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**On the search for environmental sustainability in Africa: the role of  
governance**

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**Abstract**

Africa remains the most affected by environmental degradation, thereby exacerbating the negative effect of climate change in the region. Little empirical credence has been leaned to the institutions-environmental sustainability relationship in Africa. This omission in the literature of environmental sustainability is abysmal, considering the role of institutions and government in ecological preservation. To inform policy and research on the subject matter, we estimated a balanced panel data of the indices of good governance and strong institutions to explain transformation to environmental sustainability using the dynamic system generalised method of moment estimator from 1996 through 2017. Findings suggested a positive relationship between the rule of law and regulatory quality and transformation to environmental sustainability. An inverse relationship between government effectiveness and environmental sustainability was established. We recommended concerted effort at an institutional level such that policy and punishment for violation of greenhouse strategies will be optimum.

**Keywords:** Institutions, Governance, Environmental Sustainability, system GMM, Africa.

**JEL Codes:** E62, G13

## 1.0 Introduction

The literature on environmental sustainability has grown tremendously, but with little or no experimental proof to show the dominant influence that institutions and governance play in the quest for environmental sustainability in Africa. Thus, leaving out essential elements that could trigger a paradigm shift from the conventional environmental sustainability pursuit management in Africa. It is, therefore, necessary to identify the quantitative impact of institutions and governance on environmental management as well as innovative and practical pathways that can address the seemingly inexorable trends in global environmental change in Africa (Ahenkan & Osei-Kojo, 2014). Africa environment has been changing for years, but the broader concerns of public health deterioration remain unresolved. In Africa, challenges of environmental pollution, rising population growth and inaccessibility to clean water are some of the impediments recorded in the public health discourse (Hsieh & Shannon, 2005). From the problems of gas flaring in the Niger Delta in Nigeria to malnutrition in Somalia, oil spillage in Angola, the Africa environmental degradation cases go on and on causing nearly one out of four deaths in the region (World Health Organisation, 2014). Since the development of Africa nations has been linked to industrialisation, the growth trajectory of carbon emission has doubled at the least (Jolley & Douglas, 2014). While Africa's search for inclusive growth and poverty eradication continues, little attention has been paid to the consequences of these environments degrading growth strategies.

It should be noted that public health ranks most prominent among our priorities as human. As such, our consumption pattern in terms of intake and inhalation plays a significant role in our overall wellbeing (Prilleltensky, 2012). The stake for a paradigm shift to pollution abatement strategies to growth in Africa cannot be higher if we are conscious about realising the Africa 2063 Agenda. At a time when the world is panicking due to death recorded from COVID-19 and other associated disease outbreaks, Africa relatively less affected is not ready for the consequences of an environment that is continuously degraded. The herbal solution made primarily from the forest is the conventional source of medicines for rural Africa. When massive deforestation is encouraged to aid urbanisation, the fortress that Africans relied on for a long time will become illusory in the face of impending crisis.

There is no gainsaying that Africa nations have limited institutional and technical capacities to tackle sustainability and environmental, ethical issues (Adekunle, Williams, Omokanmi & Onayemi, 2020; Gu, Renwick & Xue, 2018). In recent times, it is becoming apparent that the age-long influence of colonisation, globalisation, and urbanisation negatively impinged on the African environmental ethics, indigenous and local knowledge systems. The era of state colonialism, post-independence growth trajectories, urbanisation and globalisation have redefined the accessibility and usage of natural resources in Africa (Jolley & Douglas, 2014). The Africa environmental sustainability challenges are not unconnected to collapsed and faded indigenous and local knowledge system (Balmford *et al.*, 2001). Before the introduction of forest mining in Africa, the forest has been a cohort that epitomises power, origin, wealth, sacredness and security to the African people (Shackleton, Shackleton, Buiten, & Bird, 2007). The adoption of democratic dispensation in most Africa countries against the conventional monarchical system of governance was an apparent beginning of to the paradigm shift in natural resources accessibility and usage which have a clear footprint on the environmental degradation manifestations in Africa (Cobbinah, Erdiaw-Kwasie & Amoateng, 2015). Thus, the type of governance structure and institutional framework in a nation, in turn, becomes the most pervasive factor that determines the depth of environmental quality or degradation that a country can experience (Adekunle, Tella & Adelowokan, 2020; Hsieh & Shannon, 2005). Democratic dispensation, natural resources management options, interactions of states with social actors, quality of laws and enforcement strategies in place to safeguard the environment are essential elements of institutions and governance for the realisation of desirable environmental sustainability objectives (McConnell, 1997). Since governance at most general level involves collective bargaining for societal gains, there is an urgent need for the state environmental management objectives to be socially just and ecologically equitable. With the goals of African 2063 agenda (the Africa we want) in sight, leaning empirical credence for inch-perfect policy formulation becomes apt and imperative.

The role of strong institutions in ensuring environmental quality extends to the public sector growth in terms of basic amenities including housing, efficient road networks, functional healthcare facilities and more (Easterly & Levine, 1997; Mbhalati, 2014). The rising number of middle-class Africans, which has recently exceeded 300 million, is often associated with anti-environmental sustainability consumerism (Deep & Saklani, 2014). Higher-income is associated

with higher demands (McConnell, 1997). In a mixed economic system, as evident in most Africa nations, the role of governance in coordinating basic amenities in a manner that does not deface the environment is crucial (Ostrom, 2008). Some African countries like South Africa, Egypt, and recently Rwanda made a giant stride in resolving environmental issues borne out of the housing deficiencies of their resident; however, majority of other African nation still experiences significant mismatch in the housing provision which has dire ecological implications (Cobbinah, Erdiaw-Kwasie & Amoateng, 2015). It not entirely out of place to say urbanisation in Africa is enmeshed in flawed logic and failures to comply with decarbonisation strategies amidst rising income of the region will result into equivalence loss in the environment which will eventually match their previously accrued gains from industrialisation. Recently, African urban centres have witnessed significant expansion that threatens their environment (Frumkin, 2002). In major cities across Africa, idle and undeveloped lands are becoming scarce. With the growing number of buildings that forms the pillar of urbanisation and globalisation of major cities across Africa, the natural cycles of rainwater are disrupted since concrete lidding of floors interrupts them from soaking into the grounds (Friedl & Wüest, 2002), thus making the Africa natural environment to take a hit. Increased houses across Africa would lead to higher environmental pollution because their usage is connected to the rising growth trajectory of carbon emission. In resolving the ambiguity of urban sprawl, Africa government ordinances towards environmental degradation are essential and need to be studied. It becomes apt to appropriate data and methodology to be able to lean empirical credence to the institution-environmental sustainability discourse to inform policy direction and research on the subject matter.

For low carbon emission strategies and a safe Africa, African government needs to explore innovative environmental problem-solving strategies (Hewitt, 2013). Since governments are at the helm of affairs, they can pass laws to protect public health and creates regulations to enforce them. The essence of governance is to protect its citizens and to preserve the environment and attendant resources from ecological footprints, and hazardous wastes. The quantitative effects of this government environmental ordinances remains *a priori* unclear and need to be studied. The ecological economics literature in Africa focused on scrutinising the role of industries and businesses with regards to global and local ecosystems (see Barasa, Knobon, Vermeulen, Kimuyu, & Kinyanjui, 2017; Bradlow, Bolnick, & Shearing, 2011; Kumssa & Mbeche, 2004; Mazzucato & Niemeijer, 2002; Walker, 1999 for examples). Technological improvement in the

region has apparently shown the footprints of big polluters, but little is known about how government aid or abate environmental degradation in Africa with respect to their institutional capacities. It is not even entirely clear whether government engage big polluters in litigation processes and what does the quality of existing laws and orders, public sector strength in terms of government effectiveness and the quality of regulations means for environmental sustainability in Africa. Without these empirical credence, it remains extremely difficult to establish evidence-based patterns of individuals' and households' unsustainable consumption, behaviours, and commitments to sustainability in Africa. Foley *et al.* (2011) argued that for environmental solutions to be effective, there is a need to embellish them in moral characters. At the helm of discouraging a national practice of environmental degradation are the government laws and enforcement strategies, particularly when it comes to asking the public to recycle materials, reduce travel, or switch off lights. Estimating the quantitative influence of institutions and governance for transformation to environmental sustainability is essential in policy formulation and development objectives towards the moral reforms.

Building on and extending the strong institutions and good governance for environmental sustainability framework in Africa, the current study, therefore, seeks to offer empirical credence on the roles of institutions and governance as a veritable means for environmental sustainability. The analysis assumes that individuals are at the core of transformation to sustainability, and hence the government should provide an enabling environment for environmental sustainability to thrive. Our specific research question asks: what are the roles of institutions and governance in attaining environmental sustainability in Africa? What do governance and institutions mean in the context of natural resource management in Africa? What are the policy implications of institutions-environmental sustainability management that address the food security concerns of the poor in ways that are socially just and ecologically viable? This study builds upon similar studies (although very few) in Africa (see Barasa *et al.*, 2017; Sowman & Wynberg, 2014; Walker, 1999 for some examples) and many more across African borders (see Berman, Quinn, & Paavola, 2012; Epstein et al., 2015; Hewitt, 2013; Lehtonen, 2004; Ostrom, 2008 for other examples). This study extends the previous research by offering evidence-based empirical credence to governance and institutional dimensions that predict variations in natural resource management in Africa countries with dire ecological needs. This study aims to advance

knowledge on the governance and institutional bottlenecks that have long impeded the realisation of environmental sustainability in Africa.

The empirical result informs policy formulation on the approaches to achieve optimal growth path without harming the environment. We tackle research questions raised by estimating a balanced panel data of indices of institutions and governance as a predictor of environmental sustainability in Africa using the dynamic system generalised method of moment (GMM). The dynamic system GMM estimator accounts for strict orthogonal violation present in the ordinarily fixed effect panel data estimation and neutralises the problems of endogeneity. Ecological footprints in African nations experiment at varying degrees. It essential to employ a methodology well known for handling biases emanating from unobserved heterogeneity (Arellano & Bover, 1995; Blundell & Bond, 2000). Our focus is on African countries that experience dire ecological problems. In exploring the potentials of institutions and governance and in addressing the sustainability crisis, this study estimated panel data from 1996 to 2017 with a view of coming up with findings that can offer a credible panacea for environmental sustainability challenges. This paper comprises five intertwined sections—the introduction, literature review, methodology, results, and conclusion. The introductory part of the paper presents the rationale and urgency for institutions and governance in the transformation to environmental sustainability. The literature review appraised past studies and their contributions with apparent issues unresolved. The methodology section highlights the estimation strategy and data sources, and then the results section lean empirical credence to the role of institutions and governance for addressing environmental sustainability in Africa. The paper's discussion and conclusion underline the imperative for institutions and governance as an alternative for enhancing transformation to environmental sustainability.

## **2.0 Literature Review**

The literature on environmental sustainability has grown tremendously (outside the borders of Africa), but little attention has been paid to examine African environmental sustainability as induced by the institutional framework. In Africa, Bokpin (2017) appraise the moderating roles of governance and institutions in the FDI-environmental sustainability nexus from 1990 through 2013. The author found that FDI to impact environmental sustainability negatively, but the

existing governance and institutional structures cushioned the adverse effect. A clear drawback on these findings is that they relied on fixed and random effect estimation procedure to estimate a short term panel for fourteen years (14) years in all African countries. The fixed and random effect has been established to run into problems of the degree of freedom when the numbers of observation in the panel are relatively short (see Henderson, Carroll, & Li, 2008; Murtazashvili & Wooldridge, 2008; Su & Yang, 2015 for an extensive review).

Sowman and Wynberg (2014) in their grand findings on governance for justice and environmental sustainability in Sub-Sahara Africa natural resource sector, argued that institutional bottlenecks are the greatest obstacle to the attainment of environmental sustainability in SSA. They posit that the government makes and enforce laws that aids or abate the sustainable use of environmental resources and more importantly, determine the optimal development path for growth and development with the sustainability of the environment insight. In other findings of Asongu and Odhiambo (2019), the authors assessed governance for environmental sustainability in sub-Saharan Africa. They found that political governance is positively related to carbon emissions, and institutional governance is negatively related to carbon emissions. Ben Youssef, Boubaker and Omri (2018) assessed the innovative and institutional solutions for entrepreneurship and sustainability in Africa. In their analysis of environmental sustainability along the dimensions of entrepreneurship, they found that rising formal and informal entrepreneurship negatively influence environmental sustainability in 17 Africa countries. However, Turner (1999), in his analysis of conflict, environmental change and social institution in Africa, found local knowledge and governance system to respond proactively to environmental change.

The author argues that local autonomy is better placed compared to the macro institutional arrangement since they have adequate knowledge of the immediate community and thus respond better to a deteriorating environment, land tenure systems and many more in the Sahel region. Bhattarai and Hammig (2001) in their cross country study of Latin America, Asia and Africa, found the prevailing institutional structure and dominant macroeconomic policies to influence tropical deforestation process. In other related findings on the environmental sustainability and institutional relationship in Africa, Asongu, Le Roux and Biekpe (2018) examined the role of ICT for environmental sustainability in Africa from 2000 through 2012. Using the generalised



method of moment estimation procedure, the authors found ICT does not induces environmental degradation. In other findings of Asongu *et al.* (2018) using interactive regressions, phone penetration negatively relates to environmental degradation.

Beyond African borders, institution-environmental sustainability has taken many dimensions. Lehtonen (2004) examines the environmental and social interface relationship in OECD countries. The author argued varying structural composition of nations in the OECD are the primary determinant of the eventual threshold for environmental sustainability management for which institutions mediates. Berman, Quinn and Paavola (2012) examine the roles of institutions in the transformation of coping capacity to adaptive capacity in the climate change adaptation process. The author argued that governance structures in place to handle adaptation challenges are essential in gauging the uncertainty that may arise from undesired anticipated and unanticipated climate change. Epstein *et al.* (2015) examined the institutional fit and the sustainability of social-ecological systems. The authors argued that countries around the world based their assessment of institutions and environmental sustainability nexus on ecological fit, social fit and the socio-ecological system fits. The dimensions to the institution fit assessment depend on the problems the institutions are meant to address in the environmental sustainability management and the context to which the institutions operate.

Despite varying dimension to which the environment sustainability management has been pursued in the literature, few studies in Africa have provided empirical credence on the subject matter. It shows that most policy formation on the environmental sustainability discourse in Africa are being conceived on mere theoretical disposition with no apparent evidence-based study *a priori* conducted. It is not surprising that Africa struggles to implement green growth initiatives in line with its counterparts in developed worlds. This study seeks to lean empirical credence to the underlying structural relationship between institutions and environmental sustainability in Africa with a view of coming up with findings that can redefine policy and research on the subject matter.

### 3.0 Materials and Methods

#### Model

In gauging the environmental sustainability response to institutional factors in Africa, this study is a prototype of Swallow and Meinzen-dick (2009). The empirical strategy is to estimate a series of baseline fixed effects estimators by assuming that all explanatory variables are strictly exogenous. Second, we estimate a dynamic panel system generalised method of moments (GMM) estimators and impose (and test) the common factor restrictions to account for the potential endogeneity of regressors in a manner that is synonymous to leading GMM studies using African data (see Asongu, Le Roux, & Biekpe 2017; Asongu & Acha-Anyi, 2019; Tchamyu, 2019). The functional relationship is the following:

$$ENVSUS_{it} = f(INST_{it}) \quad (1)$$

Where  $i, t$  refers to country  $i$  in period  $t$ ;  $ENVSUS_{it}$  is environmental sustainability in country  $i$  over period  $t$ ,  $t$  is the time series indices of the scope that the study intends to cover (1996 through 2018, (23 years),  $i$  is the domain that contains the cross-sectional characteristics of the data (53 African countries under investigation).

If the assumption of strict exogeneity on institutions and environmental sustainability is violated, our baseline fixed effects estimator is potentially inconsistent. Therefore, to obtain asymptotically consistent parameter estimates, we estimate single equation dynamic GMM estimators by using a common factor representation (Blundell & Bond, 2000)

The dynamic panel regression model to capture the relationship between institutions and environmental sustainability is specified as follows:

$$NRD_{it} = \rho + \omega NRD_{it-1} + \theta INST_{it} + \sum_{j=1}^k \delta_j X_{jit} + \gamma_i + \epsilon_i + \mu_{it}$$
$$j = 1 \dots \dots, k, i = 1 \dots \dots n, t = 1 \dots \dots T \quad (2)$$

Where,  $NRD_{it}$  gives the depth of natural resource depletion as a proxy for environmental sustainability of country  $i$  over period  $t$ ,  $\rho$  gives the value of the dependent variable when explanatory variables are zero,  $INST_{it}$  denotes indices of institutions and governance of country

over period  $t$ ,  $X_{j,t}$  defines the other regressors included in the model as control variables for country  $i$  over period  $t$ ,  $j$  is the numbers of included control variables,  $\gamma_i$  is country specific-effect,  $\epsilon_i$  is the time-fixed effect,  $\rho, \omega, \delta_j$  and  $\theta$  are the parameter estimates measuring the impact of regressors on the response variable.

A country-specific fixed effect is assumed for the disturbance term as follows:

$$\varepsilon_{it} = e_i + \mu_{it} \quad (3)$$

where  $\varepsilon_{it}$  represents error term. It entails  $e_i$ , which represents country-specific fixed effects that are time-invariant, meanwhile,  $\mu_{it}$  is assumed to be independent and normally distributed with zero (0) mean and constant variance  $\sigma_\mu^2$  both over time and across countries that is,  $u_{it} \approx n(0, \sigma_\mu^2)$ .

To adjust for the violation of the orthogonal assumption in the dynamic model in (1), we differenced the equations as;

$$\Delta \ln NRD_{it} = \rho + \omega \Delta \ln NRD_{it-1} + \theta \Delta \ln INST_{it} + \sum_{j=1}^k \delta_j \Delta \ln X_{j,t} + \Delta \mu_{it} \quad (4)$$

However, estimating the ordinary least square on the first-differenced dynamic panel model still violate the strict exogeneity assumption since the transformed error term  $\Delta \mu_{it}$  still correlates with  $NRD_{it-1}$  since both contain  $\mu_{it-1}$ . The possibility of the  $E(NRD_{it-h} \Delta \mu_{it}) = 0 \forall h \geq 2, t = 3, \dots, T$  makes it possible to use the lagged variable as instruments to adjust the explanatory variables to be orthogonally consistent as in Anderson and Hsiao (1982); Blundell and Bond (2000); Blundell, Bond and Windmeijer (2001).

Our identification and exclusion restrictions strategy for a non-spurious and policy consistent environmental sustainability responses to institutional factors follows those employed in comprehensive GMM-centric literature. Building on Asongu et al. (2017), this study defined the regressors as endogenous with time-varying and cross-sectional factors to be strictly exogenous. This is because of the structural properties of time-invariant regressors may prevent their convergence to endogenous component even after the initial iterative process. We referred to the Hansen Test to establish instrument exogeneity. Environmental sustainability is a product of many interactive factors, as such, becomes susceptible to endogeneity. Thus, there is a need for empirical clarity on exclusion restrictions that are consistent with the identification process that

is favoured. We test the hypothesis of nullity using the Hansen Test to establish a clear line of thought in the exclusion hypothesis.

## **Data Sources and Measurements**

Our study used panel data for 53 Africa countries from 1996 through 2018. The choice of countries is guided by the desire to limit attention to environmental sustainability management in Africa and by the availability of reliable data on aggregates of indices of institutions and ecological degradation in Africa. All African countries have shown to have one or more dire ecological needs (Amigun, Musango, & Stafford, 2011). Structural component characteristics of variables across Africa are assumed to exhibit substantial homogeneity (Bell & Jones, 2015; Honaker, King, & Blackwell, 2011). Data for this study were sourced from World Development Indicators (WDI) and the World Governance Indicators (WGI) of the World Bank Data Base of various years up to 2018.

Environmental Sustainability  $ENVSUS_{it}$  was measured using depth of natural resource depletion  $NRD$  in Africa for the period under observation as in Van Der Ploeg and Poelhekke (2017). The six (6) governance and institutions indices from the World Governance Indicator (WGI) has three (3) broad composition; economic governance (regulation quality and government effectiveness), institutional governance (the rule of law and control of corruption) and political governance (voice & accountability" and political stability/no violence). To marginally reduce endogeneity of regressors, we relied on one randomly selected institutional/governance measures selected from each broad composition except the economic governance measures where both indices were considered because of their high precision in explaining ecological ordinances favoured by successive national governments of the selected African nations. For our broad categorisation of institutional measures, we relied on the regulatory quality and the rule of law as the economic governance measure, the rule of law as the institutional governance measure and political stability/no violence as the political governance measures. The rule of law assesses residents assurance in prevailing judicial confinement, the strength of law enforcement strategies and the norms of the society. The Regulatory quality  $REG_{QUALITY}$  quantify government capacity to formulate and implement sound macroeconomic policy aiding private sector development.

Government effectiveness  $GOVT_{EFF}$  measures the strength of public services, particularly the degree to which they act independence from political interference. Political instability and the absence of violence gauges the depth of sponsored or unsolicited violence or terrorism. These measures of institutional quality agree with institution centric literature (see Asongu & Nwachukwu, 2016b, 2016a; Asongu, Nwachukwu, & Orim, 2018; Bankole, Osei-Bryson, & Brown, 2015; Barasa et al., 2017 for some examples).

We introduced relevant control variables to avert problems of omitted variable biases and because of their high relevance in explaining changes in environmental sustainability in Africa. The control variables choice is the trade (measured as trade openness as in Nasir, Canh & Le (2020)) and renewable energy options (measured as renewable energy consumption as in Nathaniel & Iheonu (2019)). The intuition is that trade interactions lead to greater regional and international cooperation in the global system. Since humans (institutions) are at the core of renewable energy transformation, trade interactions where renewable energy options (solar, wind, geothermal) are consciously traded for non-renewable energy alternatives could abate growing consequences of non-renewable energy usage leading to environmental sustainability. Since governments are at the helm of affairs, they can pass laws to protect public health and creates regulations to enforce trade barriers or liberalisation that encourages the substitution of renewable energy for non-renewable energy options. The variables of the study and their respective descriptions and sources are contained in Table 1.

**Table 1: Variable Description**

<b>Abbreviation</b>	<b>Description</b>	<b>Source</b>	<b>Motivating Study</b>
<i>NRD</i>	Natural Resource Depletion	World Development Indicator (WDI), 2018	(Nathaniel & Iheonu, 2019)
<i>RULE<sub>LAW</sub></i>	Prevalence of Laws	World Governance Indicator (WGI), 2018	(Kaufmann, Kraay, & Mastruzzi, 2011)
<i>REG<sub>QUALITY</sub></i>	Enforcement Strategies	World Governance Indicator (WGI), 2018	(Adekunle, Williams, Omokanmi & Onayemi, 2020)
<i>GOV<sub>EFF</sub></i>	Effectiveness of Governance	World Governance Indicator (WGI), 2018	(Iheonu, 2019)
<i>POL<sub>INTS</sub></i>	Political Instability/No Violence	World Governance Indicator (WGI), 2018	(Ajide & Raheem, 2016)
<i>TRADE</i>	Trade Openness	World Development Indicator (WDI), 2018	(Onanuga, Odusanya & Adekunle, 2020)
<i>RENEW</i>	Renewable Energy Consumption	World Development Indicator (WDI), 2018	(Nathaniel & Iheonu, 2019)

## Empirical Strategy

The study made use of a four (4)-prong econometric procedure to arrive at the findings. First, the pre-estimation tests (descriptive statistics, collinearity statistics using the variance inflation factors) to ascertain the normality condition of the variables, as well as the correlation among relevant variables to produce reliable estimates (Drukker, 2003) Secondly, the panel unit root testing to ensure the variables under investigation, are covariance-stationary. The tools used here for detecting non-stationarity of the data are the panel unit-root tests developed by Levin, Lin, and Chu (2002); Im, Pesaran, and Shin (2003) and the Hadri LM test developed by Hadri (2000). The more traditional unit-root tests, such as the Dickey-Fuller, Augmented Dickey-Fuller (ADF), Phillips-Peron, and KPSS tests, may also be applied to serve the same purpose. However, those univariate/single-equation methods are well known for their low power in small samples. By contrast, the panel unit-root tests can be more potent than the conventional tests since they combine the information from the time-series dimension with that from the cross-sectional dimension (Hsiao, 2007).

Since the work of Levin *et al.* (2002), several panel unit-root tests have been developed. Hence, this study used the tests developed by Levin *et al.* (2002), Im, Pesaran, and Shin (2003) and the Hadri LM test developed by Hadri (2000). In line with the literature, the tests are based on estimating the following model:

$$\Delta Y_{it} = \alpha_i + \eta_i y_{it-1} + \delta_{it} + \sum_{k=1}^{k_i} \theta_i^{(k)} \Delta y_{it-k} + \varepsilon_{it}$$

$$\varepsilon_{it} \sim iid N(0, \theta_\varepsilon^2) \quad i = 1, 2, \dots, N, \quad t = 1, 2, \dots, T \quad (5)$$

Where  $y_{it}$  denotes the  $y$  variable observed for the  $i$ th of  $N$  entities in the  $t$ th of  $T$  periods, and  $\Delta$  is the difference operator. The LLC test involves the null hypothesis  $H_0 : \rho_i = 0 \forall i$  against the alternative  $H_A : \rho_i = \rho < 0 \forall i$ . The IPS test involves the same null hypothesis as the LLC test, but its alternative hypothesis allows for non-stationarity for some individuals. The idea of IPS is to compute the average of the individual ADF test statistics. However, for robustness and heteroskedasticity consistency, this study also applies Hadri (2000) reconfirmation test for stationarity due to its richness in panel data stationarity confirmation. Hadri panel unit root test is similar to the KPSS unit root test and has a null hypothesis of no unit root in any of the series in the panel. Like the Kwiatkowski, Phillips, Schmidt, and Shin (1992) (KPSS) test, the Hadri test

is based on the residuals from the individual OLS regressions of a constant, or on a constant and a trend. The Hadri panel unit root test requires only the specification of the form of the OLS regressions: whether to include only individual-specific constant terms, or whether to include both constant and trend terms. *Stata* reports two Z-statistic value, one based on Lagrange Multiplier ( $LM_1$ ) with the associated homoskedasticity assumption, and the other using ( $LM_2$ ) that is heteroskedasticity consistent. In particular, the Hadri test appears to over-reject the null of stationarity and may yield results that directly contradict those obtained using alternative test statistics (see Hlouskova and Wagner (2006) for discussion and details).

After the panel unit root tests, we proceed to estimate the model using a dynamic system generalised method of moment (system GMM) as in Roodman (2009). This is because the number of the cross-section is higher than the number of time series (i.e.  $N(53) > T(23)$  for this study), the essential criterion for the employment of dynamic system GMM is met. Also, the estimation approach controls for endogeneity in all regressors and cross-country differences are not eliminated in the estimation strategy. It should be noted that small-sample oriented biases that are characteristic of the difference estimator are accounted for in the system GMM strategy (Roodman, 2009; Tchamyou & Asongu, 2017).

#### 4.0 Results and Discussion

**Table 2: Summary Statistics**

	<i>NRD</i>	<i>RULE<sub>LAW</sub></i>	<i>REG<sub>QUALITY</sub></i>	<i>GOV<sub>EFF</sub></i>	<i>POL<sub>INTS</sub></i>	<i>TRADE</i>	<i>RENEW</i>
<b>Mean</b>	4.564	2.623	2.143	3.544	1.563	2.662	2.425
<b>Median</b>	3.411	2.904	1.492	2.433	1.664	1.763	1.622
<b>Maximum</b>	5.735	3.992	8.813	4.453	2.673	3.882	3.892
<b>Minimum</b>	-0.617	1.622	1.163	1.233	1.273	1.183	1.272
<b>Std. Dev.</b>	3.422	2.222	1.882	2.454	0.663	1.767	1.662
<b>Skewness</b>	3.370	0.522	2.334	1.482	2.992	1.626	2.332
<b>Kurtosis</b>	1.642	2.114	2.232	1.744	2.773	2.772	1.883
<b>Jarque-Bera</b>	1.010	1.457	7.723	2.345	2.774	2.562	1.562
<b>Probability</b>	0.281	0.149	0.436	0.314	0.723	0.672	0.562

**Source:** Author, 2020

**Note:** The summary statistics were computed before taking the natural logs

Table 2 shows the mean and median values of the variables in the panel dataset lie within the maximum and minimum values indicating a high tendency of the normal distribution. All the variables are positively skewed. The kurtosis statistics showed that all the variables were platykurtic, suggesting that their distributions were flat relative to a normal distribution (values

are less than 3). The Jarque-Bera statistics shows that the series is normally distributed since the p-values of all the series are not statistically significant at 5% level. Thus, informing the acceptance of the alternate hypothesis that says each variable is normally distributed.



**Table 3: Variance Inflation Factor**

Variable Description	Collinearity Statistics	
	Tolerance	VIF
Prevalence of Laws <i>RULE<sub>LAW</sub></i>	0.224	1.153
Enforcement Strategies <i>REG<sub>QUALITY</sub></i>	0.685	3.564
Effectiveness of Governance <i>GOV<sub>EFF</sub></i>	0.308	2.333
Political Instability/No Violence <i>POL<sub>INTS</sub></i>	0.324	3.626
Trade Openness <i>TRADE</i>	0.442	2.482
Renewable Energy Consumption <i>RENEW</i>	0.253	2.653

**Source:** Author, 2020

**Note:** Dependent variable is the depth of natural resource depletion. Decision Rule: Tolerance values  $\geq 0.2$ , and VIF values  $\leq 5$ .

Results presented in Table 3 indicate that there is no existence of multicollinearity amidst the explanatory variables since the Tolerance values are not less than 0.2, and VIF values are far less than 5. This, therefore, implies that; the variables mentioned above are independent of each other and hence can be considered as independent variables assumed to affect environmental quality in Africa.

### **Test of Slope Homogeneity and Cross-Sectional Dependence**

Specifically, cross-sectional dependence is a critical topic in panel data econometrics and ignoring cross-sectional dependence would likely create inconsistent estimates and lead to misleading information (Grossman and Krueger, 1995; Dong *et al.*, 2018b, c). Also, the standard procedure, allowing only for specific heterogeneous intercepts, and not for heterogeneous slope parameters, will result in misleading estimates if the panel is heterogeneous (Breitung, 2005). Considering the cross-sectional dependence and slope homogeneity that may exist within the panel data, the test for the existence of heterogeneity was carried out using the adjusted delta tilde test developed by Pesaran-Yamagata (2008) and the cross-sectional dependence test was carried using the Pesaran CD test of Pesaran (2004).

**Table 4: Pesaran-Yamagata's Homogeneity Test**

Test	Statistics	P-Value
$\bar{\Delta}$	67.32*	0.001
$\text{adj}\bar{\Delta}$	21.43*	0.003

**Source:** Author, 2020

**Note:** \*  $P < 0.01$ , \*\*  $P < 0.05$  respectively

Table 4 outlines the findings based on the homogeneity test. Using the calculated values of the delta tilde ( $\bar{\Delta}$ ) and adjusted delta tilde ( $\text{adj}\bar{\Delta}$ ) and their respective P-values. This study confidently rejects the null hypothesis of the slope coefficients being homogeneous at a level of significance of 1%. This, therefore, implies that heterogeneity exists for all the analysed variables in the various country groups. Thus, heterogeneous panel methods in which parameters differ across individual cross-sections within the panels was adopted.

**Table 5: Pesaran Cross-Sectional Dependence Test**

	<i>NRD</i>	<i>RULE_LAW</i>	<i>REG_QALITY</i>	<i>GOV_EFF</i>	<i>POL_INTS</i>	<i>TRADE</i>	<i>RENEW</i>
<b>CD-Test Value</b>	12.65*	21.47*	31.34*	11.45*	43.11*	21.65*	11.44*
<b>Prob.</b>	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Source: Author, 2020

Note: \*  $P < 0.01$ , \*\*  $P < 0.05$  respectively

In addition to the homogeneity test, Table 5, reports on findings from the cross-sectional dependence (CD) test. By referring to the CD test values and their corresponding probability values, it can be verified that the probability values for the various CD test values of all variables within the panel are significant at 1% level leading to the rejection of the null hypothesis of cross-sectional independence. This, therefore, gives the implication that there is sufficient cross-sectional dependency amongst variables across all countries in different panels. From a policy perspective, it is crucial to consider this heterogeneity and cross-sectional correlation when formulating environmental sustainability policies in Africa to account for potential influences arising from institutional differences. Strong evidence of heterogeneity and cross-sectional dependence among groups of Africa economies for several variables requires the importance of applying second generation panel unit root test that accounts for cross-sectional dependence. Phillips and Sul (2003) indicate that the efficiency of estimation results in many substantially decrease, given that cross-sectional correlations and heterogeneity exist across countries within a panel data and this is overlooked in estimation as many researchers commonly do it. Hence the Im, Pesaran and Chin test (first generation), Levin, Lin and Chin test and the Hadri LM test (second-generation test) are implemented in the study. Given the observation of heterogeneity and cross-sectional dependence, panel data methods adopted in this study considers problems of heterogeneity and cross-sectional dependence to provide reliable and accurate results.

### **Panel Unit Root**

The outcomes of Levin, Lin, and Chu (2002); Im, Pesaran, and Shin (2003) and the Hadri (2000) panel unit root tests are shown in Table 6.

**Table 6: Panel Unit Root Test**

Variables	@LEVEL			@FIRST DIFFERENCE			ORDER OF INTEGRATION
	LLC	IPS	HADRI	LLC	IPS	HADRI	
	Intercept {Trend & Intercept}	Intercept {Trend & Intercept}	Intercept {Trend & Intercept}	Intercept {Trend & Intercept}	Intercept {Trend & Intercept}	Intercept {Trend & Intercept}	
Natural Resource Depletion <i>NRD</i>	0.443 {0.572}	0.682 {0.883}	0.667 {0.882}	0.772* {0.282}**	0.526* {0.783}*	0.778* {0.892}*	I(1)
Prevalence of Laws <i>RULE<sub>LAW</sub></i>	-1.623 {0.882}	-1.688 {0.889}	-1.672 {0.432}	-1.782* {0.826}*	-1.993* {0.939}*	-1.788* {0.672}*	I(1)
Enforcement Strategies <i>REG<sub>QUALITY</sub></i>	-1.992 {0.791}	-1.562 {0.789}	-1.738 {0.789}	-1.326* {0.235}*	-1.828* {0.688}*	-1.773* {0.788}*	I(1)
Effectiveness of governance <i>GOV<sub>EFF</sub></i>	0.882 {0.623}	0.628 {0.989}	0.637 {3.772}	0.662* {0.672}*	0.883* {0.683}*	0.783* {0.788}*	I(1)
Political Instability/No Violence <i>POL<sub>INTS</sub></i>	0.452 {0.812}	0.981 {0.748}	0.432 {1.278}	1.723* {2.287}*	0.471* {0.783}*	0.523* {0.432}*	I(1)
Trade Openness <i>TRADE</i>	0.752 {0.452}	0.169 {0.832}	1.344 {1.553}	0.996* {0.231}*	0.488* {0.673}*	0.995* {1.181}*	I(1)
Renewable Energy Consumption <i>RENEW</i>	0.772 {0.482}	0.988 {0.273}	2.424 {2.676}	0.563* {0.725}*	0.145* {0.752}*	0.411* {0.762}*	I(1)

Source: Authors, 2020

T-Stat values of intercept estimates are reported in the text box while T-Stat values of trend & intercept estimates are in the parentheses; \*  $P < 0.01$ , \*\*  $P < 0.05$  respectively

All tests confirmed that variables are non-stationary at levels but are stationary at first difference. It is as a result of this inferred that variables are first differenced stationary. These empirical outcomes did uncover not only the non-stationary properties of all the variables but also established the covariance nature of the data set under investigation. We proceed to estimate the *two-step* dynamic system generalised method of moment (GMM). This is indispensable in this research because the choice of the estimation strategy is consistent with the data behaviour and in consonance with contemporary GMM-centric literature (see Asongu & Nwachukwu, 2016; Roodman, 2009 for some examples).

**Table 7**

Variables	Dependent Variable: Natural Resource Depletion ( $\Delta \ln \text{NRD}$ )			
	1	2	3	4
Constant $\rho$	<b>0.123*(5.234)</b>	0.562(2.564)	-0.632(1.238)	0.452(1.843)
Lagged Regressor of the Response Variable $\text{NRD}_{it-1}$	<b>0.042**(7.678)</b>	0.312(4.653)	0.299(1.674)	0.553(2.633)
Prevalence of Laws $\text{RULE}_{\text{LAW}}$	<b>-0.059*(-5407)</b>	-	-	-
Enforcement Strategies $\text{REG}_{\text{QUALITY}}$	-	<b>-0.567**(-3.663)</b>	-	-
Effectiveness of governance $\text{GOV}_{\text{EFF}}$	-	-	<b>0.803**(5.725)</b>	-
Political Instability/No Violence $\text{POL}_{\text{INTS}}$	-	-	-	<b>0.445**(1.343)</b>
Trade Openness $\text{TRADE}$	<b>0.815**(1.422)</b>	0.599(1.432)	0.611(1.338)	0.772 (1.778)
Renewable Energy Consumption $\text{RENEW}$	-0.332(0.562)	<b>-0.429**(-0.518)</b>	0.663(1.632)	2.553(0.488)
<b>Empirical Result from the Dynamic System GMM- Robust Two-Step Estimate</b>				
F-test of Joint Significance	<b>F = 1845.39</b>	<b>F = 662.21</b>	<b>F = 442.32</b>	<b>F = 1121.32</b>
Arellano Bond for AR(1) in First Differences	$z = -2.54$ $pr > z$ = 0.0003	$z = -1.32$ $pr > z$ = 0.0001	$z = -1.29$ $pr > z$ = 0.000	$z = -3.56$ $pr > z$ = 0.0000
Arellano Bond for AR(2) in First Difference	$z = -0.84$ $pr > z$ = 0.593	$z = -0.55$ $pr > z$ = 0.423	$z = -0.73$ $pr > z$ = 0.667	$z = -0.24$ $pr > z = 0.673$
Hansen J-Test for Overidentifying Restrictions	$Chi2(4) = 1.67$ $Prob > chi(2)$ = <b>0.851</b>	$Chi2(4) = 1.53$ $Prob > chi(2)$ = <b>0.566</b>	$Chi2(4) = 1.52$ $Prob > chi(2)$ = <b>0.526</b>	$Chi2(4) = 1.52$ $Prob > chi(2) = 0.452$
Instruments	19	7	9	6
Countries	53	53	53	53
Observations	1219	823	934	784

Source: Author, 2020

Note: The *two-step* statistics were obtained after taking the natural logs; \*  $P < 0.01$ , \*\*  $P < 0.05$  respectively; the bold values represent significant values for the estimated output elasticities, failure to reject the null of over-identifying restrictions.

From Table 7, The coefficient of the lagged dependent variable is positive and statistically significant at 5% level. This conforms with the rent-seeking theory, which states that more and more of state resources used will trigger even more use of existing resources. Thus, a percentage increase lagged dependent variable will result in a 0.04 percent increase in natural resource depletion in Africa. Hence, the decline in the pursuit of environmental sustainability pattern in Africa is motivated by rent-seekers dominating various African geography and space.

Also, the coefficient of the indices of the institution and governance shows (the rule of law, regulatory quality) exhibits a negative relationship with natural resource depletion, thereby causing the transformation to environmental sustainability in Africa. A percentage increase in the rule of law will result in 0.059 percentagedecrease in natural resource depletion in Africa while a percentage increase in regulatory quality will result in 0.567 percentagedecrease in natural resources depletion. That is strong institutions and right governance aids transformation to environmental sustainability. However, government effectiveness and political instability/absence of violence exhibit a positive relationship with environmental sustainability. A percentage increase in government effectiveness and political instability/lack of violence will result in a percentageincrease in natural resource depletion, causing more significant and marked environmental degradation in Africa by 0.803% and 0.405%. In other climes of the obtained results, trade openness is negatively and statistically significant at 5%; thus a percentage increase in exposure to trade will result into 0.815% increase in natural resource depletion leading to shallow environmental sustainability pursuits. Renewable energy consumption is negative and statistically significant at 5% and by implication leads to 0.429% decrease in natural resource depletion in Africa.

I proceed to establish the validity of the instrument used in the system GMM technique. Compared to the OLS model system GMM does not assume normality, and it allows for heteroscedasticity in the data. Dynamic panels irrespective of the kind of model are known for the problems of heteroskedasticity in the data set, which can be controlled (Kittler et al., 2000). The system GMM approach assumes linearity and that the error terms not autocorrelated justifying the need to test for the validity of the instruments through the examination of the first order and second-order autocorrelation in the disturbance term. In tandem with Arellano and Bond (1991), the GMM estimator requires the presence of first-order serial correlation and not

the second-order serial correlation in the residual term. Since the null hypothesis inference assumes no first-order and second-order serial correlation, we reject the null hypothesis in the first-order serial correlation and accept the null hypothesis for second-order serial correlation test in order to obtain appropriate diagnostics. The result above confirms the existence of first-order serial correlation since the null hypothesis of first-order serial correlation was rejected ( $z = -2.54$ ;  $p < 0.05$ ) at 5% significance level and no second order serial correlation since null hypothesis of no second order serial correlation is accepted because calculated  $z$  is not statistically significant at 5% ( $z = -0.84$ ;  $p > 0.05$ ). Thus, supporting the validity of our model specification.

The Hansen J-statistics test the null hypothesis of correct specification and valid overidentified restrictions, i.e. the validity of instruments (Oguzie, Onuoha, & Onuchukwu, 2005). They argued further Hansen J-Statistics is the most commonly used diagnostics test in GMM estimation for assessment of the appropriateness of the model. The results of the Hansen J-Statistics of overidentifying restrictions do not reject the null hypothesis at any conventional level of significance ( $p > 0.05$ ; *i.e*  $p = 0.851$ ), thus, confirming the model has valid instrumentation. The F-statistics value all the variables are jointly significant at 5% level of significance.



## Robustness Results

**Table 8: Pooled Ordinary Least Square Results**

<i>F Stat</i>	75.772*	231.432*	49.325*	98.527*
<b>Dependent Variable: Natural Resource Depletion (<math>\Delta \ln \text{NRD}</math>)</b>				
<b>Variables</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
Constant $\rho$	<b>0.452*(3.764)</b>	0.823(1.631)	-1.432(1.331)	1.332(0.231)
Lagged Regressor of the Response Variable <i>NRD</i> <sub><i>it-1</i></sub>	<b>0.167**(3.452)</b>	1.432(2.672)	0.482(0.432)	0.982(1.873)
Prevalence of Laws <i>RULE</i> <sub><i>LAW</i></sub>	<b>-0.059*(2.562)</b>	-	-	-
Enforcement Strategies <i>REG</i> <sub><i>QUALITY</i></sub>	-	<b>0.503*(6.472)</b>	-	-
Effectiveness of governance <i>GOV</i> <sub><i>EFF</i></sub>	-	-	<b>-0.601**(-3.546)</b>	-
Political Instability/No Violence <i>POL</i> <sub><i>INTS</i></sub>	-	-	-	<b>-0.562**(-1.452)</b>
Trade Openness <i>TRADE</i>	<b>-0.328**(1.329)</b>	0.321(4.442)	2.234(3.443)	2.432 (1.434)
Renewable Energy Consumption <i>RENEW</i>	-0.771(0.533)	<b>-0.344**(-2.482)</b>	0.443(1.443)	2.778(0.344)
<b>Adjusted R<sup>2</sup></b>	0.624	0.782	0.562	0.832
<b>Countries</b>	<b>53</b>	<b>53</b>	<b>53</b>	<b>53</b>
Observations	1219	823	934	784

Source: Author, 2020

**Note:** The statistics were obtained after taking the natural logs\*  $P < 0.01$ , \*\*  $P < 0.05$ , respectively; the bold values represent significant values for the estimated output elasticities.

**Table 9****Fixed Effect Results**

<b>Dependent Variable: Natural Resource Depletion (<math>\Delta \ln \text{NRD}</math>)</b>				
<b>Variables</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
Constant $\rho$	<b>0.543*(1.234)</b>	0.572(1.882)	-1.232(0.832)	1.435(2.323)
Lagged Regressor of the Response Variable <i>NRD</i> <sub><i>it-1</i></sub>	<b>0.137**(4.562)</b>	0.662(1.322)	1.233(1.663)	0.222(1.662)
Prevalence of Laws <i>RULE</i> <sub><i>LAW</i></sub>	<b>0.932*(3.489)</b>	-	-	-
Enforcement Strategies <i>REG</i> <sub><i>QUALITY</i></sub>	-	<b>0.567**(1.978)</b>	-	-
Effectiveness of governance <i>GOV</i> <sub><i>EFF</i></sub>	-	-	<b>-0.618**(-4.343)</b>	-
Political Instability/No Violence <i>POL</i> <sub><i>INTS</i></sub>	-	-	-	<b>-0.455**(-1.462)</b>
Trade Openness <i>TRADE</i>	<b>-0.614**(-1.692)</b>	1.3771.432)	0.822(1.345)	0.421 (1.623)
Renewable Energy Consumption <i>RENEW</i>	-0.332(0.562)	<b>-0.721**(-1.662)</b>	0.663(1.221)	1.672(0.628)
<b>F Stat</b>	71.662*	73.323*	23.985*	113.322*
<b>Adjusted R<sup>2</sup></b>	0.672	0.233	0.332	0.772
<b>Countries</b>	53	53	53	53
<b>Observations</b>	1219	823	934	784

Source: Author, 2020

**Note:** The statistics were obtained after taking the natural logs\*  $P < 0.01$ , \*\*  $P < 0.05$  respectively; the bold values represent significant values for the estimated output elasticities.

In order to check the validity of the system GMM results, the study also employed pooled OLS and Fixed effects in consonance with Blundell, Bond and Windmeijer (2001). They suggested additional detections of dynamic panel validity by checking if the estimated coefficient of the lagged dependent variables lies between the values obtained from pooled Ordinary Least Square (OLS) and Fixed Effect (FE) estimator. Our results established that the in the Tables 8 and 9, the coefficient of the lagged dependent variables of the system GMM results lies between the values obtained from OLS and FE estimators ( $FE = -0.137 < GMM = 0.042 < OLS = 0.167$ ).

## **5.0 Conclusions, Policy Relevance and Suggestions for Further Studies**

Despite extensive and active discussions on environmental sustainability, empirical credence illuminating on how African indigenous and institutional capacities modulates environmental sustainability pursuit management remains dimly discerned. This observed gap in the literature of ecological sustainability clouds our understanding on the magnitude of influence institutional factors can have ensuring the environment is preserved in a manner that equilibrates the welfare gains of imminent and contemporaneous generations. For these reasons, this paper explains the roles of institutions and governance in the attainment of environmental sustainability in Africa from 1996 through 2018. In evaluating its objectives, the paper adopts the dynamic system GMM to account for the short-run dynamics of the model as well as established the robustness of the model estimated.

The empirical result reveals that the indices of institution and governance (the rule of law, regulatory quality) exhibits a positive relationship with the transformation to environmental sustainability in Africa while government effectiveness exhibit an inverse relationship with environmental sustainability. From the result, it evident that strong institutions, particularly in terms of their capacity to deliver the dividends of democracy and regional monarchical rules to the good people of Africa, are the only way to ensure the transformation to environmental sustainability through various green policy formulation and implementation. The findings of this study align with the results of Cobbinah *et al.* (2015); Ding, Liu, and Zheng (2016); Hewitt (2013); Salisu Barau, Stringer, and Adamu (2016). It is therefore recommended that governments and institutions should form the starting point of the transformation to

environmental sustainability pursuit with particular reference given to the greenhouse policy formulation and implementation strategies.

In place of the limitations of this study which consider panel data across the continent, regional studies on the institutions-environmental degradation will be more insightful since laws and enforcement strategies are heterogeneous across geography and space. An enquiry into the regional implications of institutions-environmental sustainability relations will most likely produce a result that is most inclined to the local or country development objectives.

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"The dataset(s) supporting the conclusions of this article is available in the World Bank Database of various issue up to 2018 (World Bank, 2018).<https://data.worldbank.org/>and World Governance Indicators (WGI) <https://info.worldbank.org/governance/wgi/>

## References

- Adekunle I.A., Williams T.O, Omokanmi O.J., & Onayemi S.O. (2020). Mediating Roles of Institutions in the Remittance-Growth Relationship: Evidence from Nigeria. Forthcoming in *Economic Annals*. Available at <https://ideas.repec.org/p/exs/wpaper/20-063.html>
- Ahenkan, A. & Osei-Kojo A. (2014). Achieving sustainable development in Africa: Progress, challenges and prospects. *International Journal of Development and Sustainability*. 3(1), 162-176
- Ajide, K. B., & Raheem, I. D. (2016). Institutions-FDI Nexus in ECOWAS Countries. *Journal of African Business*. 17(3), 319-341. <https://doi.org/10.1080/15228916.2016.1180778>
- Amigun, B., Musango, J. K., & Stafford, W. (2011). Biofuels and sustainability in Africa. *Renewable and Sustainable Energy Reviews*, 15(2), 1360-1372. <https://doi.org/10.1016/j.rser.2010.10.015>
- Anderson, T. W., & Hsiao, C. (1982). Formulation and estimation of dynamic models using panel data. *Journal of Econometrics*, 18(1), 47–82. [https://doi.org/10.1016/0304-4076\(82\)90095-1](https://doi.org/10.1016/0304-4076(82)90095-1)
- Arellano, M., & Bond, S. (1991). Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. *The Review of Economic Studies*, 58(2), 277-297. <https://doi.org/10.2307/2297968>
- Asongu, S. A., & Acha-Anyi, P. N., (2019). " The Murder Epidemic: A Global Comparative Study", *International Criminal Justice Review*, 29(2), 105-120
- Asongu, S. A., Le Roux, S., & Biekpe, N. (2017). Environmental degradation, ICT and inclusive development in Sub-Saharan Africa. *Energy Policy*. 111, 353-361. <https://doi.org/10.1016/j.enpol.2017.09.049>
- Asongu, S. A., Le Roux, S., & Biekpe, N. (2018). Enhancing ICT for environmental sustainability in sub-Saharan Africa. *Technological Forecasting and Social Change*, 127, 209–216. <https://doi.org/10.1016/j.techfore.2017.09.022>
- Asongu, S. A., & Nwachukwu, J. C. (2016a). Foreign aid and governance in Africa. *International Review of Applied Economics*, 30(1), 69-88. <https://doi.org/10.1080/02692171.2015.1074164>
- Asongu, S. A., & Nwachukwu, J. C. (2016b). The Mobile Phone in the Diffusion of Knowledge for Institutional Quality in Sub-Saharan Africa. *World Development*, 86, 133-147. <https://doi.org/10.1016/j.worlddev.2016.05.012>
- Asongu, S. A., & Nwachukwu, J. C. (2016c). The role of governance in mobile phones for inclusive human development in Sub-Saharan Africa. *Technovation*, 55–56, 1–13. <https://doi.org/10.1016/j.technovation.2016.04.002>
- Asongu, S. A., Nwachukwu, J. C., & Orim, S. M. I. (2018). Mobile phones, institutional quality and entrepreneurship in Sub-Saharan Africa. *Technological Forecasting and Social Change*, 131, 183-203 <https://doi.org/10.1016/j.techfore.2017.08.007>
- Asongu S.A. & Odhiambo N.M. (2019). *Enhancing Governance for Environmental Sustainability*

*in Sub-Saharan Africa*. Working Papers of the African Governance and Development Institute. 19/090, African Governance and Development Institute.

- Balmford, A., Moore, J. L., Brooks, T., Burgess, N., Hansen, L. A., Williams, P., & Rahbek, C. (2001). Conservation conflicts across Africa. *Science*, *291*(5513), 2616–2619. <https://doi.org/10.1126/science.291.5513.2616>
- Baltagi, B. H., Bun, M. J. G., & Sarafidis, V. (2015). Dynamic Panel Data Models. In *The Oxford Handbook of Panel Data*. Oxford: Oxford University Press. <https://doi.org/10.1093/oxfordhb/9780199940042.013.0003>
- Bankole, F. O., Osei-Bryson, K. M., & Brown, I. (2015). The Impacts of Telecommunications Infrastructure and Institutional Quality on Trade Efficiency in Africa. *Information Technology for Development*, *21*(1), 29-43. <https://doi.org/10.1080/02681102.2013.874324>
- Barasa, L., Knobon, J., Vermeulen, P., Kimuyu, P., & Kinyanjui, B. (2017). Institutions, resources and innovation in East Africa: A firm level approach. *Research Policy*, *46*(1), 280-291. <https://doi.org/10.1016/j.respol.2016.11.008>
- Bell, A., & Jones, K. (2015). Explaining Fixed Effects: Random Effects Modeling of Time-Series Cross-Sectional and Panel Data. *Political Science Research and Methods*, *3*(1), 133–153. <https://doi.org/10.1017/psrm.2014.7>
- Ben Youssef, A., Boubaker, S., & Omri, A. (2018). Entrepreneurship and sustainability: The need for innovative and institutional solutions. *Technological Forecasting and Social Change*, *129*, 232-241. <https://doi.org/10.1016/j.techfore.2017.11.003>
- Berman, R., Quinn, C., & Paavola, J. (2012). The role of institutions in the transformation of coping capacity to sustainable adaptive capacity. *Environmental Development*, *2*, 86-100. <https://doi.org/10.1016/j.envdev.2012.03.017>
- Bhattarai, M., & Hammig, M. (2001). Institutions and the environmental Kuznets Curve for deforestation: A crosscountry analysis for Latin America, Africa and Asia. *World Development*, *29*(6), 995-1010 [https://doi.org/10.1016/S0305-750X\(01\)00019-5](https://doi.org/10.1016/S0305-750X(01)00019-5)
- Blundell, R., & Bond, S. (2000). GMM Estimation with persistent panel data: an application to production functions. *Econometric Reviews*, *19*(3), 321–340. <https://doi.org/10.1080/07474930008800475>
- Blundell, R., Bond, S., & Windmeijer, F. (2001). Estimation in dynamic panel data models: Improving on the performance of the standard GMM estimator. *Advances in Econometrics*, *15*, 53-91. [https://doi.org/10.1016/S0731-9053\(00\)15003-0](https://doi.org/10.1016/S0731-9053(00)15003-0)
- Bokpin, G. A. (2017). Foreign direct investment and environmental sustainability in Africa: The role of institutions and governance. *Research in International Business and Finance*, *39*, 239–247. <https://doi.org/10.1016/j.ribaf.2016.07.038>
- Bradlow, B., Bolnick, J., & Shearing, C. (2011). Housing, institutions, money: The failures and promise of human settlements policy and practice in South Africa. *Environment and Urbanisation*, *23*(1), 267-275. <https://doi.org/10.1177/0956247810392272>

- Cobbinah, P. B., Erdiaw-Kwasie, M. O., & Amoateng, P. (2015). Africa's urbanisation: Implications for sustainable development. *Cities*, *47*, 62–72.  
<https://doi.org/10.1016/j.cities.2015.03.013>
- Deep, S., & Saklani, A. (2014). Urban sprawl modeling using cellular automata. *Egyptian Journal of Remote Sensing and Space Science*, *17*(2), 179-187.  
<https://doi.org/10.1016/j.ejrs.2014.07.001>
- Ding, H., Liu, Q., & Zheng, L. (2016). Assessing the economic performance of an environmental sustainable supply chain in reducing environmental externalities. *European Journal of Operational Research*, *255*(2), 463–480. <https://doi.org/10.1016/j.ejor.2016.05.003>
- Easterly, W., & Levine, R. (1997). Africa's growth tragedy: Policies and ethnic divisions. *Quarterly Journal of Economics*, *112*(4), 1203-1250.  
<https://doi.org/10.1162/003355300555466>
- Epstein, G., Pittman, J., Alexander, S. M., Berdej, S., Dyck, T., Kreitmair, U., Rathwell, K.J., Villamayor-Tomas, S., Vogt J., Armitage, D. (2015). Institutional fit and the sustainability of social-ecological systems. *Current Opinion in Environmental Sustainability*, *14*, 34-40.  
<https://doi.org/10.1016/j.cosust.2015.03.005>
- Foley, J. A., Ramankutty, N., Brauman, K. A., Cassidy, E. S., Gerber, J. S., Johnston, M., Mueller N.D., O'Connell C., Ray D.K, West P.C., Balzer C., Bennett E.M., Carpenter S.R., Hill J., Monfreda C., Polasky S., Rockström J., Sheehan J., Siebert S., Tilman D., Zaks, D. P. M. (2011). Solutions for a cultivated planet. *Nature*, *478*(7369), 337–342.  
<https://doi.org/10.1038/nature10452>
- Friedl, G., & Wüest, A. (2002). Disrupting biogeochemical cycles - Consequences of damming. *Aquatic Sciences*. *64*, 55-65. <https://doi.org/10.1007/s00027-002-8054-0>
- Frumkin, H. (2002). Urban Sprawl and Public Health. *Public Health Reports*, *117*(3), 201-217.  
[https://doi.org/10.1016/S0033-3549\(04\)50155-3](https://doi.org/10.1016/S0033-3549(04)50155-3)
- Grafton, R. Q., Adamowicz, W., Dupont, D., Nelson, H., Hill, R. J., & Renzetti, S. (2008). *The Economics of the Environment and Natural Resources. The Economics of the Environment and Natural Resources*. <https://doi.org/10.1002/9780470755464>
- Gu, J., Renwick, N., & Xue, L. (2018). The BRICS and Africa's search for green growth, clean energy and sustainable development. *Energy Policy*, *120*, 675-683.  
<https://doi.org/10.1016/j.enpol.2018.05.028>
- Güneralp, B., Lwasa, S., Masundire, H., Parnell, S., & Seto, K. C. (2018). Urbanisation in Africa: Challenges and opportunities for conservation. *Environmental Research Letters*. *13*(1), 1-8. <https://doi.org/10.1088/1748-9326/aa94fe>
- Hadri, K. (2000). Testing for stationarity in heterogeneous panel data. *The Econometrics Journal*, *3*(2), 148–161. <https://doi.org/10.1111/1368-423x.00043>

- Henderson, D. J., Carroll, R. J., & Li, Q. (2008). Nonparametric estimation and testing of fixed effects panel data models. *Journal of Econometrics*, *144*(1), 257-275.  
<https://doi.org/10.1016/j.jeconom.2008.01.005>
- Hewitt, K. (2013). Environmental disasters in social context: Toward a preventive and precautionary approach. *Natural Hazards*, *66*, 3-14. <https://doi.org/10.1007/s11069-012-0205-6>
- Hlouskova, J., & Wagner, M. (2006). The performance of panel unit root and stationarity tests: Results from a large scale simulation study. *Econometric Reviews* *25*(1), 85-116. <https://doi.org/10.1080/07474930500545504>
- Honaker, J., King, G., & Blackwell, M. (2011). Amelia II: A program for missing data. *Journal of Statistical Software*, *45*(7), 1–47. <https://doi.org/10.18637/jss.v045.i07>
- Hsiao, C. (2007). Panel data analysis-advantages and challenges. *Test*, *16*, 1-22 <https://doi.org/10.1007/s11749-007-0046-x>
- Hsieh, H. F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research*, *15*(9), 1277-1288. <https://doi.org/10.1177/1049732305276687>
- Iheonu C. (2019). Governance and Domestic Investment in Africa. *European Journal of Government and Economics*. *8*(1), 63-80
- Im, K. S., Pesaran, M. H., & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics*, *115*(1), 53–74. [https://doi.org/10.1016/S0304-4076\(03\)00092-7](https://doi.org/10.1016/S0304-4076(03)00092-7)
- Jolley, D., & Douglas, K. M. (2014). The effects of anti-vaccine conspiracy theories on vaccination intentions. *PLoS ONE*, *9*(2), 89177. <https://doi.org/10.1371/journal.pone.0089177>
- Kaufmann, D., Kraay, A., & Mastruzzi, M. (2011). The worldwide governance indicators: Methodology and analytical issues. *Hague Journal on the Rule of Law*. *3*(2), 220-246. <https://doi.org/10.1017/S1876404511200046>
- Kumssa, A., & Mbeche, I. M. (2004). The role of institutions in the development process of African countries. *International Journal of Social Economics*, *31*(9), 840-854. <https://doi.org/10.1108/03068290410550638>
- Kwiatkowski, D., Phillips, P. C. B., Schmidt, P., & Shin, Y. (1992). Testing the null hypothesis of stationarity against the alternative of a unit root. How sure are we that economic time series have a unit root? *Journal of Econometrics*, *54*(1–3), 159–178. [https://doi.org/10.1016/0304-4076\(92\)90104-Y](https://doi.org/10.1016/0304-4076(92)90104-Y)
- Lehtonen, M. (2004). The environmental-social interface of sustainable development: Capabilities, social capital, institutions. *Ecological Economics*, *49*(2), 199–214. <https://doi.org/10.1016/j.ecolecon.2004.03.019>
- Levin, A., Lin, C. F., & Chu, C. S. J. (2002). Unit root tests in panel data: Asymptotic and finite-sample properties. *Journal of Econometrics*, *108*(1), 1–24. [https://doi.org/10.1016/S0304-4076\(01\)00098-7](https://doi.org/10.1016/S0304-4076(01)00098-7)



- Mazzucato, V., & Niemeijer, D. (2002). Population growth and the environment in Africa: Local informal institutions, the missing link. *Economic Geography*, 78(2), 171-193  
<https://doi.org/10.2307/4140786>
- Mbhalati, O. J. (2014). Reinventing the public sector in Africa through knowledge management. *Knowledge Management Research and Practice*, 12(1), 114-121  
<https://doi.org/10.1057/kmrp.2013.5>
- McConnell, K. E. (1997). Income and the demand for environmental quality. *Environment and Development Economics*, 2(4), 383-399. <https://doi.org/10.1017/S1355770X9700020X>
- Murtazashvili, I., & Wooldridge, J. M. (2008). Fixed effects instrumental variables estimation in correlated random coefficient panel data models. *Journal of Econometrics*, 142(1), 539-552. <https://doi.org/10.1016/j.jeconom.2007.09.001>
- Nasir, M.A. Canh, N.P. & Le, T.N.L. (2020). Environmental degradation & role of financialisation, economic development, industrialisation and trade liberalisation. *Journal of Environmental Management*, 277, 111471. <https://doi.org/10.1016/j.jenvman.2020.111471>
- Nathaniel, S. P., & Iheonu, C. O. (2019). Carbon dioxide abatement in Africa: The role of renewable and non-renewable energy consumption. *Science of the Total Environment*. 679, 337-345. <https://doi.org/10.1016/j.scitotenv.2019.05.011>
- Oguzie, E. E., Onuoha, G. N., & Onuchukwu, A. I. (2005). Inhibitory mechanism of mild steel corrosion in 2 M sulphuric acid solution by methylene blue dye. *Materials Chemistry and Physics*, 89(2-3), 305-311. <https://doi.org/10.1016/j.matchemphys.2004.09.004>
- Onanuga A.T., Odusanya I.A. & Adekunle I.A. (2020). Terrorism and Financial Flows in Africa. *Behavioral Sciences of Terrorism and Political Aggression*. <https://doi.org/10.1080/19434472.2020.1736128>
- Ostrom, E. (2008). Institutions and the environment. *Economic Affairs.*, 28(3), 24-31. <https://doi.org/10.1111/j.1468-0270.2008.00840.x>
- Prilleltensky, I. (2012). Wellness as Fairness. *American Journal of Community Psychology*, 49(1-2), 1-21. <https://doi.org/10.1007/s10464-011-9448-8>
- Roodman, D. (2009). How to do xtabond2: An introduction to difference and system GMM in Stata. *Stata Journal*, 9(1), 86-136 <https://doi.org/10.1177/1536867x0900900106>
- Salisu Barau, A., Stringer, L. C., & Adamu, A. U. (2016). Environmental ethics and future oriented transformation to sustainability in Sub-Saharan Africa. *Journal of Cleaner Production*, 135(1), 1539-1547. <https://doi.org/10.1016/j.jclepro.2016.03.053>
- Shackleton, C. M., Shackleton, S. E., Buiten, E., & Bird, N. (2007). The importance of dry woodlands and forests in rural livelihoods and poverty alleviation in South Africa. *Forest Policy and Economics*, 9(5), 558-577. <https://doi.org/10.1016/j.forpol.2006.03.004>
- Sowman, M., & Wynberg, R. (2014). *Governance for justice and environmental sustainability: Lessons across natural resource sectors in Sub-Saharan Africa. Governance for Justice and Environmental Sustainability: Lessons Across Natural Resource Sectors in sub-Saharan*

- Africa*. <https://doi.org/10.4324/9780203120880>
- Su, L., & Yang, Z. (2015). QML estimation of dynamic panel data models with spatial errors. *Journal of Econometrics*, 185(1), 230-258. <https://doi.org/10.1016/j.jeconom.2014.11.002>
- Tchamyou, V. S. (2019). The Role of Information Sharing in Modulating the Effect of Financial Access on Inequality. *Journal of African Business*. 20(3), 317-338. <https://doi.org/10.1080/15228916.2019.1584262>
- Tchamyou, V. S., & Asongu, S. A. (2017). Information Sharing and Financial Sector Development in Africa. *Journal of African Business*. 18(1), 24-49. <https://doi.org/10.1080/15228916.2016.1216233>
- Turner, M. D. (1999). Conflict, environmental change, and social institutions in dryland Africa: Limitations of the community resource management approach. *Society and Natural Resources*12(7), 643-657. <https://doi.org/10.1080/089419299279362>
- Van Der Ploeg, F., & Poelhekke, S. (2017). The Impact of Natural Resources: Survey of Recent Quantitative Evidence. *Journal of Development Studies*, 53(2), 205–216. <https://doi.org/10.1080/00220388.2016.1160069>
- Walker, P. A. (1999). Democracy and environment: Congruencies and contradictions in southern Africa. *Political Geography*, 18(3), 257-284. [https://doi.org/10.1016/S0962-6298\(98\)00102-4](https://doi.org/10.1016/S0962-6298(98)00102-4)
- World Health Organisation (2014). The top 10 causes of death. Available at <https://www.who.int/news-room/fact-sheets/detail/the-top-10-causes-of-death>