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Role of climate financing in advancing the SDGS: Addressing global challenges through green bonds and carbon markets

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ABSTRACT

Green bonds play a pivotal role in promoting sustainable development goals by channelling financial resources toward environmentally friendly projects, fostering a greener and more resilient future. This study examined the role of climate financing in advancing the SDGs, addressing global challenges through green bonds and carbon markets. Using quarterly data from 2007Q1 to 2023Q4, with green bonds introduced in 2007, the study employed the autoregressive distributed lag model (ARDL) developed by Pesaran et al. (2001). The findings demonstrate that climate financing, green bonds, carbon markets, and global challenges, as proxy by global CO2 emissions (GtCO2), hinder the progress of sustainable development goals. Based on the conclusion, the following recommendations were made: to advance SDGs, policies should focus on strengthening local financing mechanisms like green bonds, improving carbon market efficiency to align with sustainable policies, and creating a supportive environment for green bonds to attract private investment in sustainable projects.

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1. INTRODUCTION

Climate financing has emerged as a cornerstone for achieving sustainable development globally, particularly in the context of advancing the United Nations' Sustainable Development Goals (SDGs). It encompasses financial resources allocated to mitigate greenhouse gas emissions and adapt to the impacts of climate change. Green bonds and carbon markets are two key instruments within this framework, providing innovative mechanisms to mobilize resources and direct them toward climate-friendly projects. The urgency of climate financing stems from the escalating impacts of climate change, with estimates indicating that global temperatures could rise by 1.5°C above pre-industrial levels by 2030 if current trajectories continue (IPCC, 2023). Globally, the annual financing gap to meet the SDGs, including climate-related goals, stands at approximately $3.7 trillion (UNDP, 2022), climate financing is pivotal in bridging this gap, leveraging public and private investments to scale up renewable energy, enhance energy efficiency, and support climate-resilient infrastructure. Green bonds, raised $621 billion in 2021 alone, reflecting a growing appetite among investors for sustainable financial instruments (CBI, 2022). Similarly, carbon markets, driven by mechanisms like the European Union Emissions Trading System (EU ETS), have demonstrated significant potential in reducing emissions while generating revenue for climate action.

In Africa, the climate financing landscape is both promising and challenging. The continent is one of the most vulnerable regions to climate change, facing threats such as desertification, water scarcity, and extreme weather events. Despite contributing less than 4% of global greenhouse gas emissions, Africa receives only 3% of global climate finance (CPI, 2023). The annual climate finance needs for adaptation alone are estimated at $33 billion, far exceeding the $6 billion currently mobilized (AfDB, 2022). Green bonds have begun to gain traction in Africa, with countries like South Africa, Nigeria, and Kenya issuing sovereign and corporate green bonds to finance renewable energy projects and climate-resilient infrastructure. Additionally, Africa's participation in voluntary carbon markets has increased, with nations like Gabon leveraging their vast forest resources to generate carbon credits. However, institutional and regulatory challenges continue to impede the full potential of these instruments. Nigeria, as Africa's largest economy and most populous nation, plays a critical role in the continent's climate financing narrative. The country faces a dual challenge of pursuing economic development while addressing significant environmental vulnerabilities, including desertification, flooding, and coastal erosion. The government's commitment to climate action is reflected in its Nationally Determined Contributions (NDCs), which aim to reduce greenhouse gas emissions by 20% unconditionally and 47% with international support by 2030 (FMEN, Nigeria, 2023). Nigeria made history as the first African country to issue a sovereign green bond in 2017, raising $30 million to fund renewable energy and afforestation projects. In 2021, Nigeria's second green bond issuance raised an additional $42 million (CBN, 2022). The country is also exploring carbon markets, with initiatives such as the Nigeria Emissions Trading Scheme (NETS) under development. However, achieving the SDGs through climate financing in Nigeria requires addressing structural barriers such as limited access to international finance, weak institutional frameworks, and low private sector participation. The Accord of Paris, endorsed by nearly 196 nations at the United Nations Climate Summit (COP21) on the 12th of December, 2015, was implemented on the 4th of November, 2016, one year later. Its primary objective is to curb worldwide warming by keeping temperature rise significantly under 2°C compared to the pre-industrialization baseline, with endeavour to maintain it below 1.5°C In recent times, global policymakers have emphasized the significance of this aim due to troubling indicators, such as recurring extreme heat events, underscored by the United Nations' Climate Advisory Board. To achieve these objectives, worldwide GHG output needs to its maximum prior to by 2025 and be decreased by 43% within 2030, marking a notable joint international action. Significant challenges hinder the effective implementation of climate financing as a tool for advancing the SDGs. Globally, a $3.7 trillion annual financing gap exists (UNDP, 2022), while regions like Africa receive only 3% of global climate finance despite facing acute climate vulnerabilities (CPI, 2023). In Nigeria, structural barriers such as limited international finance access, weak institutional frameworks, and low private sector involvement impede progress, raising critical questions about the adequacy of current strategies to mobilize and utilize climate finance for sustainable development. The objective of this study is to examine the effectiveness of green bonds and carbon markets in mobilizing climate finance to advance Nigeria's progress toward the Sustainable Development Goals (SDGs), with a focus on overcoming institutional, regulatory, and financial barriers.

2. LITERATURE REVIEW

2.1 Sustainable Development Financing

Sustainable development financing focuses on strategically allocating resources to promote economic growth, social inclusion, and environmental sustainability in line with the SDGs. It emphasizes innovative funding mechanisms to address global challenges like climate change, poverty, and inequality. Financial flows for renewable energy, climate adaptation, and social infrastructure are crucial, with public-private partnerships playing a key role in aligning investments with the Paris Agreement and SDG goals (UN, 2021).

2.2 Carbon Market Mechanisms

Carbon market mechanisms allow trading of carbon credits to reduce greenhouse gas emissions cost-effectively, incentivizing greener

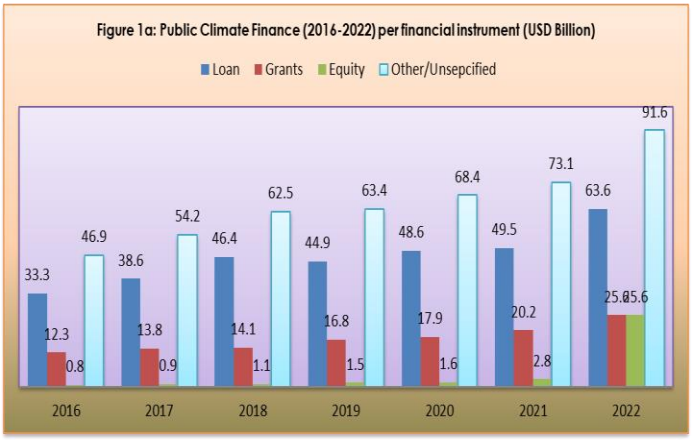
technologies. Operating under compliance schemes like the EU ETS or voluntary systems, they support SDGs by promoting clean energy (SDG 7), sustainable industries (SDG 9), and climate resilience (SDG 13), while also aiding technology transfer and capacity building in developing nations (World Bank, 2023).

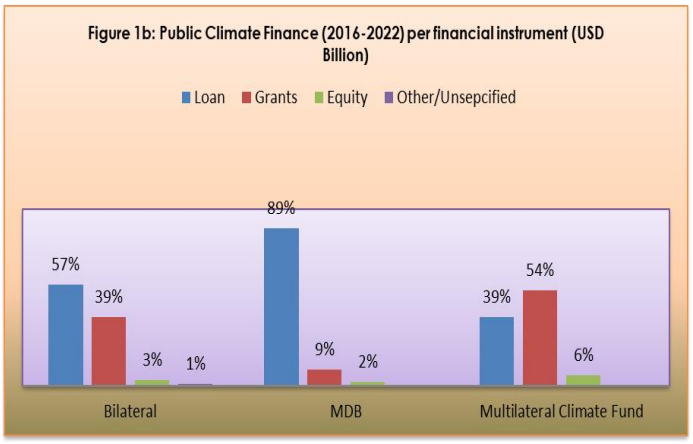
2.3 Green Finance Instruments

Green finance instruments, including green bonds, loans, and equity funds, fund projects with environmental benefits like renewable energy and sustainable infrastructure. These instruments help close the SDG financing gap, supporting clean energy (SDG 7), sustainable cities (SDG 11), and climate action (SDG 13) by attracting environmentally focused investors (OECD, 2022).

2.4 Loans Dominate Public Climate Finance, with Grants Focused on Lower-Income Nations

In 2022, developed countries primarily delivered public climate finance through loans, which made up 69% (USD 63.6 billion), while grants accounted for 28% (USD 25.6 billion), and equity investments were minimal. From 2016 to 2022, grants saw a significant increase, rising by USD 13.4 billion (109%), outpacing the 91% growth in loans, which increased by USD 30.3 billion, the financial instrument allocation varied by provider type, reflecting their distinct mandates. Multilateral development banks (MDBs) predominantly provided loans (90%), typically for large-scale projects, whereas multilateral climate funds had a more balanced distribution (39% loans, 54% grants). Bilateral providers used a mixed approach, with 57% of funding as loans and 39% as grants, supporting diverse activities and projects (Sachs et al., 2024).





Source: *Based on Biennial Reports to the United Nations Framework Convention on Climate Change (UNFCCC), Organisation for Economic Co-operation and Development (OECD) and Development Assistance Committee (DAC), statistic complementary reporting to the OECD.*

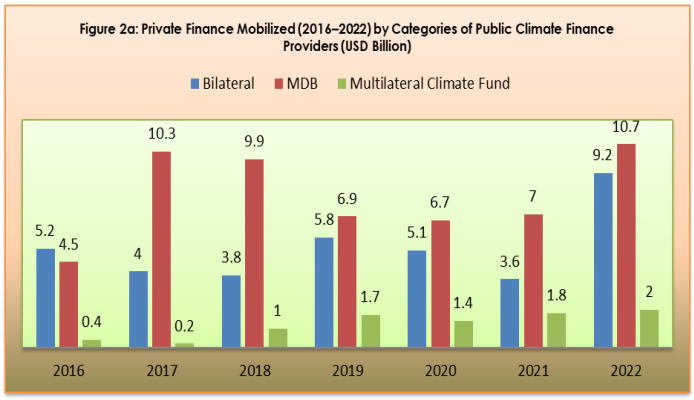
2.5 Private Finance Mobilized by Public Climate Finance Providers (2016–2022, USD Billion)

The private sector plays a critical role in financing climate action in developing countries, particularly in addressing investment gaps in areas like clean energy, agriculture, and resilience. Public finance can be strategically used to attract private investment, especially through de-risking mechanisms. The OECD report on Scaling up the Mobilisation of Private Finance for Climate Action in Developing Countries highlights key opportunities for international providers to assist in these efforts and provides insights into expanding private finance for climate action in developing nations (OECD, 2023).

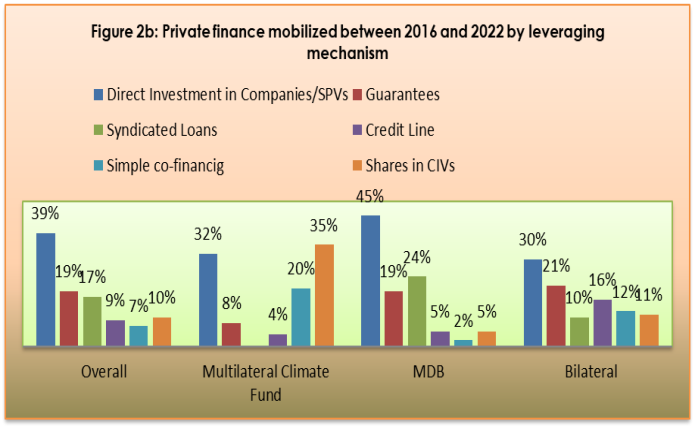
The 2023 OECD report highlights three key strategies for international providers to enhance private finance mobilization for climate action in developing countries:

- Tailor project: Use tailored interventions like blended finance, reorient loans in mature sectors, and scale up guarantees, while building capacity and exiting commercially viable projects to reallocate resources.
- Strengthen Cross-Border Financing: Improve coordination among providers, private sector, and domestic actors, and develop mechanisms to aggregate small projects into larger, tradable assets.
- Optimize International Institutions: Set private finance targets for MDBs, develop risk transfer tools, provide local currency financing, and improve transparency in data and methodologies.

After a period of stagnation, private finance mobilized by public climate finance saw a substantial increase in both relative and absolute terms, reaching USD 21.9 billion in 2022. This marks a 52% (USD 7.4 billion) rise compared to 2021. The growth was observed across all categories of public finance providers (Figure 2 a &b). Although it's difficult to pinpoint specific causes at an aggregate level, this significant increase likely reflects both the notable rise in public climate finance in 2022 (which grew by USD 18.3 billion or 25%) and improved effectiveness in leveraging private finance. In comparison, total mobilized development finance by bilateral and multilateral providers also grew by 27% in 2022, rising from USD 48 billion in 2021 to USD 61 billion.



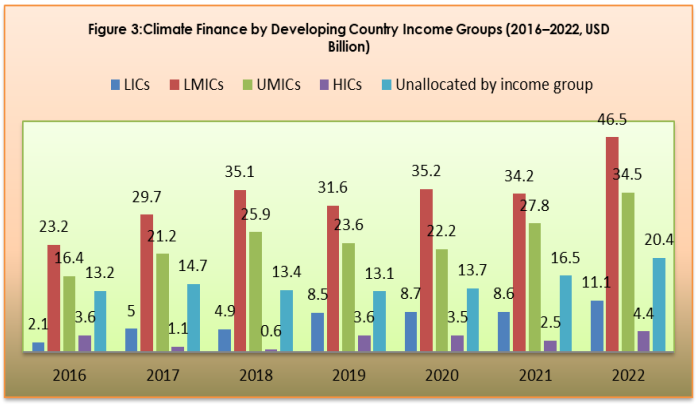
Source: *Based on Organisation for Economic Co-operation and Development (OECD) and Development Assistance Committee (DAC), statistics and complementary reporting to the OECD.*



Source: *Based on Organisation for Economic Co-operation and Development (OECD) and Development Assistance Committee (DAC), statistics and complementary reporting to the OECD.*

2.6 Growth of Climate Finance in Small Island Developing States (SIDS) and Least Developed Countries (LDCs)

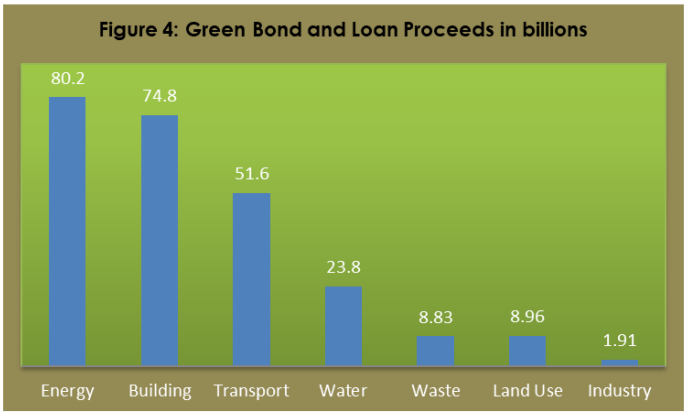
In 2022, LMICs were the largest recipients of climate finance, receiving 40% (USD 46.5 billion) of the total provided and mobilized, up from USD 23.2 billion in 2016 while maintaining a similar share (Figure 3). UMICs also exhibited a stable share, accounting for 30% in 2022 compared to 28% in 2016. LICs received 10% of the total climate finance in 2022, but in absolute terms, their funding increased five-fold to USD 9 billion since 2016. Additionally, 18% of the climate finance provided and mobilized by developed countries could not be attributed to a specific income group, mainly due to activities reported with regional or multi-country scopes.



Low-Income Countries (LICs), Lower-Middle-Income Countries (LMICs), Upper-Middle-Income
Countries (UMICs), High-Income Countries (HICs)
Source: Based on Biennial Reports to the *United Nations Framework Convention on Climate Change (UNFCCC), Organisation for Economic Co-operation and Development (OECD) and Development Assistance Committee (DAC), statistic complementary reporting to the OECD.*

2.7 Use of Green Bond and Loan Proceeds-2019

The total allocation across various sectors shows that Energy holds the largest share, accounting for 31.47% (80.2 billion), followed closely by Building at 29.35% (74.8 billion). Transport takes a significant portion as well, contributing 20.25% (51.6 billion). Other sectors include Water with 9.34% (23.8 billion), Waste at 3.46% (8.83 billion), and Land Use slightly higher at 3.52% (8.96 billion). The contributions from Industry and ICT are relatively small, at 0.75% (1.91 billion) and 0.72% (1.84 billion), respectively. Lastly, Unallocated A & R represents 1.15% (2.92 billion) of the total. This distribution highlights the emphasis on energy and infrastructure development compared to other sectors in figure 4 (CBI, 2023).



Source: *Climate Bond Initiative (2023)*

2.8 Leading Global Issuers of Aligned Green Bonds in 2023

The table 1 highlights the top 10 sources of aligned green bonds in 2023, with China leading the market, issuing USD 83.5 billion across 288 deals. Germany follows with USD 67.5 billion from 117 deals, while the USA, although third in volume at USD 59.9 billion, recorded the highest deal count at 1231, indicating smaller average deal sizes. The UK issued USD 32.7 billion from just 26 deals, reflecting fewer but larger transactions. Supranational entities, such as multinational organizations, contributed USD 31.3 billion through 69 deals. Other major contributors include Italy (USD 30.3 billion, 33 deals), France (USD 30.0 billion, 42 deals), Spain (USD 21.8 billion, 45 deals), and the Netherlands (USD 20.6 billion, 28 deals). Hong Kong, China, rounds out the list with USD 15.6 billion from 21 deals. The data underscores the dominance of China and the USA in green finance, the strong presence of European nations, and the vital role of supranational entities in advancing sustainable finance globally.

Table 1: Top Countries Driving Green Bond Issuance in 2023

Country	Volume USD bn	Deal count
China	83.5	288
Germany	67.5	117
USA	59.9	1231
UK	32.7	26
Supranational	31.3	69
Italy	30.3	33
France	30.0	42
Spain	21.8	45
Netherlands	20.6	28
Hong Kong	15.6	21

Source: *Climate Bond Initiative (2023)*

2.9 Theoretical Framework

The Sustainable Development Theory, introduced by Brundtland (1987), aligns with key SDGs, highlighting the pivotal role of climate financing in addressing global challenges. Green bonds and carbon markets directly support SDG 13 (Climate Action) by funding climate mitigation and adaptation, SDG 7 (Affordable and Clean Energy) through renewable energy initiatives, and SDG 9 (Industry, Innovation, and Infrastructure) as well as SDG 11 (Sustainable Cities and Communities) by financing sustainable infrastructure. Additionally, carbon markets encourage cleaner production practices, advancing SDG 12 (Responsible Consumption and Production), while climate financing fosters global cooperation, supporting SDG 17 (Partnerships for the Goals). These mechanisms position climate financing as a transformative tool for sustainable development.

2.10 Empirical Literature

Green bond markets require improved transparency, robust regulations, and investor trust. Axelsen et al. (2023) advocate for DLT, while Harrison et al. (2022) highlight rising issuance. Baldi and Pandimiglio (2022) emphasize ESG scores, Gabor et al. (2019) stress climate integration, and Henide (2021) calls for standardization. Axelsen et al. (2023) explored the use of distributed ledger technology (DLT) in facilitating green bond trading within the European Union, utilizing a regulatory sandbox to test a multi-sharded DLT architecture with input from key industrial and governmental stakeholders. The findings suggest that DLT can enhance transparency, efficiency, and settlement in green bond markets, though the study falls short in addressing regulatory challenges and scalability in wider markets. Similarly, Harrison, MacGeoch, and Michetti (2022) examined global trends in sustainable debt issuance, particularly green bonds, and their alignment with the Sustainable Development Goals (SDGs). Their analysis, based on Climate Bonds Initiative data, highlighted a significant rise in green bond issuance driven by increased investor interest in environmentally sustainable projects. However, the study lacks an assessment of the social and environmental outcomes of these investments. In a related vein, Baldi and Pandimiglio (2022) analysed the influence of ESG scoring and green washing risks on green bond yields, finding that higher ESG scores correlate with lower yields, signalling investor trust in credible bonds. Nevertheless, the presence of green washing risks weakens this relationship, and the study would benefit from case studies for greater contextual depth. Gabor et al. (2019) proposed a comprehensive green finance strategy for the UK aimed at integrating climate risks into financial systems and increasing public investments to align with SDGs. While the recommendations are robust, the study lacks empirical evidence to demonstrate their effectiveness in other contexts. Finally, Henide (2021) addressed the issue of adverse selection in the green bond market, emphasizing the risks posed by "green lemons" bonds that fail to deliver promised environmental benefits. The study underscores the importance of standardization and transparency to address these challenges but would be strengthened by examining a wider range of global markets for broader applicability.

3. DATA AND METHODOLOGY

The study utilises quarterly data spanning from 2007Q1 to 2023Q4. Variables such as Sustainable Development Goals, climate finance, green bonds were introduced in 2007, the carbon market, and global challenges (proxy by global CO_2 emission (G_tCO_2) were sourced from various reports. Data on Sustainable Development Goals were obtained from the *Sustainable Development Report*, climate finance data from the Organisation for Economic Co-operation and Development (OECD), green bonds data from the Climate Bonds Initiative, carbon market data from the World Bank's *State and Trends of Carbon Pricing report*, and global challenges data from the International Renewable Energy Agency.

3.1 ARDL-bound testing Cointegration

The econometric model will be estimated using the Autoregressive Distributed Lag (ARDL) approach developed by Pesaran, et al. (2001). This method is chosen due to its ability to identify long-term relationships among variables, its effectiveness in handling small sample sizes, and its flexibility in accommodating variables with different levels of integration, whether I(0) or I(1). Following the studies by Wang and Li (2023) and Patel and Gupta (2022), the econometric model is specified as follows:

$$SDGs = f(CF, GB, CM, GC) \quad (3.1)$$

$$SDGs_t = \beta_0 + CF_t + GB_t + CM_t + GC_t + \mu_t \quad (3.2)$$

Then, transformed it to the ARDL specification as;

$$\Delta lnSDGs_t = \beta_0 + \beta_1 lnCF_{t-1} + \beta_2 lnGB_{t-1} + \beta_3 lnCM_{t-1} + \beta_4 lnGC_{t-1} + \sum_{i=1}^{b} \beta_1 \Delta lnSDGs_{t-1} + \sum_{i=1}^{b} \beta_2 \Delta lnCF_{t-1} + \sum_{i=1}^{b} \beta_3 \Delta lnGB_{t-1} + \sum_{i=1}^{b} \beta_3 \Delta lnCM_{t-1} + \sum_{i=1}^{b} \beta_4 \Delta lnGC_{t-1} + \mu_t \quad (3.3)$$

The first part of the equation, which excludes Δ represents the long-run dynamics, while the second part, including Δ captures the short-run dynamics. The bounds testing procedure is applied to confirm the presence of cointegration among the variables before proceeding with the estimation. To analyse the short-run adjustment towards equilibrium, the Error Correction Model (ECM) is specified in equation 3.4 as follows:

$$\Delta lnSDGs_t = \beta_0 + \sum_{i=1}^{b} \beta_1 \Delta lnSDGs_{t-1} + \sum_{i=1}^{b} \beta_2 \Delta lnCF_{t-1} + \sum_{i=1}^{b} \beta_3 \Delta lnGB_{t-1} + \sum_{i=1}^{b} \beta_3 \Delta lnCM_{t-1} + \sum_{i=1}^{b} \beta_4 \Delta lnGC_{t-1} + \delta ECM_{t-1} + \mu_t \quad (3.4)$$

Where, the δ represents the speed of adjustment of the parameters towards long-run equilibrium after a shock to the system, while ECM_{-1} denotes the error correction term.

4. RESULTS AND DISCUSSION

Table 2: Descriptive Statistics

	SDGS	CF	GB	CM	GC
Mean	3.301854	4.657874	3.335530	-2.355005	3.368593
Median	3.255516	4.248495	3.747148	-2.188664	3.374169
Maximum	3.469105	7.244228	6.354370	-1.462737	3.459466
Minimum	3.104407	3.555348	-0.223144	-2.990973	3.277145
Std. Dev.	0.111384	1.176582	2.460901	0.538897	0.055909
Skewness	0.254550	1.491958	-0.255088	0.230497	-0.028036
Kurtosis	1.801190	3.600008	1.486932	1.882778	1.776725
Jarque-Bera	4.806263	26.24734	7.224023	4.138654	4.248711
Probability	0.090434	0.000002	0.026997	0.126271	0.119510
Sum	224.5260	316.7354	226.8160	-160.1403	229.0643
Sum Sq. Dev.	0.831233	92.75111	405.7544	19.45748	0.209427
Observations	68	68	68	68	68

Source: *Author's Computation (2025)*

Table 2, indicates that the descriptive statistics show that Climate Financing has the highest variability and investment levels, while Global Challenges is the most stable. Green Bonds exhibits the widest range, reflecting diverse adoption levels. Sustainable Development Goals demonstrate moderate consistency, and the Carbon Market shows negative mean values, indicating a focus on reducing emissions. Most variables are approximately normal, except for climate financing and green bonds, which deviate significantly.

Table 3: Correlation Matrix

	LSDGS	LCF	LGB	LCM	LGC
LSDGS	1.000000				
LCF	0.577643	1.000000			
LGB	0.167330	0.731047	1.000000		
LCM	0.334811	0.868493	0.952312	1.000000	
LGC	0.226749	0.816048	0.977943	0.960648	1.000000

Source: *Author's Computation (2025)*

The correlation matrix in Table 3 shows strong interconnections among Climate Financing, Green Bonds, Carbon Market, and Global Challenges, with correlations exceeding 0.8, indicating their collective importance in addressing climate change and global issues. Green Bonds and the Carbon Market are particularly aligned (0.9523), and Global Challenges strongly correlate with both (0.9779 and 0.9606). However, Sustainable Development Goals exhibit weaker correlations with all variables, with the highest being 0.5776 for climate financing, highlighting a more indirect relationship with financial and global efforts. These results underline the integrated nature of climate and financial initiatives.

Table 4: Unit Root Test Result

variables	ADF			PP		
	At Level	1st Diff.,	Status	At Level	1st Diff.,	Status
LSDGS	(0.1483) {0.7259}	(-8.0623) {0.0000}***	I(1)	(0.1483) {0.7259}	(-8.0623) {0.0000}***	I(1)
LCF	(1.5610) {0.9699}	(-8.0623) {0.0000}***	I(1)	(1.7053) {0.9778}	(-8.0623) {0.0000}***	I(1)
LGB	(1.5573) {0.9697}	(-8.0623) {0.0000}***	I(1)	(1.6396) {0.9744}	(-8.0623) {0.0000}***	I(1)
LCM	(-2.0221) {0.0421}**	(-8.0623) {0.0000}***	I(0)	(-2.1136) {0.0341}**	(8.0623) {0.0000}***	I(0)
LGC	2.9614 {0.9991}	(-2.2143) {0.0269}***	I(1)	(11.0380) {1.0000}	(8.0623) {0.0000}***	I(1)

(*)Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1%, Augmented Dickey Fuller (ADF), Phillips Perron (PP), First Difference (1st Diff)
Source: *Author's Computation (2025)*

The Unit Root Test results show in table 4 that the Sustainable Development Goals, Climate Financing, Green Bonds, and Global Challenges are non-stationary at the level but become stationary after first differencing, indicating they are I(1). In contrast, the Carbon Market is stationary at the level, making it I(0). This mix of I(0) and I(1) variables is appropriate for ARDL modelling.

Table 5: ARDL Bound Test Result

Test Statistic	Value	K
F-statistic	12.85371	4
	Critical Value Bounds	
Significance Level	I(0) Bound	I(1) Bound
10%	2.2	3.09
5%	2.56	3.49
1%	3.29	4.37

Source: *Author's Computation (2025)*

The F- statistics test shows that there is a long-run relationship among the variables. Since the F-statistics of 12.85371 is higher than the upper bound critical value at 5% level of significance. The null hypothesis of no cointegration is rejected. Thus, climate financing in advancing sustainable development goal measured with climate financing, green bonds, carbon market and global challenges proxy by global CO_2 emission (G_tCO_2) could be assumed to have a relationship with sustainable development goals in the long-run.

Table 6: Autoregressive Distributed Lag (ARDL) Model

PANEL A: Short run ARDL		
Variable	Coefficient	Std. Error
D(LCF)	0.097516	(0.028408) {0.0011}***
D(LGB)	0.026097	(0.020004) {0.1972}
D(LCM)	-0.173407	(0.090540) {0.0604}*
D(LGC)	-2.235918	(0.956299) {0.0229}**
CointEq(-1)	-0.111386	(0.039416) {0.0065}***
PANEL B: Long run ARDL		
LCF	0.180778	(0.055156) {0.0019}***
LGB	0.218905	(0.079133) {0.0079}***
LCM	-0.148260	(0.203399) {0.4694}
LGC	-10.646931	(3.285461) {0.0021}***
C	37.326120	(10.546141) {0.0009}***

Source: *Author's Computation (2025)*

In the short run, the carbon market has a negative and statistically significant impact on the dependent variable at the 10% level, with a coefficient of -0.17, indicating that short-term inefficiencies and volatility in carbon markets hinder progress toward sustainable development goals aligning with findings by Zhang et al. (2021), which highlighted the detrimental effects of market misalignment on development efforts. Global challenges also exert a significant and negative impact on the dependent variable at the 5% level, with a coefficient of -2.23, reflecting how crises such as geopolitical conflicts or pandemics strain resources and divert attention from SDGs, consistent with UNDP (2022). Green bonds shows a positive but statistically insignificant relationship 0.026, suggesting its limited role in addressing sustainable development goals in the short term, contrary to World Bank (2020), which emphasized the potential of global financing when appropriately utilized. Local financing has a positive and statistically significant impact at the 1% level, with a coefficient of 0.097516, highlighting the importance of domestic financial resources in driving immediate sustainable development gaols progress. The speed of adjustment term, ECM(-1), is negative and significant at the 1% level, with a coefficient of -0.111386, confirming that deviations from the long-run equilibrium are corrected at a rate of 11.14% per period, aligning with Kumar et al. (2022), which emphasized the role of short-term adjustments in equilibrium.

In the long run, the carbon market continues to have a negative impact on sustainable development gaols with a coefficient of 0.148, but this effect is statistically insignificant, suggesting that structural inefficiencies or insufficient integration with sustainable policies neutralize its influence over time, consistent with Kumar et al. (2022). Global challenges remain strongly negative and statistically significant at the 1% level, with a coefficient of -10.65, indicating the persistent and substantial adverse effects of prolonged crises on sustainable development,

aligning with IPCC (2023), which emphasized the long-term consequences of global instability on sustainable development goals. Green bonds have a positive and statistically significant impact on sustainable development goals, with a coefficient of 0.218905, showing that effective allocation of financial resources contributes positively to long-term development goals, consistent with Escobar et al. (2019), who highlighted the transformative potential of financial resources for sustainable development gaols. Similarly, local financing exerts a positive and statistically significant effect at the 1% level, with a coefficient of 0.181, underscoring its critical role in fostering sustainable development, as supported by Stern et al. (2007). The constant term (C) is also significant, with a positive value of 37.33, reflecting underlying structural or institutional factors that favorably influence the sustainable development goals in the long run.

Table 7: Diagnostic Test

Test	Chi-Square	P-value
Serial Correlation	0.088132	0.9158
Residual Heteroskedasticity Test	0.391675	0.5336
Cusum and CusumQ	Stable	Stable

Source: *Author's Computation (2025)*

Table 7, indicates that the diagnostic test results confirm that the model is reliable and well-specified. The Serial Correlation Test, with a Chi-Square statistic of 0.0881 and a p-value of 0.9158, indicates no evidence of serial correlation, meaning the residuals are independently distributed. Similarly, the Residual Heteroskedasticity Test, with a Chi-Square statistic of 0.3917 and a p-value of 0.5336, shows no evidence of heteroskedasticity, suggesting that the residuals have constant variance. Additionally, the CUSUM and CUSUMQ tests indicate stability, confirming that the model's parameters remain consistent over time.

5. CONCLUSION, POLICY RECOMMENDATIONS

The study explores the impact of climate financing, green bonds, carbon markets, and global challenges on sustainable development goals. In the short term, carbon markets and global challenges hinder sustainable development goals progress, while local financing positively impacts sustainable development goals. In the long run, carbon markets' negative impact becomes insignificant, while green bonds and local financing contribute significantly to sustainable development. Global challenges continue to impede sustainable development goals. The model's reliability is confirmed, emphasizing the importance of effective domestic financing and addressing global crises and market inefficiencies in advancing sustainable development goals. Based on the conclusion the following policy recommendation were made; there is need to advance sustainable development goals, policies should focus on strengthening local financing mechanisms like green bonds, improving carbon market efficiency to align with sustainable policies, and creating a supportive environment for green bonds to attract private investment in sustainable projects.

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