollution Research, 30*, 20311–20329.

Rahman, M. M., Vu, X. B., & Gill, A. R. (2019). Remittances and carbon emissions: Evidence from a panel of 103 countries. *Sustainability, 11*(21), 6101.

Rizk, R., & Slimane, S. B. (2018). Economic development and environmental degradation in the MENA region: Is the Environmental Kuznets Curve valid? *Environmental Economics and Policy Studies, 20*(1), 49–66.

Shah S. Q. A., Waris U., Ahmed S., Agyekum E.B., Hussien A. G., Kamal M., Rehman M. and Kamel S. (2023). What is the role of remittance and education for environmental pollution? Analyzing in the presence of financial inclusion and natural resource extraction.

Sharma, R., Dua, P., & Sharma, S. (2019). Remittances, growth and energy consumption: Empirical evidence from a panel of developing countries. *International Journal of Energy Economics and Policy, 9*(4), 104–110.

Sharma K., Bhattarai B. and Ahmed S. (2019). Aid, Growth, Remittances and Carbon Emissions in Nepal. *The Energy Journal*, Vol. 40, pp. 129-141.

Stern, D. I. (2004). The rise and fall of the environmental Kuznets curve. *World Development, 32*(8), 1419–1439.

Uzar, U. (2021). Institutional quality and ecological footprint: Empirical evidence from the E-7 countries. *Environmental Science and Pollution Research, 28*(4), 4123–4137.

Wang, Y., Liu, J., & Zhang, H. (2021). The impact of remittances on environmental quality: New evidence from developing countries. *Environmental Science and Pollution Research, 28*(19), 24089–24102.

Yang, B., Adedoyin, F. F., & Bekun, F. V. (2021). Remittances, financial development and ecological footprint in BRICS economies: A panel quantile regression approach. *Environmental Science and Pollution Research, 28*(30), 41236–41250.

Yang, X., Zhang, L., & Long, X. (2020). The impact of financial development and remittance on CO2 emissions: Evidence from emerging countries. *Journal of Cleaner Production, 261*, 121015.

Yadou, J., Diallo, T. M. O., & Mbaye, A. A. (2024). Can remittances improve environmental sustainability? New evidence from Sub-Saharan Africa. *Journal of Environmental Management, 343*, 118246.

Zafar, M. W., Shahbaz, M., Hou, F., & Sinha, A. (2019). From nonrenewable to renewable energy and its impact on economic growth: The role of research & development expenditures in Asia-Pacific Economic Cooperation countries. *Journal of Cleaner Production, 212*, 1166–1178.

Zhang, D., Liu, X., & Baloch, M. A. (2022). Institutional quality, remittances, and environmental sustainability in developing economies. *Environmental Science and Pollution Research, 29*(2), 2565–2579.

Zhao L and Qamruzzaman M (2022). Do Urbanization, Remittances, and Globalization Matter for Energy Consumption in Belt and Road Countries: Evidence from Renewable and Non-Renewable Energy Consumption. Front. Environ. Sci. 10: 930728.doi: 10.3389/fenvs.2022.93072.

Corresponding Author:
Ndzembanteh Aboubakary Nulambeh
Email: ndzembanteh10@yahoo.com

Disclaimer

The views and opinions expressed in this article are solely those of the author. The *Journal of Entrepreneurial and Business Sustainability (JEBS)* accepts no responsibility or liability for any loss, damage, or other consequences arising from the use or interpretation of the content contained herein.