Managing Environmental Quality in Sub-Saharan Africa: Does Institutional Quality Matter?

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Managing environmental quality in sub-Saharan Africa: Does institutional quality matter?

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Abstract

Climate change has been the most challenging environmental issue, which has attracted the attention of policymakers and researchers. The increasing concentration of carbon emissions in the atmosphere resulting in climate change has severe implications for development. Despite the global efforts to reduce carbon emissions, global carbon emissions have been increasing, and this conflict with the Paris agreement on climate change. In this study, we study the impact of institutional quality on carbon emissions using 45 sub-Saharan Africa countries between the period of 2000-2015. Our results indicated that institutions have a weak effect on mitigating carbon emissions. Interestingly, when we avoid the assumption of homogeneity in our sample and categories our sample based on their institutional-origin, our results revealed that institutions play a significant role in mitigating carbon emissions. We, therefore, argue that pursuing better institutions of governance are fundamental for achieving the Sustainable Development Goal (SDG) 13.

Keywords: Environmental management; Carbon emissions; Institutional quality; Sustainability

1. Introduction

This paper aims to provide an empirical assessment of the impact of institutions on carbon emissions in sub-Saharan Africa. Climate change has become a significant policy issue since it poses a severe social, economic and political threats to developing countries and sub-Saharan Africa countries in particular (Asafu-Adjaye, 2014; Simbanegavi & Arndt, 2014). In the face of global warming, it has been estimated that sub-Saharan Africa will potentially lose approximately 8% of its economic growth while agriculture productivity is expected to decline by almost 28% (Asafu-Adjaye, 2014; Simbanegavi & Arndt, 2014). In absolute terms, sub-Saharan Africa will lose about 20 to 30 billion dollars per year to climate change (Mekonnen, 2014). While carbon emissions have been the primary driver of climate change, international organisations have focused on strategies and policies to control the rise of global carbon emissions (Tamazian & Bhaskara Rao, 2010). Existing carbon emissions mitigation policies have primarily focused on energy consumption and economic growth (Bhattacharya, Awaworyi Churchill, & Paramati, 2017).

In both energy and environmental economics, a vast literature has empirically investigated the impact of population, economic growth and energy consumption on carbon emissions, but an issue that has not attracted much attention in the literature is whether institutions influence carbon emissions (Bhattacharya et al., 2017). As institutions refer to the rules and norms of behaviour that structure repeated human interaction (North, 1989;1990), some scholars argue that the role of institutional factors on the environment cannot be underestimated. For instance, it is argued that institutional factors such as corruption, political stability, government regulation, the rule of law, government effectiveness and among others plays a significant role in influencing environmental policies and strategies to mitigate carbon emissions (Abid, 2017; Bae, Li, and Rishi, 2017; Fredriksson & Svensson, 2003). Similarly, Bhattacharya et al. (2017) added that institutions that support property right protection and voluntary exchange enables the government to implement desirable environmental policies. In other words, without effective and efficient institutions, environmental policies to mitigate carbon emissions could be undermined. While institutions are both a sign and a precursor to many development outcomes, it is better to understand the impact of institutions on carbon emissions. Given this knowledge gap, this study investigates the effect of institutional quality on carbon emissions in a panel of 45 sub-Saharan African countries between the period of 2000-2015. In achieving the goal of this paper, we seek to provide answers two major questions: (i) Does institutions affect carbon emissions in sub-Saharan Africa and (ii) Does the

impact of institutions on carbon emissions differ across countries with different institutional-origin?

We focused on sub-Saharan Africa countries because limited knowledge exists on the impact of institutions on carbon emissions, especially in developing countries Ali et al. (2019). Additionally, while carbon emissions have recently been increasing in sub-Saharan Africa (see Adams & Klobodu, 2018), the outcome of this study is critical for informing environmental policies in sub-Saharan Africa countries. For instance, if our results reveal that institutions contribute to carbon emissions mitigation, then sustainable development objectives will be easier to achieve. On the other hand, if institutions are found to induce carbon emissions, then it will be challenging to meet the goals of climate change policies. Additionally, while sub-Saharan Africa countries are bearing higher cost of climate change coupled with the region developmental challenges, the outcome of this study will help to identify the factors contributing to carbon emissions in other to formulate policies to curb it before it comes worse.

This study contributes to the literature in four ways. First, while the majority of the existing studies use corruption as a proxy for institutions, our study contributes to the literature by using six individual proxies for institutions to study their respective effect on carbon emissions. An institution is a broad concept. The use of a single proxy provides only a limited dimension of the concept. The six institutional quality measures used in this study will provide broader understanding about which aspects of institutions improve the quality of the environment most. Second, unlike the existing studies, we contribute to the literature by providing empirical evidence on how the impact of institutions on carbon emissions differ across countries with different institutional origins or source. This will provide an understanding of why carbon mitigation policies differ across countries. This study also employs the system-generalised method of moment approach (system-GMM) estimation technique. The use of system-GMM is capable of solving the problem of endogeneity, simultaneity and variable omissions bias. Furthermore, we contribute to the literature by examining the impact of institutions within the Environmental Kuznets curve (EKC) framework and further accounts for other variables such as population size, urbanisation, energy consumption, financial development, foreign direct investment, trade openness, which have a substantial influence on carbon emissions. Accounting for these variables in the carbon emissions model will prevent variable omissions bias and presents consistent estimates. Theoretically, this study provides detailed theoretical channels through which institutions could influence the environment.

The remaining sections of the paper are organised in four parts. In section 2, we provide both theoretical on the role of institutions on carbon emissions while methodology and data for the study are described in Section 3. The results and discussions are presented in Section 4, while conclusions and policy suggestions are presented in Section 5.

2. Theoretical framework

In this section, we provide the theoretical channels through which institutions could affect the environment and summarise the empirical works on institutions and the environment. The role of institutions in shaping countries' long-run economic growth is well documented in several cross-sectional studies (Acemoglu, Johnson, & Robinson, 2001;2005; Acemoglu & Robinson, 2010; Rodrik, Subramanian, & Trebbi, 2004). Recently, the role of institutions in also influencing the environment has attracted the attention of policymakers. Theoretically, *policy, growth* and *technological effects* are the mechanisms through which institutions could affect the quality of the environment. The *policy effect* channel suggests that policies are outcomes institutions; therefore, weak institutions could exacerbate environmental problems while efficient institutions could decrease environmental issues. The implication is that institutions condition the stringency of environmental policy. For instance, the theoretical model of Fredriksson and Svensson (2003) indicate that both corruption and political instability reduce the stringency of environmental policies. Cole, Elliott, and Fredriksson (2006) and Damania, Fredriksson, and List (2003) further argue that institutions conditions the impact of trade and foreign direct investment policies on the environment. This implies that weak institutions in the form of relatively high corruption level could weaken trade and foreign direct investment policies to increase carbon emissions and vice versa. In a nutshell, countries with efficient institutions could implement and enforce stringent environmental policies relative to countries with weak institutions.

The *growth effect* channel suggests that institutions could influence the quality of the environment via economic growth and the development of other sectors of the economy. The impact of institutions could either increase or reduce carbon emissions through economic growth (Welsch, 2004). Thus, when institutions promote economic growth without strict enforcement of environmental regulation, it could increase carbon emissions. Alternatively, if institutions support economic transformation towards the development of information-

intensive industries, better technology and higher environmental budget, they could help mitigate carbon emissions. As institutions determine property right protection, Cropper and Griffiths (1994) argue that countries with high property right protection have an efficient allocation of resource, which helps to boost economic growth to limit environmental problems. Similarly, Biswas, Farzanegan, and Thum (2012) contend that weak institutions (high corruption) could strengthen the shadow economy to increase carbon emissions. Thus, the shadow economy worsens the environment when such an economy is poorly regulated, and there exist highly political corruption. The *technological effect* channel indicates that institutions could influence the environment through technological development. Bhattacharya et al. (2017) argue that institutions that support property right protection and reduce transaction cost could increase the development and adoption of environmentally friendly technologies that could limit the growth of carbon emissions. Put differently, when institutions support property right protection and reduce the risk of expropriation, it could act as an incentive for investment in environmentally friendly technologies that could help reduce carbon emissions. Similarly, institutions that support the transfer of environmentally friendly technologies through foreign direct investment could contribute to carbon emissions reduction.

Although empirical studies linking institutions to carbon emissions are limited, these few studies reveal some insightful results. For instance, Fredriksson and Svensson (2003) in their simulation study, indicated that political instability and corruption reduce the stringency of environmental policies, thereby increasing carbon emissions. Similarly, Damania et al. (2003), in their study, found that corruption reduces environmental stringency. Using system-GMM, the results of Tamazian and Bhaskara Rao (2010) indicated that institutional quality reduces carbon emissions in transitional economies. Abid (2016) used both static and dynamic estimation techniques to examine the role of an institutional factor on carbon emission and argued that institutional variables such as control of corruption, political stability and government effectiveness reduce carbon emissions while regulatory quality and the rule of law increases carbon emissions in 25 sub-Saharan African countries. Extending this study, Abid (2017) further investigated the impact of institutions on carbon emissions in the EU and MENA countries using system-GMM. The results from the study suggested that government effectiveness, political stability, control of corruption regulatory quality and the rule of law contributes to the reduction in carbon emissions in EU countries while none of institutions measures significantly affects carbon emissions in the MENA countries.

Ali et al. (2019) examined the impact of institutions on carbon emissions in 47 developing countries using system-GMM. Using corruption, the rule of law and bureaucratic

quality to develop a holistic indicator for institutional quality, the study revealed that institutional quality reduces carbon emissions. In another study, Cole (2007) investigated the effect of corruption on carbon emissions in 94 countries using an instrumental variable approach. The empirical results indicated that corruption contributes to the increase in carbon emissions. Recently, Arminen and Menegaki (2019) examined the impact of corruption in energy-economic growth-carbon emissions framework in 67 upper and middle-income countries using system-GMM. The results from the study revealed that institutions measured using corruption have a negligible effect on carbon emissions. Using a generalised method of moment approach, Bae et al. (2017) indicated that institutional quality variables such as corruption, political democracy and economic freedom increase carbon emissions in 15 post-Soviet Union Independent countries. In the same way, Lisciandra and Migliardo (2017) conducted a study on the effect of corruption on environmental degradation in 153 countries, and the results indicated that corruption increases environmental degradation. Bhattacharya et al. (2017) also examined the effect of institutions proxied using economic freedom index on carbon emissions in 85 countries using system-GMM and Fully Modified Ordinary Least Square (FMOLS). The study revealed that institutions reduce carbon emissions. This study extends the existing literature by using system-GMM to investigate the impact of six indicators of institutions on mitigating carbon emissions in sub-Saharan Africa.

3. Methodology and Data

3.1 Data

This study employs a panel data analysis for 45 sub-Saharan African countries[1] between the periods of 2000-2015.

Dependent variables and variable of interest

The dependent variable for this study is carbon emissions. Institutions are the primary variable of interest. Following M. Abid (2017), institutions are measured using voice and accountability, the rule of law, regulatory quality, political stability, control of corruption and government effectiveness.

Control variables

1. ***Economic growth*:** Economic growth is blame to be a significant cause of global carbon emissions. However, the Environmental Kuznets Curves (EKC) hypothesis argues that an inverted-shaped relationship exists between economic growth and carbon emissions. Grossman and Krueger (1995) contend that economic growth initially deteriorates the environment (increase carbon emissions); however, after a certain threshold of economic growth, the quality of the environments improve (reduction in carbon emissions). The implication is that at the early stage of economic development when there is real economic growth without any change in technological innovation would increase carbon emissions. However, at the advanced stage of economic development, there is an increase in the development of better technologies coupled with stringent environmental regulations and enforcement, which limits the rise in carbon emissions (Stern, 2004). Empirically, some studies have validated the EKC hypothesis (Ahmad et al., 2017; Apergis & Ozturk, 2015; Narayan & Narayan, 2010) while other studies have refuted the EKC hypothesis (Abid, 2016; Özokcu & Özdemir, 2017; Stern, 2004; Stern & Common, 2001)
2. ***Population size*:** In addition to economic growth, population has contributed immensely to global carbon emissions. It is contested that population increase energy consumption and deforestation, which results in the rise of carbon emissions (Birdsall, 1992). Additionally, Zhu and Peng (2012) argue that population size harms the environment (increase carbon emissions) by changing the scale as well as the structure and composition of production and consumption in an economy. Empirical studies by Shi (2003); Weber and Sciubba (2018) and Dong et al. (2018) indicate that population

[1] See the appendix for the countries

increases carbon emissions while the studies of Begum, Sohag, Abdullah, and Jaafar (2015) reveal that population growth does not influence carbon emissions.

3. ***Energy consumption*:** Energy consumption remains one of the essential sources of global carbon emissions. The International Energy Agency (IEA) (2019) report indicates that in 2018, energy-related carbon emissions increased 1.7% to a very high level of 33.1 gigatons CO_2. The report suggests that the 2018 growth in energy-related carbon emissions is the highest since 2013, and 70% higher than the average increase since 2010. The findings from the report indicate that excessive use of energy will continue to emit carbon into the atmosphere. Many empirical studies that incorporated energy consumption in carbon emissions model have revealed that energy consumption increases carbon emissions Zhang and Cheng (2009); Shahbaz, Hye, Tiwari, and Leitão (2013); Salahuddin, Alam, Ozturk, and Sohag (2018); Omri (2013); Jahangir Alam, Ara Begum, Buysse, and Van Huylenbroeck (2012); Halicioglu (2009).
4. ***Trade openness***: Trade openness, which refers to the flow of goods between countries, remains one of the critical factors that is argued to influence carbon emissions. Antweiler, Copeland, and Taylor (2001) argue that *scale, composition and techniques effects* are the theoretical channels through which trade influence the environment. The *composition effect* indicates that based on comparative advantage, trade openness impact on the environment by changing the composition of production. If trade openness results in the demand of goods that are produced using polluting methods, countries will increase the production of polluted products, thereby increasing carbon emissions (Ertugrul, Cetin, Seker, & Dogan, 2016). The composition effect of trade makes developing countries more polluting while making developed countries environmentally clean Antweiler et al. (2001). The *technique effect* suggests that trade liberalisation could enable the transfer of environmentally friendly technologies and energy-efficient technologies, which could lower carbon emissions (Cole, 2006; Ertugrul et al., 2016). Contrarily, when the technological transfer associated with trade openness results in high production, it could equally increase carbon emissions. The *scale effect* posits that trade openness results could boost economic growth, energy use, and production activities, thereby increasing carbon emissions. On the other hand, at a higher level of economic growth, trade openness could improve the environment (Ertugrul et al., 2016). The empirical findings on the impact of trade openness on carbon emissions remain contradictory. For instance, the empirical work of (Shahbaz, Nasreen, Ahmed, & Hammoudeh, 2017) suggest that trade openness induce carbon emissions

while (Acheampong, 2018; Al-Mulali, Ozturk, & Lean, 2015; Antweiler et al., 2001; Rafiq, Salim, & Nielsen, 2016) the work of also indicate that trade openness contributes to carbon emissions abatement.

5. ***Foreign direct investment*:** A growing body of literature argues that FDI has essential implications in carbon emissions model. However, the impact of FDI on carbon emissions is theoretically ambiguous. For instance, the *pollution-haven hypothesis* indicates that FDI could worsen the environment by increasing carbon emissions. The argument is that polluting industries are migrating from developed countries with stringent environmental regulatory policies to developing countries with unregulated or less stringent environmentally policies, thereby contributing to the rise in carbon emissions in the host countries (Shahbaz, Nasir, & Roubaud, 2018). On the other hand, the pollution-halo hypothesis argues that FDI contributes to the decline of carbon emissions. Thus, FDI inflow has associated the transfer of technologies and proper management environmental management practice that helps to the mitigation of carbon emissions in the host countries (Doytch & Uctum, 2016; Zarsky, 1999). Similar to trade openness, the empirical results on the impact of FDI on carbon emissions remain conflicting. For instance, the empirical work of (Behera & Dash, 2017; Shahbaz et al., 2018) suggests that FDI induce carbon emissions while the work of (Tamazian, Chousa, & Vadlamannati, 2009; Zhang & Zhou, 2016) also indicate that FDI contributes to carbon emissions reduction. Another strand of empirical literature demonstrates that FDI does not influence carbon emissions (Abbasi & Riaz, 2016).
6. ***Urbanisation*:** Urbanisation is a manifestation of social and economic modernisation, which is not only about the movement of people from rural areas to urban centres but also about the structural transformation of rural areas into urban areas (Poumanyvong & Kaneko, 2010). The impact of urbanisation on carbon emissions is priori uncertain. The ecological modernisation and urban transition theory conjecture that the effect of urbanisation on carbon emissions depends on the level of economic development. Thus, at an early stage of economic development, urbanisation contributes to the rise in carbon emissions because of weak economic growth, less technological development, heavy dependency on agriculture, which is associated urbanisation at the early stage of economic development. However, at the advanced stage of economic development, urbanisation mitigates carbon emissions as societies realise the benefits of environmental sustainability, technological development and the development of knowledge and service-based economy (Poumanyvong & Kaneko, 2010; Sadorsky,

2014). The only difference between the ecological modernisation and urban transition is that the former at the macro (national) level while the latter is at the micro (city) level. While both theories suggest that urbanisation could either increase or reduce carbon emissions, Sadorsky (2014) contend that the resultant effect is indeterminate. One group of the empirical studies indicate that urbanisation increases carbon emissions (Wang et al. 2016; Zhang and Lin, 2012; Wu et al.,2016; Al-Mulali et al., 2015; Liu et al., 2018) while another strand of the empirical studies suggest that urbanisation contributes to carbon emissions mitigation (Sharma, 2011). The last strand of the empirical studies indicate that urbanisation does not affect carbon emissions (Rafiq et al., 2016; Sadorsky, 2014)

7. ***Financial development*:** Recently, the role of financial development on the environment has gained momentum among energy and environmental economists. Financial development is argued to fuel carbon emissions by enabling households and firm to have access to funds. Access to funds by households will allow them to patronise high-energy consumption durables such as washing machines, refrigerators, automobiles, air conditioners and among others (Sadorsky, 2010, 2011), which contribute to the rise of carbon emissions. Similarly, access to funding enables firms to expanse their business by expanding their plants, patronising machines and equipment that consumes more energy (Sadorsky, 2010, 2011), thereby increasing the intensity of carbon emissions (Shahbaz et al., 2018). Contrarily, a vibrant financial system could also reduce carbon emissions through research and development, technological innovation and the facilitation of good corporate governance (Claessens, 2007; Dasgupta, Laplante, & Mamingi, 2001; Tamazian & Bhaskara Rao, 2010; Tamazian et al., 2009). There are mixed findings on the impact of financial development on carbon emissions. For instance, empirical studies of (see Al-Mulali, Tang, & Ozturk, 2015; Tamazian et al., 2010; Tamazian et al., 2009) reveal that financial development limits the growth of carbon emissions while (see Boutabba, 2014; Sehrawat, Giri, & Mohapatra, 2015; Shahbaz et al., 2016) in their studies reveal that financial development induce carbon emissions. Lastly, the findings of (see Dogan & Turkekul, 2016; Maji, Habibullah, & Saari, 2017; Omri, Daly, Rault, & Chaibi, 2015) indicate that financial development does not influence carbon emissions.

Table 1: Variable descriptions

Variables	proxy	Description	Mean	Sd	Min	Max	CV	Source
Carbon emissions	lnco2kt	Carbon emissions measured in kiloton (kt)	7.586	1.624	3.864	13.129	21.408	WDI
Economic growth squared	lnrgdpg2	Real GDP per capita growth squared	1.550	2.373	-10.828	8.082	153.097	WDI
Economic growth	rgdpg	Real GDP per capita growth	2.118	5.434	-36.830	56.883	256.563	WDI
Population size	lnpop	Total population	15.694	1.596	11.304	19.015	10.169	WDI
Energy consumption	lnenpc	Kg of oil equivalent per capita	6.137	0.865	2.260	8.040	14.095	WDI
Trade openness	lntra	Total trade as a % of GDP	4.271	0.458	3.043	5.861	10.723	WDI
Urbanisation	lnturpop	Total urban population	3.537	0.459	2.110	4.468	12.977	WDI
Foreign direct investment	lnfdi	Foreign direct investment, net inflow as a % of GDP	0.992	1.376	-6.089	4.494	138.710	WDI
Financial development	lndcp	Domestic credit to the private sector as a % of GDP	2.586	0.900	-0.891	5.076	34.803	WDI
Voice and accountability	account	Measures the extent to which country's citizen can participate in selecting their government as well as freedom of expression, association and free media	0.735	0.511	0.001	2.226	69.524	WDI
Rule law	law	Measures the extent to which agents have confidence in and abide by rules of society and in particular the quality of contract enforcement, property rights, the police and the courts as well as the likelihood of crime and violence	0.790	0.472	0.000	2.009	59.747	WGI
Regulatory quality	regul	Measures the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development	0.752	0.482	0.006	2.244	64.096	WGI
Political stability	polistab	Measures the likelihood that government will be destabilised or overthrown by unconstitutional means, including politically motivated violence and terrorism	0.754	0.614	0.000	2.699	81.432	WGI
Control of corruption	concorrup	Measures the extent to which public power is exercised for private gains including both petty and grand forms of corruption as well as the capture of the state by elites and private interests	0.759	0.403	0.002	1.773	53.096	WGI
Government effectiveness	effgov	Measures the quality of public services, civil services and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of government's commitment to such policies	0.834	0.444	0.003	1.884	53.237	WGI

The descriptive statistics and variables descriptions are presented in Table 1. As indicated in Table 2, carbon emissions have a mean of 7.586% with a standard deviation of 1.624. The mean of SSA economic growth for the period of study is 2.118, with a standard deviation of 5.434 while energy consumption has a mean of 6.137 with a standard deviation of 0.865. The average population size is 15.694, with a standard deviation of 1.596 whiles urbanisation has an average growth rate of 3.537 with a standard deviation of 0.459. Trade openness has a mean of 4.271 and a standard deviation of 0.458. Foreign direct investment and financial development have a mean of 0.992 and 2.586 respectively. The institutions variables, which include voice and accountability, the rule of law, regulatory quality, political stability, control of corruption and government effectiveness have a mean (and a standard deviation) of 0.735 (0.511), 0.790 (0.472), 0.752(0.482), 0.754(0.614), 0.759(0.403) and 0.843(0.444) respectively. As presented in Table 3, the coefficient of variation (CV) indicates that economic growth, foreign direct investment and financial development have been volatile in sub-Saharan Africa. Additionally, institutions also remain volatile in sub-Saharan Africa. For instance, voice and accountability, the rule of law, regulatory quality, political stability, control of

corruption and government effectiveness have a coefficient of variation of 69.524%, 59.747%, 64.096%, 81.432%, 53.096% and 53.237% respectively, which are relatively high.

Table 2: Correlation matrix

	lnco2kt	lnrgdpg2	rgdpg	lnpop	lnenpc	lntra	lnturpop	lnfdi	lndcp	account	law	regul	polistab	concorrup	effgov
lnco2kt	1														
lnrgdpg2	0.0877	1													
rgdpg	0.0857	0.347***	1												
lnpop	0.627***	-0.0264	-0.0215	1											
lnenpc	0.577***	0.219***	0.112	-0.0287	1										
lntra	-0.171**	0.194***	0.195***	-0.548***	0.220***	1									
lnturpop	0.246***	-0.00347	0.0423	-0.207***	0.465***	0.340***	1								
lnfdi	-0.189**	0.225***	0.291***	-0.136*	0.00773	0.407***	0.152**	1							
lndcp	0.444***	0.121*	-0.000903	-0.0694	0.408***	0.107	0.0323	-0.182**	1						
account	-0.178**	-0.0528	-0.210***	-0.0941	-0.0631	0.0143	-0.0606	-0.0465	-0.260***	1					
law	-0.151**	-0.0744	-0.141*	0.145*	-0.182**	-0.0329	-0.164**	-0.115*	-0.460***	0.693***	1				
regul	-0.222***	-0.0188	-0.182**	-0.0183	-0.184**	-0.0874	-0.190**	-0.0809	-0.364***	0.787***	0.772***	1			
polistab	0.0604	0.0269	-0.0582	0.269***	-0.00845	-0.0823	-0.0966	-0.0727	-0.220***	0.332***	0.632***	0.378***	1		
concorrup	-0.0238	-0.0480	-0.0484	0.182**	-0.0301	-0.0346	0.0631	-0.0402	-0.540***	0.461***	0.803***	0.527***	0.537***	1	
effgov	-0.202***	-0.153**	-0.150*	0.0982	-0.188**	-0.0679	-0.119*	-0.0406	-0.506***	0.700***	0.829***	0.790***	0.414***	0.704***	1

Table 2 presents the correlation between the variables. Table 2 reveals that there is a mild to a strong relationship among the institutional variables. We, therefore, estimated the impact of each institutional variables on carbon emissions in separate models to present unbiased results. In addition to the correlation matrix, the scatter plots (see Fig. 1) reveal that voice and accountability, the rule of law, regulatory quality, political stability, control of corruption and government effectiveness are negatively related. However, it could be observed from the scatterplots that the negative relationship between these institutional quality variables and carbon emissions are weak.

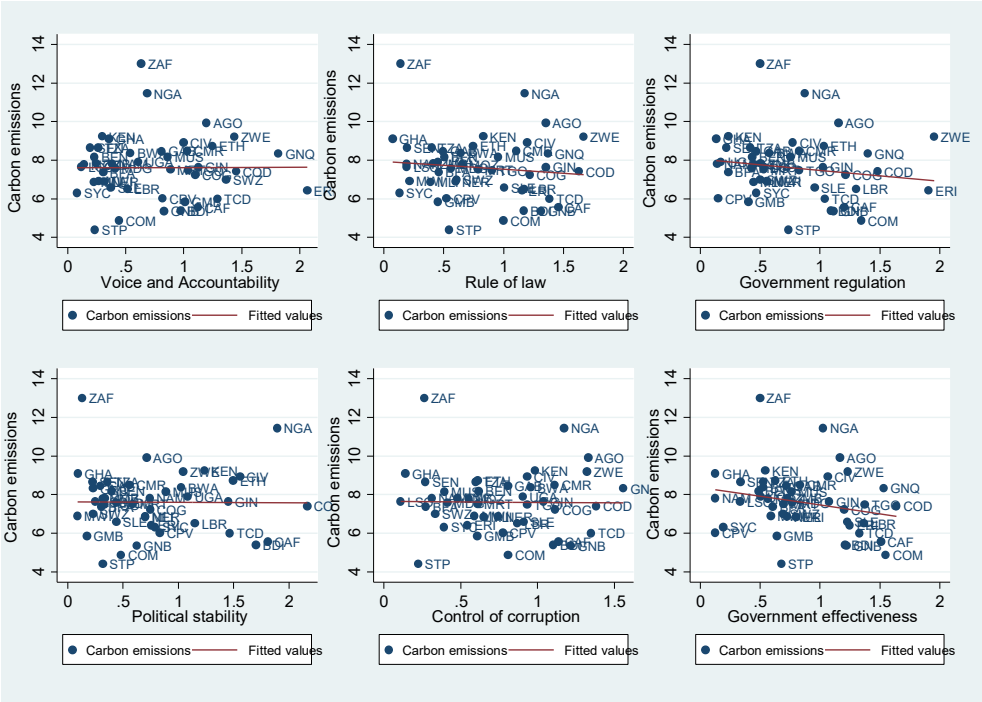

Fig.1: Relationship between carbon emissions and the measures of institutions

3.2 Empirical model

This study follows the panel data estimation technique of Abid (2017) to estimate the effect of institutions on carbon emissions. Thus, we augment the popular EKC model with institutions variables. Therefore, the dynamic reduced-form empirical model to be estimated is specified in Eq. (1):

$$lnCO_{2_{it}} = \alpha_0 + \beta_1 lnCO_{2_{it-1}} + \beta_2 lnGDP_{it} + \beta_3 lnGDP^2{}_{it} + \beta_4 INST_{it} + \beta_5 X_{it} + v_i + \varepsilon_{it} \quad (1)$$

Where $lnCO_{2_{it}}$ is the carbon emissions of country i at time t; $lnGDP$ and $lnGDP^2$ are the main term and the squared term of economic growth respectively; $INST$ is the vector of the institutions variables [voice and accountability, the rule of law, regulatory quality, political stability, control of corruption and government effectiveness]; X is a set of control variables [population, trade openness, urbanisation, financial development, foreign direct investment, energy consumption]; the coefficient to be estimated are captured in $\beta_1 - \beta_5$; α_0 is the coefficient of the constant term; v_i is the individual effect and ε_{it} is the stochastic error term.

Initially, we estimated the above equation using the Ordinary Least-Squares (OLS). However, OLS techniques would result in inconsistent and biased results in the presence of an unobserved panel fixed effect, which is correlated with the lag of the independent variable (Arellano & Bond, 1991). To address these inherent problems, Arellano and Bond (1991) developed a generalised method of moment (GMM), which uses the first differencing transformation to eliminate the countries specific unobserved heterogeneities. However, the first difference-generalised method of moments is found to have poor precision in simulation studies and large finite sample bias when the time series observation is small, and the autoregressive parameter is relatively large (cited in Blundell & Bond, 1998, p. 115). To overcome the weakness of the first difference GMM, Blundell et al. (1998) developed the system-generalised method of moment (System-GMM) which uses the lagged differences of the dependent variable as instruments for equations in levels and also includes the lagged levels of the dependent variable as instruments for equations in first differences. There, we empirically estimate above equation using the System-GMM estimation approach. This econometric helps to control the problem of endogeneity, sample heterogeneity, and simultaneity between the variables. In using the system-GMM estimation technique, we employ the Sargan test to check for the validity of the instruments while the first and second-

order autocorrelation was used to check autocorrelation in our model. We further accounted for the Windmeijer (2005) finite-sample correction for the covariance matrix.

4. Empirical results and discussions

From Table 3: Model 1-7 present the OLS estimates while Model 8-14 presents the dynamic system-GMM estimates. Based on the limitations of OLS, we limit the analysis and discussion on the system-GMM results [Model 8-14]. The results indicate that institutional quality measures such as voice and accountability, the rule of law, regulatory quality, control of corruption and government effectiveness and political stability reduces carbon emissions. However, it can be observed from the empirical results that only political stability significantly contributes to carbon emissions reduction. Although political stability is statistically significant, it could be argued that institutions in Sub-Saharan Africa are weak to curb carbon emissions. The policy implication is that formulating, implementing and enforcing sound environmental regulatory policies devoid of corruption are key for institutions to have a stronger mitigating effect on carbon emissions. In comparison, our results contradict the empirical findings of Abid (2016), which indicate that institutional quality measures such as control of corruption government effectiveness significantly reduce carbon emissions while regulatory quality and the rule of law significantly induce carbon emissions in sub-Saharan Africa. The evidence that political stability substantially limits the growth of carbon emissions supports the theoretical argument that political stability enhances the stringency of environmental regulation, thereby contributing to carbon emissions mitigation (Fredriksson & Svensson, 2003).

The results further indicate that energy consumption significantly induces carbon emissions. Thus, excessive energy consumption, which could be due to the desire to increase production, increase carbon emissions. This result supports the broader theoretical and empirical argument that energy consumption remains one of the significant sources of carbon emissions (Shahbaz et al., 2013; Salahuddin et al., 2018; Omri, 2013; Jahangir Alam et al., 2012). These results imply that until we improve energy efficiency or make an effective transition towards renewable energy, the continued dependence on fossil energy could worsen the developmental challenges in developing countries and especially sub-Saharan Africa countries through climate change. Similarly, financial development contributes to the rise of carbon emissions, and the estimated coefficient is between 0.022% to 0.027%. The significant positive effect of financial development on carbon emissions could imply that sub-Saharan Africa financial system is not driving technological innovation needed to improve the

environment by reducing carbon emissions. This result could also indicate that sub-Saharan Africa financial institutions are providing loans/funds to environmentally unconscious firms. Our results are consistent with the empirical findings of (see Boutabba, 2014; Sehrawat et al., 2015; Shahbaz et al., 2016), which revealed that financial development contributes to the increase in carbon emissions.

Consistent with the ecological modernisation theory, our results indicate that urbanisation increases carbon emissions in sub-Saharan Africa. Sub-Saharan Africa is regarded as one of the fastest-growing urbanised regions in the world with currently 472 million people in the urban centres and expected to double in the next 25 years (Saghir & Santoro, 2018). Our results imply that as rapid urbanisation is associated with heavy traffic congestion and overcrowding, it would increase energy use and carbon emissions. Thus, with the relatively low economic progress in sub-Saharan Africa, coupled with less technological development, urbanisation will contribute to energy use and the rise in carbon emissions. Our results provide broad support to the strand of the empirical literature, which suggest that rapid urbanisation will increase carbon emissions (Wang et al., 2016; Zhang et al., 2012; Wu et al. 2016; Al-Mulali et al., 2015; Liu et al., 2018).

Apparently, population size contributes significantly to carbon emissions. The estimated elasticity of population size on carbon emissions ranges between 0.066% to 0.077%. This result suggests that an increase in population size coupled with unstainable consumption will increase carbon emissions and this result confirms the empirical findings of Shi (2003); Weber and Sciubba (2018); Dong et al. (2018). It is evident from our results that trade openness significantly contributes to the rise in carbon emissions in sub-Saharan Africa. This evidence could reflect the *composition effect* of trade, as Antweiler et al. (2001) argue that the *composition effect* of trade makes developing countries more polluting while making developed countries environmentally clean. Thus, similar to the argument of Stern (1998), trade liberalisation is making developing countries such as sub-Saharan African countries with weak environmental regulation to specialise in the production of goods that make intensive use natural resource and labour, thereby contributing to the rise in carbon emissions. A similar result is provided in the previous studies of Shahbaz et al. (2017).

Clearly, foreign direct investment has a negligible effect on reducing carbon emissions. Thus, policies to attract FDI in sub-Saharan Africa will not conflict with strategies to mitigate carbon emissions. Our findings also indicate that economic growth has a significant positive impact on carbon emissions, while its squared term has an insignificant negative effect on carbon emissions. The negligible effect of the squared term of economic growth refutes the

EKC hypothesis in sub-Saharan Africa. This result implies that economic growth in sub-Saharan Africa is monotonically increasing carbon emissions and confirms the findings of previous research that refute the validity of the EKC hypothesis (Abid, 2016; Özokcu & Özdemir, 2017). The lagged term of carbon emissions contributes significantly to the rise of current carbon emissions.

Table 3: Institutions and carbon emissions (Full-sample)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	OLS							System-GMM						
Lagged carbon emissions								0.929***	0.925***	0.923***	0.925***	0.917***	0.924***	0.923***
								(0.014)	(0.015)	(0.016)	(0.015)	(0.018)	(0.015)	(0.015)
Economic growth squared	-0.025	-0.019	-0.018	-0.021	-0.016	-0.019	-0.019	-0.003	-0.002	-0.002	-0.002	-0.001	-0.002	-0.002
	(0.019)	(0.020)	(0.020)	(0.020)	(0.021)	(0.020)	(0.020)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Economic growth	0.026**	0.030**	0.028**	0.031***	0.027**	0.029**	0.028**	0.004*	0.004*	0.004*	0.004*	0.004*	0.004*	0.004*
	(0.012)	(0.012)	(0.012)	(0.012)	(0.011)	(0.012)	(0.012)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Population size	0.769***	0.759***	0.761***	0.759***	0.772***	0.752***	0.758***	0.066***	0.068***	0.072***	0.068***	0.077***	0.070***	0.070***
	(0.030)	(0.031)	(0.031)	(0.031)	(0.028)	(0.032)	(0.031)	(0.009)	(0.010)	(0.011)	(0.010)	(0.013)	(0.010)	(0.010)
Energy consumption	0.673***	0.660***	0.670***	0.661***	0.679***	0.658***	0.671***	0.049***	0.052***	0.054***	0.052***	0.061***	0.053***	0.054***
	(0.115)	(0.115)	(0.114)	(0.117)	(0.117)	(0.113)	(0.115)	(0.018)	(0.018)	(0.019)	(0.018)	(0.023)	(0.020)	(0.019)
Trade openness	0.416**	0.368**	0.404**	0.370**	0.414**	0.357*	0.388**	0.051**	0.058**	0.068**	0.057**	0.065**	0.061**	0.062**
	(0.174)	(0.184)	(0.194)	(0.181)	(0.186)	(0.188)	(0.186)	(0.026)	(0.028)	(0.027)	(0.028)	(0.027)	(0.028)	(0.027)
Urbanisation	0.987***	1.001***	0.965***	1.018***	0.958***	0.988***	0.972***	0.067**	0.069**	0.064**	0.068**	0.070**	0.072**	0.067**
	(0.125)	(0.124)	(0.127)	(0.126)	(0.133)	(0.131)	(0.129)	(0.027)	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)
Foreign direct investment	-0.151***	-0.167***	-0.177***	-0.164***	-0.178***	-0.163***	-0.172***	-0.001	-0.006	-0.008	-0.006	-0.008	-0.007	-0.007
	(0.032)	(0.035)	(0.039)	(0.034)	(0.036)	(0.037)	(0.036)	(0.008)	(0.008)	(0.009)	(0.008)	(0.008)	(0.009)	(0.009)
Financial development	0.510***	0.516***	0.484***	0.526***	0.482***	0.527***	0.487***	0.026**	0.026**	0.022*	0.026**	0.027**	0.024*	0.024**
	(0.058)	(0.054)	(0.055)	(0.056)	(0.060)	(0.053)	(0.056)	(0.011)	(0.012)	(0.012)	(0.011)	(0.012)	(0.013)	(0.012)
Voice and accountability		0.066							-0.010					
		(0.084)							(0.012)					
Rule of law			-0.078							-0.026				
			(0.092)							(0.017)				
Regulatory quality				0.099							-0.006			
				(0.071)							(0.012)			
Political stability					-0.125*							-0.027**		
					(0.065)							(0.012)		
Control of corruption						0.080							-0.015	
						(0.113)							(0.019)	
Government effectiveness							-0.070							-0.018
							(0.093)							(0.018)
Constant	-14.794***	-14.482***	-14.391***	-14.616***	-14.595***	-14.294***	-14.317***	-1.259***	-1.309***	-1.357***	-1.307***	-1.466***	-1.352***	-1.337***
	(0.820)	(0.878)	(0.847)	(0.923)	(0.803)	(0.837)	(0.858)	(0.204)	(0.221)	(0.210)	(0.222)	(0.243)	(0.215)	(0.204)
Observations	310	293	293	293	293	293	293	291	274	274	274	274	274	274
r2	0.870	0.869	0.869	0.869	0.871	0.869	0.869							
sargan								218.989	209.412	209.146	209.543	209.111	209.614	209.375
P(sargan)								0.339	0.383	0.388	0.380	0.388	0.379	0.383
AR(1)								0.001	0.001	0.001	0.001	0.001	0.001	0.001
AR(2)								0.210	0.260	0.237	0.253	0.264	0.256	0.260

Heteroskedastic robust standard errors in parentheses.* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

4.1 Further analysis

The institutional economics literature suggests that institutions are not homogenous among countries. From institutional origin perspective, countries have maintained the institutions that they inherited from their colonial masters after independence (Lange et al., 2006; Lee & Schultz, 2012; North, 1989; Shirley, 2008). Thus, countries that were ruled by the British, France, Spain and among others have maintained the institutions that they inherited from the respective colonial masters, and that such institutions are shaping their post-colonial development outcomes (North, 1989; Olsson, 2009; La Porta et al., 2008). Based on this theoretical argument, we conduct further analysis from disaggregating[2] our sample into their institutional/colonial heritage. The results for the disaggregated analysis are presented in Table 4.

Interesting, when we disaggregate our sample based on their institutional origin, the results reveal that institutional quality measures such as accountability, the rule of law, regulatory quality, control of corruption and political stability significantly reduce carbon emissions in countries with French institutional origin while government effectiveness has a negligible effect on reducing carbon emissions. Similarly, the rule of law, political stability, control of corruption, government effectiveness significantly mitigate carbon emissions while accountability and regulatory quality exert an insignificant negative effect on emissions. However, in countries without either British or French institutions[3], the institutional variables no influence on carbon emissions. From these results, we argue that institutions have been effective in reducing carbon emissions in countries with British and French institutional-origin; however, the estimated elasticities are higher for the countries with French institutional-origin relative to countries with British institutional source.

Financial development exerts an insignificant impact on carbon emissions in countries with British institutional origin. However, financial development significantly increases carbon emissions in countries with French institutional-origin (see Model 8, 11, 13, 14). Concerning in countries without either British or French institutions, financial development increases carbon emissions only in Model 15-16. The significant positive effect of financial development on increasing carbon emissions in countries with French institutional origin and countries

[2] We follow the work of (Bertocchi & Canova, 2002; Lange et al., 2006; La Porta et al., 1998) to disaggregate the sample.

[3] Countries with non-British and French institutions includes countries that were never colonised, Belgium, Portugal, Spain and Germany ex-colonies. We put all these countries together because with respect to their colonial masters, their sample size was small to warrant further comparative analysis using panel data approach.

without either British or French institutions is a manifestation of the weak financial system of these countries. For instance, (La Porta et al., 2008; La Porta et al., 1998) argue that countries with French, German and Scandinavian institutional origin (legal origin) have weak financial system relative to countries with British institutional origin (legal origin). We, therefore, argue countries with French institutional origin and countries without British and French institutions financial system is not capable of driving technological innovation that could limit the growth of carbon emissions.

Foreign direct investment does not affect carbon emissions in countries with British institutional origin and countries without either British or French institutions; however, foreign direct investment significantly reduces carbon emissions in countries with French institutional-origin when political stability is controlled. Thus, ensuring a stable political environment in countries with French institutional-origin could attract FDI with its associated technological spillover, which could contribute to carbon emissions mitigation. This result confirms Damania et al. (2003) theoretical argument that institutions could condition the impact of foreign direct investment in the environment.

Urbanisation significantly increases carbon emission in countries with British institutional-origin only when voice and accountability are controlled. On the other hand, urbanisation significantly increases carbon emissions in countries with French institutional origin and countries without either British or French institutions. Trade openness has a negligible effect on carbon emissions in countries with British institutional background while it increases carbon emissions in the countries without British and French institutions. With respective to countries with French institutional-origin, trade openness significantly reduces carbon emissions. Thus, in countries with British institutional-origin, trade liberalisation policies would not conflict with strategies to reduce carbon emissions but will increases emissions in countries without either British or French institutions. On the other hand, trade liberalisation policies in countries with French institutional-origin could support the introduction of efficient environmental technologies that could reduce carbon emissions.

Energy consumption significantly increases carbon emissions in countries with British and French institutional origin while its impact on carbon emissions in countries without either British or French institutions is negligible. Thus, energy consumption in countries with British and French institutional-origin is high compared to countries without either British or French institutions, thereby contributing to the rise of carbon emissions in these countries. Our results further indicate that the main term of economic growth has a positive impact on carbon

emissions but significant only in countries with British institutional origin when the institutional variables are controlled. This finding suggests that institutional quality condition or contributes to economic growth to increase carbon emissions, and this reflects the *growth effect* channel of institutions. However, the squared term of economic growth has an insignificant effect on carbon emissions in the sub-samples. This result consistently indicates that the EKC hypothesis is not validated among the sub-samples. From the sub-samples, the lagged of carbon emissions contribute significantly to current carbon emissions, but the estimated coefficients are higher in countries with British institutional source.

Table 4: Institutions and carbon emissions (Sub-sample)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	British institutional-origin							French institutional-origin							Non-British and French institutional-origin						
Lagged carbon emissions	0.960***	0.961***	0.961***	0.959***	0.964***	0.963***	0.963***	0.693***	0.660***	0.638***	0.565***	0.693***	0.662***	0.607***	0.933***	0.931***	0.923***	0.931***	0.932***	0.913***	0.936***
	(0.018)	(0.018)	(0.017)	(0.019)	(0.018)	(0.018)	(0.018)	(0.062)	(0.061)	(0.075)	(0.056)	(0.069)	(0.068)	(0.094)	(0.023)	(0.027)	(0.032)	(0.029)	(0.035)	(0.042)	(0.026)
Economic growth squared	-0.004	-0.007	-0.006	-0.008	-0.007	-0.007	-0.006	0.000	-0.001	-0.004	0.000	-0.004	0.000	-0.002	-0.004	-0.004	-0.004	-0.004	-0.003	-0.004	-0.003
	(0.005)	(0.007)	(0.006)	(0.007)	(0.006)	(0.006)	(0.006)	(0.007)	(0.010)	(0.008)	(0.008)	(0.008)	(0.008)	(0.009)	(0.008)	(0.009)	(0.009)	(0.009)	(0.008)	(0.010)	(0.009)
Economic growth	0.004	0.005*	0.004*	0.005*	0.005**	0.005*	0.004*	0.006	0.002	0.003	0.007*	0.004	0.005	0.005	0.002	0.002	0.001	0.002	0.001	0.001	0.001
	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)	(0.004)	(0.003)	(0.003)	(0.004)	(0.005)	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)	(0.005)	(0.005)
Population size	0.034*	0.027	0.029*	0.030	0.027	0.026	0.027	0.212***	0.281***	0.330***	0.335***	0.297***	0.240***	0.298***	0.064***	0.067***	0.065***	0.066***	0.067***	0.068***	0.064***
	(0.018)	(0.019)	(0.017)	(0.020)	(0.018)	(0.018)	(0.018)	(0.051)	(0.050)	(0.069)	(0.045)	(0.094)	(0.059)	(0.092)	(0.011)	(0.015)	(0.014)	(0.016)	(0.016)	(0.017)	(0.013)
Energy consumption	0.025	0.021	0.025*	0.024	0.027*	0.025*	0.025*	0.041*	0.206**	0.164***	0.129***	0.113**	0.086**	0.179	0.027	0.018	0.038	0.026	0.021	0.044	0.022
	(0.016)	(0.015)	(0.014)	(0.016)	(0.016)	(0.015)	(0.014)	(0.025)	(0.097)	(0.043)	(0.021)	(0.049)	(0.036)	(0.119)	(0.035)	(0.037)	(0.040)	(0.039)	(0.045)	(0.051)	(0.036)
Trade openness	0.010	-0.003	0.005	-0.001	0.001	-0.012	-0.010	-0.249***	-0.026	-0.058	-0.129*	-0.173**	-0.211***	-0.073	0.110***	0.135**	0.129**	0.130**	0.121**	0.116**	0.117**
	(0.038)	(0.042)	(0.041)	(0.042)	(0.040)	(0.042)	(0.041)	(0.065)	(0.171)	(0.109)	(0.074)	(0.074)	(0.076)	(0.152)	(0.041)	(0.061)	(0.058)	(0.060)	(0.049)	(0.048)	(0.049)
Urbanisation	0.050	0.061*	0.045	0.061	0.048	0.055	0.047	0.614***	0.351	0.501**	0.705***	0.538***	0.583***	0.445**	0.100***	0.120***	0.116***	0.129**	0.108***	0.061	0.108**
	(0.037)	(0.037)	(0.037)	(0.039)	(0.036)	(0.037)	(0.038)	(0.177)	(0.274)	(0.210)	(0.164)	(0.186)	(0.184)	(0.220)	(0.022)	(0.031)	(0.033)	(0.051)	(0.040)	(0.044)	(0.050)
Foreign direct investment	0.001	-0.011	-0.014	-0.010	-0.014	-0.013	-0.010	-0.009	-0.007	-0.008	0.004	-0.021**	-0.006	-0.004	0.003	0.001	-0.000	0.002	0.003	0.001	0.002
	(0.011)	(0.011)	(0.011)	(0.011)	(0.010)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.009)	(0.011)	(0.011)	(0.012)	(0.014)	(0.015)	(0.013)	(0.014)	(0.013)	(0.012)	(0.014)
Financial development	0.008	0.005	0.001	0.004	-0.004	-0.004	0.002	0.140***	0.063	0.072	0.143***	0.056	0.134***	0.123**	0.023**	0.026*	0.041	0.028	0.018	0.055	0.026
	(0.012)	(0.010)	(0.014)	(0.012)	(0.016)	(0.014)	(0.013)	(0.048)	(0.084)	(0.062)	(0.044)	(0.054)	(0.050)	(0.054)	(0.010)	(0.015)	(0.031)	(0.021)	(0.011)	(0.047)	(0.029)
Voice and accountability		-0.018							-0.221**							0.024					
		(0.020)							(0.107)							(0.018)					
Rule of law			-0.034***							-0.211***							0.063				
			(0.010)							(0.065)							(0.072)				
Regulatory quality				-0.002							-0.246***							0.026			
				(0.018)							(0.070)							(0.039)			
Political stability					-0.026***							-0.110*							-0.015		
					(0.009)							(0.062)							(0.025)		
Control of corruption						-0.032**							-0.077**							0.109	
						(0.015)							(0.031)							(0.114)	
Government effectiveness							-0.048***							-0.188							0.016
							(0.018)							(0.136)							(0.064)
Constant	-0.563	-0.399	-0.396	-0.444	-0.382	-0.308	-0.315	-2.679***	-4.130***	-4.922***	-4.864***	-4.208**	-3.114***	-4.104***	-1.478***	-1.674***	-1.722***	-1.720***	-1.540***	-1.541***	-1.552***
	(0.475)	(0.494)	(0.468)	(0.520)	(0.475)	(0.493)	(0.487)	(0.861)	(0.879)	(1.286)	(0.687)	(1.674)	(0.998)	(1.508)	(0.306)	(0.463)	(0.568)	(0.625)	(0.413)	(0.413)	(0.523)
Observations	127	119	119	119	119	119	119	76	72	72	72	72	72	72	88	83	83	83	83	83	83
sargan	126.951	113.381	112.564	114.208	112.809	114.380	112.654	64.948	65.580	64.764	68.391	55.620	62.425	65.171	69.794	66.904	67.384	67.313	67.169	67.734	67.227
P(sargan)	0.249	0.343	0.363	0.323	0.357	0.319	0.360	0.514	0.321	0.347	0.241	0.670	0.425	0.334	0.735	0.648	0.632	0.634	0.639	0.621	0.637
AR(1)	0.014	0.014	0.015	0.014	0.014	0.014	0.015	0.046	0.049	0.044	0.050	0.040	0.046	0.047	0.032	0.026	0.026	0.027	0.028	0.026	0.027
AR(2)	0.539	0.406	0.365	0.388	0.396	0.353	0.407	0.068	0.369	0.675	0.415	0.785	0.234	0.418	0.096	0.193	0.207	0.194	0.194	0.201	0.189

Heteroskedastic robust standard errors in parentheses. $^{*}\ p < 0.10$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$

5. Conclusions and policy suggestions

This study employs the system-GMM, which is a panel-data estimation technique, to investigate the impact of institutional quality on carbon emissions in 45 sub-Saharan African countries for the period of 2000-2015. Using voice and accountability, the rule of law, regulatory quality, political stability, control of corruption and government effectiveness as measures for institutional quality, our findings reveal that these measures of institutions (except political stability) have a weak effect on reducing carbon emissions. Interestingly, when we avoid the assumption of homogeneity in our sample and categories our sample based on their institutional-origin, our results reveal that these measures of institutions play a significant role in mitigating carbon emissions in countries with British and French institutional-origin while the impact is negligible in countries without either British or French institutions. The results further indicate that factors such as population size, trade openness, urbanisation, financial development and energy consumption exacerbate carbon emissions while foreign direct investment plays no substantial role in carbon emissions sub-Saharan Africa. As we analysed our results within the Environmental Kuznets Curve (EKC) framework, our empirical findings do not validate the EKC hypothesis.

The policy implications of these findings are that for institutions to have a stronger effect on mitigating carbon emissions, policymakers should formulate, implement and enforce stringent environmental policies devoid of corruption. Additionally, strengthening stable political climate is essential for sub-Saharan Africa for attracting investment in technological innovations that are capable of contributing to carbon emissions mitigation. We argue that embarking on institutions that protect property right, build effective judicial system, strengthen media freedom, freedom of expression and government commitment are crucial to achieving the goals of any future environmental policies that seek to mitigate carbon emissions. Sub-Saharan Africa is heavily endowed with renewable energy but relies heavily on dirty (fossil) energy; therefore, embarking on renewable energy policies with clear incentives for investors will quicken the region's transition towards renewable energy as it remains critical for limiting the growth of carbon emissions. With rapid urbanisation occurring in sub-Saharan Africa and its attendant ecological challenges, urban planners should embark on the development of urban infrastructures that are energy-efficient and environmentally sustainable. Similarly, as trade openness worsens carbon emissions, policymakers should embark on a sound environmental regulatory framework to control the degrading effect of trade. There is a need for policymakers to consider institutional heterogeneity in sub-Saharan Africa when formulating and

implementing environmental policies. Briefly, pursuing better institutions of governance are fundamental for achieving the Sustainable Development Goal (SDG) 13.

APPENDIX

Appendix Table 1: The study sample

Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic, Chad, Comoros, Congo, Dem. Rep., Congo, Rep., 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, Sudan, Swaziland, Tanzania, Togo, Uganda, Zambia, Zimbabwe.

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