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Moderating role of private energy investment on the relationship between institutional quality and climate change mitigation

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Abstract
There has been growing threat to our environment due to climate change that manifests in climate variation and many unplanned and uncontrollable deserters. Policies are continuously being put in place to counter the menace without due consideration of the importance of governance indicator in ensuring reduction to the threat. This study looks into the effectiveness the governance institutional pillars in reducing the climate change through reduction in greenhouse gas emission. The study further investigates the moderating role of private sector in reducing carbon emission. To achieve this, this study obtained secondary data and analyses it using both descriptive statistics and multivariate regression. The study found that the relationship between institutional qualities (rule-based governance, legal and social protection rating) and the in the greenhouse gas emissions in sub-Sahara Africa is positive while environmental protection has negative effect on carbon emission. furthermore, the findings revealed a moderating role of private sector investment on the relationship between institutional qualities and carbon emission. The study concludes that strengthening the institutional framework and encouraging private sector participation will work toward mitigating the climate challenges globally. Important among these institutions are the country's adherence to good governance through effective rule-based system, efficient legal system and effectiveness of the law enforcement.

Key words: Carbon Emission, Climate Change, Institutional Quality, Sub-Sahara.

1. Introduction

There exist two important episodes of human survival that are shaped by technological changes and each of them has some significant intellectual heritage. The first phase is when the technological changes transformed humans and eject them out of the stone-age living standard. The second phase is marked by the externalities of the technologies triggering climate change which in all projections poses threat to human existence. While we succeeded in harnessing every new technology in making our lives easy, we fail to address the climate change which is threat to our existence. Several challenges are posed by the threat to human existences emanated from the human activity triggered carbon emission that results in the climate change.

To understand the intricacies of the climate change, theory of public goods highlighted that climate change has negative externality or "public bad" in the form of greenhouse gas (GHG) emissions rather than a public good of improved knowledge. Climate change is a principally issue for its global faces of the externality. The negative impact left behind is globally felt and the impact has continuously and indivisibly spread around the entire world. The focus of the most governments of the developed economies in the early part of the last century was to support the governments of the other countries they have similar religious affiliation, political and military alliances and support in the

control of some spread of infectious diseases to stop any global pandemic. However, these days has witnessed an important issue which could eclipse those identified in the last century – ie climate change. While the older challenges still matter, the attention of various governments are on how to tackle these global challenges arising from global warming and other related issues such as the threat of nuclear proliferation (Germano, 2022).

The impact of climate change on sub-Sahara Africa is likely to be severe due to thei global positioning (Moshobane, et al. 2022), high agricultural dependence in the face of the annual flood occurrences (Derbile, Bonye, & Yiridomoh, (2022), and limited capacity to uplift institutional frameworks (Ogunyiola, Gardezi, & Vij, 2022). Direct effects vary widely across the continent, with some areas (eg eastern Africa) predicted to get wetter, but much of southern Africa getting drier and hotter. In such places, agricultural produce is considerably affected by the weather change and the challenges are often insurmountable given the nature of its occurrences. Adaptation to climate change has to be multifaceted moved by government initiatives. This could be done through providing the information, incentives and economic environment to facilitate such changes.

Despite the calls for the need to come up with acceptable regional solutions, it is pointed that adopt a blanket initiative may likely be difficult due to the fragmentation of the region into political segments, ethnics groups and poor business environments (Osabohien, et al 2019). On the mitigation side, there is a need to design emissions trading frameworks that support greater African participation than at present, and that include land-use change. Mitigation undertaken elsewhere will have a major impact on Africa, both positive (eg new technologies) and negative (e.g. commodity price changes arising from biofuel policies).

In an effort to mitigate the global warming through carbon emission, United Nation (UN) has come up with the Clean Development Mechanism (CDM) scheme. The scheme aimed at proving channels for countries to fund their greenhouse projects in other countries and claim the saved emission as their own efforts. The CDM already functions as an institution by which developing countries can earn income from reducing carbon emissions. Surprisingly, the level of participation in the scheme by the sub-Saharan countries is not encouraging. For instance, from the more than two-billion-dollar worth of CDM currently being traded, only two percent of the amount goes to sub-Sahara Africa (Kreibich, Hermwille, Warnecke, & Arens, 2017; Lo & Cong, 2022). In addition, the benefit accrued for the participation is not evenly distrusted as the low-income countries hardly participate in the scheme. Being the second largest continent, the need for better participation in the effort to mitigate the climate change could not be over emphasized giving the challenges posed by its externalities.

The externalities resulting from the climate change are undisputable and the inevitable impact for Earth and all its inhabitants is a serious concern. Ice is melting in the north and south poles, the general sea levels are rising, biodiversity is declining, precipitation has increased, atmospheric levels of carbon dioxide and greenhouse gases are alarmingly high, and extreme weather conditions are becoming increasingly common. What effort have governments across the globe been putting in place? How powerful has been the governance instruments used in enforcing the environmental laws? To what extent has the institutions works what mitigating the effect of the climate change? and what are the private sectors role in the reduction of carbon emission? This study looks into some of the governance mechanism in the

effort to mitigate climate change through reduction in the countries' carbon emission.

Governance is a central issue in dealing with global externalities because effective management requires the concerted action of major countries. However, under current international law, there is no legal mechanism by which disinterested majorities of countries can require other nations to share in the responsibility for managing global externalities. As a result, World leaders are being increasingly confronted with difficult decisions on development and the environment and the drastic cuts in greenhouse gas emissions that are required to address the climate crisis. Following growing awareness and anxiety among voters, environmental and climate issues have featured prominently in recent election campaigns in many parts of the world. Regular reports, including those published by the Intergovernmental Panel on Climate Change (IPCC), have generated considerable global media attention on the need for sustainable development and the bold decisions that are required to save the planet from overheating. Numerous social movements such as the youth-led movement Fridays for Future, inspired by activists such as Greta Thunberg—are mobilizing new groups of citizens to protest and hold political and corporate leaders to account for inaction.

Underlying much of this activism is the concern about political decisions today that may radically impact planetary health and the lives of future generations. In retaliating against such movements and policies, opposition groups are mobilizing citizens against the drastic changes proposed by environmentalists and climate campaigners to current lifestyles and consumption patterns. The democratic discourse on climate change and sustainable development is thus becoming increasingly polarized. While some voters are pushing back against the movement to wean the world economy away from fossil fuels, others are questioning the huge costs that transitioning to the green economy will impose and whether such attempts will have the required impact.

The remaining part of this paper is structured into four sections. Section two discusses literature review by reviewing some of the recent studies made in the area. Section three discusses the research design by explaining the sample used for the data collection and method used for data analysis. Section 4 discusses the data analysis and the discussion of the findings and finally, section five is on the conclusion of the study.

2. Literature Review

Extant studies showed that the sources of energy are the key drivers for the global warming and the consequent externalities. The sources from the fossil fuel such as coal, oil and natural gas are the major contractors to the carbon emission globally (Sun, et al., 2022; Sajid, et al., 2022; Jiang, et al. 2022). Similarly, studies have shown that energy production is one of the most important causes of environmental degradation (Mukhtarov, 2022). It is a fact that demand and supply of energy increases as the world population increases (Mutezo and Mulopo, 2021). Consequently, environmental degradation and global warming has been hastening due to the fact that fossil fuel sources (especially, coal and oil) still have an important share in total energy production in some countries, such as China and India, causing a significant amount of carbon dioxide (CO_2) emissions. On the other hand, it is not an easy task for policy makers to restructure the existing energy production structure from fossil fuel sources to renewable sources because of environmental concerns.

Studies in the current literature point out a nexus between energy consumption and environmental degradation (Adebayo et al., 2021; Kartal, 2022). There is often a bidirectional nexus between energy consumption and environmental

degradation. An increase in energy consumption leads to an increase in environmental degradation through CO_2 emission. Nowadays, the nexus between energy consumption and environmental degradation is among the top priorities to be studied (Anuar et al., 2021). In line with the increasing energy consumption and environmental degradation, research on the nexus has been increasing recently with the determination of a net-zero emissions goal for countries.

Sheraz et al (2022) examined the influence of institutional qualities of the Belt and Road Initiative countries in connection to carbon emission. The study analysed evidence from 64 countries and found that institutional qualities effectively help in the reduction of carbon emission. Khan et al. (2022) studied the efforts made by the G7 countries by analysing the effect of institutional quality in relation to carbon emission and the study found that institutional quality and renewable energy consumption help in mitigating the carbon emission in the developed economies. Similarly, it has also been found that good governance helps in the reduction of carbon emission (Güney, 2022). Interestingly, analysing evidence from MENA countries, Saadaoui (2022) affirmed that transition to renewable energy is fastened by political factors and institutional factors.

Number of extant studies identified that the extent of the country's adherence to some democratic principles as well as the quality of the democratic institutions are essential drivers to clean energy consumption which is a good step in mitigating climate change (Dasgupta, & De Cian, 2018). Glass and Newig (2019) while the level of democracy is correlated with better performance in most environmental SDGs, such as clean water and sanitation (SDG 6) and life below water (SDG 15), as well as the total average SDG achievement. Similarly, empirical examination of the impact of institutional quality revealed that institutional quality improves environmental performance in protected areas, air pollution and deforestation (Dasgupta, & De Cian, 2018). Following Selseng, Linnerud and Holden (2022) that the democratic principles are the key drivers for mitigating climate change, this study used legal system, rule of law, social protection and law enforcement as the core institutional tools used by the governments promoting the governments climate agenda.

3. Methodology

This study investigates the moderating effect of private energy investment in the relationship between institutional qualities and greenhouse gas emission in sub-Saharan Africa. The sample of the study comprises all the 49 sub-Saharan countries and data for the analysis are obtained from World Bank. The study used data on greenhouse gas emission and private energy investment from World Bank database. The data on rule based governance, strength of the legal system, Social and environmental protection rating are obtained from World Bank Country Policy and Institutional Assessment (CPIA). This study covers six eleven years' period from 2014 to 2023.

Six variables are used in the study that include the natural logarithm of the annual greenhouse gas emission (LGHG) of which indicates the mitigating the climate change. The LGHG is the dependent variable in the study. The independent variables are from the Strength of the Legal system (LEGAL); Rule based Governance Rating (RBGR); Social Protection Ratings (SOCPR); Environment Protection Rating (ENVIRON); and Private Energy Investment (PRIVAT). The summary of the variables and their measurements are summarised in the Table 1 below:

Table 1: Summary the Variables and their Measurements

Variable Names	Description	Sources	Used in
Log of Greenhouse Gas emission (LGHG)	Is measured using the logarithm of the Country's Annual greenhouse gas emissions in kilo tone of CO2 equivalent as reported by the world Bank.	World Bank	Boaitey, Goddard and Mohapatra (2019)
Rule Based Governance Rating (RULE)	Is measured by the Country Policy and Institutional Assessment Property Right and rule-based governance rating (CPIA property rights and rule-based governance rating). From the lowest (1) to highest (6).	World Bank	Namit (2016); Tzu-Yorn, and Huang, (2017)
Strength of the Legal System (LEGAL)	This measures the degree to which collateral and laws protect the rights of borrowers and lenders that facilitate lending. The index ranges from 0 to 12, with higher scores indicating that these laws are better designed to expand access to credit. Strength of the legal system (Strength of legal rights index (0=weak to 12=strong)	World Bank	Gani,and Clemes, (2016); Arslan, (2020).
Social Security Rating (SOCIAL)	This is based on world Bank Country Policy and Institutional Assessment of social protection, labour market regulations that reduces the risk of poverty and assist the poor ones to further manage the risk. The CPIA social protection rating is from lowest (1) to highest (6).	World Bank	Alola, Alola, Avci, and Ozturen, (2021); Osabohien, Matthew, Aderounmu, and Olawande, (2019); Osabohien, Olurinola, Matthew, and Ufua, (2022).
Environmental Protection Rating (ENVIRON)	World Bank Global Competitive Index measuring the Strength of Environmental protection from 0 (loest) to 10 (best)	World Economic Forum Global Competitive Index	Boţa-Avram, (2013)
Private Sector Participation Rating (PRIVATE)	World Bank Global Competitive Index measuring the Private Sector Participation 0 (lowest) to 10 (best)	World Economic Forum Global Competitive Index	Gerell, (2018)

4. Results and Discussion

Data of the study is analysed using three analytical tools that include the descriptive statistics correlation analysis and panel regression analysis. The Descriptive statistics reveals some of the variable parameters that include the mean, standard deviation (SD), maximum and minimum values in the dataset. In addition, the descriptive statistics include the number of observations for each of the variable. The correlation statistics measure the correlations between two pairs of the variables while the regression analysed the extent to which the test variables affect the changes in the greenhouse gas emission.

Descriptive Analysis

Table 2 summarises the descriptive statistics of the variables used in the analysis of the moderating role of private energy investment in the relationship between the institutional factors and greenhouse gas emission across all the countries in the sub-Sahara Africa. The statistics summarised in the table include the mean, maximum and minimum values of the variables in the distribution. The table also highlighted the standard deviation and the number of observations for all the variables in the dataset.

It could be noted that the mean log of greenhouse gas emission of the sub-Sahara countries is 4.179 which is 46,192 kilo tones of CO_2 equivalent. This shows that on average, each of the country emits over forty-six thousand kilo tones of carbons every year. This is relatively low compared to the carbon emission in other regions such as Europe, North and South America and Asia (Yaya, 2017; Panait 2022; Lee et al. 2018). the study also analysed the descriptive statistics of the independent variables as summarized in the Table 2. The table shows that the rule-based governance rating (RBGR) for all the countries under study is 2.6 with standard deviation of 1.166 and maximum of 4 and minimum of 1 which is an indication that the average rule base governance is relatively low on the scale 0f 1 to 6. The mean strength of the legal system (LEGAL) for sub-Saharan countries are 4.83 with a standard deviation of 2.4. The minimum and maximum values for the LEGAL are 0 and 11 respectively. Similarly, social protection score (SOCPR) has an average of 2.86 and standard deviation of 0.65. The maximum social protection score in the distribution is 5 while the minimum value is 1. The mean environmental protection rating (ENVIRON) for all the sub-Sahara countries is 3.059 with standard deviation of 0.698 and minimum of 2 and maximum of 8. The scores range between 1 and 10 for worst and best respectively.

Table 2 Descriptive Statistics of the Study Variables

Variables	Mean	SD	MAX	MIN	N
GHG	4.197	0.775	6	2	539
RULE	2.655	1.166	4	1	539
LEGAL	4.817	2.393	11	0	539
SOCIAL	2.858	0.658	5	1	539
ENVIRON	3.059	0.698	5	1	539
PRIVATE	3.829	0.845	5	0	539

Note: GHG = Greenhouse Gas Emission (in kilo Ton): RULE = rule based governance: LEGAL= strength of the Legal system: SOCIAL= Social protection rating: ENVIRON= Environmental protection rating: PRIVAT = Private energy investment.

Correlation Analysis

This study used Pearson's correlation statistics to analyse the extent of linear associativity between any two pair of the variables used in the study. Table 3 summarises the correlation statistics between the study variables and the result shows a positive correlation between the rule based governance (RULE) and the greenhouse gas emission (GHG) and the result is statistically significant. The relationship between strength of the legal

system (LEGAL) and GHG is also positive but not statistically significant. Similarly, the result of correlation between Social protection rating (SOCIAL) and greenhouse gas emission is positive and statistically significant. However, the relationship between environmental protection rating and greenhouse gas emission is not statistically significant.

Furthermore, Table 3 explains the correlation among the test variables to check the possible multicollinearity among the test variables. The table shows that RULE has a positive association with LEGAL and the relationships are significant. Also, the relationship between Private energy investment with three of the independent variables (LEGAL, SOCIAL and ENVIRON) are negative and statistically significant. Similarly, environmental protection rating have negative relationship with RULE, LEGAL and SOCIAL and the results are statistically significant. Despite the significant correlations among the test variables, it does not denote multicollinearity. Table 3 shows that the highest correlation coefficient is -0.627 for the correlation between the ENVIRON and LEGAL. This is below 0.8 treshold for the likelihood of the presence of multicollinearity (Shrestha, 2020; Kim 2019; Midi et al, 2010).

Table 3 Correlation Statistics

	1	2	3	4	5	6
(1) GHG	1					
(2) RULE	0.1698***	1				
	0.000					
(3) LEGAL	0.0613	0.2471***	1			
	0.156	0.000				
(4) SOCIAL	0.0932**	0.022	0.4016***	1		
	0.031	0.611	0.000			
(5) ENVIR	0.0491	-0.2809***	-0.6270***	-0.4277***	1	
	0.255	0.000	0.000	0.000		
(6) PRIVAT	0.2211***	-0.0438	-0.1687***	-0.1444***	0.2031***	1
	0.000	0.310	0.000	0.001	0.000	

Note: GHG = Greenhouse Gas Emission (in kilo Ton): RULE = rule based governance: LEGAL= strength of the Legal system: SOCIAL= Social protection rating: ENVIRON= Environmental protection rating: PRIVAT = Private energy investment.

Result of the Regression estimation

This study uses OLS regression estimations for empirical analysis of the relationship between the institutional strength and the greenhouse gas emission. The study further analysed the moderating effect of the private energy investment the relationship between the institutional qualities and greenhouse gas emission. Table 4 summarises the results of two OLS regression. The two models have 0% probability of f-statistics indicating that the models are significant at 99% confidence levels.

Table 4 Regression Estimation Results

	Model 1			Model 2		
Variables	Coef.	T-stat	P Value.	Coef.	T-stat	P Value.
Cons	3.575	17.69	0.000***	1.928	9.78	0.000***
RULE	0.138	4.71	0.000***	0.243	6.12	0.000***
LEGAL	0.074	1.72	0.087*	0.111	1.96	0.050*

SOCIAL	0.168	3.14	0.002***	0.182	3.44	0.001***
ENVIRON	0.256	4.08	0.000***	-0.046	-1.38	0.167
RULE_PRIV				-0.472	-10.67	0.000***
LEGAL_PRIV				-0.233	-38.46	0.000***
SOCIAL_PRIV				-0.050	-4.96	0.000***
ENVIRON_PRIV				-0.027	-1.98	0.048**
R-Square		0.0664			0.769	
Adj. R-Square		0.0594			0.7651	
Prob F-Stat		0.000			0.000	

Note: GHG = Greenhouse Gas Emission (in kilo Ton): RULE = rule based governance: LEGAL= strength of the Legal system: SOCIAL= Social protection rating: ENVIRON= Environmental protection rating: PRIV = Private energy investment.

The result as resented in the Table 4 has shown the results of a direct relationship and moderating effect of private energy investment. Model 1 summarises the regression result of the direct relationship which indicates that rule based governance, strength of the legal system and social and environmental protection ratings have positive effect on the greenhouse gas emission in the sub-Sahara Africa. The relationships are significant at 1% for both rule based rating and social protection rating. On the other hands, the strength of legal system is statistically significant at 10%. The result is not surprise given that the legal system and rule based governance in Africa is relatively at growing stage and may likely allow environmental pollution through greenhouse gas emission (Chen et al. 2022; McKay & Thorbecke, 2019; Davis, 2017). This result indicates that Rule based system, legal system and social protection in the region does not help in the reduction of the greenhouse gas emission which is the major contributor to the global warming and climate change. The region is has less developed legal system to protect environments (Bribena 2019; Kohler, & Schmithüsen, 2004; Bakibinga-Ibembe, Said & Mungai, 2011). Also, Osabohien et al (2019) identified that the shortage and in some cases, unavailability of the social protection programs are instrumental in worsening crop production through undeterred effect of the greenhouse gas emission as such, recommended insurance programmes to be put in place to provide cover for loses.

The Table 4 further show the regression result for testing the moderating effect of private energy investment on the relationship between the regressand and the repressors. The result of the moderating effect of private energy investment is shown in model 2 in the Table 4. The results show that private energy investment moderates the effect between all the independent variables (the strength of the legal system, rule based settings, social protection rating and environment protection rating) and greenhouse gas emission in the sub-Saharan region. It could be noted that the results in the model 1 are positive and significant for the first three independent variables (RULE, LEGAL and SOCIAL) but not statistically significant with ENVIRON. However, the second model (model2) indicate that there is negative and statistically significant relationship between the moderating variables (RULE_PRIV, LEGAL_PRIV, SOCIAL_PRIV and ENVIRON_PRIV) and the greenhouse gas emission. This indicates that the presence of private energy investment negatively modifies the relationship between the institutional qualities and greenhouse emission. The implication is that with more private energy investment in the sub-Sahara Africa, there will be a remarkable reduction in greenhouse gas emission in the region thereby reducing the African contributions in the global warming.

5. Conclusion and Recommendations

Greenhouse gas emission through human economic activities has continued to pose threat to the human existence in the recent times. This study provides new evidence on the influence of the strength of some institutions in mitigating the climate change through the greenhouse gas emission in the region. The institutional factors matter in the reduction of the greenhouse gas emission if there is sustained private energy investment in the region. Although studies revealed that sub-Sahara countries contribute relatively less to the global greenhouse gas emission, improving legal, social and democratic principles and ideals helps in tackling the climate challenges faced by the continent. One of the important contributions of this paper is that it provides empirical evidence on the on the importance of private energy investment in protecting the environment through the reduction of greenhouse gas. This suggest that improving the private energy investment across the continent will work toward mitigating the climate change being that the carbon footprint of the GHG is effectively contained by the institutional factors.

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