Governance in the exploration of global and regional determinants of ICT development

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Abstract

The present study assesses how governance affects information and communication technology at the global level contingent on macroeconomic policy factors such as trade, foreign investment, manufacturing value added and agriculture value added. The focus of the study is on 183 countries for the period 2003 to 2021 and the empirical evidence is based on the generalised method of moments. The following main findings are established. For the full sample, governance unconditionally promotes ICT development while trade openness (industrial added value) moderate governance to promote (dampen) ICT development. In sub-Saharan Africa, only trade openness effectively moderates governance to induce an overall positive effect on ICT while in the MENA, all policy variables moderate governance for an overall positive incidence on ICT sector development. The findings of the MENA are confirmed in the ECA region with the exception of the moderating role of industrial added values which engenders an overall negative effect. In the East & South Asia and the Pacific (ESAP) countries, one overall positive incidence is apparent in the role of trade openness while net negative effects are established from the moderating roles of industrial added value and agricultural added value, respectively. In the American sub-sample, a positive (negative) net effect is apparent from the role of industrial added value (trade) in moderating the incidence of governance on ICT sector development. Policy implications are discussed.

Keywords: ICT; Governance; Trade; FDI; Industry; Agriculture

JEL Classification: G20; O38; O40; O55; P37

1. Introduction

The positioning of the study within the remit of extant scholarly literature is motivated by four main fundamentals in the extant policy and scholarly literature, especially as it pertains to: (i) the growing relevance of information and communication (ICT) in the world and corresponding drivers of the phenomenon; (ii) the importance of understanding the role of governance in driving macroeconomic outcomes that are fundamental in boosting inclusive and sustainable development outcomes; (iii) the policy importance of comparative analysis in order to understand regional differences in scholarly studies and (iv) gaps in the extant literature. These motivational elements are expanded in the same chronology as highlighted.

First, it is relevant to articulate that ICT is increasingly being used in almost every walk of life in order to facilitate households as well as corporate activities. Accordingly, the extant contemporary literature has documented the relevance of ICT in a plethora of fronts, *inter alia*: the improvement of democratic standards and associated inclusive development externalities (Sami & Gasmi, 2017; Setor *et al*., 2021); reduction of bureaucratic standards (Adam, 2020); improvement of income distribution (Sami & Gasmi, 2017; Canh et al., 2020) and enhancement of communication standards between rural and urban areas (Wantchekon & Riax, 2019). It is on the basis of the underlying that understanding what drives ICT is important especially as it pertains to understanding how various macroeconomic indicators interact in the process of driving the phenomenon.

Second, it is relevant to note that governance provides an enabling environment for the enhanced economic conditions, especially as it relates to the development of ICT infrastructure. This is essentially because dynamics such as political, institutional and economic governance have been documented to be favourable for economic development (Akpa & Asongu, 2023). It follows that governance does not only directly improve infrastructure development but could also be interacted with other macroeconomic variables in the assessment of its direct and indirect influences on infrastructure development. For instance, as positioned within the remit of the present study, governance is moderated by four macroeconomic factors to influence ICT development, namely: trade openness, foreign direct investment, agriculture value added and manufacturing value added. Accordingly, good governance can improve conditions for the ICT development by *inter alia*, reducing ICT cost and increasing corresponding penetration levels owing to better conditions for universal access and mitigating schemes that are favourable to restrictive ICT access (Anthony-Orji et al., 2019; Ongo Nkoa & Song, 2020).

Third, from a global comparative standpoint, it is worthwhile to understand cross-country differences in how macroeconomic phenomena across regions are fundamental in driving ICT development, especially as it pertains to understanding nations that are leading in the phenomenon as well as counties that are backward. Accordingly, cross-country determinants of macroeconomic factors can inform both scholars and policy makers on reasons for which some regions are doing better than others in terms of ICT development. Hence, policy syndromes can be identified in laggard regions and policy implications derived from more frontier regions to the benefit of countries and/or regions that are background with respect to the phenomenon under consideration. The underlying comparative economic insight is motivated by a growing stream of comparative research and catch-up in economic development (Andrés *et al*., 2015; Amavilah *et al*., 2017; Asongu, 2017).

Fourth, the extant literature has substantially documented the nexus between information technology and inclusive development outcomes (Lenka & Barik, 2018; Okoroafor et al., 2018; Senou et al., 2019; Chatterjee, 2020; Bayar et al., 2021; Asongu & Odhiambo, 2022; Akpa & Asongu, 2023) as well as the linkage between governance quality and socio-economic inclusion (Madestam, 2014; Ali et al., 2016; Chu et al., 2019; Anthony-Orji et al., 2019;Chinoda & Kwenda, 2019; Ongo et al., 2020; Aymar &Fabrice-Gilles, 2021;Muriu, 2021). Accordingly, although there is a well-documented literature on the nexus between governance and economic outcomes (North, 1989; Acemoglu et al., 2003; Acemoglu & Johnson, 2005; Nguyen et al., 2018), especially as it pertains to income redistribution (Asamoah, 2021; Nguyen et al., 2021; Ofori et al., 2022) as well as a corresponding literature on how information technology influences inclusive development outcomes (Canh et al., 2020), the extant literature on how governance affects information technology penetration is sparse.

The closest study in the extant literature to the positioning of the present study is Asongu and Biekpe (2017) which has investigated government quality determinants of information technology in Africa. The present study steers clear of the underlying study by using more contemporary data and engaging a comprehensive or global dataset in order to enable comparative analyses across regions. Such comparative analysis informs policy makers not just on government quality determinants in Africa, but also across other regions in the world. Another distinguishing feature of the present exposition in relation to the underlying study is that, instead of assessing direct nexuses between the individual governance indicators and ICT, interactive regressions are considered within the remit of assessing how moderating variables such as globalisation (i.e. trade and financial globalisation) and economic sector development (i.e. value added in the agricultural and industrial sectors) affect the incidence of governance on ICT development in the sampled countries. The advantage of the considering interactive regressions instead of linear additive models is that, macroeconomic variables do not affect other macroeconomic variables in isolation in the real world, not least, because the incidence of good governance on the information technology development is contingent on a plethora of factors such as the level of openness in terms of trade and financial globalisation as well as well improvement in the economic sector such agriculture and industrial value added dynamics. The highlighted contingencies are considered as moderators in the present study.

It is worthwhile to note that the present exposition also departs from the extant ICT development literature which has fundamentally focused on, *inter alia*: the decentralisation of information with the purpose of achieving higher levels of governance (Suarez, 2006; Boulianne, 2009; Diamond, 2010; Grossman et al., 2014;Merrell, 2022) and the importance of information technology in collective action schemes for quality governance standards (Morozov, 2011; Breuer et al., 2012; Pierskalla & Hollenbach, 2013; Weidmann & Shapiro, 2015; Manacorda & Tesei, 2016; Harahap et al., 2023).

The rest of the study is structured as follows. The theoretical underpinnings and related literature are covered in Section 2 while the data and methodology are discussed in Section 3. Section 4 presents the empirical results and corresponding discussion while the study concludes in Section 5 with implications and future research directions.

2. Conceptual clarification, intuition and literature review

2.1. Conceptual clarification and intuition

Consistent with Asongu and Biekpe (2017) which is closest to the current positioning in the extant literature, this section focuses on clarifying the underlying concepts of governance, before discussing the relevant intuition motivating the study, especially as it relates to discussing the intuition underlying the linkage between governance and ICT development, contingent on the moderating roles of globalisation and economic sector development. The highlight strands are expanded in the same chronological order as highlighted.

In accordance with Asongu and Biekpe (2017), the contextual clarification is engaged from two main standpoints, especially as it pertains to: (i) clarifying the governance concepts and (ii) justifying the choice of the governance concepts to be employed in the present exposition. Consistent with Dixit (2009), economic governance can be understood as *"…structure and functioning of the legal and social institutions that support economic activity and economic transactions by protecting property rights, enforcing contracts, and taking collective action to provide physical and organizational infrastructure*" 2 (p.5). As argued by Tusalem (2015), governance is a multidimensional and complex phenomenon which encompasses, *inter alia*; regulatory quality, bureaucratic effectiveness, the rule of law and corruption dynamics. Fukuyama (2013) understands governance within the remit of consolidated efforts towards the adoption of four main prospects that are imperative for comprehending the quality of the state, notably: political measures, output indicators, resources and capacity measurements which consist of professionalism insights.

As far as we have reviewed, governance indicators that are mostly employed in the extant literature are World Governance Indicators (WGI) of the World Bank from Kaufmann et al. (2010). Some reasons for which the attendant governance indicators are widely employed are that, *inter alia*, these indicators are from a renowned multilateral development institution and freely available (Asongu & Biekpe, 2017). In accordance with the attendant literature (Andrés et al., 2015), the corresponding governance indicators consists of three main categories: (i) political governance which is understood as the election and replacement of political leaders (proxied by political stability/no violence and 'voice & accountability); (ii) economic governance which is defined as the formulation and implementation of worthwhile policy initiatives that are destined to deliver public commodities for the alleviation of socio-economic conditions (measured by government effectiveness and regulatory quality) and (iii) institutional governance which is understood as the respect by the State and citizens of institutions that govern mutual interactions (proxied by corruption-control and the rule of law).

The second strand of this section pertaining to the ICT-governance linkage can be clarified with positions from Hellstrom (2008) and Asongu and Biekpe (2017). According to the authors, the nexus can be understood within the remit of information technology prospects improving governance standards on the one hand, as well as the quality of governance boosting ICT infrastructure and access. It follows that the nexus is not exclusively a one-directional traffic flowing from ICT to governance, not least, because causality could also be apparent from governance to ICT development. To put the underlying in more perspective, as argued in the corresponding literature, dynamics of governance such as electronic (e)-governance can substantially influence ICT penetration, not least, because the implementation of the strategy of governance substantially relies on the available ICT infrastructure in the economy. Accordingly, with government measures put in place to favour e-governance, the corresponding business units, governance organs and citizens collectively and individually contribute to the improvement of ICT infrastructure through continuous feedback on the effectiveness of the underlying e-governance practices.

Moreover, globalisation and openness policies (e.g. trade openness and financial openness) can also influence the development of the ICT sector, especially if the country is constantly adapting to international ICT networks and standards that are relevant in facilitating trading and financial activities across countries. By extension, improvement in economic sectors, especially as it pertains to value added in the industrial and agriculture sectors can also influence ICT development in a country. This is essentially because, as these sectors develop, there is naturally a tendency for the corresponding sectors to adapt to both domestic and international competition which obviously entail technological advancement. Thus, constraining the government to formulate and implement policies that are relevant for the smooth operation of corresponding economic activities in the agriculture and industrial sectors. It follows from the underlying intuition that governance dynamics within the remit of political, economic and institutional governance prospects are likely to influence ICT development within an economy. Moreover, from the underlying intuition, such influence is not in isolation, but can also be contingent on openness policies such as trade and financial globalisation dynamics as well as the economic sector dynamics like the industrial and agriculture value added.

2.2 Literature review

The extant literature can be discussed in two main strands, especially as it pertains to the incidence of information technology on economic development and how governance is relevant in stimulating information technology either directly or indirectly. These two strands are engaged in the same chronology as highlighted in what follows.

First, with regard to the extant literature on the linkage between information technology and economic outcomes (Nchofoung et al., 2022a), there is a stream of studies which has assessed how information technology affects inclusive development outcomes (Asongu & le Roux, 2017; Asongu & Odhiambo, 2019a; Adegboye et al. 2021; Asongu, 2021; Nchofoung et al., 2022b). In essence, this attendant stream of literature is consistent on the view that information technology is relevant in driving inclusive development. To put this in more perspective, Asongu and le Roux (2017) have concluded that, improving the penetration of information technology engenders inclusive development outcomes while Asongu and Odhiambo (2019a) and Asongu (2021) have established that the positive incidence of information technology on inclusive development is contingent on factors such as the extant level of education. With respect to Nchofoung et al. (2022b), while infrastructure-oriented investments boost inclusive development, ICT infrastructure rather engenders the opposite incidence. According to Asongu et al. (2017), information technology can be employed as a policy measure by which the unfavorable incidence of environmental degradation on inclusive development is mitigated.

Observing the narrative from a sustainable development angle, Nchofoung and Asongu (2022) have posited that sustainable development is improved by information technology, contingent on the geographical regions, income groups as well as choice of information technology indicator. Moreover, the authors have also provided thresholds of globalisation that are essential in order for the favorable nexus to be established and maintained. It is also worthwhile to note that information technology has been documented to boost environmental sustainability (Higónet al., 2017; Adebayo et al., 2020; Avom et al, 2020; N'dri et al., 2021). Moreover, some authors are of the perspective that information technology also improves the education (Livingstone, 2012; Asongu & Odhiambo, 2019b) and health (Dutta et al., 2019; Majeed & Khan, 2019; Ronaghi, 2022) dimensions of sustainable development.

Second, there is also a strand of literature on the importance of governance in driving information technology either directly or indirectly (Dossou et al., 2023). According to this strand of the literature, most of the emphasis has been placed on the incidence of information technology on governance quality. However, the present exposition focuses on the opposite effect as apparent in the motivation of this study in the introduction. Accordingly, most of the extant studies in the literature have been concerned with how information technology affects the quality of governance while the present exposition is concerned with the opposite effect. Wantchekon and Riaz (2019) have documented that ICT proliferation has enhanced possibilities of communication between rural and urban areas. Hence, leading to a decrease in information asymmetry and corresponding unfavorable economic development externalities associated with such information asymmetry (Tchamyou & Asongu, 2017). Moreover, the authors are also of the perspective that, ICT has substantially improved the quality of governance, especially as it pertains to improving accountability which is worthwhile for inclusive and sustainable development outcomes. Accordingly, corruption decreases with the growth of information technology and these better governance standards engender more equitable distribution of income among the population (Sami & Gasmi, 2017).

In the same empirical vein as in the above strand of studies, other contemporary studies have also established that enhanced information technology is relevant in boosting democratic standards (Setor et al., 2021). An empirical position that is confirmed bySassi and Ben Ali (2017) within the remit of the "Arab Spring", especially in the light of how these movements subsequently led to more opportunities for the improvement of socio-economic conditions in the countries concerned. More recent experiences entail the Sudanese revolution which has been facilitated by information technology dynamics (Reuters, 2021). This is consistent with Adam (2020) who has concluded that increased penetration of information technology reduces bureaucracy and consequently provides more opportunities for the equitable distribution of income across the population (Schopf, 2019). Kossow et al. (2017) are also consistent with the underlying positioning, especially as it relates to governance efficiency and enhanced distribution of income as a potential consequence.

How the present study departs from the extant literature in its contribution to the extant literature has been clarified in the introduction, especially within the remit of understanding what has been done in the extant literature on the subject, gaps in the attendant literature and how the present exposition aims to address the identified gaps, especially as it pertains to extending Asongu and Biekpe (2017).

3. Methodology and data

a. Principal components approach (PCA)

The study used PCA to generate a composite index for the variables of ICT development (ICT) and governance index (GOVI). To better understand the process, a brief description of PCA is required. Introduced by Karl Pearson (1901) and further expanded by Hotelling (1933), PCA involves extracting information from high-dimensional sets of indicators and transforming them into new indices that capture relevant information on separate dimensions and are uncorrelated with one another. It functions by reducing a large set of variables while preserving as much of the original data as possible. To obtain the composite index for ICT development and governance index (GOVI) variables, we used the first eigenvectors (loading matrix) from the PCA as the required weights, and thus the following linear combination exists:

$$ICT = \varphi_1 \, LmobT + \varphi_2 \, LFLT + \varphi_3 \, LIAS \quad (1)$$

$$GOVI = ß_1 \, WGIcr + ß_2 \, WGIpo + ß_3 \, WGIge + ß_4 \, WGIreg + ß_5 \, WGIru + ß_6 \, WGIv \quad ,(2)$$

where φ_1, φ_2 and φ_3 are the eigenvectors (weights) from the PCA and mobT, FLT and IAS are the three synthetic of ICT development; and$ß_1, ß_2, ß_3, ß_4, ß_5$ and $ß_6$are the eigenvectors (weights) from the PCA andWGIcr, WGIpo, WGIge, WGIreg, WGIru and WGIvc are the six synthetic of governance index.

3.2Empirical model specification

Our model specification inches on the diffusion of ICT/innovation theory postulated by Rogers(2003) which suggested that the adoption and use of ICT are influenced by various factors, namely, socio-economic, macroeconomic factors among others. Therefore, we specify our model as follows:

$$ICT_{i,t} = f(X_{i,t}) \quad (3)$$

$$ICT_{i,t} = \beta_0 + \beth_0 X_{i,t} \quad (4)$$

$$ICT_{i,t} = \beta_0 + \beth_0 X_{i,t} + \varepsilon_{it}, \quad (5)$$

where ICT and X represent ICT development index and regressors[1], respectively. The study specifies the system-GMM model below which took its bearing from Eq. (5)

Model *1*:$ICT_{i,t} = \beta_1 ICT_{i,t-1} + \beth_1 LCO2E_{it} + \beth_2 LIND_{it} + \beth_3 LAGRI_{it} + \beth_4 LGDPC_{it} + \beth_5 LGFCF_{it} + \beth_6 LFDV_{it} + \beth_7 FDI_{it} + +\beth_8 LHUM_{it} + \beth_9 LTRD_{it} + \beth_{10} LTNR_{it} + +\beth_{11} LLAN_{it} + \beth_{12} LPOP_{it} + \beth_{13} GOVI_{it} + \mho_i + \ell_t + \varepsilon_{it}$, (6)

where $\beta, \beth$, ε_{it},$\mho_i$ and $\ell_t$represents the coefficient of the lagged dependent variable, coefficient of regressors, error term, country-specific and time-specific effects, respectively. $\mho_i$ and ℓ_t measure country-specific and time-specific effects, respectively. ε_{it} is the error term. Model 1excludes the interaction terms between GOVI and LTRD, GOVI and FDI, GOVI and LIND, and GOVI and LAGRI, while the rest of the models (i.e7-10) does in a systemic manner one after the other. The details of the variables can be found in Table 1.

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[1]Due to the governing rules, it is important for the reader to take note that we did not log variables with negative values.

Capturing the interaction between GOVI and LTRD

$$\textit{Model 2}: ICT_{i,t} = \beta_1 ICT_{i,t-1} + \beth_1 LCO2E_{it} + \beth_2 LIND_{it} + \beth_3 LAGRI_{it} + \beth_4 LGDPC_{it} + \beth_5 LGFCF_{it} + \beth_6 LFDV_{it} + \beth_7 FDI_{it} + + \beth_8 LHUM_{it} + \beth_9 LTRD_{it} + \beth_{10} LTNR_{it} + + \beth_{11} LLAN_{\ it} + \beth_{12} LPOP_{it} + \beth_{13} GOVI_{it} + \beth_{14} GOVI * LTRD_{it} + \mho_i + \ell_t + \varepsilon_{it} \quad (7)$$

Capturing the interaction between GOVI and FDI

$$\textit{Model 3}: ICT_{i,t} = \beta_1 ICT_{i,t-1} + \beth_1 LCO2E_{it} + \beth_2 LIND_{it} + \beth_3 LAGRI_{it} + \beth_4 LGDPC_{it} + \beth_5 LGFCF_{it} + \beth_6 LFDV_{it} + \beth_7 FDI_{it} + \beth_8 LHUM_{it} + \beth_9 LTRD_{it} + \beth_{10} LTNR_{it} + \beth_{11} LLAN_{\ it} + \beth_{12} LPOP_{it} + \beth_{13} GOVI_{it} + \beth_{14} GOVI * FDI_{it} + \mho_i + \ell_t + \varepsilon_{it} \quad (8)$$

Capturing the interaction between GOVI and LIND

$$\textit{Model 4}: ICT_{i,t} = \beta_1 ICT_{i,t-1} + \beth_1 LCO2E_{it} + \beth_2 LIND_{it} + \beth_3 LAGRI_{it} + \beth_4 LGDPC_{it} + \beth_5 LGFCF_{it} + \beth_6 LFDV_{it} + \beth_7 FDI_{it} + \beth_8 LHUM_{it} + \beth_9 LTRD_{it} + \beth_{10} LTNR_{it} + \beth_{11} LLAN_{\ it} + \beth_{12} LPOP_{it} + \beth_{13} GOVI_{it} + \beth_{14} GOVI * LIND_{it} + \mho_i + \ell_t + \varepsilon_{it} \quad (9)$$

Capturing the interaction between GOVI and LAGRI

$$\textit{Model 5}: ICT_{i,t} = \beta_1 ICT_{i,t-1} + \beth_1 LCO2E_{it} + \beth_2 LIND_{it} + \beth_3 LAGRI_{it} + \beth_4 LGDPC_{it} + \beth_5 LGFCF_{it} + \beth_6 LFDV_{it} + \beth_7 FDI_{it} + \beth_8 LHUM_{it} + \beth_9 LTRD_{it} + \beth_{10} LTNR_{it} + \beth_{11} LLAN_{\ it} + \beth_{12} LPOP_{it} + \beth_{13} GOVI_{it} + \beth_{14} GOVI * LAGRI_{it} + \mho_i + \ell_t + \varepsilon_{it} \quad (10)$$

3.3 Data and variables description

This study utilized annual panel data for 183 countries covering the period from 2003 to 2021. The countries were further disaggregated into five major regions (45 Sub-Saharan African (SSA) countries; 20 Middle East and North African (MENA) countries; 47 Europe & Central Asian (ECA) countries; 35 East & South Asia and the Pacific (ESAP) countries; and 36 American countries) according to the World Bank's classification of regions. The data were sourced from three main databases, namely, the International Telecommunication Union (ITU), the World Bank's World Development Indicators (WDI), and the World Governance Indicators (WGI). The time span and countries used were selected based on data availability. The variables ICT development index and governance index are obtained from the indicators listed in Tables 1 through the utilization of PCA. Table 1 and 2 list the variables and countries used in this study, respectively.

"Insert Table 1 here"

"Insert Table 2 here"

4. Empirical results and discussion

4.1 Principal component analysis

Table 3 presents the principal component approach and correlation matrix results for governance index (GOVI) and ICT development index variables for the full sample, while the PCA results for the regional ones were majorly represented by using the figures in order to save space. We first started by testing whether or not there are some degree of association between the indicators used to generate an index for each of the variables, that is, GOVI and ICT development. The results in Panel A and B show that the indicators are strongly correlated, hence, the study proceeded to the estimation of the PCA given that the condition of the indicators being correlated was filled (Saba & Ngepah, 2022a, 2022b, 2022c). At the global and regional levels, to create a composite index for governance and ICT development, we selected the first principal component that explains the highest percentage of the total variation. For the globe level, we selected the first component for the GOVI variable because its eigenvalue accounts for 5.51%, which is the highest percentage of the total variation. Likewise, we chose the first component for the ICT development variable because its eigenvalue accounts for 2.39%, the highest percentage of the total variation. We applied the same rule of thumb to the others regions. The scree plots in Figure 1 further supports our results for both the full and the regional samples.

"Insert Table 3 here"

"Insert Figure 1 here"

4.2Summary statistics and correlation analysis

The summary statistics and correlation matrix are disclosed in Table 4 and Table 5, respectively. It is apparent from Table 4 that the mean values of the variables are comparable. Moreover, from the corresponding standard deviations, reasonable estimated linkages can be established from the regressions. The Jarque-Bera test confirms that the variables do not follow a normal distribution. However, this is not an issue because the GMM estimation technique to be adopted instead follows a Gaussian distribution.

From the correlation matrix in Table 5, some of the paired correlations are higher than the 0.700 threshold which has been established in the extant literature as a criterion for assessing evidence of multicollinearity that is likely to affect the signs of the estimated coefficients (Kennedy, 2008). However, the underlying issue of multicollinearity is not much of a concern for the study because the specifications are interactive and hence, to avoid the pitfalls of interactive regressions documented in Brambor *et al*. (2006) and thus account for the issue of multicollinearity, net effects of governance on ICT sector development are computed. These net effects entail both the conditional or interactive and unconditional effects of governance, consistent with the extant contemporary interactive regressions' literature (Tchamyou & Asongu, 2017).

"Insert Table 4 here"

"Insert Table 5 here"

4.3Empirical results

The empirical findings are presented in this section in Tables 6 to 11. Table 6 focuses on the full sample of the GMM findings while Table 7 is concerned with the sub-Saharan African sub-sample. Table 8 shows findings from the Middle East & North African (MENA) region whereas Table 9 discloses the corresponding findings for the Europe& Central Asian (ECA) sub-region. The focus of Table 10 is on East & South Asia and the Pacific (ESAP) countries while Table 11 is concerned with countries in the continent of America. The presentation of the findings in each of the table is tailored such that the first specification respectively involves non-linear models (i.e. in which interactive regressions are not involved) while the last-four specifications disclose findings respectively corresponding to interactions between good governance and trade openness (LTRD), foreign investment (FDI), industrial added value (LIND) and agriculture added value (LAGRI).

In order to assess the validity of the attendant GMM regressions, four main information criteria are taken into account, in accordance with the extant GMM-centric literature[2]. Moreover, in accordance with the extant interactive regressions literature (Tchamyou & Asongu, 2017), in order to examine the moderating roles of globalisation and economic sector added values in the incidence of governance on ICT development, net effects are computed in order to limit the pitfalls of interactive regressions, especially as is it pertains to interpreting interactive

[2] "*First, the null hypothesis of the second-order Arellano and Bond autocorrelation test (AR (2)) in difference for the absence of autocorrelation in the residuals should not be rejected. Second the Sargan and Hansen over-identification restrictions (OIR) tests should not be significant because their null hypotheses are the positions that instruments are valid or not correlated with the error terms. In essence, while the Sargan OIR test is not robust but not weakened by instruments, the Hansen OIR is robust but weakened by instruments. In order to restrict identification or limit the proliferation of instruments, we have ensured that instruments are lower than the number of cross-sections in most specifications. Third, the Difference in Hansen Test (DHT) for exogeneity of instruments is also employed to assess the validity of results from the Hansen OIR test. Fourth, a Fisher test for the joint validity of estimated coefficients is also provided*" (Asongu & De Moor, 2017, p.200).

regressions as in linear additive models (Brambor *et al.*, 2006). Hence, the fact that net effects involve both conditional (or interactive) and unconditional effects in the computation are evidence that the estimated governance linkages are not interpreted as in linear additive models.

Building on the above, to put the calculation of net impact in more perspective, in the second specification or third column in Table 6, the net impact of governance on ICT penetration, contingent on the moderating role of FDI is 0.098 ([-0.242 × 6.065] + [1.147]). In the corresponding computation, 6.065 is the mean value of FDI, 1.147 is the unconditional effect of governance on ICT development while -0.242 is the conditional or interactive impact of governance on ICT development. As clarified in the corresponding table footnote, some net impacts are not computed because at least one estimated coefficient needed for the relevant computation is not significant. Accordingly, "not applicable" (i.e. na) is used when net effects cannot be computed because of one or more insignificant estimated coefficients needed for the corresponding computation while "not specifically applicable" (i.e. nsa) is used when net effect cannot be computed because interactive regressions are not involved.

The following findings can be established from Tables 6 to 11. In Table 6, governance unconditionally promotes ICT development while trade openness (industrial added value) moderate governance to promote (dampen) ICT development. In the SSA sample (i.e. Table 7), only trade openness effectively moderates governance to induce an overall positive effect on ICT while in the MENA sub-sample all policy variables (i.e. trade, FDI, industrial added value and agriculture value added) moderate governance for an overall positive incidence on ICT sector development. The findings of the MENA are confirmed in the ECA region with the exception of the moderating role of industrial added value which engenders an overall negative effect. In the East & South Asia and the Pacific (ESAP) countries, an overall positive incidence is apparent in the role of trade openness while net negative effects are established from the moderating role of industrial added value and agriculture added value, respectively. In the American sub-sampled, a positive (negative) net effect is apparent from industrial added value (trade) in moderating the incidence of governance on ICT sector development.

The expected signs/effects of the control variables cannot be established with certainty because multicollinearity is apparent in the specifications[3]. Hence, it is difficult to confirm the signs of

[3] "*The political indicators sometimes enter negatively and significantly, perhaps because the predicted components of the political and adaptability channels are highly correlated. Although we did obtain the same*

the control variables because when multicollinearity is apparent, not all the variables emerge from the regression output with the expected signs. Accordingly, as clarified earlier, the concern of multicollinearity is taken into account in the independent variables of interest by computing the net effects of governance involving both the unconditional and conditional or interactive effects of governance.

"Insert Table 6 here"

"Insert Table 7 here"

"Insert Table 8 here"

"Insert Table 9 here"

"Insert Table 10 here"

"Insert Table 11 here"

It is relevant to further clarify the findings in the light of contextual underpinnings and intuition. Accordingly, from the unconditional effect of governance in influencing ICT development, it is apparent from the findings that in some regions (e.g. SSA and ECA), governance positively affects ICT development while in other regions (e.g. the MENA, ESAP & America), governance instead acts as a deterrent to ICT development. This is not very surprising because country-specific effects are eliminated from the GMM-centric estimations in order to avoid the correlation between country-specific effects and the lagged outcome variable which is a source of endogeneity. Hence, GMM analytical technique cannot explain why some regions with comparatively higher standards of governance can still be associated with governance negatively affecting ICT development. Accordingly, in the corresponding regions, governance in some counties may be substantially weighing to influence the overall effects. This explanation also applies to sub-samples in which governance positively affects ICT development, especially as it pertains to some countries with above-average levels of governance heavily weighing on the overall effect. The underlying explanation on the absence of country-specific effects also explains why some tendencies in the incidence of the moderating variables in the effect of governance on ICT development do vary within and across regions.

5. Conclusion and policy implications

results when we added many additional instrumental variables, we interpret these results cautiously and note that they do not imply that the political channel is unimportant in general" (Beck et al., 2003, p. 671).

The present study has assessed how governance affects information and communication technology at the global level contingent on macroeconomic factors such as trade, foreign investment, manufacturing value added and agriculture value added. The focus of the study is on 183 countries for the period 2003 to 2021 and the empirical evidence is based on the generalised method of moments. The empirical analysis is tailored such that the incidence of general governance (i.e. encompassing political stability/no violence, voice & accountability, government effectiveness, regulatory quality, corruption-control and rule of law) on ICT development is first assessed before the moderating incidence of openness policies (i.e. trade and financial openness) and economic sector development (i.e. agriculture and manufacturing value added dynamics) in the effect of governance on ICT development.

The following main findings are established. For the full sample, governance unconditionally promotes ICT development while trade openness (industrial added value) moderate governance to promote (dampen) ICT development. In SSA, only trade openness effectively moderates governance to induce an overall positive effect on ICT while in the MENA sub-sample, all policy variables (i.e. trade, FDI, industrial added value and agriculture value added) moderate governance for an overall positive incidence on ICT sector development. The findings of the MENA region are confirmed in the ECA region with the exception of the moderating role of industrial added value which engenders an overall negative effect. In the East & South Asia and the Pacific (ESAP) countries, an overall positive incidence is apparent on the role of trade openness while net negative effects are established from the moderating roles of industrial added value and agricultural added value, respectively. In the American sub-sample, a positive (negative) net effect is apparent from the role of industrial added value (trade) in moderating the incidence of governance and ICT sector development. Policy implications are discussed in what follows.

The first main policy implication is that, how macroeconomic factors interact with governance to influence ICT development is contingent on attendant macroeconomic factors as well as on regional specific features. Hence, in formulating policies on how globalisation can influence governance for domestic technology improvement, blanket or universal measures should not be recommended not least, because regional specific tendencies are apparent that should be taken into account. For instance, in situations where governance is effectively moderated by the considered policy variables to positively affect ICT development, as is the case in the

MENA region, policy makers should also be aware that the corresponding interactive effects are worth taking into account. Accordingly, while there are overall positive effects in the MENA, most of the corresponding interactive or conditional effects are negative which is an indication that complementary policies are needed at certain thresholds of the moderating variables (trade, FDI and industrial added value) in order to maintain the overall positive effect on ICT development. Conversely, in the light of the positive conditional effect related to the agriculture added value specification, it is apparent that a certain threshold of agriculture value added is needed for governance to promote ICT development.

The second main policy implication is that the relevance of governance in boosting ICT development in the world is fundamentally driven by sub-Sahara Africa and Europe and Central Asian countries and dampened by the Middle East and North Africa, 'East & South Asia and the Pacific' and American sub-samples. It follows that, some countries are driving the importance of governance in ICT sector development in respective regions and hence, understanding these countries within and across regions is worthwhile for robust policy initiatives.

The study obviously leaves space for future studies, especially as it relates to assessing how governance interacts with other macroeconomic factors to influence ICT development. Moreover, it is also relevant to assess how such interactions influence sustainable development outcomes, especially as it pertains to examining how countries and regions are moving towards the attainment of the United Nations Sustainable Development Goals (SDGs). In order to establish more country-specific policy implications, it is also worthwhile to revisit the analysis within the contexts of country-specific settings to provide findings with more relevant country-specific implications.

Table 1: Variable description and sources

Variables	Description	Sources
Dependent variable		
ICT development variable		
ICT	ICT penetration is captured by a composite index of ICT development indicators (which comprises of three indicators) by applying principal components method/analysis (PCA). These indicators include: (i)mobile-cellular telephone subscriptions per 100 inhabitants (penetration of connected mobile lines) (LmobT); (ii)fixed-telephone subscriptions per 100 inhabitants (LFLT); and (iii) percentage of Individuals using the Internet(LIAS).	ITUdatabase
Independent variables		

Macroeconomic variables		
LINDU	*Log of*industrial, value added (% of GDP)	WDI database
LAGRI	*Log of*agriculture, value added (% of GDP)	WDI database
LGDPC	*Log of*GDP per capita (constant 2010 US$)	WDI database
LGFCF	*Log of*gross fixed capital formation (% of GDP) proxy for investment	WDI database
LFDV	*Log of d*omestic credit to private sector (% of GDP) proxy for financial development	WDI database
FDI	Foreign direct investment, net inflows (% of GDP)	WDI database
LTRD	*Log of*Trade (% of GDP)	WDI database
LHUM	*Log of*School enrollment, secondary (% gross) proxy for human capital endowments	WDI database
Socio-economic variables		
LTNR	*Log of*Total natural resource rent (% of GDP)	WDI database
LLAN	*Log of*Land area (sq. km)	WDI database
LPOP	*Log of*Population, total	WDI database
LCO2E	*Log of*CO_2 emissions (metric tons per capita)	WDI database
Governance index (GOVI) variable obtained from governance indicators		
WGIcr	Control of Corruption	WGI database
WGIpo	Political stability and absence of violence/terrorism	WGI database
WGIge	Government effectiveness	WGI database
WGIreg	Regulatory quality	WGI database
WGIru	Rule of law	WGI database
WGIvc	Voice and accountability	WGI database

Note: WDI represents World Bank's World Development Indicators. ITU represents International Telecommunication Union database. WGI represents World Bank's World Governance Indicators. There were missing data, but these were handled by means of interpolation and extrapolation of data[4].

Table 2: List of countries classified into five regions

Country ID (cid)	Sub-Saharan Africa (SSA)	Middle East and North Africa (MENA)	Europe & Central Asia (ECA)	East & South Asia and the Pacific (ESAP)	America
1	Angola	Algeria	Albania	Afghanistan	Antigua and Barbuda
2	Benin	Bahrain	Armenia	Australia	Argentina
3	Botswana	Djibouti	Austria	Bangladesh	Aruba
4	Burkina Faso	Egypt, Arab Rep.	Azerbaijan	Bhutan	Bahamas
5	Burundi	Iran, Islamic Rep.	Belarus	Brunei Darussalam	Barbados
6	Cabo Verde	Iraq	Belgium	Cambodia	Belize
7	Cameroon	Israel	Bosnia and Herzegovina	China	Bolivia
8	Central African Rep,	Jordan	Cyprus	Fiji	Brazil
9	Chad	Kuwait	Czech Republic	Hong Kong SAR, China	Chile
10	Congo (Rep. of the)	Lebanon	Denmark	India	Colombia
11	Cote d'Ivoire	Libya	Estonia	Indonesia	Costa Rica

[4] Studies that have used these techniques include those of Saba & Ngepah (2022a,2020b, 2020c) and Saba (2023) and Saba and Biyase (2022).

12	Dem. Rep. of the Congo	Malta	Faroe Islands	Japan	Cuba
13	Equatorial Guinea	Morocco	Finland	Kiribati	Dominica
14	Eritrea	Oman	France	Korea, Rep.	Dominican Republic
15	Eswatini	Qatar	Georgia	Lao PDR	Ecuador
16	Ethiopia	Saudi Arabia	Germany	Macao SAR, China	El Salvador
17	Gabon	Syrian Arab Republic	Greece	Malaysia	Grenada
18	Gambia	Tunisia	Greenland	Maldives	Guatemala
19	Ghana	United Arab Emirates	Hungary	Micronesia, Fed. Sts.	Guyana
20	Guinea	Yemen, Rep.	Iceland	Mongolia	Haiti
21	Guinea-Bissau		Ireland	Myanmar	Honduras
22	Kenya		Italy	Nepal	Jamaica
23	Lesotho		Kazakhstan	New Caledonia	Mexico
24	Liberia		Kyrgyz Republic	New Zealand	Nicaragua
25	Madagascar		Latvia	Pakistan	Panama
26	Malawi		Lithuania	Philippines	Paraguay
27	Mali		Luxembourg	Samoa	Peru
28	Mauritania		Moldova	Singapore	Puerto Rico
29	Mauritius		Montenegro	Sri Lanka	Saint Kitts and Nevis
30	Mozambique		Netherlands	Thailand	Saint Vincent and the Grenadines
31	Namibia		North Macedonia	Timor-Leste	Suriname
32	Niger		Norway	Tonga	Uruguay
33	Nigeria		Poland	Tuvalu	Venezuela, RB
34	Rwanda		Portugal	Vanuatu	Bermuda
35	Sao Tome and Principe		Romania	Vietnam	Canada
36	Senegal		Russian Federation		United States
37	Seychelles		Serbia		
38	Sierra Leone		Slovak Republic		
39	South Africa		Slovenia		
40	Sudan		Spain		
41	Tanzania		Sweden		
42	Togo		Tajikistan		
43	Uganda		Turkey		
44	Zambia		Turkmenistan		
45	Zimbabwe		Ukraine		
46			United Kingdom		
47			Uzbekistan		

Table 3:Principal component and correlation matrix results for governance index, and ICT variables

Panel (A): Governance index variable

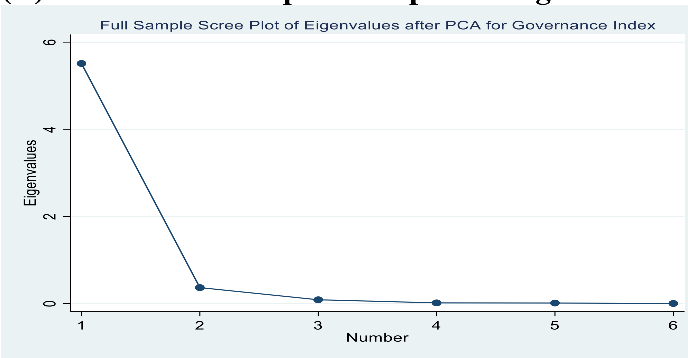
Principal component results

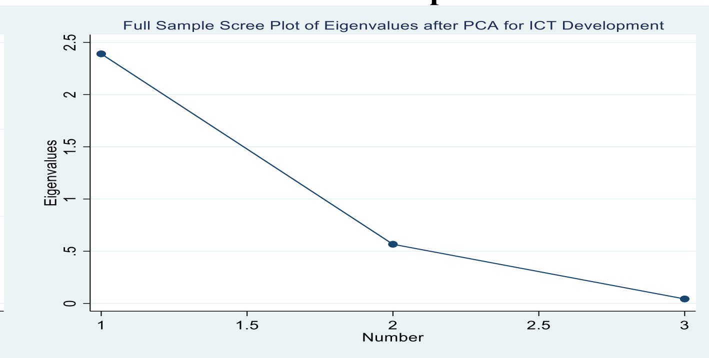
Compnnt	Eigenvalue	Difference	Proportion	Cumulative
Compnnt 1	5.51188	5.1446	0.9186	0.9186
Compnnt 2	.367281	.278978	0.0612	0.9799
Compnnt 3	.0883031	.071986	0.0147	0.9946
Compnnt 4	.0163171	.00324681	0.0027	0.9973
Compnnt 5	.0130703	.00992442	0.0022	0.9995
Compnnt 6	.00314586		0.0005	1.0000

Principal components eigenvectors results							
Variables	Compnnt 1	Compnnt 2	Compnnt 3	Compnnt 4	Compnnt 5	Compnnt 6	Unexplained
WGIcr	0.4222	-0.1475	0.1521	-0.1681	-0.6725	-0.5444	.01734
WGIpo	0.3972	0.4703	-0.7368	-0.2766	0.0202	0.0353	.1304
WGIge	0.4169	-0.3205	-0.0387	0.2274	-0.3374	0.7459	.04194
WGIreg	0.4175	-0.2278	0.3418	-0.6512	0.4723	0.0987	.03925
WGIru	0.4119	-0.3768	-0.2289	0.5465	0.4500	-0.3671	.06472
WGIvc	0.3823	0.6786	0.5131	0.3474	0.0890	0.0388	.1944
Correlation matrix results							
WGIcr	1.000						
WGIpo	0.890*** (0.000)	1.000					
WGIge	0.988*** (0.000)	0.859*** (0.000)	1.000				
WGIreg	0.986*** (0.000)	0.856*** (0.000)	0.981*** (0.000)	1.000 (0.000)			
WGIru	0.971*** (0.000)	0.849*** (0.000)	0.991*** (0.000)	0.969*** (0.000)	1.000		
WGIvc	0.858*** (0.000)	0.919*** (0.000)	0.798*** (0.000)	0.835*** (0.000)	0.767*** (0.000)	1.000	
Panel (B): ICT development index variables							
Principal component results							
Component	Eigenvalue	Difference	Proportion	Cumulative			
Compnnt 1	2.39036	1.82367	0.7968	0.7968			
Compnnt 2	.566687	.523735	0.1889	0.9857			
Compnnt 3	.0429526		0.0143	1.0000			
Principal components eigenvectors results							
Variable	Compnnt 1	Compnnt 2	Compnnt 3	Unexplained			
Fixed-telephone	0.5060	0.8245	0.2534	.388			
Mobile-telephone	0.5846	-0.5438	0.6021	.1831			
Internet access	0.6342	-0.1566	-0.7571	.03852			
Correlation matrix results							
Variables							
Fixed-telephone	1.000						
Mobile-telephone	0.460*** (0.000)	1.000					
Internet access	0.686*** (0.000)	0.915*** (0.000)	1.000				

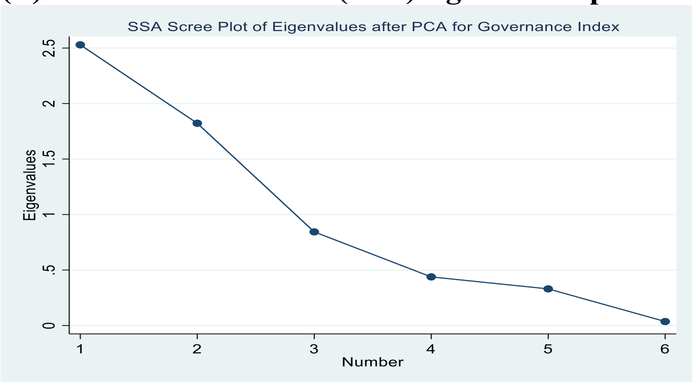
Note: ***$p < 0.01$; **$p < 0.05$; *$p < 0.1$, p-value in parentheses. Where compnnt is component **Source:** Author's computation using WDI, WGI and ITU data. **Source**: Authors' computations, 2023.

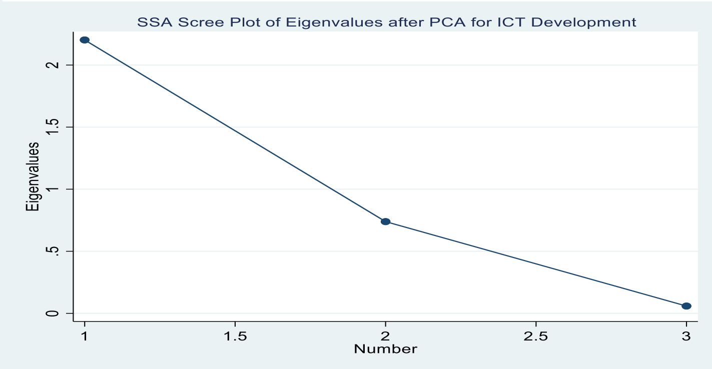
(A): Global/full sample scree plot of Eigenvalues for Governance and ICT development indexes



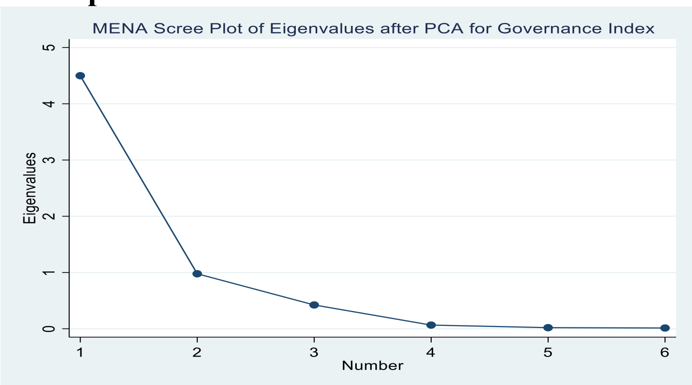


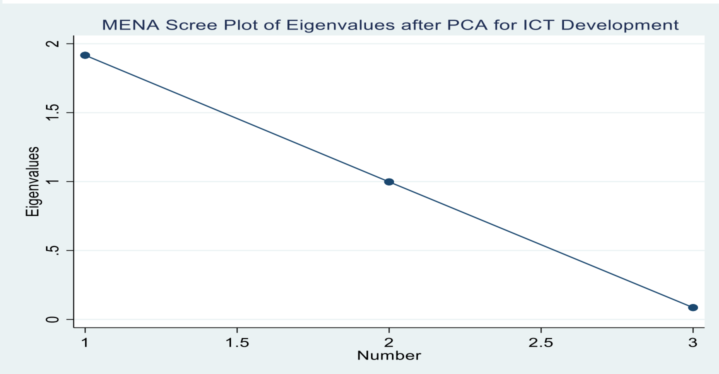
(B):Sub-Saharan Africa (SSA)region scree plot of Eigenvalues for Governance and ICT development indexes



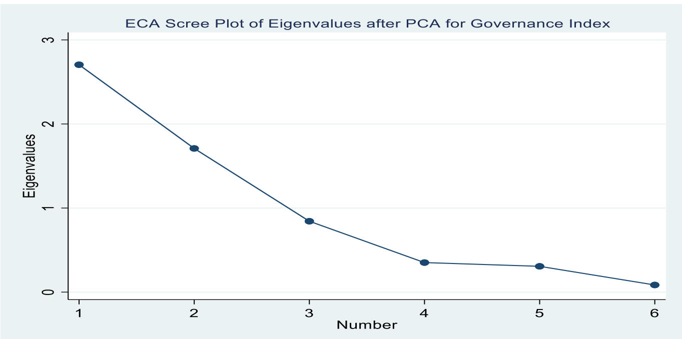


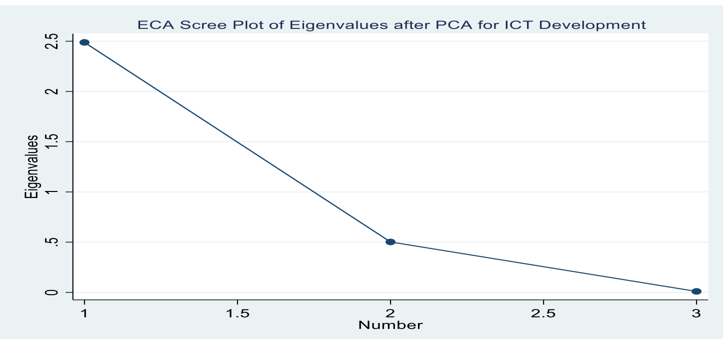
(C): Middle East and North Africa (MENA) region scree plot of Eigenvalues for Governance and ICT development indexes



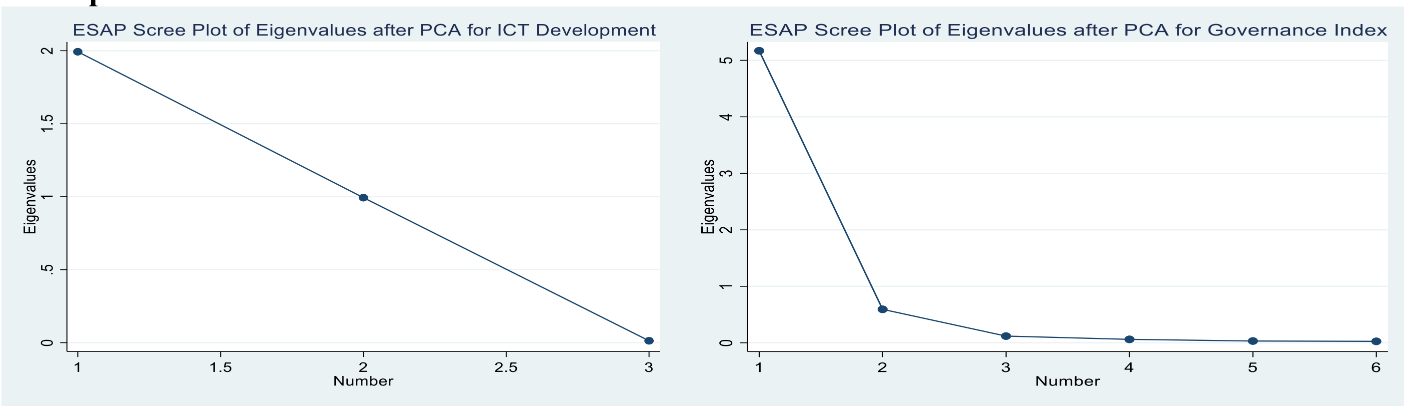


(D): Europe & Central Asia (ECA) region scree plot of Eigenvalues for Governance and ICT development indexes





(E): East & South Asia and the Pacific (ESAP) region scree plot of Eigenvalues for Governance and ICT development indexes



(F): America region scree plot of Eigenvalues for Governance and ICT development indexes

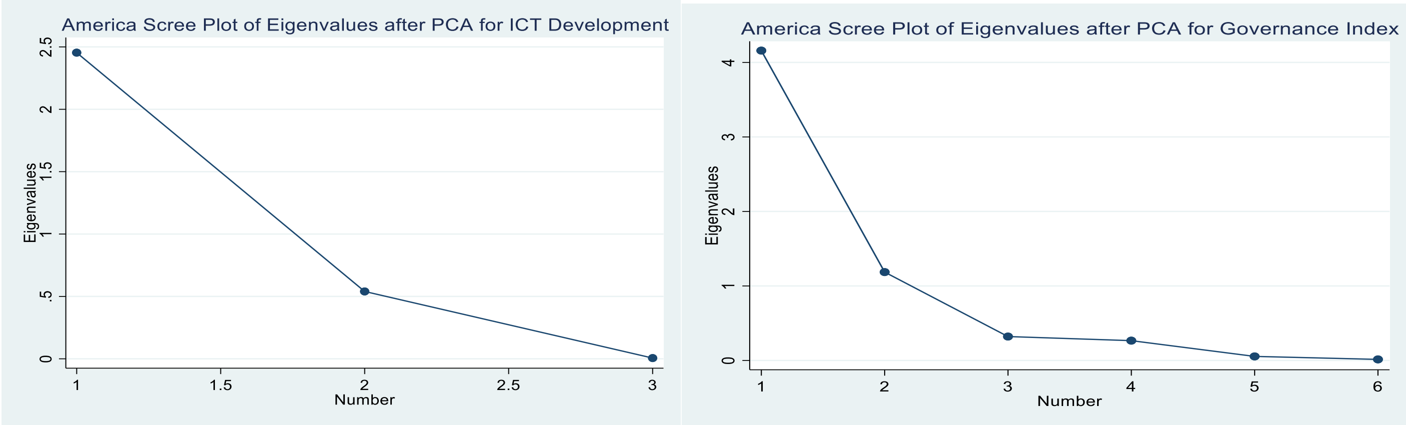


Figure 1: (A): Global/full sample scree plot of Eigenvalues for Governance and ICT development indexes; (B): Sub-Saharan Africa (SSA) region scree plot of Eigenvalues for Governance and ICT development indexes; (C): Middle East and North Africa (MENA) region scree plot of Eigenvalues for Governance and ICT development indexes; (D): Europe & Central Asia (ECA) region scree plot of Eigenvalues for Governance and ICT development indexes; (E): East & South Asia and the Pacific (ESAP) region scree plot of Eigenvalues for Governance and ICT development indexes; (F): America region scree plot of Eigenvalues for Governance and ICT development indexes

Table 4: Descriptive statistics results

	Mean	Median	Max	Min	Std. Dev.	Skew.	Kurt	Jarque-Bera	Prob.	Obs
ICT	0.315	0.546	2.837	-6.992	1.154	-1.243	5.625	1494.002	0.000	2743
GOVI	0.032	-0.051	5.549	-5.115	2.199	0.172	2.375	58.246	0.000	2743
LCO2E	0.612	0.874	1.770	-1.188	1.075	-0.532	1.784	298.503	0.000	2743
LIND	3.204	3.161	3.697	3.064	0.147	2.182	6.874	3891.927	0.000	2743
LAGRI	1.894	1.761	2.901	0.748	0.654	0.040	1.632	214.627	0.000	2743
LGDPC	8.491	8.840	9.680	6.956	0.920	-0.428	1.703	276.076	0.000	2743
LGFCF	3.096	3.083	3.339	2.845	0.119	0.123	2.731	15.136	0.001	2743
LFDV	3.547	3.736	4.315	2.243	0.596	-0.761	2.413	304.164	0.000	2743
FDI	6.035	3.056	449.083	-58.323	18.321	14.088	265.914	7990997.	0.000	2743
LHUM	4.251	4.409	4.689	3.385	0.391	-0.829	2.277	373.719	0.000	2743
LTRD	4.332	4.253	4.638	4.097	0.170	0.345	1.526	302.703	0.000	2743
LTNR	0.570	0.172	2.250	-0.998	1.035	0.276	1.453	308.360	0.000	2743
LLAN	11.562	11.660	12.025	11.068	0.342	-0.024	1.726	185.904	0.000	2743
LPOP	15.740	15.849	16.135	15.153	0.257	-1.221	3.176	684.669	0.000	2743

Table 5: Correlation matrix results

	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)
(a)	1.000													
(b)	0.550***	1.000												
	(0.000)	-----												
(c)	-0.959***	-0.670***	1.000											
	(0.000)	(0.000)	-----											
(d)	0.987***	0.462***	-0.951***	1.000										
	(0.000)	(0.000)	(0.000)	-----										
(e)	0.271***	0.123***	-0.152***	0.196***	1.000									
	(0.000)	(0.000)	(0.000)	(0.000)	-----									
(f)	0.891***	0.219***	-0.776***	0.890***	0.518***	1.000								
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	-----								
(g)	0.070***	0.092***	-0.080***	0.068***	0.009	0.035*	1.000							
	(0.000)	(0.000)	(0.000)	(0.000)	(0.642)	(0.069)	-----							
(h)	0.947***	0.311***	-0.861***	0.960***	0.325***	0.956***	0.044**	1.000						
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	0.021	-----						
(i)	0.764***	0.601***	-0.808***	0.747***	0.301***	0.621***	0.090***	0.623***	1.000					
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	-----					
(j)	-0.619***	0.234***	0.409***	-0.644***	-0.378***	-0.818***	0.011***	-0.759***	-0.326***	1.000				
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	-----				

(k)	-0.455***	-0.076***	0.275***	-0.406***	-0.480***	-0.597***	0.029	-0.568***	0.014	0.598***	1.000			
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.136)	(0.000)	0.476	(0.000)	-----			
(l)	-0.003	0.212***	-0.060***	-0.056***	0.420***	0.044**	0.017	-0.119***	0.501***	0.091***	0.389***	1.000		
	(0.886)	(0.000)	(0.002)	(0.003)	(0.000)	(0.022)	(0.365)	(0.000)	(0.000)	(0.000)	(0.000)	-----		
(m)	0.009	0.013	-0.010	0.009	-0.000	0.004	0.125***	0.009	0.004	0.003	-0.002	-0.008	1.000	
	(0.634)	(0.500)	(0.609)	(0.635)	(0.993)	(0.827)	(0.000)	(0.638)	(0.846)	(0.876)	(0.936)	(0.666)	-----	
(n)	0.012	-0.044**	-0.044**	0.034*	0.161***	0.112***	0.069***	0.086***	0.032*	0.022	0.003	0.109***	0.636***	1
	(0.526)	(0.022)	(0.020)	(0.078)	(0.000)	(0.000)	(0.000)	(0.000)	(0.099)	(0.241)	(0.891)	(0.000)	(0.000)	-

Note: ***,**,*: significance levels at 1%, 5% and 10% respectively.p-value in parentheses.(a) LCO2E ; (b) LIND; (c)LAGRI; (d) LGDPC; (e) LGFCF; (f) LFDV; (g) FDI ; (h) LHUM; (i) LTRD; (j) LTNR; (k) LLAN; (l) LPOP; (m) GOVI; (n) ICT.
Source: Authors' computations, 2023.

Table 6: Full sample SGMM results

	(1)	(2)	(3)	(4)	(5)
Variables	SGMM	SGMM	SGMM	SGMM	SGMM
LCO2E	-0.321*	-0.422*	-0.137	-0.029	-0.109
	(0.186)	(0.216)	(0.085)	(0.055)	(0.209)
LIND	-1.135***	-1.085***	-1.574***	-1.990***	-1.527***
	(0.199)	(0.274)	(0.221)	(0.186)	(0.133)
LAGRI	-0.893***	-0.929***	-1.204***	-1.017***	-1.450***
	(0.186)	(0.270)	(0.339)	(0.166)	(0.296)
LGDPC	-0.091	0.168	-0.354	-0.081	-0.596**
	(0.223)	(0.196)	(0.257)	(0.091)	(0.248)
LGFCF	-0.317	-0.073	-0.371	0.228	-0.411
	(0.236)	(0.317)	(0.268)	(0.179)	(0.250)
LFDV	-0.448***	-0.419***	-0.523***	-0.387***	-0.260***
	(0.095)	(0.075)	(0.122)	(0.051)	(0.065)
FDI	0.011**	0.015***	0.009**	0.007**	0.008
	(0.005)	(0.005)	(0.004)	(0.003)	(0.005)
LHUM	-0.650***	-0.501	-0.590*	-0.482***	-1.563***
	(0.243)	(0.305)	(0.331)	(0.144)	(0.510)
LTRD	0.034	0.021	0.322*	0.147	0.190
	(0.118)	(0.106)	(0.193)	(0.090)	(0.161)
LTNR	0.077**	0.091**	0.114***	0.144***	0.067*
	(0.036)	(0.035)	(0.042)	(0.017)	(0.035)
LLAN	-0.493**	-1.996***	-1.697***	-1.904***	-2.458***
	(0.226)	(0.398)	(0.531)	(0.349)	(0.530)
LPOP	0.362***	1.153***	0.699***	0.727***	1.114***
	(0.112)	(0.198)	(0.202)	(0.091)	(0.245)

GOVI	0.198**	1.147***	0.083	0.880***	-0.091
	(0.080)	(0.393)	(0.053)	(0.274)	(0.089)
GOVI×LTRD		-0.242**			
		(0.095)			
GOVI×FDI			0.005**		
			(0.002)		
GOVI×LIND				-0.277***	
				(0.105)	
GOVI×LAGRI					0.148***
					(0.052)
Net Effect of GOVI	nsa	0.098	na	-0.007	na
Diagnostic test results					
AR(1)	(-1.27)	(-1.41)	(-1.82)	(-1.44)	(-1.08)
p-value	0.158	0.158	0.069	0.150	0.281
AR(2)	(-0.77)	(-1.26)	(1.40)	(0.51)	(-0.83)
p-value	0.206	0.206	0.161	0.608	0.400
Sargan OIR	(0.62)	(0.61)	(0.19)	(0.34)	(0.38)
p-value	0.894	0.894	0.979	0.951	0.943
Hansen OIR	(2.72)	(0.79)	(1.19)	(1.85)	(1.18)
p-value	0.853	0.853	0.756	0.604	0.758
DHT for instruments					
(a)Instruments in levels					
Hansen excluding group	(2.09)	(0.79)	(0.60)	(1.44)	(0.86)
p-value	0.675	0.675	0.739	0.486	0.649
Dif(null, H=exogenous)	0.62	(0.00)	(0.58)	(0.41)	(0.31)
p-value	0.993	0.993	0.445	0.523	0.576
(b) GMM instruments forIV					
Hansen excluding group	0.86	(0.46)	(0.01)	(1.62)	(0.03)
p-value	0.500	0.500	0.914	0.203	0.871
Dif(null, H=exogenous)	1.86	(0.33)	(1.18)	(0.23)	(1.15)
p-value	0.847	0.847	0.556	0.892	0.562
Fisher	4797.74***	16845.68***	20470.13***	35133.53***	27377.26***
Instruments	19	19	19	19	19
Observations	2,572	2,572	2,572	2,572	2,572

Note:***,**,*: significance levels at 1%, 5% and 10% respectively. Standard errors in parentheses. DHT: Difference in Hansen Test for Exogeneity of Instruments Subsets. Dif: Difference. OIR: Over-identifying Restrictions Test. Arellano-Bond test for zero autocorrelation: H_0: no autocorrelation. Sargan test of overidentifying restrictions: H_0: overidentifying restrictions are valid. 183 countries for the full sample. **Source**: Authors' computations, 2023.The mean values of LTRD, FDI, LIND and LAGRI are respectively 4.332, 6.035, 3.204 and 1.894. nsa: 'not specifically applicable' because it is a linear additive model. na: 'not applicable' because at least one estimated coefficient needed for the computation of net effect is not significant. Lagged outcome variables are included in the regressions.

Table 7: SSA SGMM results

	(1)	(2)	(3)	(4)	(5)
Variables	SGMM	SGMM	SGMM	SGMM	SGMM
LCO2E	-17.766***	-5.823*	-11.138***	-22.588***	-11.021***
	(4.739)	(3.441)	(3.345)	(5.714)	(4.060)
LIND	6.085***	-0.865	5.975***	10.005***	2.777
	(1.148)	(2.753)	(1.844)	(2.622)	(3.805)
LAGRI	2.387***	0.193	2.258***	6.357**	-1.792
	(0.391)	(0.798)	(0.637)	(2.673)	(3.944)
LGDPC	2.276	0.978	-0.403	-1.881	1.881
	(3.413)	(0.872)	(2.540)	(3.750)	(2.269)
LGFCF	0.896	0.173	1.792	3.394*	-1.583
	(0.732)	(0.437)	(1.081)	(1.760)	(2.554)
LFDV	0.303	2.112***	1.252	-2.509	1.314*

	(0.867)	(0.575)	(1.155)	(2.165)	(0.736)
FDI	0.057*	0.031*	0.062	0.000	0.050*
	(0.032)	(0.016)	(0.067)	(0.045)	(0.028)
LHUM	9.599***	10.789***	10.293***	12.354***	10.840***
	(0.797)	(0.608)	(1.293)	(2.024)	(1.563)
LTRD	-6.457***	-2.787**	-7.039***	-7.340***	-8.169***
	(0.807)	(1.363)	(1.018)	(0.937)	(1.725)
LTNR	0.523**	1.270***	1.000**	0.941**	1.737
	(0.248)	(0.281)	(0.397)	(0.352)	(1.156)
LLAN	-23.367	3.660	-2.208	-12.450	7.998
	(24.461)	(3.659)	(4.097)	(22.057)	(13.336)
LPOP	1.350	-5.759**	-1.615	8.160*	-8.329
	(1.757)	(2.509)	(3.104)	(4.823)	(8.864)
GOVI	0.091***	-8.685***	-0.042	11.373	4.771
	(0.026)	(3.225)	(0.094)	(7.492)	(4.477)
GOVI×LTRD		2.070***			
		(0.762)			
GOVI×FDI			0.024		
			(0.027)		
GOVI×LIND				-3.590	
				(2.383)	
GOVI×LAGRI					-1.728
					(1.649)
Net Effect of GOVI	nsa	0.282	na	na	na
Diagnostic test results					
AR(1)	(-2.54)	(-2.34)	(-1.04)	(-0.00)	(-2.54)
p-value	0.011	0.019	0.300	1.000	0.011
AR(2)	(1.92)	(2.50)	(0.82)	(-0.00)	(2.22)
p-value	0.255	0.213	0.410	1.000	0.326
Sargan OIR	(2.09)	(6.23)	(5.73)	(10.09)	(0.72)
p-value	0.352	0.513	0.767	0.259	0.948
Hansen OIR	(1.16)	(3.16)	(0.65)	(0.00)	(1.75)
p-value	0.559	0.870	1.000	1.000	0.781
DHT for instruments					
(a)Instruments in levels					
Hansen excluding group	(0.00)	(3.35)	(0.65)	(0.00)	(1.75)
p-value	1.000	0.646	0.999	1.000	0.416
Dif(null, H=exogenous)	(1.16)	(-0.19)	(-0.00)	(0.00)	(0.00)
p-value	0.280	1.000	1.000	1.000	1.000
(b) GMM instruments forIV					
Hansen excluding group	(1.16)	(3.16)	(0.64)	(0.00)	(1.69)
p-value	0.280	0.368	0.727	1.000	0.430
Dif(null, H=exogenous)	(0.00)	(0.00)	(0.01)	(0.00)	(0.07)
p-value	0.993	1.000	1.000	1.000	0.968
Fisher	1460.76***	9877.88***	26951.61***	1724.09***	2422.79***
Instruments	17	23	25	24	20
Observations	668	668	668	668	668

Note: ***,**,*: significance levels at 1%, 5% and 10% respectively. Standard errors in parentheses. DHT: Difference in Hansen Test for Exogeneity of Instruments Subsets. Dif: Difference. OIR: Over-identifying Restrictions Test. Arellano-Bond test for zero autocorrelation: H_0: no autocorrelation. Sargan test of overidentifying restrictions: H_0: overidentifying restrictions are valid.Estimation for 45 Sub-Saharan African (SSA) Countries. **Source**: Authors' computations, 2023.The mean values of LTRD, FDI, LIND and LAGRI are respectively 4.332, 6.035, 3.204 and 1.894. nsa: 'not specifically applicable' because it is a linear additive model. na: 'not applicable' because at least one estimated coefficient needed for the computation of net effect is not significant. Lagged outcome variables are included in the regressions.

Table 8 : MENA SGMM results

	(1)	(2)	(3)	(4)	(5)

Variables	SGMM	SGMM	SGMM	SGMM	SGMM
LCO2E	-2.508***	-2.614***	-1.771***	-2.416***	-1.762***
	(0.090)	(0.191)	(0.223)	(0.119)	(0.128)
LIND	-0.998***	2.693***	-0.313	-0.023	-0.187
	(0.177)	(0.528)	(0.261)	(0.304)	(0.270)
LAGRI	2.154***	1.158***	1.789***	2.022***	0.775***
	(0.089)	(0.141)	(0.104)	(0.127)	(0.231)
LGDPC	-2.062***	-0.726***	-1.024***	-1.651***	-1.173***
	(0.071)	(0.138)	(0.265)	(0.080)	(0.089)
LGFCF	5.061***	5.765***	3.062***	4.674***	4.989***
	(0.150)	(0.321)	(0.496)	(0.165)	(0.289)
LFDV	-2.800***	-1.860***	-1.244***	-2.074***	-2.077***
	(0.117)	(0.067)	(0.397)	(0.147)	(0.188)
FDI	0.005	0.007**	0.024***	0.016*	0.014*
	(0.005)	(0.003)	(0.008)	(0.008)	(0.007)
LHUM	-1.611***	-1.506***	-1.216***	-1.404***	-0.777***
	(0.077)	(0.065)	(0.152)	(0.111)	(0.183)
LTRD	-2.405***	-1.398***	-1.386***	-2.302***	-2.225***
	(0.106)	(0.148)	(0.268)	(0.164)	(0.150)
LTNR	1.266***	-0.022	0.968***	1.171***	0.951***
	(0.036)	(0.211)	(0.080)	(0.061)	(0.100)
LLAN	-13.160***	-15.579***	-16.070***	-19.997***	-12.983***
	(0.400)	(0.524)	(0.944)	(1.677)	(1.465)
LPOP	11.711***	11.409***	12.669***	16.025***	10.485***
	(0.218)	(0.619)	(0.444)	(1.142)	(1.117)
GOVI	-0.088***	6.351***	0.120**	1.200***	-0.635***
	(0.016)	(0.910)	(0.054)	(0.230)	(0.115)
GOVI×LTRD		-1.410***			
		(0.204)			
GOVI×FDI			-0.005***		
			(0.002)		
GOVI×LIND				-0.325***	
				(0.060)	
GOVI×LAGRI					0.659***
					(0.098)
Net Effect of GOVI	nsa	0.242	0.089	0.158	0.613
Diagnostic test results					
AR(1)	(-0.03)	(0.000)	(0.000)	(0.000)	(0.000)
p-value	0.979	0.000	0.000	0.000	0.000
AR(2)	(-2.84)	(0.400)	(0.200)	(0.600)	(0.012)
p-value	0.504	0.510	0.410	0.110	0.310
Sargan OIR	(12.07)	(26.78)	(12.84)	(4.28)	(4.06)
p-value	0.334	1.000	0.412	0.370	0.398
Hansen OIR	(19.44)	(11.73)	(3.41)	(3.74)	(3.78)
p-value	0.002	0.019	0.492	0.442	0.437
DHT for instruments					
(a)Instruments in levels					
Hansen excluding group	(19.44)	(11.73)	(3.41)	(3.74)	(3.78)
p-value	0.001	0.008	0.333	0.291	0.286
Dif(null, H=exogenous)	(-0.00)	(0.00)	(0.00)	(0.00)	(0.00)
p-value	1.000	0.998	1.000	1.000	1.000
(b) GMM instruments for IV					
Hansen excluding group	(19.62)	(15.25)	(6.69)	(4.14)	(4.18)
p-value	0.000	0.000	0.210	0.042	0.241
Dif(null, H=exogenous)	(-0.17)	(-3.51)	(-3.29)	(-0.40)	(-0.40)
p-value	1.000	1.000	1.000	1.000	1.000
Fisher	437620.27***	3.06e+06***	653494.49***	198097.03***	231784.48***
Instruments	20	20	20	20	20

Observations	289	289	289	289	289

Note: ***,**,*: significance levels at 1%, 5% and 10% respectively. Standard errors in parentheses. DHT: Difference in Hansen Test for Exogeneity of Instruments Subsets. Dif: Difference. OIR: Over-identifying Restrictions Test. Arellano-Bond test for zero autocorrelation: H_0: no autocorrelation. Sargan test of overidentifying restrictions: H_0: overidentifying restrictions are valid. Estimation for 20 Middle East and North African (MENA) countries **Source**: Authors' computations, 2023.The mean values of LTRD, FDI, LIND and LAGRI are respectively 4.332, 6.035, 3.204 and 1.894. nsa: 'not specifically applicable' because it is a linear additive model. Lagged outcome variables are included in the regressions.

Table 9: ECA SGMM results

Variables	(1) SGMM	(2) SGMM	(3) SGMM	(4) SGMM	(5) SGMM
LCO2E	3.703***	2.731*	3.368***	-2.567***	5.435***
	(0.004)	(1.385)	(0.002)	(0.768)	(0.132)
LIND	-12.383***	-14.395***	-12.093***	-2.275	-9.252***
	(0.010)	(3.265)	(0.005)	(2.482)	(0.230)
LAGRI	-3.560***	-4.865***	-3.475***	-1.507**	-4.548***
	(0.002)	(0.999)	(0.001)	(0.579)	(0.074)
LGDPC	-0.635***	7.511***	-0.315***	0.000	6.704***
	(0.005)	(0.852)	(0.002)	(0.000)	(0.072)
LGFCF	0.416***	-2.245***	0.348***	1.449***	-4.792***
	(0.002)	(0.653)	(0.002)	(0.341)	(0.069)
LFDV	-0.556***	-0.862***	-0.546***	-1.354***	-1.149***
	(0.001)	(0.170)	(0.000)	(0.131)	(0.016)
FDI	0.000**	0.005	0.000***	0.014***	0.001**
	(0.000)	(0.005)	(0.000)	(0.004)	(0.000)
LHUM	3.920***	1.783*	3.687***	2.984***	-3.666***
	(0.003)	(0.944)	(0.003)	(0.826)	(0.101)
LTRD	3.790***	2.641***	3.719***	1.711***	4.448***
	(0.003)	(0.702)	(0.001)	(0.542)	(0.068)
LTNR	-0.042***	-0.023	-0.019***	0.307***	-0.538***
	(0.000)	(0.093)	(0.000)	(0.069)	(0.010)
LPOP	0.606***	-2.129***	0.484***	-0.427	-1.357***
	(0.003)	(0.626)	(0.001)	(0.300)	(0.055)
GOVI	0.034***	7.347***	0.030***	4.972***	-2.136***
	(0.000)	(1.499)	(0.000)	(0.584)	(0.023)
GOVI×LTRD		-1.614***			
		(0.326)			
GOVI×FDI			-0.000***		
			(0.000)		
GOVI×LIND				-1.588***	
				(0.187)	
GOVI×LAGRI					1.714***
					(0.019)
Net Effect of GOVI	nsa	0.355	0.030	-0.115	1.110
Diagnostic test results					
AR(1)	(-6.63)	(-1.33)	(-6.62)	(-1.91)	(-4.80)
p-value	0.000	0.183	0.000	0.056	0.010
AR(2)	(-6.52)	(-0.76)	(-6.50)	(-0.06)	(4.50)
p-value	0.601	0.448	0.500	0.951	0.210
Sargan OIR	(625.37)	(10.06)	(604.46)	(9.20)	(251.01)
p-value	1.000	0.218	1.000	0.227	0.500
Hansen OIR	(45.00)	(20.53)	(45.18)	(42.65)	(43.72)
p-value	0.000	0.000	0.001	0.000	0.000
DHT for instruments					
(a)Instruments in levels					
Hansen excluding group	(45.00)	(20.53)	(45.01)	(42.65)	(43.72)
p-value	0.000	0.000	0.000	0.000	0.000

Dif(null, H=exogenous)	(0.00)	(0.00)	(0.16)	(0.00)	(0.00)
p-value	0.993	1.000	0.922	1.000	1.000
(b) GMM instruments for IV					
Hansen excluding group	(45.00)	(20.53)	(45.06)		(43.72)
p-value	0.000	0.000	0.000		0.000
Dif(null, H=exogenous)	(0.00)	(-0.00)	(0.12)		(0.00)
p-value	1.000	(1.000)	(1.000)		(1.000)
Fisher	2943.30***	17047.27***	7363.16***	2438.67***	91322.49***
Instruments	18	17	33	17	17
Observations	669	669	669	669	669

Note: ***,**,*: significance levels at 1%, 5% and 10% respectively. Standard errors in parentheses. DHT: Difference in Hansen Test for Exogeneity of Instruments Subsets. Dif: Difference. OIR: Over-identifying Restrictions Test. Arellano-Bond test for zero autocorrelation: H_0: no autocorrelation. Sargan test of overidentifying restrictions: H_0: overidentifying restrictions are valid.Estimation for 47 Europe & Central Asian (ECA) countries. **Source**: Authors' computations, 2023.The mean values of LTRD, FDI, LIND and LAGRI are respectively 4.332, 6.035, 3.204 and 1.894. nsa: 'not specifically applicable' because it is a linear additive model. Lagged outcome variables are included in the regressions.

Table 10: ESAP SGMM results

Variables	(1) SGMM	(2) SGMM	(3) SGMM	(4) SGMM	(5) SGMM
LCO2E	0.354***	3.655**	-2.191***	3.742***	-0.585***
	(0.007)	(1.764)	(0.575)	(0.268)	(0.156)
LIND	-5.037***	-8.820***	-6.124***	-4.894***	1.726***
	(0.009)	(1.657)	(0.269)	(0.263)	(0.441)
LAGRI	0.432***	2.985**	-3.004**	-2.633***	0.741***
	(0.009)	(1.114)	(1.284)	(0.379)	(0.157)
LGDPC	5.648***	-5.242	0.000	7.813***	4.730***
	(0.033)	(5.163)	(0.000)	(1.227)	(0.860)
LGFCF	-1.753***	5.083**	0.871**	-6.318***	-6.455***
	(0.013)	(2.186)	(0.365)	(0.666)	(0.510)
LFDV	0.983***	-4.103***	-0.646	0.396	-0.243
	(0.006)	(1.155)	(0.535)	(0.266)	(0.168)
FDI	-0.001***	-0.186**	-0.058*	0.015**	0.012***
	(0.000)	(0.076)	(0.033)	(0.007)	(0.004)
LHUM	2.988***	-4.631***	0.015	0.304	0.963***
	(0.009)	(1.554)	(0.311)	(0.261)	(0.229)
LTRD	-1.067***	0.011	-1.758***	-0.564***	-1.263***
	(0.002)	(0.493)	(0.089)	(0.087)	(0.037)
LTNR	0.171***	1.450***	0.276***	-0.654***	-0.427***
	(0.002)	(0.374)	(0.066)	(0.131)	(0.092)
LLAN	1.035***	-7.202	0.000	-9.851***	-26.160***
	(0.058)	(10.278)	(0.000)	(2.128)	(1.251)
LPOP	-3.114***	10.261	2.195***	5.336**	16.890***
	(0.055)	(8.979)	(0.135)	(2.085)	(1.324)
GOVI	-0.058***	-4.189***	0.109*	11.419***	-2.642***

	(0.000)	(1.278)	(0.061)	(0.703)	(0.121)
GOVI×LTRD		0.990***			
		(0.299)			
GOVI×FDI			-0.017		
			(0.016)		
GOVI×LIND				-3.714***	
				(0.230)	
GOVI×LAGRI					1.131***
					(0.050)
Net Effect of GOVI	nsa	0.099	na	-0.480	-0.499
Diagnostic test results					
AR(1)	(-5.58)	(0.000)	(-1.34)	(-3.77)	(-4.40)
p-value	0.000	0.000	0.180	0.000	0.000
AR(2)	(-4.24)	(-0.55)	(0.06)	(4.44)	(4.86)
p-value	0.200	0.581	0.954	0.401	0.520
Sargan OIR	(459.94)	(15.99)	(14.43)	(117.49)	(151.59)
p-value	0.221	0.267	0.544	0.601	1.000
Hansen OIR	(32.00)	(11.43)	(28.87)	(31.44)	(31.58)
p-value	0.001	0.248	0.000	0.000	0.000
DHT for instruments					
(a) Instruments in levels					
Hansen excluding group	(31.99)	(10.68)	(28.87)	(31.46)	(31.60)
p-value	0.000	0.258	0.000	0.000	0.000
Dif(null, H=exogenous)	(0.00)	(0.75)	(-0.00)	(-0.02)	(-0.02)
p-value	1.000	0.946	1.000	1.000	1.000
(b) GMM instruments for IV					
Hansen excluding group	(31.99)	(11.81)	(14.41)	(31.43)	(31.53)
p-value	0.000	0.008	0.002	0.000	0.000
Dif(null, H=exogenous)	(0.01)	(-0.38)	(0.34)	(0.02)	(0.05)
p-value	1.000	1.000	1.000	1.000	1.000
Fisher	2350.34***	30300.82***	1875.67***	44985.47***	33023.83***
Instruments	25	24	22	24	24
Observations	470	470	470	470	470

Note: ***,**,*: significance levels at 1%, 5% and 10% respectively. Standard errors in parentheses. DHT: Difference in Hansen Test for Exogeneity of Instruments Subsets. Dif: Difference. OIR: Over-identifying Restrictions Test. Arellano-Bond test for zero autocorrelation: H_0: no autocorrelation. Sargan test of overidentifying restrictions: H_0: overidentifying restrictions are valid.Estimation for 35 East & South Asia and the Pacific (ESAP) countries. **Source**: Authors' computations, 2023.The mean values of LTRD, FDI, LIND and LAGRI are respectively 4.332, 6.035, 3.204 and 1.894. nsa: 'not specifically applicable' because it is a linear additive model. na: 'not applicable' because at least one estimated coefficient needed for the computation of net effect is not significant.

Table 11: America SGMM results

Variables	(1) SGMM	(2) SGMM	(3) SGMM	(4) SGMM	(5) SGMM
LCO2E	-1.853***	-1.335***	-3.421***	-1.757***	-1.442***
	(0.002)	(0.259)	(1.188)	(0.016)	(0.471)
LIND	5.218***	-0.841	-2.352***	4.566***	-0.119
	(0.012)	(2.180)	(0.328)	(0.097)	(3.565)
LAGRI	-2.720***	-2.004***	-2.545***	-3.332***	-3.291***
	(0.002)	(0.377)	(0.641)	(0.029)	(0.828)
LGDPC	-8.630***	-11.863***	-1.918***	-14.347***	-15.006***
	(0.011)	(2.475)	(2.949)	(0.064)	(1.846)
LGFCF	1.509***	3.828***	-1.172	0.968***	3.017**
	(0.006)	(0.980)	(2.829)	(0.050)	(1.216)
LFDV	1.391***	-0.742	6.129*	4.280***	2.789***
	(0.003)	(0.760)	(3.364)	(0.050)	(0.743)

FDI	0.000**	0.090***	0.035	-0.000	0.072***
	(0.000)	(0.028)	(0.065)	(0.002)	(0.021)
LHUM	3.268***	4.211***	4.305***	4.682***	3.699***
	(0.003)	(0.766)	(1.131)	(0.025)	(0.723)
LTRD	-1.870***	-0.839	-5.100***	-2.617***	-2.505***
	(0.003)	(0.646)	(1.841)	(0.029)	(0.589)
LTNR	-0.305***	0.151	-0.538	0.115***	0.341
	(0.001)	(0.147)	(0.468)	(0.007)	(0.307)
LLAN	24.750***	7.857***	0.148**	36.487***	21.915***
	(0.031)	(1.590)	(0.950)	(0.393)	(6.167)
LPOP	-14.974***	0.000	-38.491*	-20.939***	-8.651
	(0.025)	(0.000)	(21.730)	(0.308)	(5.557)
GOVI	-0.067***	2.050*	-0.341	-6.220***	-3.148
	(0.000)	(1.030)	(0.220)	(0.105)	(1.972)
GOVI×LTRD		-0.501**			
		(0.246)			
GOVI×FDI			0.044		
			(0.035)		
GOVI×LIND				1.944***	
				(0.033)	
GOVI×LAGRI					1.800
					(1.152)
Net Effect of GOVI	nsa	-0.120	na	0.008	na
Diagnostic test results					
AR(1)	(-5.66)	(-1.64)	(-0.74)	(-5.57)	(-1.63)
p-value	0.001	0.101	0.458	0.010	0.103
AR(2)	(-5.64)	(-0.74)	(-0.67)	(5.36)	(-0.73)
p-value	1.000	0.457	0.502	0.401	0.463
Sargan OIR	(463.84)	(7.90)	(3.08)	(237.46)	(7.30)
p-value	0.820	0.639	0.279	1.000	0.606
Hansen OIR	(32.00)	(6.11)	(0.08)	(30.25)	(6.60)
p-value	0.001	0.806	0.776	0.000	0.679
DHT for instruments					
(a) Instruments in levels					
Hansen excluding group	(32.00)	(6.12)	(6.31)	(30.24)	(6.60)
p-value	0.000	0.410	0.277	0.000	0.359
Dif(null, H=exogenous)	(0.00)	(-0.01)	(0.04)	(0.000)	(-0.01)
p-value	1.000	1.000	0.979	1.000	1.000
(b) GMM instruments for IV					
Hansen excluding group	(31.98)	(6.64)	(6.36)	(29.95)	(6.92)
p-value	0.00	0.156	0.442	0.000	0.031
Dif(null, H=exogenous)	(0.01)	(-0.53)	(0.00)	(0.30)	(-0.33)
p-value	1.000	1.000	1.000	1.000	1.000
Fisher	8047.20***	5355.75***	8266.35***	10749.42***	1194.63***
Instruments	25	24	17	24	24
Observations	476	476	476	476	476

Note: ***,**,*: significance levels at 1%, 5% and 10% respectively. Standard errors in parentheses. DHT: Difference in Hansen Test for Exogeneity of Instruments Subsets. Dif: Difference. OIR: Over-identifying Restrictions Test. Arellano-Bond test for zero autocorrelation: H_0: no autocorrelation. Sargan test of overidentifying restrictions: H_0: overidentifying restrictions are valid. Estimation for36 American countries. **Source**: Authors' computations, 2023.The mean values of LTRD, FDI, LIND and LAGRI are respectively 4.332, 6.035, 3.204 and 1.894. nsa: 'not specifically applicable' because it is a linear additive model. na: 'not applicable' because at least one estimated coefficient needed for the computation of net effect is not significant.

References

Acemoglu, D., & Johnson, S. (2005). Unbundling institutions. *Journal of Political Economy*, 113(5), 949–995.

Acemoglu, D., Johnson, S., Robinson, J., & Thaicharoen, Y. (2003). Institutional causes, macroeconomic symptoms: Volatility, crises and growth. *Journal of Monetary Economics*, 50(1), 49–123.

Adam, I. O. (2020). Examining E-Government development effects on corruption in Africa: The mediating effects of ICT development and institutional quality. *Technology in Society*, *61*(February), 101245.

Adebayo, T. S., Agyekum, E. B., Altuntaş, M., Khudoyqulov, S., Zawbaa, H. M., & Kamel, S. (2022). Does information and communication technology impede environmental degradation? fresh insights from non-parametric approaches. *Heliyon*, *8*(3), e09108.

Adegboye, A., Ojeka, S. A., Tolase, O., Omoremi, O., & Jude-Okeke, Y. (2021). Technology penetration and human development nexus in middle-income countries: the synergy effect of inclusive resources distribution. *Information Technology for Development*, 1-15.

Akpa, A. F., & Asongu, S. A., (2023). The role of governance in the effect of the internet on financial inclusion in sub-Saharan Africa. *EXCAS Working Paper* No. 23/004, Liège.

Ali, S. H., Law, S. H., Yusop, Z., & Chin, L. (2016). Institutional Quality and Financial Inclusion Nexus in Developing Countries: a Dynamic Panel GMM Estimation Analysis. Paper presented at the 18th Malaysian Finance Association Annual Conference (MFAC) 2016 and The 7th Islamic Banking, Accounting and Finance Conference (iBAF) 2016 on 29th-31st May, 2016 at Equatorial Hotel, Melaka-Malaysia.

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, 91-103.

Andrés, R. A, Asongu, S. A., &Amavilah, V. H., (2015). The impact of formal institutions on knowledge economy.*Journal of the Knowledge Economy*, 6(4), pp. 1034-1062.

Anthony-Orji, O. I., Orji, A., Ogbuabor, J. E., & Nwosu, E. O. (2019). Do financial stability and institutional quality have impact on financial inclusion in developing economies? A new evidence from Nigeria. *International Journal of Sustainable Economy*, 11(1), 18–40.

Asamoah, L. A. (2021). Institutional Quality and Income Inequality in Developing Countries: A Dynamic Panel Threshold Analysis. *Progress in Development Studies*, *21*(2), 123–143.

Asongu, S. A., (2016). Determinants of growth in fast developing countries: evidence from bundling and unbundling institutions. *Politics & Policy*, 97(1), pp. 97-134.

Asongu, S. A. (2017). Knowledge economy gaps, policy syndromes, and catch-up strategies: Fresh South Korean lessons to Africa. *Journal of the Knowledge Economy*, 8(1), 211-253.

Asongu, S. A. (2021). The effects of mobile phone technology, knowledge creation and diffusion on inclusive human development in sub-Saharan Africa. *Journal of the Knowledge Economy*, *12*(3), 1367-1398.

Asongu, S. A., & Biekpe, N. (2017). Government quality determinants of ICT adoption in Sub-Saharan Africa. *NETNOMICS: Economic Research and Electronic Networking*, 18, 107-130.

Asongu, S. A, & De Moor, L., (2017). "Financial Globalisation Dynamic Thresholds for Financial Development: Evidence from Africa", *European Journal of Development Research*, 29(1), pp.192-212.

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

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

Asongu, S. A., & Odhiambo, N. M. (2019a). Basic formal education quality, information technology, and inclusive human development in sub‐Saharan Africa. *Sustainable Development*, *27*(3), 419-428.

Asongu, S. A., & Odhiambo, N. M. (2019b). Enhancing ICT for quality education in sub-Saharan Africa. *Education and information technologies*, *24*(5), 2823-2839.

Asongu, S. A., & Odhiambo, N. M. (2022). Information technology and sustainability in developing countries: An introduction *Telecommunications Policy*, 46(6), 102383

Asongu, S. A., Nwachukwu, J. C., & Pyke, C. (2019). The comparative economics of ICT, environmental degradation and inclusive human development in Sub-Saharan Africa. *Social Indicators Research*, *143*(3), 1271-1297.

Avom, D., Nkengfack, H., Fotio, H. K., & Totouom, A. (2020). ICT and environmental quality in Sub-Saharan Africa: Effects and transmission channels. *Technological Forecasting and Social Change*, *155*, 120028.

Aymar, G. Z. U. J., & Fabrice-Gilles, N. A. (2021). Institutional Environment and Financial Inclusion in Sub-Saharan Africa. *Modern Economy*, 12(2013), 477–494.https://doi.org/10.4236/me.2021.123025

Bayar, Y., Gavriletea, M. D., & Paun, D. (2021). Impact of mobiles phones and internet use on financial inclusion: empirical evidence from the EU post communist countries. *Technological and Economic Development of Economy*, 27(3), 722–741.

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

Boulianne, S., (2009). Does internet use affect engagement? A meta-analysis of research. *Political Communication*, 26(2), pp. 193-211.

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

Breuer, A., Landmann, T., & Farquhar, D., (2012). Social media and protest mobilization: evidence from the Tunisian revolution. *Democratization*, 22(4), pp. 764-792.

Canh, N. P., Schinckus, C., & Thanh, S. D. (2020). The natural resources rents: Is economic complexity a solution for resource curse? *Resources Policy*, *69*(May), 101800.

Chatterjee, A. (2020). Information Technology for Development Financial inclusion , information and communication technology diffusion , and economic growth : a panel data analysis. *Information Technology for Development*, 26(3), 607–635. https://doi.org/10.1080/02681102.2020.1734770

Chinoda, T., & Kwenda, F. (2019). The impact of institutional quality and governance on financial inclusion in Africa: A two-step system generalised method of moments approach. *Journal of Economic and Financial Sciences*, 12(1), 1-9.

Chu, L. K., Minh, P. N., & Huong, T. H. D. (2019). Determinants of Financial Inclusion: New Evidence from Panel Data Analysis. (March 5, 2019). Available at SSRN: https://ssrn.com/abstract = or http://dx.doi.org/10.2139/ssrn.3346911

Diamond, L., (2010). Liberation technology.*Journal of Democracy*, 21(3), 69-83.

Dossou, T. A. M., Kambaye, E. N., Berhe, M. W., & Asongu, S. A. (2023). Moderating effect of ICT on the relationship between governance quality and income inequality in sub-Saharan Africa. *Information Development*, 02666669231170396.

Dutta, U. P., Gupta, H., & Sengupta, P. P. (2019). ICT and health outcome nexus in 30 selected Asian countries: Fresh evidence from panel data analysis. *Technology in Society*, *59*, 101184.

Grossman, G., Humphreys, M.,& Sacramone-Lutz, G., (2014). "I wld like u WMP to extend electricity 2 our village": On Information Technology and Interest Articulation, *American Political Science Review*, 108(3), pp. 688-705.

Harahap, M. A. K., Kraugusteeliana, K., Pramono, S. A., Jian, O. Z., & Ausat, A. M. A. (2023). The Role of Information Technology in Improving Urban Governance. *Jurnal Minfo Polgan*, 12(2), 371-379.

Hellstrom, J. (2008). Mobile phones for good governance– challenges and way forward. Stockholm University / UPGRAID,http://www.w3.org/2008/10/MW4D_WS/papers/hellstrom_gov.pdf(Accessed: 22/11/2015).

Higón, D. A., Gholami, R., &Shirazi, F. (2017). ICT and environmental sustainability: A global perspective. *Telematics and Informatics*, *34*(4), 85-95.

Kaufmann, D., Kraay, A & Mastruzzi, M., (2010). The worldwide governance indicators: methodology and analytical issues. *World Bank Policy Research Working Paper* No 5430, Washington.

Kennedy, P. (2008). A Guide to Econometrics. Oxford: Blackwell Publishing.

Lenka, S. K., & Barik, R. (2018). Has expansion of mobile phone and internet use spurred financial inclusion in the SAARC countries ? *Financial Innovation*, 4(1), 1-19.

Livingstone, S. (2012). Critical reflections on the benefits of ICT in education. *Oxford review of education*, *38*(1), 9-24.

Madestam, A. (2014). Informal finance: a theory of moneylenders. *Journal of Development Economics*., 107, 157–174.

Majeed, M. T., & Khan, F. N. (2019). Do information and communication technologies (ICTs) contribute to health outcomes? An empirical analysis. *Quality & quantity*, *53*(1), 183-206.

Manacorda, M., & Tesei, A., (2016). Liberation technology: mobile phones and political mobilization in Africa. Queen Mary University of London,http://personal.lse.ac.uk/manacorm/liberation_technology.pdf(Accessed: 20/02/2016).

Merrell, I. (2022). Blockchain for decentralised rural development and governance. *Blockchain: Research and Applications*, 3(3), 100086.

Morozov, E., (2011), The Net Delusion: How Not to Liberate The World. London: Penguin Books.

Muriu, P. W. (2021). Does the Quality of Institutions Matter for Financial Inclusion ? Cross Country Evidence. *International Journal of Economics and Finance*, 13(7), 27–41.https://doi.org/10.5539/ijef.v13n7p27

Nchofoung, T. N., & Asongu, S. A. (2022). ICT for sustainable development: Global comparative evidence of globalisation thresholds. *Telecommunications Policy*, *46*(5), 102296.

Nchofoung, T., Asongu, S., & Tchamyou, V. S. (2022a). Tourism, ICT and inclusive development: global evidence. *EXCAS Working Paper*, 22/037, Liege.

Nchofoung, T., Asongu, S., & Tchamyou, V. S. (2022b). *Effect of women' s political Inclusion on the level of infrastructures in Africa* (No. 22/004). The Association for Promoting Women in Research and Development in Africa (ASPROWORDA).

N'dri, L. M., Islam, M., &Kakinaka, M. (2021). ICT and environmental sustainability: any differences in developing countries?*Journal of Cleaner Production*, *297*, 126642.

Nguyen, C. P., Schinckus, C., Su, T. D., & Chong, F. H. L. (2021). The Influence of Tourism on Income Inequality. *Journal of Travel Research*, *60*(7), 1426–1444.

North, D.C. (1989). Institutions and economic growth: An historical introduction. *World Development*, 17(9),1319-1332.

Ofori, Isaac K., Dossou, T. A. M., & Akadir, S. S. (2021). Towards The Quest To Reduce Income Inequality In Africa: Is There A Synergy Between Tourism Development And

Governance? *Current Issues in Tourism,* 26(3), 429-449.

Okoroafor, D. O. K., Adeniji, S., David, O. O. K., Oluseyi, A. S., & Emmanuel, A. (2018). Empirical Analysis of the Determinants of Financial Inclusion in Nigeria: 1990-2016. *Journal of Finance and Economics*, 6(1), 19–25.https://doi.org/https://doi.org/10.12691/jfe-6-1-3

Ongo Nkoa, B. E., & Song, J. S. (2020). Does institutional quality affect financial inclusion in Africa ? A panel data analysis. *Economic Systems*, 44(4), 100836.https://doi.org/10.1016/j.ecosys.2020.100836

Pierskalla, J. H., & Hollenbach, F. M., (2013). Technology and collective action: the effect of cell phone coverage on political violence in Africa.*American Political Science Review*, 107(2), pp. 207-224.

Reuters (2021). Sudan internet cuts complicate civil disobedience campaign against coup. Reuters, https://www.reuters.com/world/africa/sudan-internet-cutscomplicate-civil-disobedience-campaign-against-coup2021-11-07/ (Accessed: 10/12/2022).

Rogers, E. (2003). Diffusion of Innovations, 5th ed., Free Press, New York, NY

Saba, C. S. (2023). Nexus between CO2 emissions, renewable energy consumption, militarisation, and economic growth in South Africa: Evidence from using novel dynamic ARDL simulations. *Renewable Energy*, *205*, 349-365.

Saba, C. S., & Biyase, M. (2022). Determinants of renewable electricity development in Europe: Do Governance indicators and institutional quality matter?. *Energy Reports*, *8*, 13914-13938.

Saba, C. S. & Ngepah, N. (2022a). Convergence in renewable energy sources and the dynamics of their determinants: An insight from a club clustering algorithm. *Energy Reports,* 78, 116-125*https://doi.org/10.1016/j.egyr.2022.01.190*

Saba, C. S. & Ngepah, N. (2022b). Convergence in renewable energy consumption and their influencing factors across regions: evidence from convergence algorithm approach. *Environmental Science and Pollution Research*https://doi.org/10.1007/s11356-022-19731-9

Saba, C. S., & Ngepah, N. (2022c). ICT diffusion, industrialisation and economic growth nexus: An international cross-country analysis. *Journal of the Knowledge Economy*, *13*(3), 2030-2069.

Sami, M., Ali, B., & Gasmi, A. (2017). Does ICT diffusion matter for corruption ? An Economic Development Perspective. *Telematics and Informatics*, 34(8), 1445-1453

Sassi, S., & Ben Ali, M. S. (2017). Corruption in Africa: What role does ICT diffusion play. *Telecommunications Policy*, *41*(7–8), 662–669.

Schopf, J. C. (2019). Room for improvement: Why Korea's leading ICT ODA program has failed to combat corruption. *Telecommunications Policy*, *43*(6), 501–519.

Senou, M. M., Ouattara, W., & Acclassato, D. (2019). Financial inclusion dynamics in WAEMU : Was digital technology the missing piece ? *Cogent Economics & Finance*, 7(1), 1665432
https://doi.org/10.1080/23322039.2019.1665432

Suarez, S. L., (2006). Mobile democracy: text messages, voter turnout and the 2004 Spanish general election.*Representation*, 42(2), pp. 117-128.

Tchamyou, V. S., & Asongu, S. A. (2017). Information sharing and financial sector development in Africa. *Journal of African Business*, 18(7), 24–49.

Tusalem, R. F., (2015). State regulation of religion and the quality of governance. P*olitics & Policy*, 43(1), pp. 94-141.

Wantchekon, L., & Riaz, Z. (2019). Mobile technology and food access. *World Development*, *117*, 344–356.

Weidmann, J. N., & Shapiro, N. B., (2015). Is the phone mightier than the sword? Cellphones and insurgent violence in Iraq.*International Organisation*, 69(2), 247-274.