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CO_2 emission thresholds for inclusive human development in Sub-Saharan Africa[1]

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Abstract

We provide policy-relevant critical masses beyond which, increasing CO_2 emissions negatively affects inclusive human development. This study examines how increasing CO_2 emissions affects inclusive human development in 44 Sub-Saharan African countries for the period 2000-2012. The empirical evidence is based on Fixed Effects and Tobit regressions. In order to increase the policy relevance of this study, the dataset is decomposed into fundamental characteristics of inclusive development and environmental degradation based on income levels (Low income versus (vs.) Middle income); legal origins (English Common law vs. French Civil law); religious domination (Christianity vs. Islam); openness to sea (Landlocked vs. Coastal); resource-wealth (Oil-rich vs. Oil-poor) and political stability (Stable vs. Unstable). All computed thresholds are within policy range. Hence, above these thresholds, CO2 emissions negatively affect inclusive human development.

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

Keywords: CO2 emissions; Economic development; Africa

1. Introduction

The positioning of this study builds on three fundamental trends in academic and policy circles, notably: growing non-inclusive development in Sub-Saharan Africa (SSA); poor energy and environmental management in the sub-region and gaps in the literature. We follow the same chronology in substantiating the points.

First, exclusive development has been growing in SSA because according to a report by the World Bank on the achievement of Millennium Development Goals (MDGs), extreme poverty has been decreasing in all regions of the world with the exception of SSA (World Bank, 2015; Asongu & le Roux, 2017; Tchamyou, 2018). The narrative maintains that about half of countries in the sub-region were substantially off-track from reaching the MDG extreme poverty target. This is an indication that the fruits of economic growth have not been trickling down to the poor in the continent because the sub-region has been experiencing a recent period of growth resurgence which began in the mid 1990s (Asongu & Nwachukwu, 2016a)[2]. It is obvious that the corresponding economic prosperity is positively associated with green house gas emissions which represent a major challenge to environmental sustainability in the post-2015 development era (Akinyemi *et al*., 2015).

Second, while environmental sustainability is a key theme in the post-2015 sustainable development agenda (Akpan *et al*., 2015; Asongu *et al*., 2016a; Mbah & Nzeadibe, 2016), the consequences of climate change are projected to be most nefarious in Africa for at least three fundamental reasons, notably: growing energy crises, consequences of energy mismanagement and climate change and crises of environmental pollution. In what follows, we engage the points in detail. (i) Energy consumption per capita in SSA is approximately one-sixth of the global average. Furthermore, according to some narratives, energy access in the sub-region is the equivalent of the total energy consumed in a single state like New York in the United States of America (USA) (Shurig, 2015). (ii) The emission of Carbon dioxide (CO_2) constitutes about three-quarter of emissions of green house gases globally (Akpan, 2012) and many estimates are consistent with the fact that the negative consequences of climate change will be most felt in Africa (Kifle, 2008; Asongu, 2018).

[2] This has motivated a recent stream of African inclusive development literature in the light of sustainable development goals (Afutu-Kotey *et al*., 2017; Bongomin *et al*., 2018 ; Gosavi, 2018; Hubani & Wiese, 2018; Isszhaku *et al*., 2018; Minkoua Nzie *et al*., 2018; Muthinja & Chipeta, 2018).

Naturally, such climate change is the direct effect of unsustainable consumption of fossil fuels globally (Huxster *et al*., 2015). (iii) There have been growing concerns about the ability of policy makers to address environmental challenges effectively in most nations of SSA (Anyangwe, 2014). A good example with which to substantiate this narrative is Nigeria which is poorly managing its electricity outage and shortage by subsidizing petroleum fuel, as opposed to investing massively in renewable sources of energy (Apkan, 2012).

Third, this inquiry unites the concerns documented in the second strand with the issues raised in the first strand, by assessing how environmental degradation affects inclusive human development in SSA. The positioning of the inquiry addresses an important gap in the extant literature which has largely focused on nexuses between CO_2 emissions, energy consumption and economic growth. The underlying literature has been dominated by two principal strands: the first articulates the relationship between economic growth and environmental pollution with some emphasis on the Environmental Kuznets Curve (EKC) [3] hypothesis (Diao *et al*., 2009; Akbostanci *et al*., 2009; He & Richard, 2010), whereas the second strand engages two sub-strands. On the one hand, we find studies focusing on the relationship between economic growth and energy consumption (Jumbe, 2004; Ang, 2007; Apergis & Payne, 2009; Odhiambo, 2009a, 2009b; Ozturk & Acaravci, 2010; Menyah & Wolde-Rufael, 2010; Bölük & Mehmet, 2015; Begum *et al*., 2015) and on the other hand, inquiries on the nexus between environmental pollution, energy consumption and economic growth (Mehrara, 2007; Olusegun, 2008; Akinlo, 2009; Esso, 2010).

In the light of the engaged literature, emphasis on the EKC hypothesis has fundamentally been articulated on the relationship between per capita income and environmental degradation. This inquiry steers clear of the underlying literature in a twofold manner. On the one hand, we focus on inclusive human development as opposed to per capita income. On the other hand, we investigate how environmental degradation affects inclusive human development, which is different from the influence of per capita income on environmental degradation when assessing the EKC hypothesis. We provide policy-relevant critically masses or thresholds beyond which, increasing CO_2 emissions negatively affects inclusive human development.

In the light of the above clarifications, the intuition underpinning this inquiry falls within an empirical framework of theory-building because we are engaging a direction of

[3] The EKC hypothesis postulates that in the long term, there is an inverted U-shaped relationship between per capita income and environmental degradation.

causality that is reverse to the EKC hypothesis as far as the outcome and independent variables of interest are concerned. Hence, we are consistent with recent empirical literature in arguing that applied econometrics should not exclusively be based on the acceptance or rejection of existing theories (Narayan *et al.*, 2011; Asongu & Nwachukwu, 2016b). In essence, an empirical exercise that is consolidated with sound intuition is a useful scientific activity that could lead to theory-building, especially in the post-2015 era when inclusive development and environmental pollution are key challenges to sustainable human development in less developed countries.

Our intuition for a nexus between environmental degradation and inclusive human development is simple to follow. We postulate that environmental degradation affects the inequality adjusted human development index (IHDI) which is composed of: health and long life, education and income or living standards. First, it is logical to postulate that environmental pollution directly affects the health and life expectancy of citizens. Second, it is also logical to assert that environmental decadence can directly affect the capacity of parents to send their children to school, especially in scenarios where atmospheric pollution is critical and/or transport facilities are absent. Furthermore, atmospheric pollution could also severely constraint the ability of pupils to study effectively. Third, environmental degradation and pollution can affect the family income by stifling the ability of workers in a household to search for work on the one hand and work effectively, on the other hand.

In order to increase the policy relevance of this study, the dataset is decomposed into fundamental characteristics of environmental degradation based on income levels (Low income versus (vs.) Middle income); legal origins (English Common law vs. French Civil law); religious domination (Christianity vs. Islam); openness to sea (Landlocked vs. Coastal); resource-wealth (Oil-rich vs. Oil-poor) and political stability (Stable vs. Unstable). The intuition motivating the choice of fundamental characteristics is substantiated in Section 2.

The rest of the study is structured as follows. Section 2 discusses the intuition motivating the comparative inclusive development. The data and methodology are engaged in Section 3. The empirical results are presented in Section 4 whereas Section 5 concludes with implications and future research directions.

2. Intuition for comparative economic development

In this section, we discuss the intuition for comparative CO_2 emissions and inclusive human development. In other words, we substantiate the relevance of disaggregating the sample in terms of income levels, legal origins, religious domination, openness to sea, natural resources and political stability. These fundamental characteristics have been employed in recent comparative development literature (Narayan *et al*., 2011; Mlachila *et al*., 2017; Asongu & Nwachukwu, 2017; Asongu & Le Roux, 2017). The intuitions consist of substantiating how environmental degradation and inclusive development are linked to the selected fundamental characteristics.

First, income levels determine degrees of environmental degradation and inclusive development because compared to low income countries, middle income countries are likely to be associated with more effective instruments for addressing challenges to environmental degradation. Moreover, high income countries have been documented to be associated with institutions that enable more inclusive development, compared to their low income counterparts. In essence, better institutions associated with income levels enable better environmental and inclusive development management (Fosu, 2013a, 2013b; Anyanwu & Erhijakpor, 2014; Efobi, 2015).

Second, the importance of legal origins in contemporary development has been widely documented in the broad (La Porta *et al*., 1998, 1999) and African (Agbor, 2015) development literature. The consensus maintains that compared to English Common law countries, their French Civil law counterparts have lower quality institutions owing to political and adaptability channels (Beck *et al*., 2003). Hence, in accordance with the adaptability mechanism, compared to French Civil law countries, their English Common law counterparts are more likely to adapt to challenges of the environment. In summary, the institutional web of formal norms, informal rules and enforcement characteristics underlying the legal traditions affect the capacity of the government to formulate and implement policies that: (i) deliver public commodities to improve inclusive development and (ii) address concerns of environmental degradation and global warming.

Third, the fact that politically-stable nations are endowed with more feasible conditions for effective environmental management is not difficult to understand. This extends to the intuition that countries which are political-unstable have less feasible conditions for the formulation and implementation of policies that deliver public commodities to enhance inclusive human development. The underpinnings of these intuitions are broadly consistent with Beegle *et al*. (2016) who have documented that politically fragile countries are linked with comparatively less economic development.

Fourth, the intuition motivating the relevance of income levels in comparative economic development extends to resource-wealth, since resource-wealthy nations are also associated with comparatively higher average income levels. However, it is also important to balance this narrative with the fact that resource-rich countries could be linked with comparatively lower levels of institutional quality and environmental management. As we have observed from the introduction, a case in point is Nigeria which addresses electricity outage and shortage by subsidizing non-renewable sources of energy like petroleum fuel, instead of substantially investing in renewable sources of energy. Moreover, it is also important to note that countries that have acknowledged scarcity in natural resources have been more effective at implementing policies of inclusive and sustainable development (America, 2013; Fosu, 2013b; Amavilah, 2016). An eloquent example is Rwanda, which has banned the use of plastic bags and is recognised for its exemplary policies of inclusive development, especially when it comes to gender equality (Sharp *et al.*, 2010; Debusscher & Ansoms, 2013).

Fifth, owing to the fact that landlockedness is associated with relatively more economic and institutional costs, compared with countries that are open to the sea (Arvis *et al.*, 2007), it is logical to assert that environmental cost is also strongly associated with the underlying economic and institutional costs. Two perspectives motivate this assertion: (i) effective institutions provide more feasible conditions for environmental management and (ii) there is more reliance by landlocked countries on road traffic as a means of transportation and road traffic is responsible for substantial environmental pollution.

Sixth, the intuition for religious domination as a comparative feature builds on the fact that religions translate some form of solidarity towards sustainable development (Asongu & Nwachukwu, 2017). Furthermore, granting that Christian-dominated countries are more liberal on the one hand and neoliberal societies have comparatively better institutions on the other hand, it is logical to assert that, Islam-oriented countries which are traditionally more conservative are associated with less effective institutions that determined inclusive and environmental development. These neoliberal underpinnings and institutional quality influence policies that determine the cross-country quality of inclusive and environmental development (Roudometof, 2014).

3. Data and methodology

3.1 Data

We investigate a sample of forty-nine countries in SSA with data from the United Nations Development Program (UNDP) and World Development Indicators for the period 2000-2012[4]. The adopted periodicity and scope of inquiry are based respectively on data availability constraints and the motivation discussed in the introduction. Consistent with recent inclusive human development literature, the inequality adjusted human development index (IHDI) is employed as the main outcome variable (Asongu *et al.*, 2015). It is important to note that the human development index (HDI) represents the average achievement of nations in three fundamental dimensions, namely: health and long life, knowledge and basic living standard. Conversely, the IHDI goes a step further by adjusting the HDI to prevalent levels of inequality in the aforementioned three dimensions. Hence, the IHDI considers the manner in which the three underlying achievements are distributed within the population.

We adopt four main CO_2 emission variables, namely: CO_2 emissions per capita; CO_2 emissions from electricity and heat production; CO_2 emissions from liquid fuel consumption and CO_2 intensity. In order to avoid variable omission bias, four control variables are employed, namely: education quality, private domestic credit, foreign aid and foreign direct investment. We expect three of the four variables to positively influence human development. Accordingly, foreign aid is expected to reduce inclusive human development as recently established by Asongu (2014). Conversely, education, domestic credit and foreign direct investment are anticipated to have the opposite effect. Education is a component of the IHDI and recent literature is consistent with the positive nexus between education and inclusive development (Dunlap-Hinkler *et al.*, 2010). Moreover, Petrakis and Stamakis (2002) and Asiedu (2014) have established that when countries are at their initial stages of development, compared to other levels of education, primary education is associated with more social returns to education. Let us note that it is relevant to balance the underlying anticipated positive sign with the fact that despite an appealing pupil-teacher ratio defining the quality of education, the quality of education may also be compromised by the lack of academic infrastructure. This is apparent when rural areas and sub-urban peripheries in a country are characterised with poor educational facilities. Hence, in the light of the construction of the

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

pupil-teacher ratio, we expect a negative effect from primary education. This is essentially because an increasing ratio denotes decreasing quality in primary education.

Foreign direct investment and private domestic credit have been established by a broad stream of literature to positively influence inclusive human development. This is partly because they provide favourable conditions for social mobility and unemployment reduction (Mishra *et al*., 2011; Seneviratne & Sun, 2013; Anand *et al*., 2012; Mlachila *et al*., 2017). Given the above clarifications, the choice of control variables is motivated by both intuition on the constitution of the HDI and the extant inclusive development literature. For example, education is a component of HDI while the literature has been used to justify the other variables. More details on the definitions of variables and sources can be found in Appendix 1. Appendix 2 provides the summary statistics. The correlation matrix is presented in Appendix 3.

Consistent with the discourse in Section 2[5], the fundamental characteristics have been employed in recent comparative development literature (Mlachila *et al*., 2017; Asongu & Nwachukwu, 2017). Classification of nations by legal categorisation is from La Porta *et al*. (2008, p. 289) while decomposition by income levels is consistent with the World Bank's classification[6]. Categorisation of countries by resource-wealth is based on the availability of petroleum resources, such that petroleum exports represent about 30% of the country's GDP for at least one decade of the sampled periodicity. Information on religious-domination is obtained from the Central Intelligence Agency (CIA) World Fact Book (CIA, 2011), while Landlocked versus Not landlocked nations are apparent from an Africa map. Countries that are politically-unstable represent those that have witnessed political violence and/or instability for at least half of the periodicity being investigated. Appendix 4 provides the categorisation of countries.

3.2 Methodology

[5] While the motivations for the choice of fundamental features have been postulated in Section 2, in Section 3 we discuss the selection criteria for the fundamental characteristics.

[6] There are four main World Bank income groups: (i) high income, $12,276 or more; (ii) upper middle income, $3,976-$12,275; (iii) lower middle income, $1,006-$3,975 and (iv) low income, $1,005 or less.

Two empirical strategies are adopted to control for specific characteristics, notably: (i) Fixed Effects (FE) regressions are used to control for the unobserved heterogeneity and (ii) Tobit regressions to control for the limited range in the dependent variable.

The panel FE model is presented as follows:

$$IHD_{i,t} = \partial_0 + \partial_1 CO_{i,t-1} + \partial_2 COCO_{i,t-1} + \sum_{h=1}^{4} \omega_h W_{h,i,t-\tau} + \eta_i + \varepsilon_{i,t} \ , \qquad (1)$$

where, $IHD_{i,t}$ is inclusive human development for country i at period t; ∂_0 is a constant; $CO_{i,t-1}$ is a CO_2 emissions variable for country i at period $t-1$; $COCO_{i,t-1}$, is an interaction term representing the multiplication of two identical CO_2 emissions variables for country i at period $t-1$; W is the vector of control variables (education quality, private domestic credit, foreign aid and foreign direct investment); η_i is the country-specific effect and $\varepsilon_{i,t}$ the error term. The purpose of lagging the independent variables of interest by one is to have some bite on endogeneity (Asongu *et al.*, 2017).

Given that the estimation technique involves interactive regressions, it is important to briefly engage some pitfalls that are linked to such interactive specifications. Consistent with Brambor *et al.* (2006), all constitutive variables are involved in the specifications. Furthermore, in order for the estimated parameters to make economic sense, they should be interpreted as conditional or marginal effects.

Since the IHDI theoretically falls between 0 and 1, it is not appropriate to employ the Ordinary Least Squares (OLS) estimation technique. Consistent with recent empirical literature, a double-censored Tobit estimation approach is employed to control for the limited range in the dependent indicator (Kumbhakar & Lovell, 2000; Koetter *et al.*, 2008; McDonald, 2009; Coccorese & Pellecchia, 2010; Ariss, 2010). This is in line with the constitution of the IHDI because it has minimum and maximum values of 0.129 and 0.768 respectively.

The standard Tobit model (Tobin, 1958; Carsun & Sun, 2007) is as follows:

$$y^*_{i,t} = \alpha_0 + \beta X_{i,t} + \varepsilon_{i,t}, \qquad (2)$$

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

$$y_{i,t} = \begin{cases} y^*_{i,t,} \; if \; y^*_{i,t} > \gamma \\ 0, \; if \; y^*_{i,t} \leq \gamma, \end{cases} \qquad (3)$$

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

4. Empirical results

4.1 Baseline results

Table 1 presents baseline results. It entails four sets of specifications corresponding to the four CO_2 independent variables of interest. Each specification has two sub-specifications for respectively Fixed Effect regressions and Tobit estimations. The impact of environmental degradation on inclusive development is investigated from two main perspectives, namely: marginal effects and net impacts. While the marginal impacts are the estimated coefficients corresponding to the interaction between CO_2 emission variables, net impacts are also computed to examine the overall impact of growing CO_2 emissions. For example, in the third column of Table 1, the net effect of increasing CO_2 emission per capita in the Tobit regression is 0.107 (2×[-0.011× 0.901] + [0.127]). In the computation, the mean value of CO_2 emissions per capita is 0.901; the unconditional effect of CO_2 emissions per capita is 0.127, the conditional effect from the interaction of CO_2 emissions per capita is -0.011 and the leading 2 on the first term is from the differentiation of the quadratic term (Boateng *et al.*, 2018; Asongu & Odhiambo, 2018).

The following can be established from Table 1. First, significant marginal and net effects are apparent exclusively from Tobit estimations. The marginal and net effects are respectively negative and positive for 'CO_2 emission per capita' and 'CO_2 emissions from liquid fuel consumption'. Conversely, for CO_2 emissions from electricity and heat production, the marginal impact and net effect are respectively positive and negative. In summary, a Kuznets shape outweighs a U-shape in the proportion of 2:1. Second, the significant control variables have the expected signs.

Table 1: Fixed Effects and Tobit Regressions

	Dependent variable: Inequality Adjusted Human Development (IHDI)							
	CO2 emissions per capita (CO2mtpc)		CO_2 emissions from electricity and heat production(CO2elehepr)		CO_2 emissions from liquid fuel consumption (CO2lfcon)		CO_2 inttensity (CO2inten)	
	FE	Tobit	FE	Tobit	FE	Tobit	FE	Tobit
Constant	**0.417*** **	**0.420*** **	**0.444*** **	**0.599*** **	**0.460*** **	**0.452*** **	**0.417*** **	**0.518*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
CO2mtpc(-1)	**0.040***	**0.127*** **	---	---	---	---	---	---
	(0.068)	**(0.000)**						
CO2elehepro(-1)	---	---	0.0008	**-0.003*** **	---	---	---	---
			(0.295)	**(0.009)**				
CO2lfcon(-1)	---	---	---	---	**-0.00002*** **	**0.002*** **	---	---
					(0.000)	**(0.004)**		
CO2inten	---	---	---	---	---	---	**0.022***	0.005
							(0.097)	(0.141)
CO2mtpc× CO2mtpc(-1)	-0.002	**-0.011*** **	---	---	---	---	---	---
	(0.108)	**(0.000)**						
CO2elehepro ×CO2elehepro(-1)	---	---	-0.00002	**0.00005*** **	---	---	---	---
			(0.132)	**(0.045)**				
CO2lfcon ×CO2lfcon(-1)	---	---	---	---	-0.00002	**-0.00001*** **	---	---
					(0.929)	**(0.008)**		
CO2inten× CO2inten(-1)	---	---	---	---	---	---	-0.0001	-0.00007
							(0.100)	(0.119)
Education(-1)	-0.0003	**-0.0005***	-0.00006	**-0.001*** **	-0.00002	**-0.002*** **	-0.0001	**-0.001*** **
	(0.246)	**(0.057)**	(0.880)	**(0.023)**	(0.929)	**(0.000)**	(0.798)	**(0.036)**
Credit(-1)	**0.001*** **	**0.0006*** **	**0.002*** **	**0.001*** **	**0.001*** **	**0.002*** **	**0.002*** **	**0.002*** **
	(0.000)	**(0.018)**	**(0.000)**	**(0.003)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
Foreign Aid(-1)	-0.0002	**-0.001*** **	**0.002*** **	**-0.009*** **	-0.0002	**-0.002*** **	**-0.002*** **	**-0.006*** **
	(0.157)	**(0.000)**	**(0.000)**	**(0.000)**	(0.118)	**(0.000)**	**(0.000)**	**(0.000)**
FDI(-1)	**0.0003***	**0.001*** **	**0.0009***	**0.002***	**0.0003***	**0.001*** **	**0.0009***	**0.002*** **
	(0.094)	**(0.002)**	**(0.076)**	**(0.060)**	**(0.088)**	**(0.001)**	**(0.058)**	**(0.008)**
Net effects	na	0.107	na	-0.0006	na	0.0004	na	na
Within (R^2)	0.225		0.350		0.338		0.349	
LR Chi-Square		**356.60*** **		**166.26*** **		**222.74*** **		**157.25*** **
Log Likelihood		402.541		196.643		335.612		205.146
Fisher	**11.39*** **		**11.42*** **		**20.05*** **		**11.97*** **	
Countries	40		21		40		27	
Observations	281	281	154	154	281	281	167	167

*,**,***: significance levels of 10%, 5% and 1% respectively. na: not applicable because at least one estimated coefficient needed for the computation of net effects is not significant. The mean value of CO2mtpc: 0.901. The mean value of CO2elehepro is: 23.730. The mean value of CO2lfcon is: 78.880. The mean value of CO2inten is: 2.044.

4.2 Extension with comparative development

Table 2 presents findings from Fixed Effects regressions in four main panels. Hence, Panel A, Panel B, Panel C and Panel D respectively present findings corresponding to: 'CO_2 emissions per capita', 'CO_2 emissions from electricity and heat production', 'CO_2 emissions from liquid fuel consumption' and 'CO_2 intensity'. Whereas, control variables used in the baseline regressions are included in the specifications, their estimated coefficients are not reported for lack of space. Net effects are also computed as in the baseline regressions. The following findings can be established. First, in Panel A on 'CO_2 emissions per capita', positive net effects are exclusively apparent in Middle income, French Civil law and Landlocked countries. Second, in Panel B on 'CO_2 emissions from electricity and heat production', negative net effects are apparent from French Civil law and Politically-stable countries. Third, in Panel C on 'CO_2 emissions from liquid fuel consumption': (i) we find positive net effects in French Civil law countries while; (ii) negative net impacts are apparent in Low income, Middle income, Coastal and Politically-stable and Oil-poor countries. Fourth, in Panel D on CO_2 intensity, positive and negative net effects are apparent in respectively, Coastal and Oil-rich and countries.

Table 2: Comparative analysis with Fixed Effects

Dependent variable: Inequality Adjusted Human Development Index (IHDI)

Panel A: CO2 emissions per capita(CO2mtpc)

	Income Levels		Legal Origins		Resources		Religion		Openness to Sea		Political Stability	
	L.I	M.I	Eng.	Frch.	Oil-rich	Oil-poor	Christi	Islam	Land locked	Unland locked	Stable	Unstable
Constant	0.420***	0.340***	0.384***	0.422***	0.379***	0.427***	0.412***	0.367***	0.329***	0.412***	0.432***	0.337***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
CO2mtpc(-1)	0.054*	0.117***	0.085*	0.052**	0.492*	0.029	0.076	0.010	0.346***	0.040**	0.026	0.071
	(0.065)	(0.001)	(0.087)	(0.017)	(0.050)	(0.229)	(0.128)	(0.739)	(0.000)	(0.048)	(0.271)	(0.467)
CO2mtpc× CO2mtpc(-1)	-0.005	-0.007***	-0.006	-0.003**	-0.609	-0.001	-0.135	-0.0007	-0.089**	-0.002	-0.001	-0.001
	(0.169)	(0.002)	(0.198)	(0.030)	(0.127)	(0.312)	(0.585)	(0.741)	(0.042)	(0.113)	(0.300)	(0.820)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Net effects	na	0.104	na	0.046	na	na	na	na	0.186	na	na	na
Within	0.190	0.523	0.281	0.240	0.388	0.240	0.282	0.333	0.262	0.342	0.295	0.067
Fisher	6.00***	13.90***	6.53***	6.79***	4.13***	10.02***	10.61***	5.59***	5.03***	12.49***	12.67***	0.58
Countries	27	13	16	24	7	33	27	13	13	27	30	10
Observations	186	95	122	159	52	229	195	86	104	177	217	64

Panel B: CO_2 emissions from electricity and heat production(CO2elehepro)

	Income Levels		Legal Origins		Resources		Religion		Openness to Sea		Political Stability	
	L.I	M.I	Eng.	Frch.	Oil-rich	Oil-poor	Christi	Islam	Land locked	Unland locked	Stable	Unstable
Constant	0.456***	0.421**	0.496***	0.434***	0.441***	0.470***	0.424*	0.409**	0.701**	0.430***	0.427**	0.393***

	L.I	M.I	Eng.	Frch.	Oil-rich	Oil-poor	Christi	Islam	Land locked	Unland locked	Stable	Unstable
		*					**	*			*	
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.022)**	**(0.000)**	**(0.000)**	**(0.001)**
CO2elehepro (-1)	-0.00007	0.0005	-0.002	**0.001*****	**0.001****	-0.001	0.0005	0.001	-0.013	0.001	**0.001***	-0.0004
	(0.950)	(0.621)	(0.397)	**(0.003)**	**(0.018)**	(0.337)	(0.623)	(0.176)	(0.449)	(0.124)	**(0.058)**	(0.907)
CO2elehepro × CO2elehepro (-1)	-0.000004	-0.00002	-0.000008	**-0.00003*****	-0.00001	0.000001	-0.00001	-0.00002	0.0001	**-0.00002***	**-0.00004****	0.000004
	(0.854)	(0.413)	(0.892)	**(0.003)**	(0.190)	(0.953)	(0.467)	(0.268)	(0.506)	**(0.090)**	**(0.016)**	(0.921)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Net effects	na	na	na	-0.0004	na	na	na	na	na	na	-0.0008	na
Within	0.347	0.588	0.472	0.478	0.902	0.374	0.447	0.461	0.503	0.368	0.386	0.748
Fisher	**6.20*****	**12.17*****	**6.87*****	**11.47*****	**29.14*****	**10.17*****	**11.34*****	**5.29*****	**2.71***	**10.21*****	**11.57*****	**5.45*****
Countries	13	8	8	13	4	17	15	6	3	18	16	5
Observations	89	65	60	94	29	125	105	49	25	129	132	22

Panel C: CO_2 emissions from liquid fuel consumption (CO2lfcon)

	Income Levels		Legal Origins		Resources		Religion		Openness to Sea		Political Stability	
	L.I	M.I	Eng.	Frch.	Oil-rich	Oil-poor	Christi	Islam	Land locked	Unland locked	Stable	Unstable
Constant	**0.512*****	**0.273*****	**0.484*****	**0.425*****	0.413	**0.459*****	**0.449*****	**0.460*****	**0.633*****	**0.446*****	**0.465*****	**0.325****
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	(0.460)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.021)**
CO2lfcon (-1)	**0.001***	**0.005****	0.0008	**0.002****	0.002	**0.001****	0.0009	0.001	0.0005	**0.001****	**0.001***	0.004
	(0.080)	**(0.016)**	(0.277)	**(0.047)**	(0.815)	**(0.042)**	(0.157)	(0.420)	(0.852)	**(0.018)**	**(0.074)**	(0.208)
CO2lfcon × CO2lfcon (-1)	**-0.00002*****	**-0.00004*****	**-0.00002*****	**-0.00002*****	-0.00003	**-0.00002*****	**-0.00001*****	**-0.00002***	-0.00002	**-0.00001*****	**-0.00001*****	**-0.00004****
	(0.000)	**(0.005)**	**(0.001)**	**(0.001)**	(0.665)	**(0.000)**	**(0.001)**	**(0.068)**	(0.121)	**(0.000)**	**(0.000)**	**(0.046)**
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Net effects	-0.0031	-0.0013	na	0.0004	na	-0.0021	na	na	na	-0.0005	-0.0005	na
Within	0.341	0.545	0.390	0.407	0.376	0.363	0.347	0.489	0.397	0.466	0.392	0.270
Fisher	**13.23*****	**15.21*****	**10.66*****	**14.77*****	**3.93*****	**18.09*****	**14.39*****	**10.70*****	**9.36*****	**21.01*****	**19.50*****	**2.97****
Countries	27	13	16	24	7	33	27	13	13	27	30	10
Observations	186	95	122	159	52	229	195	86	104	177	217	64

Panel D: CO2 intensity (CO2inten)

	Income Levels		Legal Origins		Resources		Religion		Openness to Sea		Political Stability	
	L.I	M.I	Eng.	Frch.	Oil-rich	Oil-poor	Christi	Islam	Land locked	Unland locked	Stable	Unstable
Constant	**0.381*****	**0.397*****	**0.383*****	**0.451*****	**0.433*****	**0.421*****	**0.391*****	**0.465*****	**-0.168**	**0.404*****	**0.414*****	**0.369*****
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.508)**	**(0.000)**	**(0.000)**	**(0.000)**
CO2inten (-1)	0.035	-0.002	0.013	0.014	**0.118*****	0.015	0.018	-0.011	**0.729****	**0.025****	0.024	-0.068
	(0.102)	(0.932)	(0.746)	(0.522)	**(0.006)**	(0.368)	(0.220)	(0.803)	**(0.012)**	**(0.018)**	(0.113)	(0.250)
CO2inten × CO2inten (-1)	-0.0002	0.011	-0.0001	0.001	**-0.053****	-0.0001	-0.0001	-0.001	-0.153	**-0.0002****	-0.0002	0.031
	(0.105)	(0.398)	(0.752)	(0.848)	**(0.038)**	(0.375)	(0.222)	(0.918)	(0.127)	**(0.019)**	(0.115)	(0.340)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Net effects	na	na	na	na	-0.0986	na	na	na	na	0.0241	na	na
Within	0.369	0.606	0.417	0.441	0.873	0.351	0.451	0.440	0.648	0.383	0.363	0.785
Fisher	**7.02*****	**14.38*****	**5.97*****	**10.29*****	**25.33*****	**9.56*****	**12.48*****	**4.85*****	**5.53*****	**11.41*****	**11.12*****	**6.75*****
Countries	16	11	10	17	5	22	19	8	5	22	22	5
Observations	94	73	66	101	33	134	116	51	29	138	145	22

LI: Low Income countries. MI: Middle Income countries. Eng: English Common law countries. Frch: French Civil law countries. Oil-rich: Oil exporting countries. Oil-poor: Nonoil exporting countries. Christ: Christian-dominated countries. Islam: Islam-dominated countries. Landlocked: Landlocked countries. Coastal: Coastal countries. Stable: Politically stable countries. Unstable: Politically unstable countries. *,**,***: significance levels of 10%, 5% and 1% respectively. na: not applicable because at least one estimated coefficient needed for the computation of net effects is not significant. The mean value of CO2mtpc: 0.901. The mean value of CO2elehepro is: 23.730. The mean value of CO2lfcon is: 78.880. The mean value of CO2inten is: 2.044.

Table 3: Comparative analysis with Tobit regressions

Dependent variable: Inequality Adjusted Human Development Index (IHDI)

Panel A: CO2 emissions per capita(CO2mtpc)

	Income Levels		Legal Origins		Resources		Religion		Openness to Sea		Political Stability	
	L.I	M.I	Eng.	Frch.	Oil-rich	Oil-	Christi	Islam	Land	Unland	Stable	Unstable

	L.I	M.I	Eng.	Frch.	Oil-rich	Oil-poor	Christi	Islam	Land locked	Unland locked	Stable	Unstable
Constant	0.429***	0.393***	0.407***	0.430***	0.231***	0.412***	0.388***	0.473***	0.397***	0.397***	0.389***	0.465***
	(0.000)	(0.000)	(0.407)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
CO2mtpc(-1)	0.094***	0.123***	0.118***	0.096***	0.808***	0.127***	0.219***	0.128***	0.218***	0.124***	0.109***	0.100**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.027)
CO2mtpc× CO2mtpc(-1)	-0.009***	-0.009***	-0.011 ****	- 0.007***	- 0.482***	- 0.011***	- 0.059***	- 0.011***	-0.047***	- 0.010***	- 0.008***	-0.008*
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.058)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Net effects	0.077	0.101	0.098	0.083	-0.060	0.107	0.219	0.108	0.133	0.105	0.094	0.085
LR Chi-Square	230.26***	148.25***	117.05***	244.9***	106.7***	329.5***	147.5***	219.2***	143.0***	249.4***	286.2***	67.89***
Log Likelihood	263.087	144.133	171.314	233.506	113.581	331.732	267.585	153.900	163.346	259.884	310.594	95.826
Observations	186	95	122	159	52	229	195	86	104	177	217	64

Panel B: CO_2 emissions from electricity and heat production(CO2elehepro)

	Income Levels		Legal Origins		Resources		Religion		Openness to Sea		Political Stability	
	L.I	M.I	Eng.	Frch.	Oil-rich	Oil-poor	Christi	Islam	Land locked	Unland locked	Stable	Unstable
Constant	0.571***	0.754***	0.764***	0.391***	0.315***	0.630***	0.469***	0.629***	1.071***	0.567***	0.575***	0.343***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
CO2elehepro (-1)	-0.002	-0.007***	-0.003	- 0.003***	0.0006	-0.003**	0.001	0.006	-0.018***	-0.003**	- 0.005***	0.007***
	(0.111)	(0.007)	(0.199)	(0.005)	(0.769)	(0.044)	(0.597)	(0.110)	(0.001)	(0.010)	(0.000)	(0.001)
CO2elehepro × CO2elehepro (-1)	0.00002**	0.00008	-0.00005	0.00006 ***	- 0.000002	0.00004	-0.00005	-0.00006	0.0002***	0.00006 **	0.00009 ***	-0.0001 ***
	(0.024)	(0.153)	(0.311)	(0.008)	(0.965)	(0.135)	(0.232)	(0.316)	(0.009)	(0.035)	(0.001)	(0.002)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Net effects	na	na	na	-0.0015	na	na	na	na	-0.0085	-0.0015	-0.0007	0.0022
LR Chi-Square	96.95***	99.54***	87.83***	162.3***	35.80***	148.3***	102.0***	84.95***	43.75***	151.6***	187.5***	62.98***
Log Likelihood	111.538	101.746	83.948	153.755	65.465	154.036	142.296	72.587	39.175	167.387	187.297	46.514
Observations	89	65	60	94	29	125	105	49	25	129	132	22

Panel C: CO_2 emissions from liquid fuel consumption (CO2lfcon)

	Income Levels		Legal Origins		Resources		Religion		Openness to Sea		Political Stability	
	L.I	M.I	Eng.	Frch.	Oil-rich	Oil-poor	Christi	Islam	Land locked	Unland locked	Stable	Unstable
Constant	0.383***	0.850***	0.535***	0.392***	-0.079	0.469***	0.497***	0.359***	0.353***	0.402***	0.488***	0.479**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.766)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.016)
CO2lfcon (-1)	0.004***	-0.012**	0.001	0.002	0.016***	0.002***	0.0004	0.008***	0.007***	0.0007	0.0006	0.0009
	(0.000)	(0.021)	(0.103)	(0.344)	(0.006)	(0.008)	(0.715)	(0.000)	(0.000)	(0.425)	(0.552)	(0.848)
CO2lfcon × CO2lfcon (-1)	-0.00003 ***	0.00009 ***	-0.00001*	-0.00001	-0.0001 ***	-0.00001 **	- 0.000003	-0.00006 ***	-0.00006 ***	0.000004	- 0.000003	- 0.000009
	(0.000)	(0.009)	(0.056)	(0.495)	(0.002)	(0.013)	(0.673)	(0.000)	(0.000)	(0.517)	(0.638)	(0.758)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Net effects	-0.0007	0.0021	na	na	0.0002	0.0004	na	0.0014	0.0024	na	na	na
LR Chi-Square	197.60***	107.24***	73.79***	180.5***	37.87***	205.3***	77.21***	154.1***	112.83***	179.4***	183.3***	64.05***
Log Likelihood	246.760	123.629	149.683	201.275	79.135	269.626	232.409	121.357	148.230	224.901	259.121	93.910
Observations	186	95	122	159	52	229	195	86	104	177	217	64

Panel D: CO2 intensity (CO2inten)

	Income Levels		Legal Origins		Resources		Religion		Openness to Sea		Political Stability	
	L.I	M.I	Eng.	Frch.	Oil-rich	Oil-poor	Christi	Islam	Land locked	Unland locked	Stable	Unstable
Constant	0.520***	0.476***	0.509***	0.330***	0.297***	0.569***	0.453***	0.637***	0.252	0.496***	0.469***	0.408***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.339)	(0.000)	(0.000)	(0.000)
CO2inten (-1)	0.002	-0.091	-0.0001	0.092***	0.149***	0.004	0.002	0.163***	0.155	0.003	0.003	0.162***
	(0.526)	(0.107)	(0.969)	(0.002)	(0.000)	(0.270)	(0.402)	(0.008)	(0.373)	(0.353)	(0.252)	(0.001)
CO2inten × CO2inten (-1)	-0.00003	0.037**	-0.000006	-0.020**	- 0.040***	-0.00005	-0.00004	-0.039**	-0.029	-0.00004	-0.00005	- 0.043***
	(0.454)	(0.025)	(0.906)	(0.016)	(0.000)	(0.254)	(0.369)	(0.030)	(0.551)	(0.312)	(0.226)	(0.005)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Net effects	na	na	na	0.0102	-0.0145	na	na	0.0035	na	na	na	-0.0137

LR Chi-Square	**87.69*** **	**88.31*** **	**60.89*** **	**139.0*** **	**64.26*** **	**146.5*** **	**81.95*** **	**94.93*** **	**35.56*** **	**148.8*** **	**170.2*** **	**62.17*** **
Log Likelihood	112.678	100.993	77.340	148.113	88.454	160.683	146.830	78.007	40.595	174.068	191.600	46.107
Observations	94	73	66	101	33	143	116	51	29	138	145	22

LI: Low Income countries. MI: Middle Income countries. Eng: English Common law countries. Frch: French Civil law countries. Oil-rich: Oil exporting countries. Oil-poor: Nonoil exporting countries. Christ: Christian-dominated countries. Islam: Islam-dominated countries. Landlocked: Landlocked countries. Coastal: Coastal countries. Stable: Politically stable countries. Unstable: Politically unstable countries. *,**,***: significance levels of 10%, 5% and 1% respectively. na: not applicable because at least one estimated coefficient needed for the computation of net effects is not significant. The mean value of CO2mtpc: 0.901. The mean value of CO2elehepro is: 23.730. The mean value of CO2lfcon is: 78.880. The mean value of CO2inten is: 2.044.

Table 3 presents results from Tobit regressions in four main panels. Like in Table 2, Panel A, Panel B, Panel C and Panel D respectively show findings corresponding to 'CO_2 emissions per capita', 'CO_2 emissions from electricity and heat production', 'CO_2 emissions from liquid fuel consumption' and 'CO_2 intensity'. Accordingly, while control variables used in the baseline regressions are included in the specifications, their estimated coefficients are not reported for lack of space. As usual, net effects are also computed. The following findings can be established. First, in Panel A on 'CO_2 emissions per capita', with the exception of Oil-rich countries, positive net effects are consistently apparent in all specifications. Second, in Panel B on 'CO_2 emissions from electricity and heat production', a positive net effect is evident exclusively from Politically-unstable countries whereas negative net impacts are visible in French Civil law, Landlocked, Coastal and Politically-stable countries. Third, in Panel C on 'CO_2 emissions from liquid fuel consumption': (i) there is a negative net effect in Low Income countries and (ii) positive net effects are apparent in Middle Income, Oil-rich, Oil-poor, Islam-dominated and Landlocked countries. Fourth, in Panel D on CO_2 intensity, positive net effects are apparent in French Civil law and Islam-dominated countries while negative net effects are apparent Oil-rich, and Politically-unstable countries.

Positive net effects are associated with Kuznets shapes owing to decreasing marginal effects whereas negative effects are linked with U-shapes because of increasing marginal effects. The overwhelming dominance of positive net effects and associated decreasing marginal effects motivate the computation of thresholds corresponding to the decreasing marginal effects at which CO_2 emissions compromise inclusive human development.

4.3 CO_2 emissions thresholds in comparative inclusive human development

Table 4 presents thresholds that which CO_2 emissions negatively affect inclusive human development. Hence, only thresholds corresponding to negative marginal effects are computed. Moreover, as we have stated earlier, negative marginal effects overwhelmingly dominate positive marginal effects. In what follows, we clarify the concept of threshold before discussing technicalities.

The notion of threshold or critical mass represents a point at which, further CO_2 emissions compromise development by yielding a net negative effect on inclusive human development. This conception of threshold is consistent with the literature, notably: minimum conditions for desired impacts (Cummins, 2000); critical masses for appealing results (Roller & Waverman, 2001; Batuo, 2015) and requirements for inverted U-shaped and U-shaped patterns (Ashraf & Galor, 2013). However, for these thresholds to be practically-feasible from a policy-making perspective, they should be within the corresponding statistical range.

On the technical front, thresholds are computed as a quotient of the 'unconditional effect/(conditional or marginal effect×2)', with 2 being from the differentiation of the quadratic term. For instance in Panel A of Table 4, the 25.00 threshold corresponding to CO_2 emissions from liquid fuel consumption established for Low Income countries is the quotient of '0.001/(0.00002×2)' from Panel C of Table 2. This implies that when CO_2 emissions from liquid fuel consumption is 25 (% of total), the net effect on inclusive human development is null or 0.000 ([-0.00002×25×2] + [0.001]). Hence, CO_2 emissions from fuel consumption beyond 25 (% of total) correspond to a net negative effect on inclusive human development. However, the established threshold has little practical relevance unless it is consistent with the range of CO_2 emissions from fuel consumption provided by the summary statistics. The minimum and maximum values respectively corresponding to CO_2 emissions from fuel consumption are 0.000 and 100.

Table 4: Comparative analysis and CO_2 thresholds

Dependent variable: Inequality Adjusted Human Development Index (IHDI)

	Income Levels		Legal Origins		Resources		Religion		Openness to Sea		Political Stability	
	L.I	M.I	Eng.	Frch.	Oil-rich	Oil-poor	Christi	Islam	Land locked	Unland locked	Stable	Unstable
						Panel A: Fixed Effects regressions						
CO2mtpc	na	**8.357**	na	**8.666**	na	na	na	na	**1.943**	na	na	na
CO2elehepro	na	na	na	**33.333**	na	na	na	na	na	na	**12.50**	na
CO2lfcon	**25.00**	125	na	**50.00**	na	**25.00**	na	na	na	**50.00**	**50.00**	na
CO2inten	na	na	na	na	**1.113**	na	na	na	na	**62.50**	na	na
						Panel B: Tobit regressions						
CO2mtpc	**5.222**	**6.833**	**5.363**	**6.857**	**0.838**	**5.772**	**3.711**	1.855	**2.319**	**6.200**	**6.812**	**6.250**
CO2elehepro	na	na	na	nsa	na	na	na	na	nsa	nsa	nsa	**35.000**
CO2lfcon	**66.666**	nsa	na	na	**80**	**100**	na	**66.666**	**58.333**	na	na	na
CO2inten	na	na	na	**2.30**	**1.862**	na	na	**2.089**	na	na	na	**1.883**

LI: Low Income countries. MI: Middle Income countries. Eng: English Common law countries. Frch: French Civil law countries. Oil-rich: Oil exporting countries. Oil-poor: Nonoil exporting countries. Christ: Christian-dominated countries. Islam: Islam-dominated countries. Landlocked: Landlocked countries. Coastal: Coastal countries. Stable: Politically stable countries. Unstable: Politically unstable countries. *,**,***: significance levels of 10%, 5% and 1% respectively. na: not applicable because at least one estimated coefficient needed for the computation of threshold is not significant. nsa: not specifically applicable because of positive marginal effects. CO2mtpc: CO_2 emissions per capita. CO2elehepro: CO_2 emission from electricity and heat production.

CO2lfcon: CO_2 emissions from liquid fuel consumption. CO2inten: CO_2 intensity. Bold values represent thresholds that are relevant to policy because they are within range (minimum to maximum).

In the light of the above, thresholds of policy relevance are highlighted in bold in Table 4. For brevity and lack of space, we do not literally translate these thresholds because they are self evident from the table. It is important to articulate the thresholds from baseline regressions which are apparent from Tobit regressions in the first-three CO_2 emission variables. They are: 5.772 (0.127/(0.011×2)) for CO_2 emissions per capita; 30 (0.003/(0.00005×2)) CO_2 emissions from electricity and heat production and 100 (0.002/(0.00001×2)) CO_2 emissions from liquid fuel consumption. All three thresholds are within policy range because they are within the minimum and maximum ranges provided by the summary statistics.

5. Concluding implications and future research directions

This study has examined how increasing CO_2 emissions affect inclusive human development in 44 Sub-Saharan African countries for the period 2000-2012. CO_2 emissions is measured with CO_2 emissions per capita, CO_2 emissions from electricity and heat production, CO_2 emissions from liquid fuel consumption and CO_2 intensity. The empirical evidence is based on Fixed Effects and Tobit regressions. In order to increase the policy relevance of the study, the dataset has been decomposed into fundamental characteristics of inclusive development and environmental degradation based on income levels (Low income versus (vs.) Middle income); legal origins (English Common law vs. French Civil law); religious domination (Christianity vs. Islam); openness to sea (Landlocked vs. Coastal); resource-wealth (Oil-rich vs. Oil-poor) and political stability (Stable vs. Unstable).

From the baseline regressions, significant marginal and net effects are apparent exclusively from Tobit estimations. The marginal and net effects are respectively negative and positive for 'CO_2 emissions per capita' and 'CO_2 emissions from liquid fuel consumption'. Conversely, for CO_2 emissions from electricity and heat production, the marginal impact and net effects are respectively positive and negative. In summary, a Kuznets shape outweighs a U-shape in the proportion of 2:1. After computing corresponding marginal and net effects for all the identified fundamental features, we have noticed overwhelmingly that positive net effects are associated with Kuznets shapes owing to decreasing marginal effect whereas negative effects are linked with U-shapes because of increasing marginal effects. The overwhelming dominance of positive net effects and associated decreasing marginal effects have motivated the computation of thresholds corresponding to the decreasing marginal effects at which CO_2 emissions compromise inclusive human development. All three thresholds are within policy range because they are within the minimum and maximum ranges provided by the summary statistics. Hence, above these thresholds, CO_2 emissions negatively affect inclusive human development. More policy-relevant thresholds are apparent when the computation of thresholds is within the framework of fundamental characteristics.

In summary, we have provided policy-relevant critical masses beyond which, increasing CO_2 emissions negatively affects inclusive human development. These critical thresholds have implications to the green growth strategies of sampled nations as well as sustainable development policies. First, on the green growth front, the thresholds inform policy that economic growth resulting from CO_2 emissions should not be achieved at the price of exclusive human development. Hence, these critical masses partly respond to a policy challenge from a growing consensus that, economic development patterns are characterized by inefficiency and the inequitable distribution of fruits from economic prosperity across the population (OECD, 2012). It is relevant to note that the conception and definition of the outcome variable used in this study is consistent with the relevance of equitable distribution.

Second, it is important to discuss the implications of this study beyond the scope of green growth because green growth is only a dimension of sustainable development (Akinyemi *et al.*, 2018). This is essentially because CO_2-driven economic growth can be sustainable if and only if, it is associated with social equity (i.e. inequality mitigation) and environmental sustainability. The established thresholds in this study reflect both dimensions of inclusiveness and sustainability. “Inclusiveness” because human development that is adjusted for inequality is the outcome variable on the one hand and on the other hand, “sustainability” because we have provided thresholds beyond which environmental pollution is harmful to humans. It is also worthwhile to note that such a framework for policy complementarity between sustainability and inclusiveness is in accordance with Amavilah *et al.* (2017) who have posited that for inclusive growth to be sustainable it should be sustained and for sustained growth to be sustainable, it must be inclusive.

Third, given that most sampled countries are at the early stage of industrialisation and that CO_2 are driven by the agricultural and extractive primary economic sector, effective policies and a favorable institutional framework are needed to fast-track the adoption of cleaner energy sources in order to potentially reduce the environmental and human costs associated with CO_2 emissions.

Future studies can assess whether the established findings withstand empirical scrutiny from country-specific perspectives. This recommendation is essentially because country-specific thresholds are necessary for more targeted policy implications.

Appendices

Appendix 1: Definitions of variables

Variables	Signs	Definitions of variables (Measurements)	Sources
Inclusive development	IHDI	Inequality Adjusted Human Development Index	UNDP
CO_2 per capita	CO2mtpc	CO_2 emissions (metric tons per capita)	World Bank (WDI)
CO_2 from electricity and heat	CO2elehepro	CO_2 emissions from electricity and heat production, total (% of total fuel combustion)	World Bank (WDI)
CO_2 from liquid fuel	CO2lfcon	CO_2 emissions from liquid fuel consumption (% of total)	World Bank (WDI)
CO_2 intensity	CO2inten	CO_2 intensity (kg per kg of oil equivalent energy use)	World Bank (WDI)
Educational Quality	Educ	Pupil teacher ratio in Primary Education	World Bank (WDI)
Foreign Aid	Aid	Total Official Development Assistance (% of GDP)	World Bank (WDI)
Private Credit	Credit	Private credit by deposit banks and other financial institutions (% of GDP)	World Bank (WDI)
Foreign investment	FDI	Foreign Direct Investment inflows (% of GDP)	World Bank (WDI)

WDI: World Development Indicators. UNDP: United Nations Development Programme.

Appendix 2: Summary statistics (2000-2012)

	Mean	SD	Minimum	Maximum	Observations
Inequality Adj. Human Development	0.450	0.110	0.219	0.768	431
CO_2 per capita	0.901	1.820	0.016	10.093	567
CO_2 from electricity and heat	23.730	18.870	0.000	71.829	286
CO_2 from liquid fuel	78.880	23.092	0.000	100	567
CO_2 intensity	2.044	6.449	0.058	77.586	321
Educational Quality	43.784	14.731	12.466	100.236	425
Private Credit	19.142	23.278	0.550	149.78	458
Foreign aid	11.944	14.712	-0.253	181.187	531
Foreign direct investment	5.381	8.834	-6.043	91.007	529

S.D: Standard Deviation. Adj: Adjusted.

Appendix 3: Correlation matrix

CO2 emissions dynamics				Control variables				
CO2mtpc	CO2ele	CO2lfcon	CO2inten	Educ	Credit	Aid	FDI	IHDI

	hepro								
1.000	0.690	-0.721	0.805	-0.369	0.853	-0.367	-0.108	0.607	CO2mtpc
	1.000	-0.695	0.703	-0.502	0.561	-0.442	-0.276	0.396	CO2elehepro
		1.000	-0.551	0.246	-0.352	0.219	0.222	-0.132	CO2lfcon
			1.000	-0.509	0.705	-0.482	-0.183	0.734	CO2inten
				1.000	-0.460	0.516	0.151	-0.505	Educ
					1.000	-0.323	-0.195	0.614	Credit
						1.000	0.112	-0.633	Aid
							1.000	-0.043	FDI
								1.000	IHDI

CO2mtpc: CO_2 emissions (metric tons per capita). CO2elehepro: CO_2 emissions from electricity and heat production, total (% of total fuel combustion). CO2lfcon: CO_2 emissions from liquid fuel consumption (% of total). CO2inten: CO_2 intensity (kg per kg of oil equivalent energy use). Educ: Quality of primary education. Credit: Private domestic credit. Aid: Foreign aid. FDI: Foreign Direct Investment. IHDI: Inequality Adjusted Human Development Index.

Appendix 4: Categorization of Countries

Categories	Panels	Countries	Num
Income levels	Middle Income	Algeria, Angola, Botswana, Cameroon, Cape Verde, Côte d'Ivoire, Egypt, Equatorial Guinea, Gabon, Lesotho, Libya, Mauritius, Morocco, Namibia, Nigeria, Senegal, Seychelles, South Africa, Sudan, Swaziland, Tunisia.	21
	Low Income	Benin, Burkina Faso, Burundi, Central African Republic, Chad, Comoros, Congo Democratic Republic, Congo Republic, Djibouti, Eritrea, Ethiopia, The Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Niger, Rwanda, Sierra Leone, Somalia, Togo, Uganda, Zambia, Zimbabwe.	30
Legal Origins	English Common-law	Botswana, The Gambia, Ghana, Kenya, Lesotho, Liberia, Malawi, Mauritius, Namibia, Nigeria, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Uganda, Zambia, Zimbabwe.	19
	French Civil-law	Algeria, Angola, Benin, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo Democratic Republic, Congo Republic, Côte d'Ivoire, Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Guinea, Guinea-Bissau, Libya, Madagascar, Mali, Mauritania, Morocco, Mozambique, Niger, Rwanda, Senegal, Togo, Tunisia.	32
Religion	Christianity	Angola, Benin, Botswana, Burundi, Cameroon, Cape Verde, Central African Republic, Congo Democratic Republic, Congo Republic, Côte d'Ivoire, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Ghana, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Rwanda, Seychelles, South Africa, South Africa, Togo, Uganda, Zambia, Zimbabwe.	31
	Islam	Algeria, Burkina Faso, Chad, Comoros, Djibouti, Egypt, The Gambia, Guinea, Guinea Bissau, Libya , Mali, Mauritania, Morocco, Niger, Nigeria, Senegal, Sierra Leone, Somalia, Sudan, Tunisia,	20
Resources	Petroleum Exporting	Algeria, Angola, Cameroon, Chad, Congo Republic, Equatorial Guinea, Gabon, Libya, Nigeria, Sudan.	10
	Non-Petroleum Exporting	Benin, Botswana, Burkina Faso, Burundi, Cape Verde, Central African Republic, Comoros, Congo Democratic Republic, Côte d'Ivoire, Djibouti, Eritrea, Ethiopia, Egypt, The Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Senegal, Sierra Leone, Somalia, Rwanda, Seychelles, South Africa, Swaziland, Togo, Tunisia, Uganda, Zambia, Zimbabwe.	41
Stability	Conflict	Angola, Burundi, Chad, Central African Republic, Congo Democratic Republic, Côte d'Ivoire, Liberia, Nigeria, Sierra Leone, Somalia, Sudan, Zimbabwe.	12
	Non-Conflict	Algeria, Benin, Botswana, Burkina Faso, Cameroon, Cape Verde, Comoros, Congo Republic, Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Gabon, The Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Senegal, Rwanda, Seychelles, South	39

		Africa, Swaziland, Togo, Tunisia, Uganda, Zambia.	
Openness to Sea	Landlocked	Botswana, Burkina Faso, Burundi, Chad, Central African Republic, Ethiopia, Lesotho, Malawi, Mali, Niger, Rwanda, Swaziland, Uganda, Zambia, Zimbabwe	15
	Not landlocked	Algeria, Angola, Benin, Cameroon, Cape Verde, Comoros, Congo Democratic Republic, Congo Republic, Côte d'Ivoire, Djibouti, Egypt, Equatorial Guinea, Eritrea, Gabon, The Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Liberia, Libya, Madagascar, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Nigeria, Senegal, Sierra Leone, Somalia, Sudan, Seychelles, South Africa, Togo, Tunisia.	36

Num: Number of cross sections (countries)

References

Afutu-Kotey, R. L. , Gough, K. W., & Owusu, G., (2017). "Young Entrepreneurs in the Mobile Telephony Sector in Ghana: From Necessities to Aspirations", *Journal of African Business*, 18(4), pp. 476-491.

Agbor, J. A. (2015). "How does colonial origin matter for economic performance in sub-Saharan Africa?", In Augustin K. Fosu (Ed.), *Growth and Institutions in African Development,* Chapter 13, pp. 309-327, Routledge Studies in Development Economics: New York.

Akbostanci, E., S. Turut-Asi & Tunc, G. I., (2009). "The Relationship between Income and Environment in Turkey: Is there an Environmental Kuznets Curve?", *Energy Policy*, 37(3), pp. 861-867.

Akinlo, A. E., (2008). "Energy consumption and economic growth: evidence from 11 Sub-Sahara African countries". *Energy Economics,* 30(5), pp. 2391–2400.

Akinyemi, O., Alege, P., Osabuohien, E., & Ogundipe, A., (2015). "Energy Security and the Green Growth Agenda in Africa: Exploring Trade-offs and Synergies", Department of Economics and Development Studies, Covenant University, Nigeria.

Akinyemi, O., Efobi, U., Asongu, S., & Osabuohien, E., (2018). "Green Growth Strategy and Trade Performance in sub-Saharan Africa", Department of Economics and Development Studies, Covenant University, Nigeria.

Akpan, G. E. & Akpan, U. F. (2012). "Electricity Consumption, Carbon Emissions and Economic Growth in Nigeria", *International Journal of Energy Economics and Policy*, 2(4), pp. 292-306.

Akpan, U., Green, O., Bhattacharyya, S., & Isihak, S., (2015). "Effect of Technology Change on CO2 Emissions in Japan's Industrial Sectors in the period 1995-2005: An Input-Output Structural Decomposition Analysis", *Environmental and Resources Economics*, 61(2), pp. 165-189.

Amavilah, V. H. (2016). “Social Obstacles to Technology, Technological Change, and the Economic Growth of African Countries: Some Anecdotal Evidence from Economic History”, *Turkish Economic Review*, 3(2), pp. 320-340.

Amavilah, V., Asongu, S. A. & Andrés, A. R. (2017). “Effects of globalization on peace and stability: Implications for governance and the knowledge economy of African countries”, *Technological Forecasting and Social Change*, 122(C), pp. 91-103.

America, R., (2013). “Economic Development with Limited Supplies of Management. What to do about it - the case of Africa”, *Challenge*, 56(1), pp. 61-71.

Anand, R., Mishra, S., & Spatafora, N., (2012). “Structural Transformation and the Sophistication of Production,” *IMF Working Paper* No. 12/59, Washington.

Ang, J. B. (2007). “CO2 emissions, energy consumption, and output in France”, *Energy Policy*, 35(10), pp. 4772-4778.

Anyangwe, E. (2014). “Without energy could Africa’s growth run out of steam?” *theguardian*, http://www.theguardian.com/global-development-professionals-network/2014/nov/24/energy-infrastructure-clean-cookstoves-africa (Accessed: 08/09/2015).

Anyanwu, J., & Erhijakpor, A., (2014). “Does Oil Wealth Affect Democracy in Africa?”*African Development Review*, 26 (1), pp. 15-37.

Apergis, N. & J. Payne, J. E., (2009). “CO2 emissions, energy usage, and output in Central America”, *Energy Policy*, 37(8), pp. 3282-3286.

Ariss, R. T., (2010), “On the Implications of Market Power in Banking: Evidence from Developing Countries”, *Journal of Banking and Finance*, 34(4), pp. 765-775.

Arvis, J-F., Marteau, J-F., & Raballand, G. (2007). The cost of being landlocked: logistics costs and supply chain reliability”, *Word Bank Working Paper Series* No. 4258, Washington.

Asiedu, E., (2014). “Does Foreign Aid in Education Promote Economic Growth? Evidence From Sub-Saharan Africa”, *Journal of African Development*, 16(1), pp. 37-59.

Ashraf, Q., & Galor, O., (2013). “The Out of Africa Hypothesis, Human Genetic Diversity, and Comparative Economic Development”. *American Economic Review*, 103(1), pp. 1-46.

Asongu, S. A., (2014). “The Questionable Economics of Development Assistance in Africa: Hot-Fresh Evidence, 1996–2010”, *The Review of Black Political Economy*, 41(4), pp. 455-480.

Asongu, S. A., (2018). “ICT, Openness and CO2 emissions in Africa”, *Environmental Science and Pollution Research*, 25(10), pp 9351–9359.

Asongu, S. A., Anyanwu, J. C., & Tchamyou, V. S., (2017). “Technology-driven information sharing and conditional financial development in Africa”, *Information Technology for Development*. DOI: 10.1080/02681102.2017.1311833.

Asongu, S. A., Efobi, U., & Beecroft, I., (2015). "Inclusive Human Development in Pre-Crisis Times of Globalisation-Driven Debts", *African Development Review*, 27(4), pp. 428-442.

Asongu, S. A., El Montasser, G., & Toumi, H., (2016a). "Testing the relationships between energy consumption, CO2 emissions, and economic growth in 24 African countries: a panel ARDL approach", *Environmental Science and Pollution Research*, 23(7), pp. 6563–6573.

Asongu, S. A., & Le Roux, S., (2017). "Enhancing ICT for inclusive human development in Sub-Saharan Africa", *Technological Forecasting and Social Change*, 118(May), pp. 44–54.

Asongu, S. A., Le Roux, S.,, & Biekpe, N., (2017). "Environmental degradation, ICT and inclusive development in Sub-Saharan Africa", *Energy Policy*, 111(December), pp. 353-361.

Asongu, S. A., Le Roux, S.,, & Biekpe, N., (2018). "Enhancing ICT for environmental sustainability in sub-Saharan Africa", *Technological Forecasting and Social Change*, 127(February), pp. 209-216.

Asongu, S. A., & Nwachukwu, J. C., (2016a). "The Role of Governance in Mobile Phones for Inclusive Human Development in Sub-Saharan Africa", *Technovation*, 55-56 (September- October), pp. 1-13.

Asongu, S. A., & Nwachukwu, J. C., (2016b). "Revolution empirics: predicting the Arab Spring", *Empirical Economics*, 51(2), pp. 439-482.

Asongu, S. A., & Nwachukwu, J. C., (2017). "The Comparative Inclusive Human Development of Globalisation in Africa", *Social Indicators Research*, 134(3), pp. 1027–1050.

Asongu, S. A., & Odhiambo, N. M., (2018). "Mobile banking usage, quality of growth, inequality and poverty in developing countries", *Information Development*.
DOI: 10.1177/0266666917744006.

Batuo, M. E., (2015). "The role of telecommunications infrastructure in the regional economic growth of Africa", *Journal of Development Areas*, 49(1), pp. 313-330.

Beck, T., Demirgüç-Kunt, A., & Levine, R., (2003), "Law and finance: why does legal origin matter?", *Journal of Comparative Economics*, 31(4), pp. 653-675.

Beegle, K., Christiaensen, L., Dabalen, A., & Gaddis, I., (2016). "Poverty in a Rising Africa", Africa Poverty Report, the World Bank, Washington.
http://www.worldbank.org/en/region/afr/publication/poverty-rising-africa-poverty-report (Accessed: 23/07/2016).

Begum, R. A., Sohag, K., Abdullah S. M. S., & Jaafar, M., (2015). "CO2 emissions, energy consumption, economic and population growth in Malaysia", *Renewal and Sustainable Energy Reviews*, 41(January), pp. 594-601.

Boateng, A., Asongu, S, Akamavi, R., & Tchamyou, V., (2018). "Information asymmetry and market power in the African banking industry", *Journal of Multinational Financial Management*, 44(March), pp. 69-83.

Bölük, G., & Mehmet, M., (2015). "The renewable energy, growth and environmental Kuznets curve in Turkey: An ARDL approach", *Renewal and Sustainable Energy Reviews*, 52(December), pp. 587-595.

Bongomin, G. O. C., Ntayi, J. M., Munene J. C., & Malinga, C. A., (2018). "Mobile Money and Financial Inclusion in Sub-Saharan Africa: the Moderating Role of Social Networks", *Journal of African Business*. DOI: 10.1080/15228916.2017.1416214.

Brambor, T., Clark, W. M., and Golder, M., (2006). "Understanding Interaction Models:Improving Empirical Analyses", *Political Analysis*, 14 (1), pp. 63-82.

Carson, R. T., & Sun, Y., (2007), "The Tobit model with a non-zero threshold", *Econometrics Journal*, 10(3), pp. 488-502.

CIA (2011). Central Intelligence Agency, The World Factbook 2011.

Coccorese, P., & Pellecchia, A., (2010), "Testing the 'Quiet Life' Hypothesis in the Italian Banking Industry", *Economic Notes by Banca dei Paschi di Siena SpA*, 39(3), pp. 173-202.

Cummins, J. (2000). Language, power and pedagogy: Bilingual children in the crossfire. Clevedon, England: Multilingual Matters.

Debusscher, P., & Ansoms, A., (2013). "Gender Equality Policies in Rwanda: Public Relations or Real Transformations?", *Development and Change*, 44(5), pp. 1111–1134.

Diao, X. D., Zeng, S. X., Tam, C. M. & Tam, V. W .Y., (2009). "EKC Analysis for Studying Economic Growth and Environmental Quality: A Case Study in China", *Journal of Cleaner Production*, 17(5), pp. 541-548.

Dunlap-Hinkler, D., Kotabe, M., & Mudambi, R., (2010)."A story of breakthorough versus incremental innovation: Corporate entrepreneurship in the global pharmaceutical industry", *Strategic Entrepreneurship Journal*, 4(2), pp. 106-127.

Efobi, U., (2015). "Politicians' Attributes and Institutional Quality in Africa: A Focus on Corruption", *Journal of Economic Issues*, 49(3), pp. 787-813.

Esso, L.J. (2010). "Threshold cointegration and causality relationship between energy use and growth in seven African countries", *Energy Economics*, 32(6), pp. 1383-1391.

Fosu, A., (2013a), "Growth of African Economies: Productivity, Policy Syndromes and the Importance of Institutions" *Journal of African Economies*, 22(4), pp. 523-551.

Fosu, A. (2013b). Achieving development success: Strategies and lessons from the developing world, *UNU-WIDER Policy Brief* (November), Helsinki.

Gosavi, A., (2018). "Can mobile money help firms mitigate the problem of access to finance in Eastern sub-Saharan Africa", *Journal of African Business*. DOI: 10.1080/15228916.2017.1396791.

He, J., & Richard, P., (2010). “Environmental Kuznets Curve for Co2 in Canada”, *Ecological Economics*, 69(5), pp. 1083-1093.

Hubani, M., & Wiese, M., (2018). “A Cashless Society for All: Determining Consumers’ Readiness to Adopt Mobile Payment Services”, *Journal of African Business*, DOI: 10.1080/15228916.2017.1396792.

Huxster, J. K., Uribe-Zarain, X. & Kempton, W., (2015). “Undergraduate Understanding of Climate Change: The Influences of College Major and Environmental Group Membership on Survey Knowledge Scores”, *The Journal of Environmental Education*, 46(3), pp. 149-165.

Issahaku, H., Abu, B. M., & Nkegbe, P. K., (2018). “Does the Use of Mobile Phones by Smallholder Maize Farmers Affect Productivity in Ghana?”, *Journal of African Business* DOI: 10.1080/15228916.2017.1416215.

Jumbe, C. B., (2004). “Cointegration and Causality between Electricity Consumption and GDP: Empirical Evidence from Malawi”, *Energy Economics*, 26(1), pp. 61-68.

Kifle, T. (2008). “Africa hit hardest by Global Warming despite its low Greenhouse Gas Emissions”, *Institute for World Economics and International Management Working Paper* No. 108, http://www.iwim.uni-bremen.de/publikationen/pdf/b108.pdf (Accessed: 08/09/2015).

Koetter, M., Kolari, J. W., & Spierduk, L., (2008), “Efficient Competition ? Testing the ‘Quiet Life’ of U.S Banks with Adjusted Lerner Indices”, Proceedings of the 44th ‘Bank Structure and Competition’ Conference, Federal Reserve Bank of Chicago.

Kumbhakar, S. C., & Lovell, C. A. K., (2000), *Stochastic Frontier Analysis*, Cambridge MA: Cambridge University Press.

La Porta, R., Lopez-de-Silanes, F., Shleifer, A., & Vishny, R. W. (1998). “Law and finance”, *Journal of Political Economy*, 106(6), 1113-1155.

La Porta, R., Lopez-de-Silanes, F., Shleifer, A., & Vishny, R. W. (1999). “The quality of government”, *Journal of Law, Economics and Organization*, 15(1), pp. 222-279.

La Porta, R., Lopez-de-Silanes, F., & Shleifer, A., (2008), “The Economic Consequences of Legal Origin,” *Journal of Economic Literature*, 46(2), pp. 285-332.

Narayan, P.K., Mishra, S., & Narayan, S., (2011). “Do market capitalization and stocks traded converge? New global evidence”. *Journal of Banking and Finance*, 35(10), pp. 2771-2781.

Mbah, P.O., & Nzeadibe, T. C., (2016). “Inclusive municipal solid waste management policy in Nigeria: engaging the informal economy in post-2015 development agenda”, *Local Environment. The International Journal of Justice and Sustainability*, 22(2), pp. 203-224.

McDonald, J., (2009), “Using Least Squares and Tobit in Second Stage DEA Efficiency Analyses”, *European Journal of Operational Research*, 197(2), pp. 792-798.

Mehrara, M., (2007). “Energy consumption and economic growth: The case of oil exporting countries”, *Energy Policy*, 35(5), pp. 2939-2945.

Menyah, K., & Wolde-Rufael, Y., (2010). “Energy consumption, pollutant emissions and economic growth in South Africa”, *Energy Economics*, 32(6), pp. 1374-1382.

Minkoua Nzie, J. R., Bidogeza, J. C., & Ngum, N. A., (2018). “Mobile phone use, transaction costs, and price: Evidence from rural vegetable farmers in Cameroon”, *Journal of African Business*, DOI: 10.1080/15228916.2017.1405704.

Mishra, S., Gable, S. L., &Anand, R., (2011), “Service Export Sophsitication and Economic Growth,” *World Bank Policy Working Paper* No. 5606, Washington.

Mlachila, M., Tapsoba, R., &Tapsoba, S. J. A., (2017). “A Quality of Growth Index for Developing Countries: A Proposal”, *Social Indicators Research*, 134(2), pp 675-710.

Muthinja, M. M., & Chipeta, C., (2018). “What Drives Financial Innovations in Kenya’s Commercial Banks? An Empirical Study on Firm and Macro-Level Drivers of Branchless Banking”, *Journal of African Business*, DOI: 10.1080/15228916.2017.1405705.

Odhiambo, N. M., (2009a). “Electricity consumption and economic growth in South Africa: a trivariate causality test”. *Energy Economics*, 31(5), pp. 635–640

Odhiambo, N. M., (2009b). “Energy consumption and economic growth nexus in Tanzania: an ARDL bounds testing approach”. *Energy Policy*, 37 (2), pp. 617–622.

OECD (2012), “Green Growth and Developing Countries: A Summary for Policy Makers”. Available on https://www.oecd.org/greengrowth/green-development/50526354.pdf (Accessed: 09/06/2018).

Olusegun, O. A., (2008). “Consumption and Economic Growth in Nigeria: A bounds testing cointegration approach”, *Journal of Economic Theory*, 2(4), pp. 118-123.

Ozturk, I., & Acaravci, A., (2010). “CO2 emissions, energy consumption and economic growth in Turkey”, *Renewable and Sustainable Energy Reviews*, 14(9), pp. 3220-3225.

Petrakis, P. E., & Stamatakis, D., (2002). “Growth and educational levels: a comparative analysis”. *Economics of Education Review*, 21(2), pp. 513-521.

Roller, L-H., & Waverman, L., (2001). “Telecommunications infrastructure and economic development: a simultaneous approach”, *American Economic Review*, 91(4), pp. 909-923.

Roudometof, V., (2014). “Religion and globalisation”, in The SAGE Handbook of Globalisation, Edited by Steger, M., Battersby, P., & Siracusa, J., Chapter 10, pp. 151-165, SAGE Publications: London.

Seneviratne, D., & Sun, Y., (2013), “Infrastructure and Income Distribution in ASEAN-5: What are the Links?” *IMF Working Paper* No. 13/41, Washington.

Sharp, A., Hoj, S., & Wheeler, M., (2010). "Proscription and its impact on anti-consumption behaviour and attitudes: the case of plastic bags", *Journal of Consumer Behaviour*, 9(6), pp. 470-484.

Ssozi, J., & Asongu, S. A., (2016). " The Effects of Remittances on Output per Worker in Sub-Saharan Africa: A Production Function Approach", *South African Journal of Economics*, 84(3), pp. 400-421.

Tchamyou, V. S., (2018). "Education, Lifelong learning, Inequality and Financial access: Evidence from African countries", *Contemporary Social Science*. DOI: 10.1080/21582041.2018.1433314.

Tobin, J., (1958). "Estimation of relationships for limited dependent variables". *Econometrica* 26(1), pp. 24-36.

World Bank (2015). "World Development Indicators", *World Bank Publications*http://www.gopa.de/fr/news/world-bank-release-world-development-indicators-2015 (Accessed: 25/04/2015).