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Governance and renewable energy consumption in sub-Saharan Africa

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Governance and renewable energy consumption in sub-Saharan Africa

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Abstract

The purpose of this study is to assess the nexus between governance and renewable energy consumption in sub-Saharan Africa. The focus is on 44 countries in Sub-Saharan Africa with data from 1996 to 2016. The empirical evidence is based on Tobit regressions. It is apparent from the findings that political and institutional governance are negatively related to the consumption of renewable energy in the sampled countries. The unexpected findings are clarified and policy implications are discussed in the light of sustainable development goals.
This study extends the extant literature by assessing how political governance (consisting of political stability and "voice & accountability") and institutional governance (entailing the rule of law and corruption-control) affect the consumption of renewable energy in sub-Saharan Africa.

JEL Codes: H10;Q20; Q30; O11; O55
Keywords: Renewable energy; Governance; Sub-Saharan Africa; Sustainable development

1. Introduction

The positioning of this study in the energy literature is motivated by four main fundamentals in the scholarly and policy literature. These fundamentals which are expanded below in no order of importance include: (i) the issue of environmental degradation in sub-Saharan Africa (SSA); (ii) gaps in the scholarly literature; (iii) the contribution of this study in the light of shortcomings identified in the extant literature and (iv) the policy importance of

the study in the light of sustainable development goals (SDGs).

First, it is now apparent that SSA is host to some of the worst systems of energy grid in the world, with the obvious lack of political will and financial resources to address corresponding policy syndromes related to environmental pollution and adoption of cleaner sources of energy (Jarrett, 2017). In fact, there is a bulk of contemporary literature supporting the position that concerns of poor economic performance and environmental degradation and energy crisis in Africa are substantially traceable to issues of governance, *inter alia* (Nathaniel & Iheonu, 2019; Asongu, Iheonu & Odo, 2019; Joshua & Alola, 2020; Nathaniel & Bekun, 2020; Joshua & Bekun & Sakordie, 2020; Abdulqadir, 2020). However, despite the scholarly and policy concerns surrounding the importance of governance in driving environmental reforms for energy sustainability, SSA has not yet received the scholarly attention it deserves. The scholarly concern is even more deserving because of the 2015 United Nations Paris Agreement on climate change where a substantial number of countries pledged to reduce carbon emissions by embarking on renewable energy sources (Warren, Price, Van Der Wal & Sohl, 2018).

Second, in the light of the above, the extant literature on the nexus between environmental degradation and governance is scant because the extant literature has substantially been oriented towards the examination of nexuses between the consumption of energy, pollution of the environment and economic development in terms of economic growth, for the most part. This attendant literature can be grouped into two principal categories. The first is articulated with examinations of directions of linkages underlying the nexus between environmental pollution and economic growth, with particular emphasis on the Environmental Kuznets Curve (EKC) hypothesis[1]. Some contemporary studies in this direction include: Bah, Abdulwakil and Azam (2019), Layachi (2019) and Magazzino, Bekun, Etokakpan and Uzuner (2020) and Bah, Abdulwakil and Azam (2020). The second category pertains to studies on linkages between environmental pollution and the consumption of energy. Some contemporary inquiries focusing on this direction include: Acheampong, Adams, Boateng (2019); Wang and Dong (2019); Adams and Nsiah (2019); Nathaniel and Iheonu(2019); Akinyemi, Efobi, Osabuohien and Alege (2019); Kuada and Mensah (2020). In essence, contemporary literature on the nexus between governance and environmental sustainability in SSA is sparse.

Third, while much has been documented on the positive relevance of governance in

[1]"The EKC hypothesis is the position that in the long term, there is an inverted U-shape nexus between per capita income and environmental degradation.

macroeconomic outcomes (Ajide & Raheem, 2016a, 2016b), the closest paper to this study in the literature is Asongu and Odhiambo (2021) which has investigated how enhancing governance is related to environmental sustainability. The findings of the study broadly show that increasing governance boosts carbon dioxide (CO_2) emissions in the sampled countries. This paper aims to complement the underlying study on three main fronts. First, instead of focusing on CO_2 emissions, this study is concerned with renewable energy consumption. Accordingly, adopting an energy variable with a positive economic signal (i.e. renewable energy consumption) instead of an energy variable with a negative economic signal (i.e. CO_2 emissions) is a form of assessing if the underlying study withstands empirical scrutiny. Second, consistent with the new dependent variable and the imperative of adopting an estimation technique that is consistent with the data behaviour; the estimation approach in this study is a Tobit regressions technique as opposed to the Generalized Method of Moments (GMM) used by the underlying study. Third, this study devotes space to clarify the nexus between governance and environmental pollution in the light of the conception, measurement and statistical tendencies of the governance variables. For instance, the fact that enhancing governance in SSA only further degrades the environment can be contingent on the fact that the governance variables are negatively skewed. Hence, increasing governance may only engender an unfavourable incidence on the targeted outcome variable. It follows that beyond providing findings on the investigated nexus, some emphasis is placed on the measurement and conflation in the governance concept as empirically engaged in SSA countries, and by extension, developing countries that are characterised by negative governance standards. These clarifications are also worthwhile in understanding the importance of leveraging on governance mechanisms in the achievement of sustainable development goals (SDGs) related to environmental sustainability.

Fourth, the global focus of promoting environmental sustainability in the post-2015 development agenda is tailored along limiting (promoting) CO_2 emissions (renewable energy consumption) in household and economic activities (Asongu, El Montasser & Toumi, 2016; Mbah & Nzeadibe, 2016). The attendant literature maintains that the underlying sustainable development concerns are prominent in SSA because *inter alia*: (i) energy crisis is very appalling in the sub-region and (ii) environmental pollution is also a relatively more concerning policy syndrome compared to other regions of the world. To put the above insights into more perspective, it is worthwhile to note that approximately 600 million people in SSA lack access to "*affordable, reliable, sustainable and modern electricity*" which represents more than half of the population (Shurig, 2015; Jarrett, 2017; The Economist,

2017; Adesola & Brennan, 2019). Furthermore, the attendant crisis is less apparent in North Africa, compared to SSA (IRENA, 2010).

The remainder of the paper proceeds as follows. The underpinnings supporting the linkages between governance and renewable energy consumption are engaged in Section 2 while the data and methodology are covered in Section 3. Section 4 presents and discusses the empirical results. Section 5 concludes with implications and future research insights.

2. Underpinnings for nexuses between governance and renewable energy consumption

The theoretical considerations of this study are articulated along the conception and definitions of institutional and political governance in the light of contemporary governance literature. To put these insights into more perspective: "*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 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, Asongu & Amavilah, 2015: 1041). It is also worthwhile to emphasise that the theoretical linkages between the attendant governance dynamics and environmental quality are broadly consistent with Emmelin and Lerman (2008), Kurian and Ardakanian (2015), Masud, Nurunnabi and Bae (2018) and Asongu and Odhiambo (2021). In what follows, arguments for the testable hypotheses to be investigated in the empirical section are provided.

The policy literature on the relationships between governance and CO_2emissions maintain that, *inter alia*, challenges in governance in Africa in particular and the world in general, are affecting economic development on several fronts, notably: inequality, water scarcity, poverty, food insecurity and environmental degradation (Emmelin & Lerman, 2008; Masud et al., 2018; Chemutai, 2009; Kurian & Ardakanian, 2015; Tchamyou, 2017, 2019, 2020; Tchamyou, Erreygers & Cassimon, 2019; Asongu & Odhiambo, 2021). In the light of the attendant literature, concerns pertaining to governance rotate around the mismanagement of the environment essentially because most African countries are substantially constrained in terms of financial resources and technological knowledge, which to some extent are contingent on political will and good governance standards, notably: political and institutional governance. Whereas Chemutai (2009) largely focuses on how countries that are more advanced in terms of availability of financial resources and quality of governance standards can help African countries in the direction of environmental sustainability, this study focuses on understanding the nuances underpinning nexuses between political governance,

institutional governance and the consumption of renewable energy.

With the above insights fully acknowledged, political governance is hypothetically linked to renewable energy consumption because the decision on whether to consume fossil fuels or revert to the renewable energy alternative, *inter alia*, rests on the capacity of the government to provide incentives for the consumption of renewable energy. Such incentives are largely contingent on political will (i.e. as discussed in the previous paragraphs) and such political will is naturally also contingent on the process by which political leaders are elected and replaced (i.e. political governance). It is also worthwhile to note that political governance is also directly linked to the choice of types and sources of energy because there are various strands of politics. For instance, while ecologists and left-wing political movements may be more inclined to be sympathetic to policies favourable to renewable energy consumption, political movements more aligned with liberal capitalism and less priority in economic rights (as opposed to political rights), are more inclined to adopt less environmentally-friendly policies (Knill, Debus & Heichel, 2010; Wen, Hao, Feng & Chang, 2016; Han, Zhang & Shan, 2019; Deng, Wu & Xu, 2020). Moreover, if governments are overthrown by unconstitutional and violent means, it can affect the potentially positive externalities of political governance on environmental protection (Asongu & Odhiambo, 2019). In the light of the definition of political governance disclosed at the beginning of this section, arguments for the political stability component of political governance can be extended to the "voice & accountability" component because the capacity of the government to implement sustainable policies of environmental management and renewable energy use, can be dampened by the degree at which citizens in countries can: (i) enjoy the freedoms of association and speech as well as the fruits of free media and (ii) effectively participate in the selection of government officials. These underlying insights motivate the following testable hypothesis pertaining to political governance.

Hypothesis 1: Political governance is positively associated with renewable energy consumption

On the front of institutional governance, building on the arguments for a positive nexus between governance and sustainable energy production and consumption already covered, it is intuitive to posit that institutional governance positively influences the effectiveness of policies that are implemented in order to boost renewable energy consumption and mitigate CO_2 emissions. This is mainly because such effectiveness is contingent on how citizens and the governments respect institutions that are designed to

oversee the implementation of attendant environmentally-friendly policies (i.e. institutional governance). Accordingly, environmentally-sound institutional governance depends on the degree by which, in the implementation of environmentally-sound and renewable energy policies: (i) public power is not diverted for private gain, which entails major forms of corruption, elite state capture and petty thievery (i.e. corruption-control) and (ii) agents respect the societal rules related to underlying policies, especially as it pertains to contract enforcement and assurance of the police (i.e. rule of law). These perspectives are broadly consistent with attendant literature on the importance of corruption-control (Fan & Zhao, 2019) and rule of law (Chen, Hao, Li & Song, 2018; Sinha, Gupta, Shahbaz & Sengupta, 2019) in boosting environmental sustainability. The corresponding testable hypothesis related to the intuition above is as follows.

Hypothesis 2: Institutional governance is positively associated with renewable energy consumption

3. Data and methodology

3.1 Data

To examine the testable hypotheses outlined in the previous section, this section uses data from an unbalanced panel of 44 SSA countries for the period 1996-2016[2]. The geographical and temporal dimensions of the panel dataset are contingent on data availability constraints at the time of the study. There are two main sources of the data, notably: (i) the political governance and institutional governance indicators are sourced from the World Governance Indicators (WGI) of the World Bank while (ii) the outcome and control variables are obtained from World Development Indicators (WDI) of the World Bank.

The outcome variable which is renewable energy consumption (% of total final energy consumption) is informed by contemporary renewable energy literature (Nathaniel & Iheonu, 2019; Akinyemi et al., 2019; Asongu et al., 2019). It is important to note that renewable energy consumption is broadly defined at the national level to include both industrial and household consumption. The choice of the governance indicators, as defined in the previous section is informed by the motivational elements in the introduction, the intuition for the

[2]The sampled 44 countries are: "*Angola; Benin; Botswana; Burkina Faso; Burundi; Cabo Verde; Cameroon; Central African Republic; Chad; Comoros; Congo Democratic Republic; Republic of Congo; Cote d'Ivoire; Equatorial Guinea; Eritrea; Ethiopia; Gabon; Gambia; Ghana; Guinea; Guinea-Bissau; Kenya; Lesotho; Liberia; Madagascar; Malawi; Mali; Mauritania; Mauritius; Mozambique; Namibia; Niger; Nigeria; Rwanda; Sao Tome and Principe; Senegal; Seychelles; Sierra Leone; South Africa; Tanzania; Togo; Uganda; Zambia and Zimbabwe*".

nexuses in Section 2 as well as contemporary governance literature largely focusing on Africa (Ajide & Raheem, 2016a, 2016b; Pelizzo, Araral, Pak & Xun, 2016; Pelizzo & Nwokora, 2016, 2018; Nwokora & Pelizzo, 2018). The governance variables are also defined in Appendix 1 and measured (as apparent in Appendix 2) with both positive and negative values. The negative values are linked to countries with averagely poor governance standards whereas the positive values are associated with countries which averagely have good governance standards.

To take on board the issue of variable omission bias that is likely to unfavourably affect estimated coefficients, the study adopts the following elements in the conditioning information set, namely: internet penetration (proxied by secure internet servers), globalization in terms of trade openness and foreign direct investment, transport services and mobile phone penetration (proxied by mobile cellular subscriptions). The choice of these control variables is also informed by contemporary renewable energy literature (Nathaniel & Iheonu, 2019; Asongu et al., 2019). In what follows, the expected signs are discussed.

The anticipated signs from the control variables are ambiguous because there is no consensus in the underlying literature on how macroeconomic and infrastructural variables affect environmental pollution and by extension, renewable energy consumption. Moreover, there is also reason to posit that the expected signs cannot be established a priori because nonlinear linkages are not captured in the attendant control variables. This is mainly because, in nonlinear linkages, both positive and negative signs are apparent from the corresponding variables. However, in the light of the problem statement of this study, the assessment of nonlinear nexuses is out of scope. It follows that information and communication technology in the perspectives of the internet and mobile phone penetration can have both positive and negative effects on renewable energy consumption because the attendant effects are contingent on how the underlying information technology is tailored to promote environmental sustainability. The role of globalization in the perspectives of trade openness and foreign direct investment (FDI) is also contingent on market dynamics. For instance, trade openness can mitigate renewable energy consumption if trading activities are fundamentally skewed towards the primary sector which is the case in many developing countries. Conversely, FDI can have the opposite effect if multinational companies are favoring renewable technologies in order to reduce long term cost and meet their corporate social responsibility obligations. This clarification extends to the service industry in which, if transport companies are favorable to renewable energy for the purpose of accomplishing their services, then the effect can be positive. Appendix 1, Appendix 2 and Appendix 3

respectively, provide insights into the definitions and sources of variables, summary statistics and correlation matrix.

As apparent from the information provided in the appendices, the panel dataset is unbalanced because of a constraint in data availability. This is a characteristic of datasets from African countries (Jerven, 2015). The study is therefore based on an unbalanced panel dataset and the findings should be understood in the light of the unbalanced nature of the dataset and attendant data availability constraints[3].

3.2 Estimation technique

The selection of an estimation technique is informed by the attendant literature on the importance of aligning an estimation technique with the behavior of corresponding data (Kou, Yang, Xiao, Chen & Alsaadi, 2019; Kou, Chao, Peng & Alsaadi, 2019; Kou, Lu, Peng & Shi, 2012; Kou, Peng & Wang, 2014; Kou, Ergu, Chen, Lin, 2016). Given that the outcome variable is captured within a specific interval, a Tobit regression technique is appropriate, in the light of contemporary literature (Ajide et al., 2019). With these insights in mind, a double-censored Tobit model is adopted to estimate the relevance of political and institutional governance on renewable energy consumption. Accordingly, a double censored approach is considered because of its convenience when the outcome variable is within a specific minimum and maximum interval (Koetter & Vins, 2008; Kumbhakar & Lovell, 2000; Coccorese & Pellecchia, 2010; Ariss, 2010).

Equations (1) and (2) below according to authoritative papers on Tobit regressions (Tobin, 1958; Carson & Sun, 2007), summarize the standard Tobit estimation procedure.

$$y_{i,t}^{*} = \alpha_0 + \beta X_{i,t} + \varepsilon_{i,t} \qquad (1)$$

Where: $y_{i,t}^{*}$ is a latent response variable; $X_{i,t}$ is an observed $1 \times k$ vector of explanatory variables; and $\varepsilon_{i,t} \approx$ i.i.d. N(0, σ^2) and is independent of $X_{i,t}$. Instead of observing $y_{i,t}^{*}$, $y_{i,t}$ is observed:

$$y_{i,t} = \begin{cases} y_{i,t,}^{*} \; if \; y_{i,t}^{*} > \gamma \\ 0, \; if \; y_{i,t}^{*} \le \gamma, \end{cases} \qquad (2)$$

[3]In the light of the Fisher-type (Choi 2001) test, the variables are overwhelmingly stationary. Some units root tests that required balanced panel datasets could not be performed (Levin–Lin–Chu, 2002; Harris–Tzavalis, 1999; Breitung, 2000; Breitung & Das 2005; Hadri, 2000). Moreover, the Im–Pesaran–Shin (2003) could also not be carried out owing to insufficient observations. The Fisher-type unit root tests results are available upon request.

where γ is a non-stochastic constant. In other words, the value of $y_{i,t}^{*}$ is missing when it is less than or equal to γ.

4. Empirical results

The empirical results are disclosed in Table 1 for Hypothesis 1 related to political governance and Table 2 for Hypothesis 2 pertaining to institutional governance. Each table is divided into five columns: the first provides the variables and the corresponding information criteria while the last four disclose the empirical findings. The last four columns are divided into two main categories, each consisting of two specifications, pertaining to the main model and the marginal effect, respectively. It is apparent from the findings in Tables 1-2 that both political and institutional governance are negatively related to the consumption of renewable energy in the sampled countries. Hence, Hypothesis 1 and Hypothesis 2 are not validated by the empirical results. Most of the control variables are significant and the corresponding signs are largely consistent with the narrative in the data section.

Table 1: Political governance and renewable energy consumption (Hypothesis 1)

	Political Stability		**Voice & Accountability**	
	Coefficient	dy/dx	Coefficient	dy/dx
Constant	**92.533*** **	---	**91.838*** **	---
	(0.000)		**(0.000)**	
Political Stability	**-9.026*** **	**-8.324*** **	---	---
	(0.000)	**(0.000)**		
Voice & Accountability	---	---	**-15.555*** **	**-14.448*** **
			(0.000)	**(0.000)**
Secure Internet servers	**-0.052***	**-0.048***	**-0.038** **	**-0.035** **
	(0.052)	**(0.051)**	**(0.032)**	**(0.031)**
Trade Openness	**-0.183*** **	**-0.169*** **	**-0.266*** **	**-0.247*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**
Foreign Investment	**0.365*** **	**0.337*** **	**0.459*** **	**0.426*** **
	(0.008)	**(0.008)**	**(0.002)**	**(0.002)**
Transport services	0.040	0.037	0.048	0.045
	(0.385)	(0.385)	(0.329)	(0.329)
Mobile cellular subscriptions	**-0.257*** **	-0.237	**-0.211*** **	**-0.196*** **
	(0.000)	(0.000)	**(0.000)**	**(0.000)**
Fisher	**76.14*** **		**150.18*** **	
Pseudo R^2	0.115		0.139	
Observations	217	217	217	217

***,**,*: significance levels at 1%, 5% and 10% respectively.dy/dx: average marginal effects.

Table 2: Institutional governance and renewable energy consumption (Hypothesis 2)

	Rule of Law		Corruption-Control	
	Coefficient	dy/dx	Coefficient	dy/dx
Constant	**89.770*** **	---	**89.630*** **	---
	(0.000)		**(0.000)**	
Rule of Law	**-15.014*** **	**-13.951*** **	---	---
	(0.000)	**(0.000)**		
Corruption-Control	---	---	**-12.633*** **	**-11.738*** **
			(0.000)	**(0.000)**
Secure Internet servers	**-0.037***	**-0.034***	-0.038	-0.035
	(0.064)	**(0.062)**	(0.116)	(0.114)
Trade Openness	**-0.261*** **	**-0.243*** **	**-0.221*** **	**-0.205*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**
Foreign Investment	**0.386*** **	**0.358*** **	**0.344*** **	**0.320*** **
	(0.000)	**(0.003)**	**(0.006)**	**(0.005)**
Transport services	0.055	0.051	**0.084***	**0.078***
	(0.270)	(0.270)	**(0.080)**	**(0.080)**
Mobile cellular subscriptions	**-0.211*** **	**-0.196*** **	**-0.238*** **	**-0.221*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**
Fisher	**122.99*** **		**94.57*** **	
Pseudo R^2	0.125		0.120	
Observations	217	217	217	217

***,**,*: significance levels at 1%, 5% and 10% respectively. dy/dx: average marginal effects.

Consistent with the motivation of the study which has articulated the failure of the attendant literature to clarify linkages between governance and renewable energy consumption, especially within the framework of the conception, definition and measurement of governance variables, the tested hypotheses are not valid, not because both political and institutional governance negatively affect renewable energy consumption, but because bad political and institutional governance negatively influences renewable energy consumption. It is worthwhile to further clarify the concern of conflation.

While political and institutional governance indicators are simply qualified as "good governance indicators of the World Bank", these governance measurements entail both negative and positive values and hence: (i) countries characterized by governance variables that are positively skewed are experiencing favorable governance or good governance while (ii) nations typical of governance dynamics that are negatively skewed are correspondingly experiencing unfavorable governance or bad governance. Whereas countries in the former category are largely developed countries in the West, those in the latter category are largely developing countries, most of which are African countries south of the Sahara.

In the light of the above, if the conception, definition and measurements of the engaged governance variables in this study are acknowledged within the narrative of

skewness, it follows from the attendant findings that Hypotheses 1-2 are not valid are because bad political and institutional governance reduce renewable energy consumption in SSA. Accordingly, the political and institutional governance indicators are negatively skewed because: (i) their mean values are negative and (ii) their minimum negative values are higher in terms of magnitude than their corresponding maximum positive values.

5. Concluding implications, caveats and future research directions

The study investigates the nexus between governance and renewable energy consumption in a panel of 44 countries in Sub-Saharan Africa with data from 1996 to 2016. Political governance (entailing political stability/no violence and "voice & accountability") and institutional governance (consisting of corruption-control and the rule of law) are employed as the governance dynamics. The empirical evidence is based on Tobit regressions. It is apparent from the findings that political and institutional governance are negatively related to the consumption of renewable energy in the sampled countries. The unexpected signs have been clarified in the light the conception, definition and measurements of the engaged good governance indicators of the World Bank. It what follows, policy implications are discussed in the light of sustainable development goals.

Before clarifying the relevance of the findings to the post-2015 development agenda, it is important to emphasize that the fact that political governance influences renewable energy consumption negatively is actually "poor political governance negatively influencing renewable energy consumption" and in the same light, the established nexus between institutional governance and renewable energy consumption should be understood as "poor institutional governance negatively affecting renewable energy consumption". Hence, in the sustainable development era, in order to avoid conceptual conflation and biased estimates that can misplace policy implications and priorities, governance indicators should be classified in terms of skewness so that poor governance is not conflated with good governance.

The above concerns regarding the classification of governance indicators are even more worthwhile in the light of evidence that African countries are finding it difficult to implement Agenda 21[4] owing to poor governance issues (Jones, 2003; Chemutai, 2009). Moreover, implementing the Multilateral Environmental Agreements (MEAs) across the continent has not been easy because of the same underlying governance issues. Classification of governance indicators as suggested from the findings of this study would go a short way

[4]"Agenda 21 is a United Nation's voluntarily implemented plan of action that is non-binding with respect to sustainable development".

towards addressing some of the associated policy and institutional challenges linked to the implementation of MEAs. Such classification may also inform the allocation of funds for associated deficiencies that are standing on the path to the implementation of the common environmental initiatives, namely: shortages of finance, lack of equipment and expertise, *inter alia*.

In light of the above, the main practical implication of this study pertains to the need to revisit the measurement of governance indicators in order to avoid conceptual conflation between bad and good governance. Further studies can focus on assessing whether the established findings withstand empirical validity with countries more advanced in terms of governance standards. Moreover, assessing how these findings are relevant to country-specific frameworks is worthwhile because some African countries are performing better in terms of governance standards compared to others. Hence, in order to formulate country-specific policy implications that are relevant to the sustainable development era, appropriate estimation techniques should be considered in the light of providing policy makers with country-specific policy implications. The constraint of data availability which is a concern in social sciences for more comprehensive reporting in empirical studies (Giannakouros & Chen, 2018) should be addressed as time unfolds, especially as it pertains to considering other sources of data that are not affected by missing observations. By extension, the findings in this study should be understood in the light of the unbalanced nature of the dataset and attendant data availability constraints. This constraint of data availability which should be addressed in future studies is, therefore, limitation of the present study.

Appendices

Appendix 1: Definitions of Variables

Variables	Abbreviations	Definitions of variables (Measurements)	Sources
Renewable energy	RENC	Renewable energy consumption (% of total final energy consumption)	WDI
Political Stability	PS	"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"	WGI
Voice & Accountability	VA	"Voice and accountability (estimate): measures the extent to which a country's citizens are able to participate in selecting their government and to enjoy the freedom of expression, freedom of association and a free media"	WGI
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"	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".	WGI
Secure Internet	SEIS	Secure Internet servers (per 1 million people)	WDI
Trade	TRADE	Imports plus Exports of Commodities (% of GDP)	WDI
Foreign Investment	FDI	Foreign direct investment, net inflows (% of GDP)	WDI
Transport services	TRANS	Transport services (% of commercial service exports)	WDI
Mobile subscriptions	MCES	Mobile cellular subscriptions (per 100 people)	WDI

WGI: World Governance Indicators. WDI: World Bank Development Indicators of the World Bank.

Appendix 2: Summary statistics (1996-2016)

	Mean	SD	Minimum	Maximum	Observations
Renewable energy consumption	67.875	25.716	0.354	98.342	875
Political Stability	-0.455	0.879	-2.844	1.282	792
Voice & Accountability	-0.529	0.720	-2.226	1.007	792
Rule of Law	-0.663	0.644	-2.129	1.077	792
Corruption-Control	-0.598	0.623	-1.805	1.216	792
Secure Internet servers	127.640	1799.821	0.000	30947.33	296
Trade Openness	55.716	29.290	7.805	225.412	910
Foreign Investment	5.045	10.430	-8.589	161.823	906
Transport services	23.781	18.182	0.159	93.351	721
Mobile subscriptions	31.957	38.598	0.000	162.283	919

S.D: Standard Deviation.

Appendix 3: Correlation matrix (uniform sample size: 217)

		Governance Variables				Control Variables				
	RENC	PS	VA	RL	CC	SEIS	TRADE	FDI	TRANS	MCES
RENC	1.000									
PS	-0.621	1.000								
VA	-0.641	0.617	1.000							
RL	-0.635	0.734	0.815	1.000						
CC	-0.639	0.711	0.698	0.895	1.000					
SEIS	-0.506	0.279	0.285	0.338	0.369	1.000				
TRADE	-0.565	0.482	0.227	0.250	0.358	0.396	1.000			
FDI	-0.041	0.133	0.051	0.004	0.049	0.066	**0.457**	1.000		
TRANS	0.260	-0.318	-0.216	-0.241	-0.202	-0.047	**-0.143**	**0.099**	**1.000**	
MCES	-0.695	0.478	0.434	0.506	0.493	0.447	**0.451**	**-0.011**	**-0.237**	1.000

RENC : Renewable energy consumption. PS : Political Stability. VA : Voice & Accountability. RL : Rule of Law. CC: Corruption-Control. SEIS: Secure Internet servers. FDI: Foreign Direct Investment. TRANS: Transport services. MCES: Mobile cellular subscriptions.

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