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RESEARCH PAPER

Effectiveness of Climate Finance in CO_2 Emissions Reduction: An Empirical Analysis

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ABSTRACT

This study aims to analyze the relationship between climate finance and CO2 emissions in 52 developing countries from 2002 to 2021. As climate change worsens day-by-day, understanding this relationship is of paramount importance for designing effective policies to reduce CO2 emissions. The study has used two-step system GMM to find out the impact of climate finance and economic growth on CO_2 emissions in developing countries. As the economic growth ensues, pollution increases in the start but then declines as income further increases. Our results suggest that an increase in climate finance aid increases CO_2 emissions, but as economies prosper, the rise in income reduces the emissions in developing economies. The study recommends allocation of climate aid efficiently and in areas where the emissions reduction is much higher in percentage. In addition, discouraging more investment in emission generating industries is recommended.

KEYWORDS: Climate Finance, CO2 Emissions, Developing Countries, Environmental Kuznets Curve, Mitigation, Sustainable Development

Introduction

Climate change has emerged as a major concern for the global community in recent decades. Despite several adoptive and mitigating strategies, the world has yet to resolve the threat associated with climate change. The social and economic situation of underdeveloped countries poses a serious threat to sustainable development mainly related to climate change (Owen, 2020). As these countries encounter serious concerns such as climate change and the transition to cleaner energy sources, governments have the challenging task of developing and executing effective policy measures. In order to control climate change in short time, comprehensive and innovative policies are required that reflect the interactions between social, economic, and environmental issues. Therefore, policy decisions are fundamental in determining the pathway for sustainable development.

Climate finance is the financial support at the local, national, or transnational levels, derived from a variety of sources such as public, private, and alternative funding (Banga, 2019). The prime objective of climate finance is to enable climate change mitigation and adaptation strategies to address the challenges associated with climate change (Environmental Protection Agency, 2020). The origin of this concept comes from international agreements like the Kyoto Protocol, and the Paris Agreement, which stresses the need for economic support to those who are more at risk. Mitigation activities require huge expenditures to achieve significant emission reductions, whereas the adaptation strategies require significant financial aid to address the negative consequences and minimize the repercussions of a changing climate (UNCC, 2023).

After Kyoto Protocol agreement in 1997, developed countries have been offering financial aid to developing countries in terms of mitigation and adaptation. Since then, climate finance has been considered as a vital element that can help countries to fight against climate change (Carfora & Scandurra, 2019). Climate change has a broad impact on the well-being of individuals across the world. Furthermore, it presents significant dangers to the economy and financial system (Litterman et al., 2020). By leveraging the tools of financial economics, which are specifically designed to assess and manage uncertain future outcomes, society can effectively evaluate and respond to the risks associated with climate change.

Figure 01 shows the levels of CO_2 emissions in developing countries during 2002 to 2021. CO_2 emissions per capita have shown a rising trend in all countries showing a direct correlation between greenhouse gas (GHG) emissions and population size (Fig. 1). This highlights the need to address CO_2 emissions as a crucial aspect of combating global warming (Environmental Protection Agency, 2020).

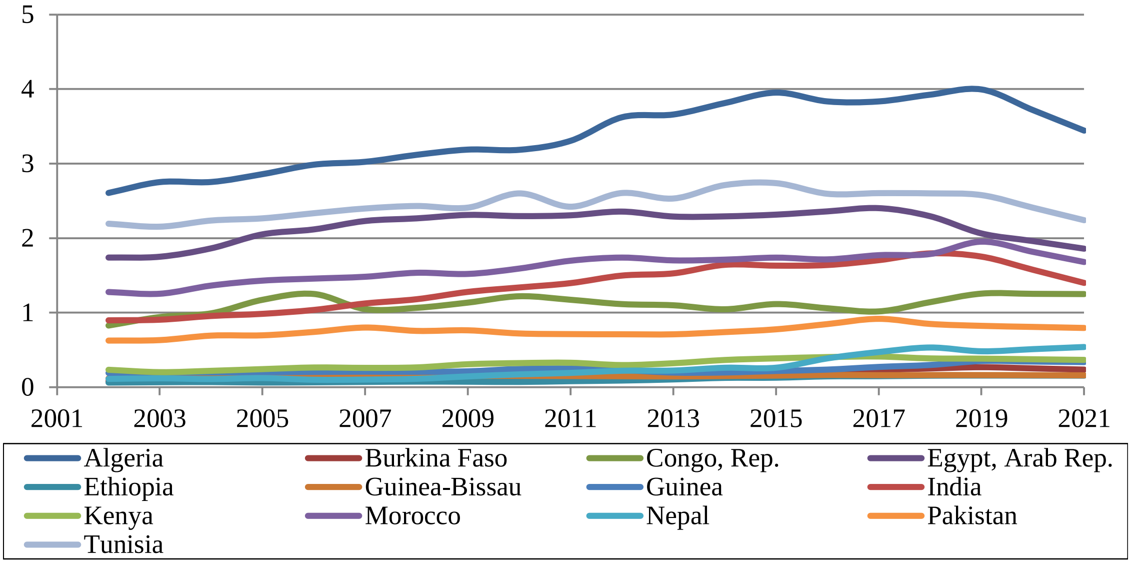

Fig. 1 CO_2 emissions (metric tons per capita) of Few Low Income Countries (2002 to 2021) Source: World Bank Indicators, 2023.

Climate change has become a serious threat to sustainable developing (World Economic Forum, 2022). Therefore, it is essential for the world to prioritize mitigation strategies to reduce CO_2 emissions (Environmental Protection Agency, 2020). The trade-off between economic growth and environmental conservation in developing countries has become a crucial debate among policy makers (IPCC, 2021). Vulnerable communities and developing countries have been disproportionately influenced by the climate change because of their limited adaptive capacity (Hallegatte et al., 2016). Reducing such disparity between investments and the actual funding remains a formidable challenge. In many developing countries, initiatives aimed at reducing carbon emissions are viewed as an impediment to progress. Though fossil fuels provide economic and efficient energy sources for economic development, they simultaneously contribute in environmental degradation. The intricate connection between economic growth and environmental impact has been a subject of extensive study since the 1990s.

There appears to be a gap in research specifically focused on the impact of climate finance on CO_2 emissions in underdeveloped countries. To address this gap, this study examines the impact of climate finance on CO_2 emissions in 52 underdeveloped countries selected based on low income. This study provides valuable insights into the effectiveness of climate finance interventions in reducing emissions and promoting sustainable development in underdeveloped countries.

Literature Review

There is a substantial body of literature examining the impact of climate finance aid on CO_2 emissions. The convergence of climate finance aid has received significant attention at the global and regional levels. Different methodological techniques, including comparative analysis, econometric models, and decomposition methods, have been employed.

Han and Jun (2023) examined the interaction between growth and emissions in developing countries. Their results indicated that EKC hypothesis aligns with a quadratic specification. The impact of mitigation aid demonstrates variability across datasets, suggesting that a mere increase in aid might not suffice in effectively decreasing emissions in developing countries.

Lee et al. (2022) measured the impact of climate finance on environmental sustainability through analyzing multilateral climate finance flows. Results suggested a decrease in carbon emissions due to an increase in climate finance aids, with mitigation finance having a greater impact than adaptation finance.

Ouyang et al. (2023) found that green finance policies improve the scale and quality of economic growth. Malik et al. (2018) analyzed the potential of green finance in Pakistan. The study proposed that a green energy-based energy policy can help meet the energy requirements, reduce dependence on imports, and lower energy costs. The study highlights the support of regulatory frameworks and power market structures towards the financial viability of renewable energy and facilitate access to financing.

Wang and Xu (2023) examined the potential for green investments within the 15 member countries of the Regional Comprehensive Economic Partnership (RCEP). Their findings indicate that GDP per capita serves as a barrier to renewable energy consumption in short term. Maâlej and Cabagnols (2022) explained the interconnections among GDP, renewable and non-renewable energy consumption, innovation, and CO_2 emissions for Germany, Finland, and Denmark. Their findings highlight that energy utilization plays a pivotal role in economic growth in Germany and Finland, while its significance is not pronounced in Denmark. Furthermore, the study underscores the pivotal roles of renewable energy and innovation in the reduction of CO_2 emissions.

Wang and Ma (2022) found that adoption of green finance in China serves as an effective strategy to mitigate GHG emissions, indicating a tangible reduction in CO_2 emissions. Especially, both green finance and CO_2 emissions exhibit significant geographical heterogeneity and asymmetry, with the beneficial impact of green finance observed primarily in the eastern and central regions, contributing to greenhouse gas mitigation. Beyond the overarching impact, green finance impacts the greenhouse effect through rapid economic growth at the provincial level, curbing improvements in energy efficiency, and expediting the optimization of the existing industrial structure.

The literature review reveals a limited number of studies using climate finance aid into the EKC framework. Kang and Jung (2016) and Moon (2017) examined the relationship between climate finance and emissions. Hence, the limited evidence for developing economies signifies a research gap, which our study can overcome.

Theoretical Framework

The ability to separate or disconnect the pattern of CO_2 emissions from economic growth is a significant characteristic observed in countries that are actively combating climate change and transitioning towards a greener economy with a focus on energy and ecology. This decoupling prospect indicates that these nations are working to lower carbon footprint and environmental degradation while maintaining or even increasing economic development. It emphasizes their commitment toward sustainable development and climate change without compromising economic well-being. Climate finance has the potential to reduce CO_2 emissions by two primary sources. First, financial support increases the credit for high-emission industries, alleviating liquidity constraints and compelling them to either reduce production or undertake low-carbon transformations, thus reducing their CO_2 output (Dikau & Volz, 2018). Policies promoting green credit effectively hinder investments in energy-intensive industries, hence, reduce carbon emissions.

Furthermore, climate finance encourages capital flow from the financial sector to industries (Nassiry, 2018) that facilities the constraints of low-emission production units by adding financial resources. The indirect support leads to decreased emissions by encouraging innovation in low-carbon technologies (Schmidt, 2014; Yu et al., 2021; Musah et al., 2022). While previous studies often rely on a single climate finance instrument to represent climate finance (Flammer, 2021; Wang & Guo, 2022), it is crucial to establish a comprehensive system that comprehensively measures the overall extent of climate finance. Furthermore, there is a tendency in scholarly work to predominantly concentrate on the immediate effects of climate finance, neglecting the time-lag effects of financial instruments and the long-term impact of climate finance. Additionally, the literature has frequently overlooked the influence of policy measures associated with climate finance on CO_2 emissions. Financial legislation, providing institutional support for climate finance, holds the potential to ultimately mitigate CO_2 emissions.

CO_2 emissions are subject to the influence of multiple factors, encompassing technological, structural, and economic aspects.

Material and Methods

This study employs panel data of 52 developing countries from year 2002 to 2021 to analyze the relationship between CO_2 emissions and climate finance. Panel data analysis allows to account for individual-specific characteristics that may affect the variables of interest (Baltagi, 2005). By observing changes within individuals or countries over time, panel data can provide insights into how variables evolve and adjust.

Data Sources and Description

The variables used are CO_2 emissions (in metric tons per capita), GDP per capita (in current USD), renewable energy consumption (expressed as a percentage of total final energy consumption), urban population (as a percentage of the total population), and climate change mitigation aid. The data is retrieved from World Bank and OECD databases, hence, having robustness and reliability in the analysis. This comprehensive approach allows for a thorough examination of the dynamic relationships among these key factors over an extended timeframe.

The study choose 52 countries in which 17 countries are low income countries and 35 countries are lower middle income (see table 1) classified based on income per-capita and HDI (human development indicators) index. This study focuses on the 'principal' and 'significant' category of climate change mitigation aid which ensures to analysis of the portion of aid which has significant contribution to climate change mitigation efforts. Log-transforming the variables, such as CO_2 emissions, GDP per capita, renewable energy consumption, and urban population, can help reduce skewness and address outliers in the data. Descriptive statistics are presented in table 2.

Table 01
Low and Lower Middles Income Countries

Low Income Countries	
Sub Saharan Africa	
Burundi	Madagascar
Burkina Faso	Malawi
Congo	Rwanda
Ethiopia	Mali
Guinea	Sierra Leone
Guinea-Bissau	Togo
Gambia	Chad
Haiti	Uganda
	Yemen
Middle East & North Africa	
Algeria	Tunisia
Egypt	Djibouti
Morocco	
Lower Middle income	
Sub Saharan Africa	**Latin America & Caribbean**
Comoros	El Salvador
Kenya	Honduras
Tanzania	Nicaragua
Angola	Bolivia
Congo	
Eswatini	**South Asia**
Lesotho	Bangladesh
Benin	Bhutan
Cabo Verde	India
Côte d'Ivoire	Nepal
Ghana	Pakistan
Mauritania	Sri Lanka
Nigeria	
Senegal	
East Asia and Pacific	
Lao People's Democratic Republic	Papua New Guinea
Solomon Islands	Philippines
Kiribati	Vanuatu

Table 02
Descriptive Statistics

Sr.no	Variable	Mean	Std. Dev.	Min.	Max.
1	**Ln CO_2**	0.6858409	0.6785872	.0217895	3.994402
2	**LnGDP**	7.088894	0.768743	4.704661	8.632437
3	**LnREC**	3.767334	1.085471	-2.813411	4.564765
4	**LnUP**	3.563002	0.4821619	2.161252	4.359487
5	**LnCF**	2.040303	2.607802	-6.474027	8.097442
No. of Observations		1020			

Econometric Model

The study aims to assess the influence of climate finance on CO_2 emissions while accounting for the effects of GDP and other factors. In equation (1), dependent variable $lnCO_{2it}$ is log of CO_2 emissions, $lnGDP_{it}$ is log of gross domestic product per capita, $lnUP_{it}$ is log of urban population, $CFaid_{it}$ refers to climate finance aid, REC_{it} refers to the renewable energy consumption and $lnGDP2_{it}$ is the log of square of GDP per capita. D1 and D2 are dummy variables of 2008 crisis and COVID-19, respectively.

$$lnCO2_{it} = \beta_0 + \beta_1 lnGDP_{it} + \beta_2 REC_{it} + \beta_3 UP_{it} + \beta_4 lnCFaid_{it} + \beta_5 D1 + \beta_6 D2 + \beta_7 lnGDP2_{it} + \varepsilon_{it} \quad (1)$$

Climate change mitigation aid, GDP, urban population, and renewable energy consumption are the independent variables.

The study uses System Generalized Method of Moments (GMM) to estimate the impact of climate finance on emissions. Equation 2 presents the empirical model formulated in the System GMM approach.

$$y_{it} = \alpha y_{i,t-1} + \beta' X_{it} + u_i + \varepsilon_{it} \quad (2)$$

Where, y_{it} is the dependent variable, $y_{i,t-1}$ denotes the lag of y_{it} and X_{it} signifies the independent variables. Before-after estimation tests are conducted to explore the relevance of the estimation technique and to validate the empirical findings.

Unit Root Test and Slope Heterogeneity

Table 3 presents the results of Panel unit root test. Findings of the study show that CO_2 emission and renewable energy consumption are significant at first difference. Whereas, GDP, climate finance and urban population are significant at level.

Table 03
Pesaran and Yamagata (2008) slope Heterogeneity analysis

	Value	P-value
Δ	9.848*	0.000
Δ_{adj}	13.278*	0.000

* indicates significance at 1%; ** indicates significance at 5%; *** indicates significance at 10%.

In assessing the unit root properties of panel data, two categories of methods, namely first-generation and second-generation unit root tests are employed. The study employs Fisher Augmented Dickey Fuller and Fisher PP, as proposed by Choi (2001) and Maddala & Wu (1999). These tests allow for heterogeneity and consider the assumption of first-order autocorrelation. The null hypothesis across all these tests states that a unit root is present, while the alternative hypothesis is that the series is stationary (table 4). This diverse set of unit root tests accommodates various conditions and characteristics in the panel data, contributing to a more comprehensive data assessment. Equation 3 presents ADF test for panel data.

$$\Delta y_{it} = \gamma_i y_{it-1} + \sum_{j=1}^{p} \alpha_j \Delta y_{it-j} + \varepsilon_{it} \quad (3)$$

Where $\gamma_i = \rho_i - 1$

Normally, null hypothesis for testing no stationarity is as follows,

$H_o: \gamma_i = 0 \quad (or\ \rho_i = 1)$

In panel data studies, the presence of cross-sectional dependency among the samples is addressed by conducting a second-generation panel unit root test. For second generation, foundational assumption underlying the Levin et al. (2002) panel unit root test is that multiple cross-sectional entities share a common unit root in panel data. Im Pesaran and Shin (2003) method is also used and is applied to test the unit root properties of variables (table 5). Particularly, this method relaxes the assumptions of no serial correlation and homogeneity across the panel. LL and IPS test forms are given in equations 4 and 5.

$$\Delta y_{i,t-1} = \alpha_i + \rho y_{i,t-1} + \sum_{k=1}^{n} \varphi_k y_{i,t-k} + \delta_i t + \theta_t + u_{it} \tag{4}$$

The null and alternative hypotheses for LL test are;

H₀: p = o

H₁: p < o

$$\Delta y_{i,t} = \alpha_i + \rho_i y_{i,t-1} + \sum_{k=1}^{n} \varphi_k y_{i,t-k} + \delta_i t + u_{it} \tag{5}$$

While now the null and alternative hypotheses for IPS test are;

H_o: ρ = 0 for all *i*

H_1: ρ < 0 for at least one *i*

Test for slope homogeneity usually use in panel with large number of observations. The null hypothesis for this test is that slope coefficients are homogenous.

Table 04
Unit root test of Augmented Dickey-Fuller and Fisher test (ADF-Fisher Chi-square)

Variable	ADF				PP				
	At level		At 1st difference		At Level		At 1st difference		
	Intercept	Trend Intercept	Intercept	Trend Intercept	Intercept	Trend intercept	Intercept	Trend intercept	
ln CO_2	89.644 (0.803)	77.388 (0.966)	262.817* (0.000)	194.639* (0.000)	80.5377 (0.9424)	72.1547 (0.989)	515.65* (0.000)	389.75* (0.000)	I(1)
lnGDP	96.308* (0.640)	100.018 (0.537)	342.628* (0.000)	267.071* (0.000)	436.178* (0.000)	128.76** (0.038)	441.33* (0.000)	479.88* (0.000)	I(1)
lnGDP^2	168.291* (0.000)	76.015 (0.9747)	293.922* (0.000)	276.364* (0.000)	367.905* (0.000)	113.66 (0.2022)	446.11* (0.000)	481.88* (0.000)	I(0)
lnCFaid	194.48* (0.000)	135.81** (0.014)	519.951* (0.000)	376.151* (0.000)	368.836* (0.000)	303.13* (0.000)	3108.13* (0.000)	909.69* (0.000)	I(0)
REC	71.178 (0.991)	78.305 (0.961)	291.473* (0.000)	222.604* (0.000)	87.5031 (0.846)	90.309 (0.789)	648.28* (0.000)	428.37* (0.000)	I(1)
UP	240.437 (0.000)	192.616* (0.000)	654.469 (0.000)	15.694* (0.003)	294.462* (0.000)	267.158* (0.000)	285.29* (0.000)	191.57* (0.000)	I(0)

*,**,*** indicate the significance of t-statistics at 1%,5% and 10% respectively

Based on unit root results, this study opted for GMM estimation technique, that shares similarities with Maximum Likelihood (ML). However, GMM differs in its approach by relying on assumptions about specific moments of random variables rather than making assumption on distribution. This characteristic makes GMM more resilient and flexible than ML, though at the expense of some efficiency in estimation. By focusing on targeted moments, GMM provides a robust framework for constructing estimators.

Table 05
Unit root test Im Pesaran Shin W-stat (IPS) and Levin Lin & Chu (LL)

Variable	IPS				LL				
	At level		At 1^{st} difference		At Level		At 1^{st} difference		
	Intercept	Trend Intercept	Intercept	Trend Intercept	Intercept	Trend intercept	Intercept	Trend intercept	
lnCO_2	0.5697 (0.716)	3.0499 (0.999)	-7.944* (0.000)	-4.419* (0.000)	-1.932** (0.027)	4.7099 (1.000)	-3.917* (0.000)	-3.291* (0.000)	I(1)
lnGDP	-5.402* (0.000)	2.2567 (0.988)	-9.779* (0.000)	-9.926* (0.000)	-10.393* (0.000)	-3.7154* (0.0001)	-11.007* (0.000)	-12.640* (0.000)	I(1)
lnGDP^2	-4.461* (0.000)	2.306 (0.989)	-10.169* (0.000)	-9.871* (0.000)	-9.491* (0.000)	-3.474* (0.000)	-11.493 (0.000)*	-12.792* (0.000)	I(0)
lnCFaid	-7.395* (0.000)	-4.7539* (0.000)	-19.108* (0.000)	-14.941* (0.000)	-7.533* (0.000)	-7.114* (0.000)	-15.863 (0.000)*	-11.869* (0.000)	I(0)
REC	2.248 (0.988)	2.358 (0.991)	-9.693* (0.000)	-7.249* (0.000)	-1.649** (0.049)	2.641 (0.996)	-7.919 (0.000)*	-9.656* (0.000)	I(1)
UP	5.169 (1.000)	5.591 (1.000)	2.073 (0.981)	-25.628* (0.000)	-12.696* (0.000)	5.915 (1.000)	2.5148 (0.994)	-46.879* (0.000)	I(1)

*,**,*** indicate the significance of t-statistics at 1%,5% and 10% respectively

Results and Discussion

Table 6 presents the results of the system GMM. Diagnostic tests results indicate statistically significant first-order autocorrelation AR (1) in all the models, suggesting the presence of autocorrelation in the first-order lag. However, the second-order autocorrelation AR (2) is statistically insignificant indicating that autocorrelation does not exist in the model beyond the first-order lag. These findings provide insights into the temporal dependencies within the data and help researchers evaluate the adequacy of the model specification. The presence of significant first-order autocorrelation might suggest the need for additional model refinement or exploration of alternative specifications to address the autocorrelation issue and improve the accuracy of model to capture the underlying data dynamics.

Economic growth and CO_2 emissions have a significant negative relationship for the low growth areas. The results indicate that all variables are significant. Both GDP and climate finance (CF) aid show a negative impact on CO_2 emissions, suggesting that climate finance effectively reduces CO_2 emissions, and GDP is significantly correlated with decreasing emissions. On the other hand, urban population has negative but insignificant relation with CO_2 emission. Renewable energy positively and significantly influences carbon emissions. The increase in GDP per capita significantly increase carbon emissions. This aligns with the EKC hypothesis, indicating a positive effect of carbon emissions on economic growth. Furthermore, the inclusion of the second-order term of GDP is associated with a reduction in emissions.

In underdeveloped countries, percentage change in climate finance (lnCF) exhibits a significant negative influence on emissions, even in the presence of a significant GDP variable. Despite the relatively modest magnitude and significance level of lnCF, it is crucial to highlight that climate finance has a statistically significant effect on emissions, contrary to anticipated results. Mitigation aid increases emissions in underdeveloped countries, contrary to its intended purpose of emission reduction. These findings imply that environmental protection strategies such as technological change as well as energy efficiency strength economic development prospects of underdeveloped countries.

Table 06
System GMM Results

Variables	Cumulative results	Low income	Lower Middle income	Sub-Saharan
ln CO_2 (L1)	1.1985* (0.000)	0.2104* (0.013)	1.192* (0.000)	0.5507* (0.000)
lnGDP	0.0716** (0.011)	0.0378*** (0.061)	0.135** (0.012)	0.0392* (0.001)
$lnGDP^2$	-0.0791 (0.196)	0.1303 (0.055)**	-0.026 (0.002)*	-
lnCFaid	-0.0311** (0.026)	-0.0722* (0.000)	-0.0284** (0.010)	-0.0059* (0.000)
REC	-0.0083** (0.035)	-0.00396* (0.000)	-0.0105** (0.039)	-0.0013* (0.023)
UP	0.0376* (0.000)	0.0069** (0.000)	-0.0338** (0.009)	0.00632* (0.034)
D1	-0.0164 (0.380)	0.0068 (0.705)	-0.0138 (0.408)	0.0049* (0.015)
D2	-0.839* (0.000)	-0.3749* (0.000)	-0.856* (0.000)	-0.0571* (0.000)
Cons.	0.9132* (0.043)	0.7039*** (0.075)	0.8735*** (0.093)	0.2139* (0.000)
AR(1)	(0.001)*	(0.001)**	(0.001)**	(0.008) **
AR(2)	(0.172)	(0.474)	(0.188)	(0.081)
Sargan test	(0.952)	(0.949)	(0.236)	(0.423)
Hansen test	(0.943)	(0.828)	(0.679)	(0.895)
Observations	1020	272	665	480
Countries	52	17	35	30
Instruments	20	18	22	41

*, **, *** indicate the significance of t-statistics at 1%,5% and 10% respectively

The negative impact of climate finance aid in low-income countries and positive impact in lower-middle-income countries reveal the departure from expected outcome under EKC hypothesis. Table 04 shows that increase in climate finance aid reduces emissions in lower income countries while increase in climate finance aid increases emissions in lower-middle income countries, indicating that in lower-middle income countries, aid in climate finance contributes toward environmental degradation.

We find positive and statistically significant impact of economic growth on carbon emissions in developing countries. Whereas the square term of GDP remained statistically insignificant in all econometric specifications, indicating the absence of non-linear relationship between growth and CO_2 emissions. Our findings reveal that the negative impact of climate finance is more pronounce in low-income countries as compared to lower middle income and sub-Saharan African countries.

Positive and significant impact of finance crisis has been confirmed in sub-Saharan African countries only showing that financial crisis did not affect the relationship between climate finance and emission in developing countries as a whole. Estimates in table 4 show that COVID-19 showed negative and significant impact on carbon emissions indicating that uncertainties may affect the impact of climate finance on emission under EKC hypothesis in developing countries. These findings imply that in policy actions should consider such uncertainties while making environmental protection strategies in future.

This unexpected finding highlights the complexities of the relationship between financial aid and environmental outcomes, calling for a more understanding of the factors affecting the relationship mainly in developing countries. It raises critical questions about the intended purpose and effectiveness of climate finance aid, as well as its correlation with increased emissions in low-income countries.

There is need to review the finance policies with a clearer distinction between development and climate funding. A more rigorous and focused strategy is required to guarantee that financial aid aligns with its stated goal of fostering sustainable development and reducing climate change. It also emphasizes the significance of appropriate awareness and targeted responses based on unique challenges and circumstances of each economy.

Conclusion

The findings of the study provide valuable insights to outline effective climate change mitigation schemes. First, it recommends a universal approach to policies, emphasizing a broader perspective beyond mere economic growth. Contrary to the EKC hypothesis, which posits that sustained economic growth inherently improves the environment, this study suggests that variables like renewable energy consumption are more significant than GDP levels in influencing emissions.

Secondly, the study underscores the importance of expediting the transition from conventional to renewable energy sources. It highlights that increased renewable energy consumption correlates with a significant reduction in CO_2 emissions. However, the study also emphasizes the need to consider the green premium associated with renewable energy, ensuring accessibility to its benefits for developing countries and vulnerable populations. It is recommended that policymakers should consider creating a supportive environment for renewable energy investments and ensure targeted financial assistance. This aligns with the concept of a "just transition" highlighted in existing literature, emphasizing fairness and inclusivity in the shift towards sustainable practices.

Policy Recommendations

The results of the study emphasize the growth of green economies through identification and highlighting of industries and programs committed to sustainability. A prominent challenge emerges from the limited transparency between microfinance institutions and environmentally cognizant enterprises which hinders effective collaboration. Economic intermediaries and business finance managers should be sensitized towards green businesses. In addition, businesses should familiarize themselves with the diverse array of financial products and funding sources available. There is a need for effective implementation of the financial architecture of green finance, coupled with a strong supporting ecosystem.

Policymakers should devise strategies and action plans to execute and implement green projects. Furthermore, strong measures should be taken to promote funds for environmental reporting quality. Successful reform initiatives are not possible without the engagement of socially responsible stakeholders and the integration of social capital. The awareness on green finance requires the use of environment friendly financial expansion plans that help to promote financing opportunities in developing countries. Acknowledging its limitations, particularly in terms of green finance and overlooking influencing factors, this research underscores the importance of further investigation by including economic and financial policy as control variable that will enhance the understanding of the dynamics impact of green financial policy.

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