Governance, CO2 emissions and Inclusive Human Development in Sub-Saharan Africa

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Abstract

This study investigates the relevance of government quality in moderating the incidence of environmental degradation on inclusive human development in 44 sub-Saharan African countries for the period 2000-2012. Environmental degradation is measured with CO2 emissions and the governance dynamics include: political stability, voice and accountability, government effectiveness, regulation quality, the rule of law and corruption-control. The empirical evidence is based on the Generalised Method of Moments. Regulation quality modulates CO2 emissions to exert a net negative effect on inclusive development. Institutional governance (consisting of corruption-control and the rule of law) modulates CO2 emissions to also exert a net negative effect on inclusive human development. Fortunately, the corresponding interactive effects are positive, which indicates that good governance needs to be enhanced to achieve positive net effects. A policy threshold of institutional governance at which institutional governance completely dampens the unfavourable effect of CO2 emissions on inclusive human development is established. Other policy implications are discussed.

JEL Classification: C52; O38; O40; O55; P37

Keywords: CO2 emissions; Economic development; Africa

1. Introduction

This research on the relevance of governance in moderating the effect of environmental degradation on inclusive human development, builds on four main factors in scholarly circles, notably: (i) the growing challenge (or policy syndrome) of economic growth because economic growth should be pro-poor in the post-2015 era in which shared economic prosperity is fundamental for the achievement of most Sustainable Development Goals (SDGs)[2]; (ii) issues surrounding the degradation of the environment, (iii) concerns of poor governance when it comes to addressing environmental degradation issues and (iv) gaps in the attendant literature.

First, as recently documented by Asongu and Odhiambo (2018a, 2019), inclusive human development is a central theme in SDGs. This importance of inclusive development is even more crucial in sub-Saharan Africa (SSA) because in spite of the sub-region achieving more than two decades of resurgence in economic growth, the population living in extreme poverty has been consistently increasing and hence, close to half of the countries in the sub-region failed to achieve the Millennium Development Goal (MDG) target of reducing extreme poverty by half (Tchamyou, 2019a, 2019b). The nexus between poverty, economic growth and inclusive development can be understood from the perspective that the fruits of economic prosperity have not been trickling to the poor factions of the population (Fosu, 2015; Asongu & Kodila-Tedika, 2017; Asongu & le Roux, 2018).

The underlying policy syndrome of exclusive growth is an important policy issue because the objective of completely eradicating poverty in the sub-region by 2030 (i.e. in the light of the SDGs) is very less likely to be reached unless inclusive human development is fostered across SSA: "*This paper examines its feasibility for Sub-Saharan Africa (SSA), the world's poorest but growing region. It finds that under plausible assumptions extreme poverty*

[2]In the light of the extant literature, a policy syndrome is conceived and defined by Fosu (2013) to reflect conditions that are unfavourable for economic development, notably: "administered redistribution", "state breakdown", "state controls", and "suboptimal inter temporal resource allocation". Following Asongu (2017), a policy syndrome denotes a gap in knowledge economy between two countries or fundamental characteristics of economic development. Consistent with recent inclusive development literature (Asongu & Nwachukwu, 2017a; Tchamyou *et al.*, 2019), a policy syndrome is a factor of exclusive development, notably: income inequality and the presence of growth that is not pro-poor.

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will not be eradicated in SSA by 2030, but it can be reduced to low levels through high growth and income redistribution towards the poor segments of the society" (Bicaba *et al*., 2017, p. 93). In this study, we contribute to addressing the discussed concern of exclusive human development by assessing how governance is relevant in moderating the effect of environmental degradation on inclusive human development.

Second, another important concern in the SDG agenda is the sustainability of the environment (Akpan *et al*., 2015; Mbah & Nzeadibe, 2016; Asongu *et al*., 2016; Asongu *et al*., 2017). This concern in SSA is premised on at least three factors, notably: (i) the startling evidence of the energy crisis across the sub-region and (ii) consequences of global environmental degradation. These points are expanded in the same order as they are highlighted. (i) About two-thirds of the African population (i.e. approximately 620 million inhabitants) does not have access to *"affordable, reliable, sustainable and modern electricity"*, which is crucial to achieve SDGs (Akinyemi *et al*., 2015; Shurig, 2015; Jarrett, 2017).

(ii) As documented in recent literature, the ramifications of fossil fuel consumption would be most detrimental in SSA (Kifle, 2008; Huxster *et al*., 2015; Asongu *et al*., 2017). This is essentially because, *inter alia*: carbon dioxide emissions (CO2) constitute about 75% of greenhouse gas emissions in the world (Akpan & Akpan, 2012; Asongu *et al*., 2018). Moreover, as maintained by Jarrett (2017), the unreliable supply of power is a principal hurdle for corporations in Africa. According to the author, about 30 countries on the continent experience regular blackouts and shortages which cost their economies approximately between 2 and 5% of GDP. In summary, the energy deficit on the continent continues to retard economic prosperity, agricultural transformation, job creation, education and improvement of health facilities. It is further acknowledged that in order to achieve SDGs, it is crucial for the leaders on the continent to improve governance standards, especially in relation to how policies can be tailored to increase socio-economic development by making energy access clean, reliable and affordable for all (Jarrett, 2017). The outcome variable of this study (i.e. inclusive human development) and policy variables (i.e. good governance dynamics) are consistent with the underlying narratives and recommendations.

Third, good governance is important in understanding the energy crisis because decades of mismanagement and neglect in SSA have led to some of the worst functioning grid systems in the world. In essence, according to the attendant literature, not enough political will has been

garnered to effectively manage energy and environmental issues (Odhiambo, 2010; Afful-Koomson, 2012; Apkan & Akpan, 2012; Hongwu, 2013; Jones, 2003; Chemutai, 2009; Odhiambo, 2014a, 2014a; Anyangwe, 2014; Akinyemi *et al*., 2015, 2018; Jarrett, 2017; Asongu *et al*., 2018; Asongu, 2018a; Efobi *et al*., 2018).

Fourth, this study is positioned on assessing how good governance can modulate the effect of CO2 emissions on inclusive development because of an apparent gap in the literature. Accordingly, the attendant literature has largely focused on nexuses between economic development, environmental degradation and energy consumption. The first stream of this attendant literature has investigated the Environmental Kuznets Curve (EKC) hypothesis (Diao *et al*., 2009; Akbostanci *et al*., 2009; He & Richard, 2010)[3]. This stream therefore focuses on the nexus between environmental degradation and economic growth. The second stream has two main branches: (i) connections between the consumption of energy and environmental pollution (Jumbe, 2004; Ang, 2007; Apergis & Payne, 2009; Odhiambo, 2009a, 2009b; Ozturk & Acaravci, 2010; Menyah & Wolde-Rufael, 2010; Bölük & Mehmet, 2015; Begum *et al*., 2015; Le Van & Chon, 2017; Cui *et al*., 2018; Rui *et al*., 2018) and (ii) linkages between energy consumption and economic growth (see Mehrara, 2007; Esso, 2010)[4].

Noticeably, a common shortcoming in the engaged literature is the fact that providing nexuses between indicators of macroeconomic development are not enough to effectively inform policy makers. This research argues that such nexuses should be tailored such that they assess how policy variables moderate policy syndromes in order to affect targeted outcomes. In the light of the challenging policy imperative of inclusive development regarding SDG, this research extends the underlying literature by assessing how good governance modulates environmental degradation to affect inclusive human development in SSA. Hence, the corresponding research question is the following: how does good governance modulate the effect of environmental degradation on inclusive human development in SSA?

While the preceding paragraph has substantiated the connection between governance and environmental degradation, it is also worthwhile to articulate the nexus between

[3]According to the EKC, in the long run, there is an inverted U-shaped relationship between per capita income and environmental pollution.

[4] Also see Olusegun (2008) and Akinlo (2008).

environmental pollution and inclusive human development. Therefore, in line with Asongu and Odhiambo (2018b), we argue that the degradation of the environment affects constituents of the inequality-adjusted human development index (IHDI) used in this study as the outcome variables, notably: education, health and long life. First, environmental pollution can affect the income of a family by influencing the capacity of workers within a household to work effectively and search for jobs (Zivin & Neidell, 2012). Second, it is reasonable to argue that the degradation of the environment directly influences parents' ability to have their children go to school (Currie *et al*., 2009). This is more apparent in the presence of pollution in the atmosphere and lack of adequate facilities of transport. Furthermore, such pollution of the atmosphere can also influence the ability of students and pupils to study effectively in class (Clark *et al*., 2012; Sunyer *et al*., 2015). Third, still building from intuition, environmental pollution and degradation also affect healthy living and by extension, the life expectancy of the population (Boogaard *et al*., 2017; Rich, 2017).

Given that this study is motivated by SDGs, it is also relevant to discuss the linkages between inclusive development and sustainable development. According to Amavilah*et al.* (2017), inclusive development is related to sustainable development in the perspective that in order for inclusive development to be sustainable, it should be sustained and for sustained development to be sustainable, it must be inclusive. This research is also positioned as a theory-building empirical study because applied econometrics is not exclusively based on the rejection and acceptance of existing theories. Hence, we are consistent with a recent strand of the literature in arguing that an empirical study motivated by sound intuition is a relevant scientific activity (Narayan *et al*., 2011; Asongu & Nwachukwu, 2016a), especially in the light of challenges to SDGs.

The remainder of the study is organised as follows. The data and methodology are covered in Section 2 while Section 3 presents the empirical results. Section 4 concludes with implications and future research directions.

2 Data and methodology

2.1 Data

This research focuses on forty-four countries in SSA with data for the period 2000-2012[5]. The data is from four main sources, notably: (i) the United Nations Development Programme (UNDP) for the outcome variable (i.e. the inequality-adjusted human development index); (ii) the World Governance indicators of the World Bank for six governance indicators (political stability/no violence, voice and accountability, regulation quality, government effectiveness, corruption-control and the rule of law); (iii) the Financial Development and Structure Database (FDSD) of the World Bank for a control variable (i.e. credit access) and (iv) the World Development Indicators of the World Bank for the policy syndrome variable (i.e. environmental degradation) and two control variables (i.e. education quality and foreign aid). The adopted periodicity and number of countries are contingent on the constraints in data availability at the time of the study.

In the light of the motivation of the study, the adopted outcome indicator is the inequality-adjusted human development index (IHDI): the human development index (HDI) that is adjusted for the prevalence of inequality among the population. This indicator has been used in recent literature on environmental sustainability. In the light of the attendant literature,

"*The human development index (HDI) denotes a national mean of results in three principal dimensions, notably: health and long life, knowledge and basic living standards. The IHDI goes a step further by adjusting the HDI to prevalent levels of inequality in the aforementioned three dimensions. In other words, the IHDI also takes into consideration the manner in which the three underlying achievements are distributed within the population*" (Asongu *et al*., 2017, p. 355).

CO2 emission per capita is used to measure environmental pollution or the policy syndrome, in line with recent environmental degradation literature (Asongu, 2018b). The policy variables are six main governance indicators highlighted above. These indicators which

[5]The 44 countries are: "Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo Democratic. Republic., Congo Republic, Cote d'Ivoire, Djibouti, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome & Principe, Senegal, Seychelles, Sierra Leone, South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda and Zambia".

are from Kaufmann *et al.* (2010), are increasingly being used in African governance literature (Andres *et al.*,2015; Anyanwu & Erhijakpor, 2014; Efobi, 2015; Oluwatobi *et al.*, 2015; Asongu & Nwachukwu, 2017b; Pelizzo *et al.*, 2016; Pelizzo & Nwokora, 2016, 2018; Nwokora & Pelizzo, 2018). According to the attendant literature: "*The first concept is about the process by which those in authority are selected and replaced (Political Governance): voice and accountability and political stability. The second has to do with the capacity of government to formulate and implement policies, and to deliver services (Economic Governance): regulatory quality and government effectiveness. The last, but by no means least, regards the respect for citizens and the state of institutions that govern the interactions among them (Institutional Governance): rule of law and control of corruption*" (Andres *et al.*, 2015, p. 1041).

Consistent with recent inclusive human development literature (Asongu&Odhiambo, 2018b), three main control variables are used to account for variable omission bias, namely: education quality, credit access and foreign aid. Foreign aid and education quality are anticipated to reduce inclusive human development whereas credit access is anticipated to have the opposite incidence. Using the same indicator of inclusive human development, Asongu (2014) has established that development assistance has a negative incidence on the outcome variable. Conversely, financial access has been documented to be an instrument of inclusive development (Tchamyou, 2019a, 2019b; Meniago & Asongu, 2018).

The education quality indicator is the pupil-teacher ratio such that an increasing ratio is associated with poor education quality because more pupils have to be accommodated by a smaller teaching staff. Hence, in terms of measurement, the indicator appreciates poor education quality. This primary education indicator is preferred to higher levels of education because it has been documented to be more associated with socio-economic development when economies are at initial stages of industrialisation (Asiedu, 2014; Petrakis & Stamakis, 2002; Asongu & Odhiambo, 2018a). The expected negative sign from poor education quality is consistent with the established positive nexus between education and inclusive development (Dunlap-Hinkler *et al.*, 2010). Furthermore, education is a component of the IHDI.

It is important to note that the motivation for limiting indicators of the conditioning information set to three variables (in order to avoid concerns of instrument proliferation) is consistent with the attendant empirical literature based on Generalised Method of Moments

(GMM) that has used a zero control variable (Osabuohien & Efobi, 2013; Asongu & Nwachukwu, 2017c) or less than three control variables (Bruno *et al*., 2012). The definitions and sources of the variables are provided in Appendix 1 while the summary statistics are disclosed in Appendix 2. Appendix 3 presents the correlation matrix.

2.2 Methodology

2.2.1 GMM: Specification, identification and exclusion restrictions

Consistent with the underlying literature, the adoption of the Generalized Method of Moments (GMM) as an empirical strategy is motivated by four main factors (Tchamyou, 2019a, 2019b). First, the primary condition of having the number of cross sections exceed the number of periods within each cross section is fulfilled because the study is dealing with 44 countries over a span of 11 years (i.e. from 2004 to 2014). Second, the outcome variable is persistent because its correlation with its first lag is greater than 0.800, which is the rule of thumb for establishing persistence in a variable (Tchamyou *et al*., 2019). Third, cross-country differences are taken on board given the panel nature of the dataset. Fourth, endogeneity is addressed because: (i) simultaneity or reverse causality are tackled with an instrumentation process and (ii) time invariant variables are used to account for the unobserved heterogeneity.

The research adopts the Roodman (2009a, 2009b) extension of Arellano and Bover (1995) essentially because it has been established in the attendant literature to limit the proliferation of instruments (Asongu & Nwachukwu, 2016b; Tchamyou *et al*., 2019; Boateng *et al*., 2018).

The following equations in level (1) and first difference (2) summarise the standard *system* GMM estimation procedure.

$$HD_{i,t} = \sigma_0 + \sigma_1 HD_{i,t-\tau} + \sigma_2 CO_{i,t} + \sigma_3 G_{i,t} + \sigma_4 COG_{i,t} + \sum_{h=1}^{3} \delta_h W_{h,i,t-\tau} + \eta_i + \xi_t + \varepsilon_{i,t} \quad (1)$$

$$HD_{i,t} - HD_{i,t-\tau} = \sigma_1 (HD_{i,t-\tau} - HD_{i,t-2\tau}) + \sigma_2 (CO_{i,t} - CO_{i,t-\tau}) + \sigma_3 (G_{i,t} - G_{i,t-\tau}) + \sigma_4 (COG_{i,t} - COG_{i,t-\tau}) + \sum_{h=1}^{3} \delta_h (W_{h,i,t-\tau} - W_{h,i,t-2\tau}) + (\xi_t - \xi_{t-\tau}) + (\varepsilon_{i,t} - \varepsilon_{i,t-\tau}) \quad (2)$$

where, $HD_{i,t}$ is the human development variable of country i in period t, σ_0 is a constant, CO represents CO2 emissions, G entails governance (political stability, voice & accountability, government effectiveness, regulation quality, rule of law and corruption-control), COG denotes an interaction between a CO2 emission variable and a governance dynamic ("political stability" × "CO2 emissions", "voice & accountability" × "CO2 emissions", "government effectiveness" × "CO2 emissions", "regulation quality" × "CO2 emissions", "corruption-control" × "CO2 emissions", and "rule of law" × "CO2 emissions"), W is the vector of control variables (education quality, credit access and foreign aid), τ represents the coefficient of auto-regression which is one within the framework of this study because a year lag is enough to capture past information, ξ_t is the time-specific constant, η_i is the country-specific effect and $\varepsilon_{i,t}$ the error term.

2.2.2Identification and exclusion restrictions

In order to ensure robustness in the estimation approach, it is worthwhile to articulate identification and exclusion restrictions that are paramount for a tight GMM specification. In line with contemporary empirical literature (Asongu & Nwachukwu, 2016c; Tchamyou & Asongu, 2017; Boateng *et al*., 2018; Tchamyou *et al*., 2019), the identification strategy is such that the time invariant variables are considered as strictly exogenous whereas the endogenous explaining variables are defined as predetermined. This strategy of identification is supported by Roodman (2009b) who has argued that it is not feasible for time invariant indicators to be first-differenced endogenous[6].

In the light of the identification framework, the assumption of exclusion restriction is confirmed if the null hypothesis corresponding to the Difference in Hansen Test (DHT) for instrument exogeneity is not rejected. The null hypothesis is the position that the identified strictly exogenous variables elucidate the outcome variable exclusively via the predetermined variables. This process is not dissimilar to the standard procedure of employing classic instruments in which, the null hypothesis corresponding to the Sargan test should not be rejected in order for selected instruments to be valid (Beck *et al*., 2003; Asongu & Nwachukwu, 2016d).

[6]Hence, the procedure for treating *ivstyle* (years) is 'iv (years, eq(diff))' whereas the *gmmstyle* is employed for predetermined variables.

3. Presentation of results

3.1 Empirical results

The empirical results are disclosed in this section in Table 1. The findings are presented in three main groups pertaining to indicators of political governance(consisting of political stability and "voice & accountability"), economic governance(entailing government effectiveness and regulation quality) and institutional governance (encompassing corruption-control and the rule of law), respectively. Each of the governance dynamic entails two indicators of governance, in the light of definitions and classifications provided in the data section. Four main criteria are used to investigate the post-estimation validity of the GMM findings[7]. In the light of these criteria, the models on government effectiveness and corruption-control do not pass all post-estimation diagnostic tests because the null hypothesis of the Hansen test is rejected. This null hypothesis is the position that instruments are valid. It is relevant to note that the Hansen test is robust but weakened by instrument proliferation, whereas the Sargan test is not robust but not weakened by instrument proliferation. Hence, a measure of dealing with the conflicting criteria is to adopt the Hansen test and control for instrument proliferation by ensuring that in each specification, the number of cross sections is higher than the number of instruments. This approach is adopted for the study.

In order to assess research question or the overall effect of government quality in modulating the effect of CO2 emissions on inclusive human development, net effects are computed from the unconditional effect of CO2 emissions on inclusive human development and the corresponding conditional effect from the interaction between CO2 emissions and government quality dynamics. For instance, in the fourth column of Table 1, in the regressions pertaining to regulation quality, the net effect of regulation quality in moderating the effect of CO2 emissions on inclusive human development is -0.0028 ([0.013× -0.604] + [0.005]). In the computation, -0.604 is the mean value of regulation quality; the unconditional effect of CO_2emissions per capita is 0.005, whereas the conditional impact from the

[7] "*First, the null hypothesis of the second-order Arellano and Bond autocorrelation test (AR (2)) in difference for the absence of autocorrelation in the residuals should not be rejected. Second the Sargan and Hansen over-identification restrictions (OIR) tests should not be significant because their null hypotheses are the positions that instruments are valid or not correlated with the error terms. In essence, while the Sargan OIR test is not robust but not weakened by instruments, the Hansen OIR is robust but weakened by instruments. In order to restrict identification or limit the proliferation of instruments, we have ensured that instruments are lower than the number of cross-sections in most specifications. Third, the Difference in Hansen Test (DHT) for exogeneity of instruments is also employed to assess the validity of results from the Hansen OIR test. Fourth, a Fischer test for the joint validity of estimated coefficients is also provided*" (Asongu & De Moor, 2017, p.200).

interaction between CO_2 emissions per capita and regulation quality, is 0.013. This approach to establishing an overall incidence based on net effects is consistent with contemporary interactive regressions literature (Tchamyou & Asongu, 2017; Agoba *et al.*, 2019).

Table 1: Governance, CO2 emissions and Inclusive Development

	Dependent variable: Inclusive Human Development					
	Political Governance		**Economic Governance**		**Institutional Governance**	
	Political Stability	Voice & Accountability	Regulation Quality	Government Effectiveness	Rule of Law	Corruption-Control
Inclusive Development (IHDI)(-1)	**0.949*** **	**0.957*** **	**0.921*** **	**0.906*** **	**0.943*** **	**0.954*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
CO2 emissions (CO2)	-0.002	**-0.005***	**0.005***	0.0001	-0.001	-0.001
	(0.311)	**(0.050)**	**(0.064)**	(0.953)	(0.631)	(0.764)
Political Stability (PS)	0.002	---	---	---	---	---
	(0.347)					
Voice & Accountability (VA)	---	**0.008*** **	---	---	---	---
		(0.009)				
Regulation Quality (RQ)	---	---	**-0.020*** **	---	---	---
			(0.000)			
Government Effectiveness (GE)	---	---	---	-0.001	---	---
				(0.720)		
Rule of Law (RL)	---	---	---	---	-0.007	---
					(0.189)	
Corruption-Control (CC)	---	---	---	---	---	**-0.010** **
						(0.037)
PS × CO2	-0.0004	---	---	---	---	---
	(0.865)					
VA × CO2	---	-0.006	---	---	---	---
		(0.162)				
RQ × CO2	---	---	**0.013*** **	---	---	---
			(0.001)			
GE × CO2	---	---	---	-0.003	---	---
				(0.491)		
RL × CO2	---	---	---	---	**0.010***	---
					(0.090)	
CC × CO2	---	---	---	---	---	**0.008** **
						(0.033)
Education	**-0.0003*** **	**-0.0004*** **	**-0.0003** **	**-0.0004*** **	**-0.0002** **	**-0.0002*** **
	(0.000)	**(0.000)**	**(0.014)**	**(0.000)**	**(0.023)**	**(0.004)**
Private Domestic Credit	0.000005	**0.0002** **	-0.00004	**0.0003** **	-0.0001	-0.00006
	(0.957)	**(0.043)**	(0.639)	**(0.021)**	(0.248)	(0.558)
Foreign Aid	-0.00003	**-0.00007** **	**-0.0001*** **	**-0.0001*** **	-0.00004	**-0.00005** **
	(0.188)	**(0.035)**	**(0.000)**	**(0.001)**	(0.116)	**(0.041)**
Time effects	Yes	Yes	Yes	Yes	Yes	Yes
Net effects	na	na	-0.0028	na	na	na
AR(1)	**(0.128)**	**(0.131)**	**(0.109)**	**(0.126)**	**(0.179)**	**(0.075)**
AR(2)	**(0.749)**	**(0.971)**	**(0.946)**	**(0.657)**	**(0.843)**	**(0.644)**
Sargan OIR	(0.000)	(0.000)	(0.002)	(0.000)	(0.001)	(0.001)
Hansen OIR	**(0.158)**	**(0.131)**	**(0.110)**	(0.070)	**(0.219)**	(0.091)
DHT for instruments						
(a)Instruments in levels						
H excluding group	**(0.129)**	(0.027)	**(0.100)**	(0.047)	**(0.135)**	(0.081)
Dif(null, H=exogenous)	**(0.234)**	**(0.375)**	**(0.185)**	**(0.172)**	**(0.314)**	**(0.170)**
(b) IV (years, eq(diff))						
H excluding group	(0.045)	(0.060)	**(0.281)**	**(0.154)**	**(0.121)**	(0.034)
Dif(null, H=exogenous)	**(0.583)**	**(0.428)**	**(0.106)**	**(0.110)**	**(0.455)**	**(0.434)**
Fisher	**55862.15*** **	**1.15e+06*** **	**38200.76*** **	**33699.51*** **	**20430.30*** **	**1.82e+06*** **
Instruments	36	36	36	36	36	36
Countries	37	37	37	37	37	37
Observations	217	217	217	217	217	217

*, **, ***: significance levels of 10%, 5% and 1% respectively. *DHT*: Difference in Hansen Test for Exogeneity of Instruments' Subsets. Dif: Difference. *OIR*: Over-identifying Restrictions Test. The significance of bold values is twofold. 1) The significance of estimated

coefficients, Hausman test and the Fisher statistics. 2) The failure to reject the null hypotheses of: a) no autocorrelation in the *AR(1)*and *AR(2)* tests and; b) the validity of the instruments in the Sargan *OIR* test. Na: not applicable because at least one estimated coefficient needed for the computation of net effects is not significant. Constants are included in the regressions. The following are the mean values of governance variables: -0.486 (political stability); -0.543 (voice & accountability); -0.697 (government effectiveness); -0.604 (regulation quality); -0.663 (rule of law) and -0.590 (corruption-control). Constants are included in the regressions.

The main finding in Table 1 is that regulation quality modulates CO2 emissions to exert a net negative effect on inclusive development. Net effects pertaining to the other governance dynamics cannot be computed because either the model does not pass post-estimation diagnostics tests or at least one estimated coefficient needed for the computation of net effects is not significant. The significant control variables have the expected signs.

3.2 Robustness checks

In order to assess whether the established findings in Table 1 withstand further empirical scrutiny, the six governance indicators are bundled into four other governance dynamics, notably: political governance (consisting of political stability and voice & accountability), economic governance (entailing government effectiveness and regulation quality), institutional governance (represented with the rule of law and corruption-control) and general governance (i.e. encompassing political, economic and institutional dynamics of governance). The approach used for the retention of common factors is the Kaiser (1974) and Jolliffe (2002) criterion for the selection of principal components in principal component analysis. According to the criterion, only principal components with an eigenvalue greater than the mean should be retained (Asongu *et al.*, 2019). This criterion is adopted in the retention of composite governance indicators in this study. The approach to bundling governance variables for robustness purposes by means of principal component analysis is consistent with recent literature (Tchamyou, 2017; Asongu & Odhiambo, 2018c).

In Table 2, results pertaining to economic governance and general governance do not pass post-estimation diagnostic tests because the null hypothesis of the Hansen test is rejected. The main finding from the table is a net negative effect from the role of institutional governance in modulating the effect of CO2 emissions on inclusive human development. The significant control variables have the expected signs.

Table 2: Robustness checks

	Dependent variable: Inclusive Human Development			
	Political Governance	**Economic Governance**	**Institutional Governance**	**General Governance**
Inclusive Development (IHDI)(-1)	**0.952*** **	**0.913*** **	**0.968*** **	**0.896*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**
CO2 emissions (CO2)	-0.0007	-0.007	**-0.013** **	-0.002
	(0.775)	(0.127)	**(0.019)**	(0.633)
Political Governance (Polgov)	**0.003***	---	---	---
	(0.061)			
Economic Governance (Ecogov)	---	**-0.004** **	---	---
		(0.035)		
Institutional Governance (Instgov)	---	---	**-0.004***	---
			(0.061)	
General Governance (Ggov)	---	---	---	-0.0001
				(0.903)
Polgov × CO2	-0.002	---	---	---
	(0.210)			
Ecogov × CO2	---	0.004	---	---
		(0.135)		
Instgov × CO2	---	---	**0.005*** **	---
			(0.007)	
Ggov × CO2	---	---	---	0.0006
				(0.707)
Education	**-0.0003*** **	**-0.0004*** **	**-0.0002*** **	**-0.0006*** **
	(0.000)	**(0.003)**	**(0.005)**	**(0.000)**
PrivateDomesticCredit	0.00009	0.00008	-0.0001	0.0001
	(0.364)	(0.627)	(0.126)	(0.332)
ForeignAid	-0.00003	**-0.0001*** **	0.000002	**-0.0001*** **
	(0.283)	**(0.001)**	(0.126)	**(0.002)**
Time Effects	Yes	Yes	Yes	Yes
Net effects	na	na	-0.0122	na
AR(1)	**(0.105)**	**(0.185)**	**(0.170)**	**(0.271)**
AR(2)	**(0.941)**	**(0.959)**	**(0.683)**	**(0.666)**
Sargan OIR	(0.000)	(0.000)	(0.001)	(0.000)
Hansen OIR	**(0.141)**	(0.088)	**(0.212)**	(0.093)
DHT for instruments				
(a)Instruments in levels				
H excluding group	(0.058)	(0.078)	(0.076)	(0.050)
Dif(null, H=exogenous)	**(0.296)**	**(0.169)**	**(0.382)**	**(0.217)**
(b) IV (years, eq(diff))				
H excluding group	**(0.137)**	**(0.256)**	**(0.223)**	**(0.237)**
Dif(null, H=exogenous)	**(0.267)**	(0.090)	**(0.287)**	**(0.103)**
Fisher	**1.41e+06*** **	**8.08e+06*** **	**16775.73*** **	**8159.59** **
Instruments	36	36	36	36
Countries	37	37	37	37
Observations	217	217	217	217

*, **, ***: significance levels of 10%, 5% and 1% respectively. *DHT*: Difference in Hansen Test for Exogeneity of Instruments' Subsets. Dif: Difference. *OIR*: Over-identifying Restrictions Test. The significance of bold values is twofold. 1) The significance of estimated coefficients, Hausman test and the Fisher statistics. 2) The failure to reject the null hypotheses of: a) no autocorrelation in the *AR(1)*and *AR(2)* tests and; b) the validity of the instruments in the Sargan *OIR* test. Na: not applicable because at least one estimated coefficient needed for the computation of net effects is not significant. Constants are included in the regressions. The following are the mean values of governance variables: 0.140 (political governance); 0.205 (economic governance); 0.144 (institutional governance) and 0.284 (general governance). Constants are included in the regressions.

4. Concluding implications and future research directions

This study has investigated the relevance of government quality in moderating the incidence of environmental degradation on inclusive human development in 44 sub-Saharan African countries for the period 2000-2012. Environmental degradation is measured with CO2 emissions while the governance dynamics include: political stability, voice and accountability, government effectiveness, regulation quality, the rule of law and corruption-control. The empirical evidence is based on the Generalised Method of Moments. The following main findings are established. First, regulation quality modulates CO2 emissions to exert a net negative effect on inclusive development. Second, when the six governance indicators are bundled by means of principal component analysis for robustness checks, institutional governance (consisting of corruption-control and the rule of law) modulates CO2 emissions to also exert a net negative effect on inclusive human development.

While this net effect pertaining to regulation quality is negative, it is worthwhile to emphasise that both the conditional and unconditional effects are positive. Hence, the negative net effect is largely traceable to the fact that the average value of regulation quality for the sample countries is negative. In other words, the fact that regulation quality is negatively skewed implies that regulation quality needs to be further improved in order for net positive effects to be achieved. As a policy implication, enhancing regulation quality is essential for the government dynamic to effectively modulate CO2 emissions for the expected positive net effects on inclusive human development

It is also worthwhile to note that the conditional effect pertaining to institutional governance is positive, which implies that enhancing institutional governance modulates the unconditional negative effect of CO2 emissions on inclusive human development. Moreover, a threshold of institutional governance at which the conditional positive effect completely dampens the unconditional negative effect is 2.6 (0.013/0.005). This threshold makes economic sense and it feasible from a policy perspective because the maximum limit of institutional governance disclosed in the summary statistics is 3.766. Hence, at a critical mass of 2.6, the net effect of institutional governance in modulating the effect of CO2 emissions on inclusive development is zero: 0 ([0.005× 2.6] + [-0.013]). As a policy implication, a level of institutional governance beyond the established 2.6 threshold ensures that institutional governance completely modulates the unfavourable effect of CO2 emissions on inclusive human development. Above the threshold, positive net effects are apparent.

The findings broadly show that there is a need for greater action in the governance dynamics from which significant findings could not be established. Such greater action is also relevant for governance dynamics that significantly modulate the effect of CO2 emissions on inclusive human development.

Future studies can employ appropriate estimation techniques for country-specific studies in order to assess if the established findings withstand empirical scrutiny from country-oriented frameworks. This recommendation for country-specific studies builds on the caveat that country-specific studies are not considered in the GMM approach. Accordingly, country-specific effects are eliminated by first-differencing in order to avoid inherent concerns of endogeneity linked to the correlation between the lagged inclusive human development indicator and country-specific effects.

Appendices

Appendix 1: Definitions of variables

Variables	Signs	Definitions of variables (Measurements)	Sources
CO_2 per capita	CO2mtpc	CO_2 emissions (metric tons per capita)	World Bank (WDI)
Political Stability	PolS	"Political stability/no violence (estimate): measured as the perceptions of the likelihood that the government will be destabilised or overthrown by unconstitutional and violent means, including domestic violence and terrorism"	World Bank (WGI)
Voice & Accountability	VA	"Voice and accountability (estimate): measure the extent to which a country's citizens are able to participate in selecting their government and to enjoy freedom of expression, freedom of association and a free media".	World Bank (WGI)
Political Governance	Polgov	First Principal Component of Political Stability and Voice & Accountability. The process by which those in authority are selected and replaced.	PCA
Government Effectiveness	GE	"Government effectiveness (estimate): measures the quality of public services, the quality and degree of independence from political pressures of the civil service, the quality of policy formulation and implementation, and the credibility of governments' commitments to such policies".	World Bank (WGI)
Regulation Quality	RQ	"Regulation quality (estimate): measured as the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development".	World Bank (WGI)
Economic Governance	Ecogov	"First Principal Component of Government Effectiveness and Regulation Quality. The capacity of government to formulate & implement policies, and to deliver services".	PCA
Rule of Law	RL	"Rule of law (estimate): captures perceptions of the extent to which agents have confidence in and abide by the rules of society and in particular the quality of contract enforcement, property rights, the police, the courts, as well as the likelihood of crime and violence".	World Bank (WGI)
Corruption-Control	CC	"Control of corruption (estimate): captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as 'capture' of the state by elites and private interests".	World Bank (WGI)
Institutional Governance	Instgov	First Principal Component of Rule of Law and Corruption-Control. The respect for citizens and the state of institutions that govern the interactions among them	PCA
General Governance	Ggov	First Principal Component of Political, Economic and Institutional Governances	PCA
Inclusive Development	IHDI	Inequality-Adjusted Human Development Index	UNDP
Educational Quality	Educ	Pupil teacher ratio in Primary Education	World Bank (WDI)
Credit Access	Credit	Population growth rate (annual %)	World Bank (WDI)
Foreign Aid	NODA	Net Official Development Assistance (% of GDP)	World Bank (WDI)

WDI: World Bank Development Indicators. WGI: World Governance Indicators. PCA: Principal Component Analysis. UNDP: United Nations Development Program.

Appendix 2: Summary statistics (2000-2012)

	Mean	SD	Minimum	Maximum	Observations
CO_2 per capita	0.911	1.842	0.016	10.093	532
Political Stability	-0.486	0.923	-2.660	1.192	496
Voice & Accountability	-0.543	0.687	-1.838	0.986	496
Political Governance	0.140	1.230	-2.653	2.583	496
Government Effectiveness	-0.697	0.584	-1.960	0.934	496
Regulation Quality	-0.604	0.542	-2.110	0.983	496
Economic Governance	0.205	1.225	-2.288	3.807	496
Rule of Law	-0.663	0.614	-2.113	1.056	496
Corruption-Control	-0.590	0.565	-1.566	1.249	496
Institutional Governance	0.144	1.282	-2.391	3.766	496
General Governance	0.284	2.040	-4.567	5.561	496
Inclusive Development	0.450	0.110	0.219	0.768	431
Educational Quality	43.892	14.775	12.466	100.236	397
Private Domestic Credit	19.142	23.278	0.550	149.78	458
Foreign Aid	11.944	14.712	-0.253	181.187	531

S.D: Standard Deviation.

Appendix 3: Correlation matrix (uniform sample size: 269)

	Governance Dynamics										Control variables				Dep. Variable
	Political Governance			Economic Governance			Institutional Governance								
	PolS	VA	Polgov	CO2mtpc	RQ	Ecogov	RL	CC	Instgov	G.gov	Educ	Credit	NODA	CO2mtpc	IHDI
PolS	1.000														
VA	0.712	1.000													
Polgov	0.929	0.920	1.000												
GE	0.688	0.805	0.805	1.000											
RQ	0.674	0.755	0.771	0.894	1.000										
Ecogov	0.700	0.803	0.811	0.976	0.969	1.000									
RL	0.805	0.835	0.886	0.890	0.872	0.912	1.000								
CC	0.715	0.722	0.777	0.854	0.822	0.862	0.868	1.000							
Instgov	0.786	0.806	0.860	0.908	0.877	0.918	0.967	0.966	1.000						
G.gov	0.841	0.884	0.931	0.942	0.916	0.955	0.968	0.912	0.973	1.000					
Educ	-0.286	-0.30	-0.319	-0.422	-0.37	-0.410	-0.38	-0.39	-0.400	-0.396	1.000				
Credit	0.335	0.489	0.443	0.573	0.561	0.583	0.517	0.522	0.538	0.548	-0.42	1.000			
NODA	-0.113	-0.02	-0.074	-0.212	-0.26	-0.243	-0.14	-0.17	-0.166	-0.168	0.139	-0.16	1.000		
CO2mtpc	0.356	0.388	0.402	0.557	0.419	0.506	0.454	0.517	0.502	0.493	-0.46	0.711	-0.230	1.000	
IHDI	0.456	0.393	0.460	0.606	0.524	0.583	0.550	0.550	0.569	0.565	-0.54	0.559	-0.388	0.650	1.000

PolS: Political Stability. VA: Voice & Accountability. Polgov: Political Governance. GE: Government Effectiveness. RQ: Regulation Quality. Ecogov: Economic Governance. RL: Rule of Law. CC: Corruption-Control. Instgov: Institutional Governance. Ggov: General Governance. Educ: Education quality. Credit: Private Domestic credit. NODA: Net Official Development Assistance. CO2mtpc: CO2 emissions per capita. IHDI: Inclusive human development.

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