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Enhancing ICT for environmental sustainability in sub-Saharan Africa

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ABSTRACT

This study examines how increasing ICT penetration in sub-Saharan Africa (SSA) can contribute towards environmental sustainability by decreasing CO_2 emissions. The empirical evidence is based the Generalised Method of Moments and forty-four countries for the period 2000–2012. ICT is measured with internet penetration and mobile phone penetration while CO_2 emissions per capita and CO_2 emissions from liquid fuel consumption are used as proxies for environmental degradation. The following findings are established: First, from the non-interactive regressions, ICT (i.e. mobile phones and the internet) does not significantly affect CO_2 emissions. Second, with interactive regressions, increasing ICT has a positive net effect on CO_2 emissions per capita while increasing mobile phone penetration alone has a net negative effect on CO_2 emissions from liquid fuel consumption. Policy thresholds at which ICT can change the net effects from positive to negative are computed and discussed. These policy thresholds are the minimum levels of ICT required, for the effect of ICT on CO_2 emissions to be negative. Other practical implications for policy and theory are discussed.

1. Introduction

It is difficult to achieve sustainable development and environmental protection without three main elements, namely: accountability, transparency and the wider participation of the public through information flow (Chemutai, 2009). The third element requires the availability of a communication tool that enables diffusion of knowledge, in order to reduce the informational/knowledge deficiencies that are associated with environmental degradation. CO_2 emissions contribute to environmental degradation or pollution. Hence in this study, the amount of pollution caused by CO_2 emissions will be used as a proxy for environmental degradation. This study is concerned with assessing how enhancing information and communication technology (ICT) can affect the emission of a greenhouse gas such as CO_2.[1]

The positioning of the inquiry is motivated by four main trends in policy and scholarly circles, namely: the need for effective communication strategies in environmental governance for multilateral policy coordination; the great potential for the penetration of ICT in Sub-Saharan Africa (SSA); issues pertaining to global warming and environmental sustainability; and gaps in the existing literature. These trends are considered in further detail below.

First, communication as a tool for environmental management has often been overlooked as part and parcel of environmental governance. With regard to the United Nations Task Force on Environment and Human Settlements credible governance of the environment can exclusively be achieved via effective coordination at national levels. The narrative further notes that only through effective communication can departments which provide consistent guidance to special agencies on environmental management respond to specific requirements within the government. While a comprehensive implementation of Multilateral Environmental Agreements (MEAs) and Agenda 21[2] is achievable via advanced communications among secretariats of MEA, it is important to share environmental databases among institutions, in order to address challenges like false reporting and other information asymmetries (Chemutai, 2009).

Second, recent ICT literature is consistent with the view that compared to other more advanced economies in the world (Asia, Europe & North America) where ICT is reaching levels of saturation, there is more room for ICT penetration in SSA (see Penard et al., 2012; Asongu, 2013; Afutu-Kotey et al., 2017; Asongu and Nwachukwu, 2016a). Such a promising potential for penetration can be leveraged by policy makers in order to address sobering policy challenges to sustainable development, such as environmental pollution and global warming.

Third, environmental sustainability by means of mitigating greenhouse gas (such as CO_2) emissions is a pressing agenda for the

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[1] For the purpose of simplicity, in some narratives, the terms ICT, the internet and mobile phones are used interchangeably.

[2] Agenda 21 is one of the United Nation's voluntarily implemented plans of action that is non-binding with respect to sustainable development.

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achievement of the Sustainable Development Goals (SDGs) (see Asongu et al., 2016a). This is particularly relevant for SSA because of the recent growth resurgence of the sub-region; the persistent energy crisis in the sub-region; poor energy management and consequences of climate change.

Over the last two decades, Africa has been experiencing a recent phase of growth resurgence after several decades of lost growth, due partly to failed Structural Adjustment Programmes (SAP) (see Fosu, 2015). Some accounts maintain that SSA has recently hosted about seven of the World's ten fastest growing economies (Asongu and Rangan, 2015).

However, the management of energy in the sub-region has not been effective, in spite of the apparent energy crisis which represents one of the most critical policy syndromes in the post-2015 development era.[3] Shurig (2015) found that access to electrical energy in the sub-region is limited to 5% of the population. Moreover, the consumption of energy in SSA is below 17% of the global average: the equivalent of energy consumed by a single state such as New York, USA.

Inefficiency has recently characterised the management of energy in most African nations (Anyangwe, 2014). To put this point into perspective, Nigeria — the most populous country in Africa, devotes a large proportion of government resources to subsidising the use of fossil fuels, instead of investing in alternative and renewable energy sources. This has led to the use of electricity generators (that burn subsidised petroleum fuel) to compensate for outages of and shortages in electricity supply (see Akpan and Akpan, 2012).

It is now abundantly clear that global warming which is one of the most dominant challenges in the post-2015 development era, is a direct consequence of the unsustainable consumption of fossil fuels (see Huxster et al., 2015). Unfortunately, compared to other regions of the world, Africa may be most severely affected by the negative effects associated with global warming (Kifle, 2008), partly because compared to other continents of the world Africa lacks adequate financial resources with which to deal with the consequences of global warming. This sobering prospect is broadly shared by Akpan and Akpan (2012) who have posited that CO_2 emissions constitute about three-quarter of the world's emissions in greenhouse gas, which cause global warming.

Fourth, this inquiry unites the three strands above by examining how enhancing ICT affects environmental sustainability through the reduction of CO_2 emissions. In addition to insights supporting the inquiry discussed in the previous paragraphs, the intuition motivating the inquiry is that by sharing information and potentially decreasing corresponding information asymmetry, ICT can reduce transaction and travelling costs that are associated with the CO_2 emissions in households and corporations. Such intuition can be framed in theory-building, as opposed to the testing of theory. Accordingly, given that practical and policy implications will be provided by the study, we are consistent with the literature (see Costantini and Lupi, 2005; Narayan et al., 2011) in arguing that applied econometrics should not exclusively be based on the rejection and acceptance of existing theories. This is essentially because an empirical exercise that is founded on solid intuition could pave the way towards theory-building, especially in the light of growing SDGs challenges.

The positioning of this study deviates from existing literature which has been fundamentally based on investigating nexuses between energy consumption, CO_2 emissions and economic growth. While the first strand of this extant literature focuses on the relationship between environmental pollution and economic growth with particular articulation on the Environmental Kuznets Curve (EKC) hypothesis (see Diao et al., 2009; Akbostanci et al., 2009; He and Richard, 2010),[4] the second strand is concerned with linkages between energy consumption, economic growth and environmental pollution (Jumbe, 2004; Ang, 2007; Odhiambo, 2009a, 2009b; Apergis and Payne, 2009; Menyah and Wolde-Rufael, 2010; Ozturk and Acaravci, 2010; Begum et al., 2015; Bölük and Mehmet, 2015) and nexuses between the consumption of energy and economic growth (Mehrara, 2007; Esso, 2010).

A common drawback to the highlighted studies is the absence of a policy variable with which associated policy syndromes underlying the inquiries can be addressed. We argue that inquiries motivated by nexuses between policy syndromes (CO_2 emissions) and macro-economic variables (e.g. energy consumption and economic growth) provide results with limited policy relevance because policy makers are not provided with policy instruments with which to address associated policy syndromes. The highlighted gap is addressed using ICT as a policy variable. In essence, we investigate how increasing ICT penetration can reduce CO_2 emissions by establishing relevant mobile phone penetration and internet penetration thresholds above which ICT penetration reduces CO_2 emissions.[5]

The current paper deviates from the recent ICT literature which has fundamentally focused on, inter alia: Africa's information revolution from the perspective of production networks and technical regimes (Murphy and Carmody, 2015); economic prosperity (Levendis and Lee, 2013; Qureshi, 2013a); banking sector progress (Kamel, 2005); living standards (Chavula, 2013); externalities in welfare (Carmody, 2013; Qureshi, 2013b); life for all (Kivuneki et al., 2011) and sustainable development (Byrne et al., 2011) in developing nations. Hence, whereas human development and socioeconomic benefits associated with ICT have been substantially documented in the existing literature, we contribute to this stream of engaged literature by assessing how ICT can be consolidated for environmental sustainability. Accordingly, we have built on a comprehensive survey of green ICT literature (see Krishnadas and Radhakrishna, 2014) and more contemporary studies to position the study.

The above positioning is also an extension of recent technological foresight literature on the role of technology and innovation in sustaining development and corporate outcomes, notably: the exploration of battery technology for grid-related energy storage (Versteeg et al., 2017); techno-organisational decarbonisation (Mazzanti and Rizzo, 2017); the importance of technology in consolidating the petroleum and petrochemical industry (Hossani et al., 2017); the relevance of environmental innovation in marketing capacity (Yu et al., 2017); linkages between unburnable fossil fuel, cumulative emissions and optimal carbon tax (van de Ploeg and Rezai, 2017) and the connection of innovation ecosystems (Pombo-Juárez et al., 2017).

The inquiry we are engaging is relevant for policy because communication, which is essential in the coordination of good environmental governance, has often been neglected in policy circles (see Chemutai, 2009). According to the narrative, the United Nations Task Force on Environment and Human Settlements and environmental protection can be achieved fundamentally through effective coordination with good communication tools.

The rest of the study is structured as follows. Section 2 engages the data and methodology. The empirical results are presented in Section 3 and Section 4 concludes with implications and future research directions.

[3] Fosu (2013) defines policy syndromes as situations that are detrimental to growth: 'administered redistribution', 'state breakdown', 'state controls', and 'suboptimal inter temporal resource allocation'. Within the framework of this study, policy syndromes are considered as issues that merit policy action in order to achieve sustainable development.

[4] According to the EKC hypothesis, in the long term, there is an inverted U-shaped relationship between per capita income and environmental degradation.

[5] Accordingly, thresholds articulate levels of ICT penetration that are essential in reducing CO_2 emissions. This objective does not suggest the existence of ICT thresholds that may be trivial if changes in some factors (e.g. desertification due to land clearing and overgrazing) contribute to decreasing CO_2 emissions. Hence, the attainment of this objective does not negate the relevance of other factors in decreasing CO_2 emissions.