economies

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Empirical Analysis of Inclusive Growth, Information and Communication Technology Adoption, and Institutional Quality

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Abstract: Using a sample of 193 countries from 2010 to 2019, this study investigates the impact of institutional quality index (IQI) and information and communication technology (ICT) on inclusive growth. The study engaged the panel spatial correlation consistent (PSCC-FE), instrumental variable-generalized method of moments (IV-GMM), and simultaneous quantile regressions (SQREG) models to assess if the impact differs by economic development (high-, low-, lower-middle- and upper-middle-income countries). The following findings emerge. The effect of IQI is positive across all models from the full sample, while that of ICT is heterogeneous, with mobile phones having a significant positive impact. The interaction effect is observed to be sensitive to the choice of ICT indicator. From the sub-samples, both IQI, ICT and their interaction show significant heterogeneous effect with consistent positive (negative interaction) outcomes in high-income countries. Thus, our findings strongly suggest that policymakers should prioritize institutional quality and ICT to ensure that economic growth translates into better living conditions for people in other income groups.

Keywords: inclusive growth; ICT; institutions

Citation: Adeleye, Bosede Ngozi, Sodiq Arogundade, and Biyase Mduduzi. 2023. Empirical Analysis of Inclusive Growth, Information and Communication Technology Adoption, and Institutional Quality. *Economies* 11: 124. https://doi.org/10.3390/economies11040124

Academic Editor: Ralf Fendel

Received: 12 February 2023
Revised: 25 March 2023
Accepted: 29 March 2023
Published: 19 April 2023

1. Introduction

Investigations of what makes some countries poor and others rich are 'long-standing' and extensively discussed by economists and policymakers. Originating from the careful analysis of Swan (1956) and Solow (1956), the neoclassical growth theory placed emphasis on technological progress as the key contributing factor to economic growth. The neoclassical theory has advanced substantially since Solow and Swan's time and now gives prominence to other contributing factors such as education (Lucas 1988) and innovation (Romer 1986). Neoclassical theories continue to be influential in shaping our knowledge of economic growth. While the debate persists regarding this key question, some economists have identified institutions and ICT as key drivers of economic growth.

A distinguished body of literature puts a great deal of emphasis on institutionally related explanations of economic growth. According to an ardent and devoted supporter of institutional-augmented growth models (Acemoglu et al. 2005), economic institutions influence a wide range of economic outcomes, including how resources will be distributed. (i.e., the distribution of wealth, physical capital, or human capital). In other words, they impact how the pie is distributed among various societal groups and people.

For economists and policymakers, the role of institutions on economic growth has become an important area of investigation (Ross 2001; Acemoglu and Robinson 2001; Rodrik et al. 2004). More recently, several studies have looked at how institutions can influence military spending-growth nexus (Compton and Paterson 2016); how natural resources may negatively influence growth in the presence of poor institutions (Acemoglu et al. 2009; Sala-i-Martin and Subramanian 2013); and the role institutions in the nexus between foreign direct investment and poverty (Arogundade et al. 2022a).

The second strand of literature claims that growth acceleration is largely fuelled by the ICT revolution emphasising the role of ICT as the chief determinant of economic growth (Oliner and Sichel 2000). Noticeable scholars in this field include Jorgenson and Stiroh (2000) and Brynjolfsson and Hitt (2000). In these studies, ICT is believed to be growth-enhancing. In contrast to the developed countries, ICT-growth nexus in low-income and middle-income countries is poorly studied. Partly inspired by the 'leapfrogging hypothesis' of Steinmueller (2001), some studies have recently attempted to unravel the degree to which less developed countries can benefit from ICT (Adeleye and Eboagu 2019; Tallon and Kraemer 2000). Promisingly, a consensus is emerging that ICT appears to be beneficial for economic growth (Adeleye and Eboagu 2019; Albiman and Sulong 2016), socio-economic development (Roztocki et al. 2019) and more recently, inclusive growth (Adeleye et al. 2021a) in less developed countries.

While this area of investigation (i.e., institutions–growth nexus & ICT–growth relationship) has been gaining momentum more recently (Acemoglu et al. 2005, for a detailed account), far less is known about the effect of institutions and ICT on inclusive growth. As the global economy entered the twenty-first century, there has been growing alertness towards inclusive growth (see Adeleye et al. 2021b). Policymakers in every continent of the world worry that a high level of economic growth is not shared by all the people living there. This is also coming at a time when high levels of unemployment, poverty and inequality accompany growth. The reality and realization that economic growth only benefits some sections of the population (but not all) are gradually becoming part of the development agenda. For example, the operations of the World Bank Group's support for inclusive growth at the country program and project levels has been paying a great deal of attention to inclusive growth. Despite promising discussions about the potential inclusive growth strategies, the concept of inclusive growth remains loosely defined. Some important scholars in this field (Rauniyar and Kanbur 2010) define inclusive growth as growth associated with reduced inequality.

The scatter plot of inclusive growth[1] and institutional quality[2] is presented in Figure 1. The plot demonstrates that countries with relatively high institutional quality are characterized with high inclusive growth regardless of the income group classification. In contrast, countries with poor institutional framework are associated with low inclusive growth. The quality of institutions has a direct and significant impact on the performance of economies; as a result, economies with robust institutions—such as the rule of law, efficient and effective government, and property rights—tend to perform better in terms of market efficiency, resource allocation and healthy competition among local businesses. However, nations with weak institutions are frequently characterized by high transaction costs, risk for lengthy trade agreements, ineffective contract enforcement, and corruption, all of which may impede growth and development (Arogundade et al. 2021; Brahim and Rachdi 2014). Hence, it is expected that countries with different levels of institutional quality across regions would have different levels of institutional quality. If not supported by empirical evidence, this conjecture may be nonsensical, lacking objectivity.

This paper is novel and differs from existing empirical studies in several ways. First, unlike the study of Acemoglu and Johnson (2005), we explore the effects of ICT and institutional quality from the inclusive growth perspective derived from the human development index from UNDP (2019). The rationale for using the human development index is that it anchors on three pillars of human development: education, life expectancy and standard of living—the most appropriate measure of inclusive growth (Adeleye et al. 2021a). Policymakers around the world are not interested in stimulating economic growth for the sake of economic growth, but they do so with the intention of reducing poverty and inequality (Ajide et al. 2021). According to Klasen (2010), there is a need to consider measures (such as non-income measures) which encompass more than just income measures.

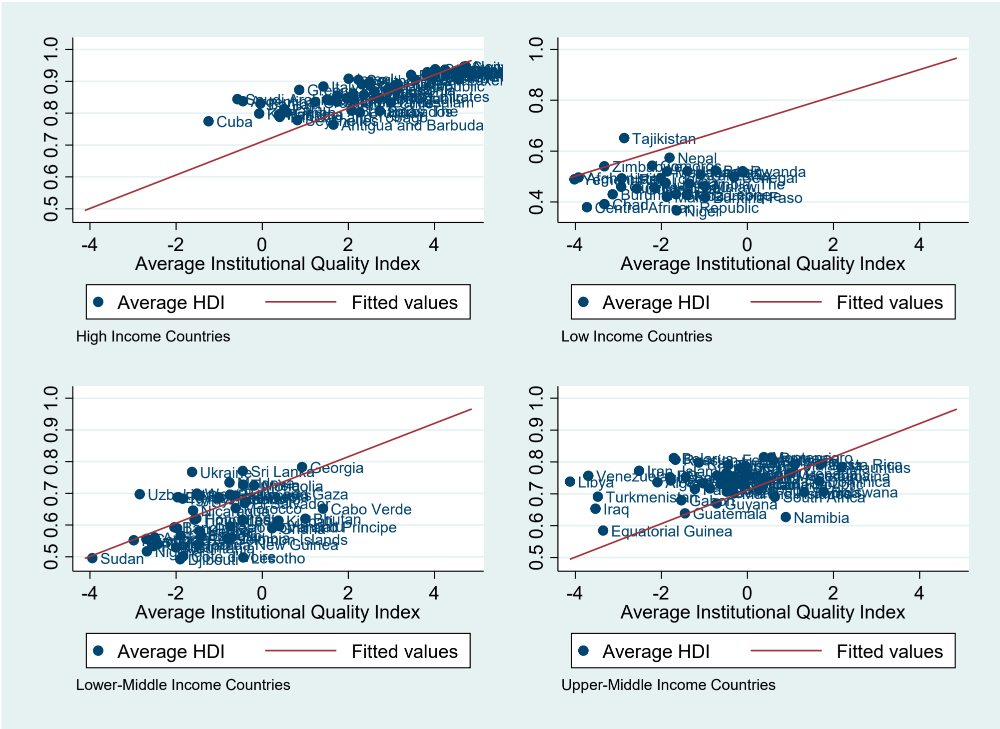

Figure 1. Institutional Quality and Inclusive Growth. Source: Authors' computation using WGI and UNDP, 2019 dataset.

Secondly, instead of capturing the impact of institutions with a single institutional variable, this study adds to the body of literature by creating an institutional index using the six governance indicators of the World Bank (2020a) using principal component analysis. Because there are so many indicators of institutional quality, it can be difficult to determine which one best represents it or is most relevant for an empirical investigation. This is why the Principal Component investigation is used. Moreover, policymakers need to understand the relationship between institutional quality and inclusive growth because poor or weak institutions can misallocate resources, which negatively impacts the economic growth process (Mbulawa 2015).

Thirdly, we consider the interaction term of an institutional quality index with each indicator of ICT indicator included to determine if the net impact of quality institutions on inclusive growth is boosted or hampered by ICT usage. We also controlled for various factors, including capital, labour, ICT adoption (proxied by mobile subscription and fixed telephones), inflation and trade in the IV-GMM framework, which accounts for endogeneity bias arising from reverse causality and omitted variables.

Lastly, we examine the impact of institutions on inclusive growth by differentiating between countries according to their level of development, such as low-income economies, low-middle-income economies, and high-income economies.

The following sub-questions guide this study: (i) Does institutional quality and ICT influence inclusive growth? (ii) How does ICT adoption interact with institutional quality in determining inclusive growth? (iii) Does the effect of ICT and institutional quality vary by the countries' economic development level? (iv) Does ICT moderate the impact of institutional quality on inclusive growth?

The rest of the paper is organized as follows. Section 2 provides a brief overview of the existing studies on the link between institutions and inclusive growth. Section 3 describes the methodology and data to be used in this paper. Section 4 presents the estimates of the impact of institutions on inclusive growth and discuss the results. Section 5 presents the conclusion with policy recommendations.

2. Brief Literature Review

This section briefly reviews related studies from two empirical standpoints: ICT–growth nexus and institutional quality growth relations. Much empirical research on the effects of ICT and institutional quality on the economy has been conducted. However, those studies have reported varying results. The reason why there is conflicting results is because of the measures of institutional quality and ICT, the scope of the study and the empirical technique(s) used.

2.1. Institutional Quality and Inclusive Growth

The theoretical nexus between quality of institutions and the economy has been established by the studies of North (1990), Olson (1982) and Jones (1987). These studies argue that a sound institution can influence a country's ability to progress economically. Institutions, according to North (1990), are the rules of the economic game. According to him, institutions establish market regulations, organize relationships between economic players and make sure that these regulations bind economic activity (George et al. 2021). Competition, which promotes technological advancement, creativity, and productivity increases, is always encouraged in an environment safeguarded by market rules. Similarly, Romer (1986) asserts that knowledge and sound institutions are essential for boosting production size and economic growth. By facilitating easier access to information and predictable actor behaviour, effective institutions are necessary to lower the inherent uncertainty in economic interactions. The quality of a nation's institutions is what determines the total productivity of its production components, according to a similar perspective by Hall and Jones (1999). Additionally, Acemoglu and Robinson (2010) contend that institutions are the fundamental driver of economic progress and are responsible for regional differences in development. Bad institutions, on the other hand, are often characterized by weak contract enforcement, high transaction costs, corruption, and risk for long-term trade commitments (Farole et al. 2011).

Numerous empirical studies on the relationship between strong institutions and long-term economic growth have been conducted. For instance, Sondermann (2018) contends that nations with sound institutions have economic shock resistance. Boschma and Capone (2016) further stressed the necessity of ongoing improvements in institution quality since they promote economic growth and increase product variety. Nawaz et al. (2014) show that institutions play a crucial role in predicting the long-term economic growth of Asian nations using fixed effect and dynamic GMM approaches. The study also demonstrates that the influence of institutional quality on economic growth varies according to economic development levels. Using a panel smooth transition regression model (PSTR) for a sample of 128 developed and developing countries, Marakbi and Turcu (2016) reveal a non-linear relationship between corruption and economic growth conditional on changes in institutional development. Similarly, the study of Arogundade et al. (2021) concludes that sound institutions are germane in enhancing the effect of FDI on inclusive human development in Africa. Despite the overwhelming support for the growth-enhancing impact of institutional quality, studies like Williamson (2009) and Rodrik (2006) could not establish a strong link between a robust institutional framework and economic growth. They argue that since countries may have to follow different development paths, institutions should not be transplanted to enhance economic development.

2.2. ICT Adoption and Inclusive Growth

On the theoretical connection between telecommunications infrastructure and development, there are two schools of thought. Technophiles who believe that telecommunications have a beneficial impact on development make up the first school of thought. ICT, according to technophiles, will increase productivity, increase job prospects, enhance working conditions for many people, and provide a variety of chances for small-scale, autonomous, and decentralized types of production. (Dholakia and Harlam 1994; Castells 1989; Mansell and Wehn 1998). Technophobes, on the other hand, assert that telecommunications have a negative impact on development and widen the information gap between the wealthy and the poor, the literate and the ignorant. (Van Dijk and Hacker 2003; Mansell 1999).

Most of the early empirical literature on the impact of telecommunication technologies concludes that investment in telecommunication infrastructure strongly influences economic growth. Some of these studies include Roller and Waverman (2001), who used data on 21 OECD (Organisation for Economic Co-operation and Development) countries spanning 20 years; Aghaei and Rezagholizadeh (2017), who looked at how Information and Communication Technology (ICT) affected the economic development of Organization of Islamic Conference (OIC) nations; Toader et al. (2018), who looked at how ICT affected the economic development of European nations over the course of 18 years.

On studies related to developing countries, a growing number of empirical studies have suggested that ICT adoption and investments have a beneficial and significant impact on their economies' growth. For instance, Adeleye and Eboagu (2019) used the generalized method of moments (GMM) to evaluate the effect of ICT development on economic growth in Africa. The study finds ICT to be crucial toward the economic growth drive of African countries. The study further concludes that the "leapfrogging" hypothesis holds for Africa. Similarly, using the OLS and system GMM model, Batuo (2015) provides empirical evidence for the growth-enhancing impact of ICT development in 44 selected African countries. In addition, using the endogenous growth model, Chavula (2013) argues that telephone main lines and mobile telephony significantly and positively impact the living standards of 49 African countries.

Additionally, Asongu and Le Roux (2017) demonstrate that policies intended to promote ICT (mobile phone, internet, and telephone) penetration will increase inclusive development in the post-2015 sustainable development agenda using a sample of 49 sub-Saharan African (SSA) nations from 2002 to 2012. However, Ejemeyovwi and Osabuohien (2020) used a System Generalised Method of Moments (SGMM) to investigate the relevance of mobile technology adoption on inclusive growth in West Africa. The study concludes that mobile technology adoption has an insignificant impact on inclusive growth in West Africa.

2.3. ICT Adoption and Institutional Quality

To justify the interaction of institutions and ICT in this study, we review some studies on the relationship between ICT and institutional quality. The conjecture is that ICT adoption can improve the quality of governance via information sharing with the public (Zuiderwijk and Janssen 2014; Sassi and Ali 2017). In other words, the efficiency, accountability, and transparency of governance is facilitated on the platform of ICT. The bulk of the literature finds a direct relationship between ICT and the quality of governance (Belanger and Carter 2012; Mohammed et al. 2016; Ziemba et al. 2016; Adam 2020). For instance, Popelyshyn et al. (2019) show that ICT improved governance transparency in Ukraine when open data were adopted. Adam (2020) demonstrates that ICT development and quality of institution significantly mediate the impact of e-government on corruption in Africa. In another dimension, Sassi and Ali (2017) reveal that skilled competency in ICT usage is required to have an appreciable impact on institutions. In addition, Rana et al. (2013) conclude that the dearth of ICT infrastructure contributes to the inefficiency of governance in Africa. However, Darusalam et al. (2021) found a non-significant impact of ICT on institutional quality from a panel of Association of Southeast Asian Nation (ASEAN) countries from 1984 to 2017. Given these outcomes, we tilt towards the general opinion and hypothesize that ICT moderates the impact of institutional quality on inclusive growth.

3. Data and Model

This study uses eleven variables across 193 selected countries[3] from 2010 to 2019 to achieve the objectives. The choice of countries and variables was based on data availability. To ensure a detailed investigation of the subject matter, the sample is disaggregated into high, low, lower-middle, and upper-middle-income countries according to the 2020 World Bank Classification to allow for sub-group analysis.

3.1. The Variables

The dependent variable is inclusive growth. Different studies use diverse proxies to measure this phenomenon (Acemoglu et al. 2009; Acemoglu and Robinson 2010; Anand et al. 2013; Johnson 2016; Tella and Alimi 2016; Asongu and Nwachukwu 2017; Asongu and Boateng 2018; Ejemeyovwi and Osabuohien 2020; Oyinlola et al. 2020; Ofori and Asongu 2021) but we chose to proxy inclusive growth using the human development index from UNDP (2019). This is because the index anchors on three pillars of human development: education, life expectancy, and standard of living. Hence, we find it as the most appropriate measure of inclusive growth (Adeleye et al. 2021a).

The main independent variable is an index of institutional quality. Studies have used different indicators (Acemoglu and Johnson 2005; Acemoglu et al. 2009; Acemoglu and Robinson 2010; Acemoglu and Robinson 2013; Adeleye et al. 2017; Arogundade et al. 2022b) and since there is no universally acclaimed measure, we therefore create an institutional index (IQI) from the six governance indicators[4] of the World Bank (2020a) using the Principal Component Analysis (PCA). The PCA is justified by the fact that there are several measures of institutional quality and that there is frequently a significant degree of correlation among them, making it difficult to determine which of these indicators best reflects it or which is most relevant for an empirical study. IQI is strongly and positively correlated with all institutions' variables (as indicated in Table 1) which is an indication that IQI best explains these variables simultaneously.

Table 1. Correlation Matrix (IQI and Institutional Variables).

Variables	IQI	POLS	RQ	ROL	VAC	GEFF	CCORR
IQI	1.000						
POLS	0.800	1.000					
RQ	0.921	0.599	1.000				
ROL	0.975	0.744	0.898	1.000			
VAC	0.835	0.662	0.707	0.775	1.000		
GEFF	0.945	0.667	0.923	0.927	0.682	1.000	
CCORR	0.956	0.728	0.854	0.943	0.744	0.91	1.000

Note: IQI = Institutional Quality Index; ROL = Rule of law; CCORR = Control of Corruption; VAC = Voice and Accountability; RQ = Regulatory Quality; Government Effectiveness, and Political Stability. Source: Authors' Computations.

When calculating IQI, the first component has an eigenvalue (the variance of the component) of 4.9444. It explains 682.41% of the common variance of the series, while the second component has an eigenvalue of 0.4854 and explains 8.09% of the variation. A value greater than one indicates that the component captures more variance than its nominal share of the total variance of the variables. As a result, the first component is applied in this instance, and Appendix A Figure A1 displays the scree plot. A further indicator of sample adequacy is the Kaiser–Meyer–Olkin (KMO) index, which compares partial correlations and correlations between variables. The usage of PCA is justified by a value greater than 0.50. Hence, with a KMO of 0.8848, PCA's use is justified. Table 2 presents some critical characteristics of the computation of the IQI.

Table 2. PCA and Eigenvectors.

Variables	Sample
PCA eigenvectors (highest)	4.9444
Proportion explained	0.8241
Kaiser-Meyer-Olkin	0.8848

Source: Authors' Computations.

Furthermore, to appraise the impact of ICT, two indicators are used: mobile cellular subscriptions and fixed telephone subscriptions (Asongu and Boateng 2018; Asongu and

Nwachukwu 2018; Niebel 2018; Xing 2018; Adeleye and Eboagu 2019; Alshubiri et al. 2019; Adeleye et al. 2021a; Kim et al. 2021). While the former is commonly used among individuals of different income strata, such that owning a mobile phone allows even the poorest in the community to have access to information, the latter is common among corporate organisations. Hence, using these two indicators ensures that ICT usage and penetration is captured adequately. Five control variables are used: individuals using the internet (Adeleye and Eboagu 2019; Adeleye et al. 2021a; Azu and Nwauko 2021), labour participation (Appiah et al. 2020; Isola et al. 2020), gross fixed capital formation (Adeleye et al. 2021a; Adusei and Adeleye 2021; Ebire et al. 2021), trade openness (Hdom and Fuinhas 2020; Kpomblekou and Wonyra 2020; Kong et al. 2020; Adeleye et al. 2021b) and inflation (Oyinlola et al. 2020; Zheng et al. 2020; Adeleye 2021; Ebire et al. 2021).

Finally, to address the main question of this study, the interaction term of institutional quality index with each ICT indicator is added to ascertain whether ICT usage positively or negatively affects the net impact of quality institutions on inclusive growth. All the variables, except the institutional quality score, are converted to their natural logarithms to account for heteroscedasticity, potential outliers, and to construct elasticity correlations. Table 3 includes a description of the variables, a priori expectations and sources.

Table 3. Variables Description, Expected Signs and Sources.

Variables	Description	Sign	Source
lnHDI	Human Development Index	N/A	UNDP (2019)
IQI *	Institutional Quality Index	+	Authors' Computation
lnMOB	Mobile cellular subscriptions	+	World Bank (2020b) WDI
lnFTEL	Fixed telephone subscriptions	+	World Bank (2020b) WDI
lnLAB	Labour force participation rate, total (% of total population ages 15+)	+	World Bank (2020b) WDI
lnGCF	Gross capital formation (% of GDP)	+	World Bank (2020b) WDI
INFL	Inflation, consumer prices (annual %)	+	World Bank (2020b) WDI
lnTR	Trade (% of GDP)	+	World Bank (2020b) WDI
lnNET	Individuals using the Internet (% of population)	+	World Bank (2020b) WDI

Note: * Created using Principal Component Analysis from 6 governance indicators of World Governance Indicators (World Bank 2020a); UNDP = United Nations Development Programme; WDI = World Development Indicators. Source: Authors' Compilations.

3.2. Theoretical Background and Empirical Model

Our empirical approach is situated within the frameworks of (i) the Rodrik (2005) institutional taxonomy, which posits that institutions are relevant in the growth process; (ii) the Acemoglu et al. (2009) modernization hypothesis, which argues on the relevance of institutions to growth; and (iii) Sein et al. (2018), who offer perspectives and theories on the role of ICT in economic development. Incorporating these theories, the implicit model expresses growth as a function of institutions and ICT:

$$\text{Growth} = \text{f}(\text{institutions, ICT}) \tag{1}$$

Hence, in examining the effect of institutional quality and ICT on inclusive growth, the study expresses inclusive growth as a linear function of an index of institutional quality, a column vector of ICT variables[5] and a row vector of control variables. It involves a two-part procedure such that in the first part, we analyse the full sample and thereafter, the sub-samples of income groups. The baseline model is stated as:

$$\text{lnHDI}_{\text{it}} = \alpha_0 + \alpha_1 \text{IQI}_{\text{it}} + \alpha_3 \ln \text{ Z}'_{\text{it}} + \varphi_{\text{t}} + \text{u}_{\text{it}} \tag{2}$$

where HDI_{it} = Human development proxy (inclusive growth proxy); ln = natural logarithm; IQI_{it} = institutional quality index; Z'_{it} = vector of control variables (labour participation, gross fixed capital, Internet users, inflation and trade openness); α_i = parameters to be estimated; φ_t = year dummies (which controls for common shocks such as the global financial crises of 2007–2009); and u_{it} = general error term. Equation (1) tests the hypothesis that institutional quality impacts inclusive growth while controlling for other macroeconomic indicators. Next, we incorporate ICT indicators into Equation (2) to capture how information technology fosters inclusiveness. This relationship is as specified in Equation (3):

$$\text{lnHDI}_{it} = \gamma_0 + \gamma_1 \text{IQI}_{it} + \gamma_2 \text{lnICT}'_{it} + \gamma_3 \ln \text{W}'_{it} + d_t + e_{it} \quad (3)$$

where ICT'_{it} = vector of information and telecommunication variables (mobile cellular and fixed telephone subscribers); W'_{it} = vector of control variables; γ_i = parameters to be estimated; d_t = year dummies; and e_{it} = general error term.

In addressing the main objective of this paper, we interacted ICT usage with quality institutions on inclusive growth. The conjecture is that ICT represents a channel through which IQI forges inclusiveness. This hypothesis is tested by including the interaction term (IQI*ICT) in Equation (3), and the model becomes:

$$\ln \text{HDI}_{it} = \eta_0 + \eta_1 \text{IQI}_{it} + \eta_2 \ln \text{ICT}'_{it} + \eta_3 \ln(\text{IQI} * \text{ICT}')_{it} + \eta_4 \ln \text{K}'_{it} + \omega_t + v_{it} \quad (4)$$

where the characteristics of Equation (Brahim and Rachdi) are analogous to those of Equations (2) and (3).

From Equation (4), η_3 offers three pieces of information. First, the sign of the coefficient indicates if the interaction of both variables spurs or hinders inclusiveness. Secondly, the magnitude of the coefficient hints at whether the net impact of IQI (evaluated at the values[6] of ICT indicators) on inclusive growth is positive or negative, which is derived as:

$$\frac{\partial \ln \text{HDI}}{\partial \ln \text{IQI}} = \eta_1 + \eta_3 \ln \text{ICT}' \quad (5)$$

Thirdly, the statistical significance of the coefficient η_1 and η_3 are relevant in the computation of the net effect. If η_1 is not significant and η_3 is significant, it means that η_1 is statistically *not* different from zero. Therefore, the net effect of IQI depends on the weight of η_3 and the value of ICT. But if η_1 is significant and η_3 is not significant, it means there is no interaction effect and the net effect of IQI equates to its marginal effect.

3.3. Estimation Techniques

By using the Driscoll and Kraay (1998) robust standard error-type approach, which takes into account cross-sectional dependency, we first engage Equations (2)–(4). It computes the spatial correlation consistent (PSCC) standard errors for linear panel models using the ordinary least squares/weighted least squares, fixed effects (within) regression and the least squares method. These estimators adjust the coefficient estimations' standard errors for potential dependency (Cameron and Trivedi 2005; Hoechle 2006). Additionally, the instrumental variables techniques nested within the generalized method of moments (IV-GMM) framework by Baum et al. (2003, 2007a, 2007b) is used if economic growth is endogenous, that is, correlated with the error term such that the outcomes are biased and may yield incorrect inferences. Finally, it becomes appropriate to use the simultaneous quantile regressions (SQREG) proposed by Koenker and Bassett (1978), Koenker and Hallock (2001), and Koenker (2005) if the dependent variable does have a normal distribution and the impact of the regressors changes along its conditional distribution. As a result, the SQREG enables assessment of inclusive growth's shifting structure at various stages using explanatory variables spread throughout the 25th, 50th and 75th quantiles.

4. Empirical Results and Discussions

4.1. Descriptive Analysis

The descriptive and correlation analysis of the variables used in the study is presented in Table 4. The average value of HDI from 2010 to 2019 across 193 countries in the world is

0.706. Niger had the lowest value of 0.331 in 2010, while Norway had the highest value of 0.957 in 2019. On the institutional quality index, the average is 0, and the standard deviation of 2.24 indicates that the sub-regions hover around the sample mean. The minimum is −5, while the maximum is 4.994. The mean value of mobile cellular subscriptions is 35.45 million, the minimum value is 1.600, and the maximum value is 1.75 billion. Fixed telephone subscriptions ranged from 0 to 294 million, with an average value of 4.96 million and a standard deviation of 19.77 million.

Table 4. Pairwise Correlation Analysis and Summary Statistics.

Variables	lnHDI	IQI	lnMOB	lnFTEL	lnLAB	lnGCF	INFL	lnTR	lnNET
lnHDI	1.000								
IQI	0.729 ***	1.000							
lnMOB	0.071 ***	−0.140 ***	1.000						
lnFTEL	0.553 ***	0.228 ***	0.795 ***	1.000					
lnLAB	−0.182 ***	0.060 **	−0.037	−0.185 ***	1.000				
lnGCF	0.034	−0.019	0.043 *	−0.02	0.095 ***	1.000			
INFL	−0.148 ***	−0.281 ***	0.137 ***	0.036	−0.015	0.002	1.000		
lnTR	0.342 ***	0.398 ***	−0.416 ***	−0.176 ***	−0.007	0.127 ***	−0.246 ***	1.000	
lnNET	0.883 ***	0.663 ***	0.055 **	0.443 ***	−0.182 ***	−0.014	−0.141	0.304	1.000
Summary Statistics									
Obs	1773	1884	1834	1836	1770	1648	1731	1736	1652
Mean	0.706	0	35,446,936	4,963,517	62.076	24.706	4.444	93.453	46.109
Std. Dev.	0.151	2.224	1.28×10^8	19,765,275	10.463	8.731	8.852	57.294	29.158
Minimum	0.331	−5	1600	0	36.83	−0.098	−4.298	0.2	0.25
Maximum	0.957	4.997	1.75×10^9	2.94×10^8	89.05	77.89	254.949	442.62	99.702

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; ln = Natural logarithm; HDI = Human development index; IQI = Institutional quality index; MOB = mobile phone subscriptions; FTEL = fixed telephone subscriptions; GCF = Gross capital formation; LAB = labour force participation rate; INFL = Inflation rate; NET = individuals using the Internet. Source: Authors' Computations.

The pairwise correlation gauges how closely the dependent and regressor variables are related. The findings show that all variables correlate statistically with inclusive growth, except for gross fixed capital formation (GFCF). However, the signs vary. Table 4 shows that all correlation statistics are less than 0.80 at a glance. This denotes no proof of multicollinearity among the variables as a result.

4.2. Full Sample Results

Table 5 presents the results using the PSCC Fixed Effects technique. The estimated coefficient of labour force participation rate (lnLAB) is negative and statistically significant. This result aligns with the empirical outcome of Adeleye et al. (2021a) and Ongo and Vukenkeng (2014) that rising labour force participation can reduce inclusive growth through the unemployment rate channel. The significant and positive sign of gross fixed capital formation (GFCF) across models indicate that an increase in capital investment and infrastructures create a favourable business climate, which positively impacts productivity and inclusive growth. This result aligns with the empirical outcome of Roztocki et al. (2019). Inflation (INFL) has a positive and statistically significant impact on inclusive growth at the 1% and 5% significance levels. This result supports the structuralists hypothesis that inflation is necessary for economic growth. However, the empirical outcome is not consistent with Gillman et al. (2004) who stated that a rise in consumer prices diminishes household savings, the volume of resources available for domestic investment, capital flows from abroad and inclusive growth.

Table 5. PSCC-Fixed Effects Results, Full Sample (Dep Var: lnHDI).

Variables	Mobile Phones				Fixed Telephones		
	[1]	[2]	[3]	[4]	[5]	[6]	[7]
lnLAB	−0.0769 ***	−0.0680 ***	−0.0623 ***	−0.0615 ***	−0.0742 ***	−0.0672 ***	−0.0682 ***
	(−8.652)	(−7.647)	(−6.878)	(−6.397)	(−7.341)	(−6.767)	(−7.167)
lnGCF	0.00453 *	0.00488 **	0.00444 *	0.00428	0.00583 **	0.00540 **	0.00578 **
	(1.808)	(1.986)	(1.730)	(1.628)	(2.385)	(2.126)	(2.142)
INFL	0.000422 **	0.000326 **	0.000406 ***	0.000410 **	0.000324 **	0.000411 **	0.000421 **
	(2.539)	(2.215)	(2.630)	(2.572)	(2.092)	(2.513)	(2.578)
lnTR	−0.00522 ***	−0.00722 ***	−0.00730 ***	−0.00698 ***	−0.00519 ***	−0.00545 ***	−0.00519 ***
	(−4.134)	(−5.161)	(−5.655)	(−5.637)	(−3.379)	(−4.115)	(−4.254)
lnNET	0.0171 ***	0.0138 ***	0.0134 ***	0.0137 ***	0.0173 ***	0.0167 ***	0.0164 ***
	(7.489)	(6.977)	(6.947)	(6.344)	(7.128)	(7.393)	(7.581)
IQI	0.00660 ***		0.00614 ***	−0.00280		0.00666 ***	−0.0136
	(5.865)		(4.850)	(−0.226)		(5.278)	(−1.450)
lnICT		0.0111 ***	0.0103 ***	0.0112 ***	−0.00480 ***	−0.00468 ***	−0.00257 ***
		(4.922)	(4.288)	(3.646)	(−4.122)	(−4.197)	(−2.991)
IQI*lnICT				0.000561			0.00150 **
				(0.726)			(2.213)
Constant	−0.116 ***	−0.309 ***	−0.318 ***	−0.338 ***	−0.0598 *	−0.0874 ***	−0.116 ***
	(−3.149)	(−6.206)	(−5.861)	(−4.561)	(−1.697)	(−2.640)	(−2.984)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1322	1320	1320	1320	1302	1302	1302
Number of groups	152	152	152	152	151	151	151
F-Statistic	4.9×10^6	1.383×10^6	4.53×10^6	2.774×10^6	3.85×10^6	1.972×10^6	36,948

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; *t*-statistics in ( ); ln = Natural logarithm; HDI = Human development index; IQI = Institutional quality index; ICT = Information and communication technology; GCF = Gross capital formation; LAB = labour force participation rate; INFL = Inflation rate; TR = Trade openness; NET = Individuals using the Internet; Endogeneity corrected using one-period lag of the regressors. Source: Authors' Computations.

The impact of trade (lnTR) on inclusive growth is negative and statistically significant at the 1% level across all the models. The intuition is that technological or financial constraints may hinder most countries to take advantage of trade facilitation. Hence, the growth effect of trade may differ according to the level of economic development (Musila and Yiheyis 2015; Jawaid and Waheed 2017). The coefficient of lnNET indicates a positive and significant influence on inclusive growth, suggesting that productive engagement of the Internet will have a progressive effect on growth. Furthermore, the coefficient of IQI suggests a significant and positive relationship with inclusive growth. The results reveal that countries with robust institutional quality systems can minimize widening gaps in income distribution, reduce poverty, and improve inclusive growth (Butkiewicz and Yanikkaya 2006; Nawaz et al. 2014).

Across all model specifications, the impact of ICT (lnMOB and lnFTEL) on inclusive growth is asymmetric. While lnMOB exerts a positive and statistical effect at the 1% level, that of lnFTEL is negative. The positive and significant relationship aligns with previous studies (Osabuohien 2008; Chavula 2013; Ghosh 2016; Adeleye and Eboagu 2019), suggesting that ICT induces inclusive growth. However, the negative effect supports Adeleye et al. (2021a), Adeleye and Eboagu (2019) and Johnson (2016), who find that countries with less robust ICT may experience moderate inclusiveness and a massive digital divide. In gauging the moderating effects of ICT, the interaction term's coefficient indicating whether ICT impedes or enhances the impact of IQI on growth is positive though statistically significant, with fixed telephones but not with mobile phones. Though the interaction coefficient with mobile phones is significantly not different from zero, the positive signs from both ICT indicators attest to the efficacy of ICT, enabling the sound workings of governance to deliver the gains of inclusive growth. This is a novel contribution to the literature.

For robustness checks, most of the findings of the IV-GMM results presented in Table 6 align with those of Table 5. We found that the moderating effect of ICT is positive and statistically significant from both indicators. We, therefore, arrive at a similar conclusion that ICT enhances the efficiency of IQI on inclusive growth. Consequently, conclusions may be drawn from the outcomes of these augmented regressions.

Table 6. IV-GMM Results, Full Sample (Dep Var: lnHDI).

Variables	**Mobile Phones**				**Fixed Telephones**		
	[1]	**[2]**	**[3]**	**[4]**	**[5]**	**[6]**	**[7]**
lnLAB	−0.0630 ***	−0.262	−0.0626 ***	−0.0610 ***	0.0507 **	−0.0450 ***	−0.0453 ***
	(−3.605)	(−0.746)	(−3.605)	(−3.463)	(2.265)	(−2.802)	(−2.828)
lnGCF	0.0203 **	0.259	0.0187 *	0.0191 **	0.000850	0.0240 **	0.0221 **
	(2.126)	(0.939)	(1.917)	(1.967)	(0.0634)	(2.570)	(2.340)
INFL	0.000880	0.0283	0.000660	0.000805	−0.00240 ***	0.000541	0.000441
	(1.453)	(1.014)	(1.080)	(1.312)	(−3.528)	(1.050)	(0.835)
lnTR	0.00274	−1.089	0.0118	0.0121	0.118 ***	0.0304 ***	0.0292 **
	(0.288)	(−0.979)	(0.953)	(0.994)	(8.435)	(2.604)	(2.493)
lnNET	0.176 ***	0.548 *	0.172 ***	0.173 ***	0.114 ***	0.149 ***	0.146 ***
	(39.44)	(1.734)	(38.78)	(38.17)	(7.308)	(30.73)	(27.19)
IQI	0.0288 ***		0.0294 ***	0.00864		0.0269 ***	0.0412 ***
	(18.71)		(19.42)	(0.767)		(17.05)	(4.928)
lnICT		−0.860	0.00708 ***	0.00673 ***	0.0659 ***	0.0194 ***	0.0193 ***
		(−1.059)	(3.256)	(2.973)	(6.686)	(12.23)	(12.28)
IQI*lnICT				0.00128 *			−0.000983 *
				(1.846)			(−1.885)
Constant	−0.804 ***	16.79	−0.942 ***	−0.950 ***	−2.377 ***	−1.178 ***	−1.153 ***
	(−8.893)	(0.966)	(−8.498)	(−8.658)	(−13.72)	(−12.27)	(−11.54)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1173	1167	1171	1171	1148	1154	1154
R-squared	0.870	0.873	0.871	0.872	0.761	0.885	0.885
F-Statistic	494.6	123.671	470.4	445.5	249.2	521.8	522.6
Hansen p-value	0.259	0.998	0.319	0.299	0.118	0.340	0.374

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; t-statistics in ( ); ln = Natural logarithm; HDI = Human development index; IQI = Institutional quality index; ICT = Information and communication technology; GCF = Gross capital formation; LAB = labour force participation rate; INFL = Inflation rate; TR = Trade openness; NET = Individuals using the Internet; Endogeneity corrected using one-period lag of the regressors. Source: Authors' Computations.

Next, we examine if the individual impact of IQI, ICT and their interaction differ across the conditional distribution of inclusive growth, and the results from the SQREG approach are shown in Table 7. Restricting interpretations to the variables of interest, from the upper panel (Mobile Phones Model) and across the quantiles, IQI and MOB exert a consistent significant and positive impact on inclusive growth, but their interaction is positive and statistically significant at the 50th quartile. In addition, from the lower panel (Fixed Telephones Model), both IQI and ICT are positive predictors of inclusiveness across the quantiles, but their interaction is negative. These results mirror earlier findings and provide sufficient evidence that ICT plays a crucial role in driving inclusiveness globally, both directly and indirectly (via IQI).

Table 7. Distributional Effects from Bootstrap SQREG Technique, Full Sample (Dep Var: lnHDI).

Variables	**Mobile Cellular Subscription Model**								
	Q = 0.25	**Q = 0.50**	**Q = 0.75**	**Q = 0.25**	**Q = 0.50**	**Q = 0.75**	**Q = 0.25**	**Q = 0.50**	**Q = 0.75**
lnLAB	−0.0361 **	−0.0777 ***	−0.0879 ***	0.0198	−0.0161	−0.0287	−0.0362 **	−0.0807 ***	−0.0975 ***
	(−2.148)	(−4.992)	(−4.934)	(0.810)	(−0.717)	(−1.366)	(−2.241)	(−4.262)	(−5.589)
lnGCF	0.00542	0.0268 ***	0.0360 ***	−0.00491	0.00314	−0.000862	0.00814	0.0289 ***	0.0382 ***
	(0.500)	(3.211)	(4.195)	(−0.323)	(0.267)	(−0.116)	(0.731)	(3.072)	(4.056)
INFL	−0.00103	0.00172 **	0.00169 ***	−0.00293 *	−0.00102	−0.00125 **	−0.00132	0.00152	0.00113 ***
	(−0.688)	(2.081)	(3.849)	(−1.693)	(−1.183)	(−2.367)	(−0.911)	(1.531)	(2.855)
lnTR	0.00553	0.00756 **	0.00402	0.0383 ***	0.0439 ***	0.0311 ***	0.0173 ***	0.0170 ***	0.0154 ***
	(1.136)	(2.326)	(0.819)	(4.187)	(6.996)	(5.558)	(4.125)	(4.031)	(3.104)
lnNET	0.192 ***	0.171 ***	0.153 ***	0.233 ***	0.210 ***	0.194 ***	0.186 ***	0.168 ***	0.146 ***
	(31.15)	(30.04)	(29.68)	(38.07)	(54.04)	(50.73)	(32.35)	(28.28)	(26.30)
IQI	0.0279 ***	0.0267 ***	0.0249 ***				0.0117	0.00409	0.0393 ***
	(17.40)	(22.56)	(15.15)				(0.956)	(0.417)	(3.229)
lnMOB				0.00763 ***	0.00665 ***	0.00624 ***	0.00713 ***	0.00540 ***	0.00933 ***
				(2.848)	(3.048)	(3.598)	(3.451)	(3.103)	(4.913)
IQI*lnMOB							0.00105	0.00137 **	−0.000862
							(1.421)	(2.275)	(−1.186)
Constant	−0.929 ***	−0.719 ***	−0.584 ***	−1.500 ***	−1.262 ***	−1.044 ***	−1.085 ***	−0.835 ***	−0.729 ***
	(−11.24)	(−9.501)	(−8.321)	(−11.42)	(−10.20)	(−10.76)	(−14.01)	(−8.257)	(−9.349)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Replications	100	100	100	100	100	100	100	100	100
Observations	1322	1322	1322	1320	1320	1320	1320	1320	1320
	Fixed Telephone Subscription Model								
lnLAB	−0.0361 **	−0.0777 ***	−0.0879 ***	0.0255	0.0161	−0.00836	−0.0139	−0.0505 ***	−0.0775 ***
	(−1.965)	(−4.336)	(−4.207)	(1.274)	(0.693)	(−0.409)	(−0.767)	(−3.375)	(−5.803)
lnGCF	0.00542	0.0268 ***	0.0360 ***	0.000803	0.00898	0.00306	0.000747	0.0333 ***	0.0481 ***
	(0.469)	(2.914)	(3.472)	(0.0518)	(0.819)	(0.257)	(0.0960)	(4.104)	(5.640)
INFL	−0.00103	0.00172 **	0.00169 ***	−0.00231 **	−0.00137	−0.00158 **	−0.00205 *	0.000727	0.000574 **
	(−0.654)	(2.577)	(4.388)	(−2.274)	(−1.430)	(−2.248)	(−1.702)	(0.878)	(2.075)
lnTR	0.00553	0.00756 **	0.00402	0.0720 ***	0.0588 ***	0.0476 ***	0.0263 ***	0.0245 ***	0.0193 ***
	(1.217)	(2.494)	(0.866)	(9.647)	(11.39)	(8.594)	(5.527)	(5.912)	(4.279)
lnNET	0.192 ***	0.171 ***	0.153 ***	0.193 ***	0.186 ***	0.165 ***	0.165 ***	0.146 ***	0.122 ***
	(33.92)	(26.79)	(25.83)	(26.75)	(37.96)	(23.95)	(35.37)	(21.91)	(22.20)
IQI	0.0279 ***	0.0267 ***	0.0249 ***				0.0502 ***	0.0507 ***	0.0535 ***
	(18.01)	(19.79)	(13.85)				(5.264)	(5.544)	(7.853)
lnFTEL				0.0236 ***	0.0188 ***	0.0183 ***	0.0177 ***	0.0161 ***	0.0156 ***
				(12.23)	(10.17)	(10.99)	(9.669)	(9.772)	(13.31)
IQI*lnFTEL							−0.00167 ***	−0.00176 ***	−0.00200 ***
							(−2.663)	(−3.044)	(−4.558)
Constant	−0.929 ***	−0.719 ***	−0.584 ***	−1.764 ***	−1.560 ***	−1.267 ***	−1.248 ***	−1.058 ***	−0.840 ***
	(−10.66)	(−7.894)	(−6.476)	(−20.36)	(−15.00)	(−12.89)	(−12.84)	(−13.52)	(−13.29)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Replications	100	100	100	100	100	100	100	100	100
Observations	1322	1322	1322	1302	1302	1302	1302	1302	1302

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; t-statistics in ( ); ln = Natural logarithm; HDI = Human development index; IQI = Institutional quality index; MOB = mobile phone subscriptions; FTEL = fixed telephone subscriptions; GCF = Gross capital formation; LAB = labour force participation rate; INFL = Inflation rate; TR = Trade openness; NET = individuals using the Internet. Source: Authors' Computations.

4.3. Sub-Sample Results

Income group results are presented in Table 8 (PSCC-FE). The empirical outcomes indicate that IQI has a positive and statistically significant impact on inclusive growth in high- and upper-middle-income countries, while the impact is negative in low- and lower-middle-income countries. These outcomes align with Dedrick et al. (2013) and Papaioannou and Dimelis (2007) and are unsurprising as more developed economies are characterized by having strong and efficient institutions (regulatory, social, political, and economic) across all strata of the economy. On the impact of ICT, high- and lower-middle-income countries show significant positive outcomes, while the effect is negative for low-income countries regarding fixed telephones. Again, this outcome is expected as more developed economies have the enabling resources to engage in ICT integration which drives inclusiveness. Furthermore, the results of the interaction term suggest that ICT slows the effect of IQI in high- and low-income countries but enhances it in lower- and upper-middle income countries (for mobile phones model); the impact is also positive in lower-middle but negative in low-income countries (for fixed telephones model).

Table 8. PSCC-Fixed Effects Results, Income Groups (Dep Var: lnHDI).

Variables	Mobile Phones Model				Fixed Telephones Model			
	High	**Low**	**Lower-Mid**	**Upper-Mid**	**High**	**Low**	**Lower-Mid**	**Upper-Mid**
lnLAB	0.0831 ***	−0.492 ***	−0.146 ***	0.0664 *	0.0793 ***	−0.487 ***	−0.147 ***	0.0664 *
	(5.305)	(−10.22)	(−7.179)	(1.797)	(5.458)	(−13.32)	(−5.405)	(1.748)
lnGCF	0.00346	−0.00522 **	0.0106 *	0.00434 ***	0.00384	−0.00441 *	0.0105 **	0.00529 ***
	(1.206)	(−2.158)	(2.016)	(2.835)	(1.410)	(−2.016)	(2.033)	(2.993)
INFL	0.000284	0.000197 *	0.000345	0.000346 ***	0.000476 **	0.000199	0.000370 *	0.000352 ***
	(1.495)	(1.711)	(1.396)	(3.552)	(2.110)	(1.228)	(2.011)	(3.747)
lnTR	−0.00254	−0.000790	−0.00106	−0.000684	−0.00163	−0.0100 *	−0.00210	−0.00652 **
	(−0.988)	(−0.225)	(−0.418)	(−0.237)	(−0.503)	(−2.041)	(−1.290)	(−2.042)
lnNET	0.0169 ***	0.00587 *	0.00332 **	0.00554 *	0.0142 *	0.00725 **	0.00504 ***	0.00650 ***
	(2.700)	(1.942)	(2.088)	(1.984)	(1.877)	(2.077)	(3.270)	(2.786)
IQI	0.0605 ***	0.0589 **	−0.0608 **	−0.0525 ***	0.0244 *	0.0497 **	−0.0795 ***	−0.0151
	(5.343)	(2.368)	(−2.286)	(−2.771)	(1.803)	(2.731)	(−3.880)	(−1.519)
lnICT	0.0137 ***	0.00147	0.0143 *	0.00534	0.00758 **	−0.0108 ***	0.0116 ***	−0.00638
	(3.837)	(0.181)	(1.875)	(0.871)	(2.026)	(−4.542)	(3.513)	(−1.350)
IQI*lnICT	−0.00331 ***	−0.00271 *	0.00401 **	0.00312 ***	−0.00116	−0.00310 *	0.00641 ***	0.000979
	(−5.109)	(−1.743)	(2.471)	(2.758)	(−1.448)	(−1.784)	(4.262)	(1.599)
Constant	−0.801 ***	1.302 ***	−0.187	−0.708 ***	−0.671 ***	1.454 ***	−0.105	−0.512 ***
	(−9.304)	(4.592)	(−1.547)	(−3.093)	(−6.489)	(9.555)	(−0.930)	(−5.193)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	449	195	327	349	447	179	327	349
Groups	47	25	39	41	47	24	39	41
F-Statistic	35983	5171	46822	753923	21685	542.2	81923	58437

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; t-statistics in ( ); ln = Natural logarithm; HDI = Human development index; IQI = Institutional quality index; MOB = mobile phone subscriptions; FTEL = fixed telephone subscriptions; GCF = Gross capital formation; LAB = labour force participation rate; INFL = Inflation rate; TR = Trade openness; NET = individuals using the Internet. Source: Authors' Computations.

For further robustness checks, we engage the IV-GMM technique, and the results are displayed in Table 9. Similar to the outcomes in Table 8, we observe that the impact of IQI is mixed. It indicates a positive and significant impact on inclusive growth in high- and upper-middle-income countries while it is negative in low- and lower-income countries. Contrarily, the heterogeneous effect of ICT is not quite vivid across the groups as it shows a positive impact in seven out of eight models. The coefficient of the interaction term indicates that ICT attenuates the impact of IQI in high and upper-middle-income countries but improves IQI in low- and lower-middle-income countries.

What stands out from the sub-sample analyses is that IQI has a positive and statistically significant impact on inclusive growth for high- and upper-income groups. In contrast, the impact is negative for lower-middle-income countries and insignificant for the low-income group. An obvious possible explanation for the negative impact of institutional quality on inclusive growth for lower-middle-income countries is the poor institutional configuration in these countries. This explanation is accepted by several (but not all) scholars (see Iqbal and Daly 2014; Aslam et al. 2021). The supposition is the configuration of institutions in lower- and upper-middle-income countries appears to resemble extractive political and economic institutions and therefore, do not contribute to inclusive growth. In addition, the mixed outcomes of ICT may be attributable to the fact that digital inclusion is broadly inexpensive in upper-middle and high-income countries (Aslam et al. 2021). According to Van Ark and Piatkowski (2004), ICT diffusion is largely constrained by low competition levels in the labour and product markets coupled with limited ICT skills of the workforce, shortage of innovation efforts, and insufficient flexibility to reform business organizations negatively impact the pace of ICT diffusion and the productivity effect of ICT.

Table 9. IV-GMM Results, Income Groups (Dep Var: lnHDI).

Variables	Mobile Phones Model				Fixed Telephones Model			
	High	Low	Lower-Mid	Upper-Mid	High	Low	Lower-Mid	Upper-Mid
lnLAB	−0.0410 ***	−0.114 *	−0.0243	−0.0384 **	−0.0172	−0.0901	−0.00853	−0.0419 ***
	(−3.524)	(−1.809)	(−0.901)	(−2.399)	(−1.322)	(−0.621)	(−0.326)	(−2.827)
lnGCF	0.00384	−0.0350 *	0.0291 **	0.0218 *	0.00920 *	−0.467 ***	0.0445 ***	0.0217 *
	(0.745)	(−1.757)	(2.217)	(1.726)	(1.800)	(−3.310)	(3.796)	(1.792)
INFL	−0.00495 ***	0.00229 **	0.000742	0.00154 ***	−0.00428 ***	0.0175 ***	0.000388	0.00115 ***
	(−7.253)	(2.109)	(0.633)	(4.274)	(−6.102)	(2.812)	(0.376)	(3.476)
lnTR	0.00727 ***	−0.00850	−0.00503	0.0186 ***	0.0107 ***	0.717 ***	0.00920	0.0253 ***
	(3.205)	(−0.382)	(−0.336)	(3.118)	(4.773)	(3.275)	(0.524)	(4.936)
lnNET	0.0825 ***	0.108 ***	0.104 ***	0.129 ***	0.0807 ***	0.0818 ***	0.0755 ***	0.116 ***
	(7.491)	(8.998)	(9.120)	(14.67)	(7.528)	(3.334)	(6.348)	(12.61)
IQI	0.0828 ***	0.133	−0.132 ***	0.125 ***	0.0743 ***	−3.315 ***	−0.0595 *	0.0664 ***
	(6.561)	(0.816)	(−3.315)	(6.289)	(7.190)	(−3.135)	(−1.889)	(5.548)
lnICT	0.0200 ***	−0.00211	0.0174 ***	0.00343 *	0.0209 ***	0.886 ***	0.0327 ***	0.00736 ***
	(8.971)	(−0.0774)	(4.933)	(1.953)	(9.490)	(3.264)	(6.918)	(4.620)
IQI*lnICT	−0.00373 ***	−0.00939	0.0106 ***	−0.00692 ***	−0.00372 ***	0.289 ***	0.00767 ***	−0.00381 ***
	(−4.824)	(−0.917)	(4.061)	(−5.073)	(−5.224)	(3.125)	(2.960)	(−3.936)
Constant	−0.731 ***	−0.495	−1.006 ***	−0.838 ***	−0.831 ***	−12.37 ***	−1.234 ***	−0.843 ***
	(−10.39)	(−0.978)	(−7.768)	(−8.897)	(−11.56)	(−3.354)	(−10.38)	(−8.990)
Year Dummies	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Observations	402	171	289	309	400	132	289	309
R-squared	0.814	0.446	0.526	0.730	0.822	−7.735	0.598	0.743
F-Statistic	156.9	12.86	31.46	99.99	140.6	5.436	34.44	132.0
Hansen *p*-value	0.304	0.0566	0.945	0.0891	0.374	0.105	0.755	0.116

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; robust z-statistics in ( ); ln = Natural logarithm; HDI = Human development index; IQI = Institutional quality index; MOB = mobile phone subscriptions; FTEL = fixed telephone subscriptions; GCF = Gross capital formation; LAB = labour force participation rate; INFL = Inflation rate; TR = Trade openness; NET = individuals using the Internet. Source: Authors' Computations.

5. Conclusions and Policy Recommendations

A distinguished body of literature has investigated the relationship between institutions and economic growth, neglecting the interaction effect of institutions and ICT on inclusive growth. Thus, our paper fills this gap using HDI, an index of institutional quality, and two ICT indicators on a panel data of 193 countries from 2010 to 2019. To observe if the outcomes differ by the state of economic development, the full sample is divided along four income delineations and analyses using three robust estimations—PSCC-FE, IV-GMM, and SQREG. Two key results emerge from the study. The full sample estimates suggest that institutional quality and ICT play an important role in stimulating inclusive growth. Our results on the effect of institutional quality are in line with the view that institutions are at the heart of economic growth acceleration and growth inclusiveness (Acemoglu et al. 2005, 2009).

An obvious implication of this finding is that institutional quality in these countries is becoming a strong catalyst to facilitating and promoting inclusiveness. Reassuringly, the estimates derived from the income groups analysis appear to support our choice of investigating the effect of institutional quality at various stages of economic development, given the remarkable differences among income groups that were uncovered. Given our findings, we strongly suggest that policymakers prioritize institutional quality and ICT innovation and usage to ensure that economic growth translates into better living conditions for the populace. Furthermore, given that institutional quality improves the inclusive growth of high- and upper-middle-income countries while it diminishes the growth of low- and lower-middle-income countries, we recommend that developing countries should build a robust institutional quality capable of reducing corruption, increasing transparency, and promoting a business-friendly environment. By implementing these recommendations, developing countries can create a robust institutional quality that will promote inclusive growth and sustainable development.

We agree with several scholars in this field (see Saba and Ngepah 2021) that policymakers in low- and lower-middle-group income countries need to urgently formulate policies that will entrench institutional reforms and such that can facilitate and accelerate the infiltration and the affordability of ICT usage.

Author Contributions: Conceptualized the major idea of this research paper, Prepared the methodology, data collection, analysis, interpretation, and conclusion section, B.N.A.; Prepared the literature review and general editing, S.A.; Prepared the introduction and formatting, B.M. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Informed Consent Statement: Not applicable.

Data Availability Statement: The datasets used and/or analysed during the current study are available from the author on reasonable request.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

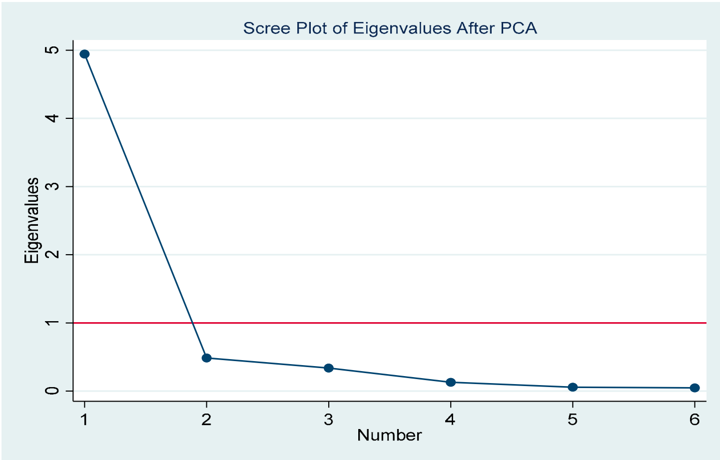

Figure A1. Scree plot of IQI. Source: Authors' Computations.

Appendix B

Table A1. List of Countries and Classifications.

S/No.	Country	Group	S/No.	Country	Group	S/No.	Country	Group
1	Afghanistan	LI	66	Georgia	LMI	131	Norway	HI
2	Albania	UMI	67	Germany	HI	132	Oman	HI
3	Algeria	UMI	68	Ghana	LMI	133	Pakistan	LMI
4	Angola	LMI	69	Greece	HI	134	Palau	HI
5	Antigua and Barbuda	HI	70	Grenada	UMI	135	Panama	HI
6	Argentina	HI	71	Guam	HI	136	Papua New Guinea	LMI
7	Armenia	UMI	72	Guatemala	UMI	137	Paraguay	UMI
8	Aruba	HI	73	Guinea	LI	138	Peru	UMI

Table A1. *Cont.*

S/No.	Country	Group	S/No.	Country	Group	S/No.	Country	Group
9	Australia	HI	74	Guinea-Bissau	LI	139	Philippines	LMI
10	Austria	HI	75	Guyana	UMI	140	Poland	HI
11	Azerbaijan	UMI	76	Haiti	LI	141	Portugal	HI
12	Bahamas, The	HI	77	Honduras	LMI	142	Puerto Rico	HI
13	Bahrain	HI	78	Hong Kong SAR, China	HI	143	Qatar	HI
14	Bangladesh	LMI	79	Hungary	HI	144	Romania	UMI
15	Barbados	HI	80	Iceland	HI	145	Russian Federation	UMI
16	Belarus	UMI	81	India	LMI	146	Rwanda	LI
17	Belgium	HI	82	Indonesia	LMI	147	Samoa	UMI
18	Belize	UMI	83	Iran, Islamic Rep.	UMI	148	San Marino	HI
19	Benin	LI	84	Iraq	UMI	149	Sao Tome and Principe	LMI
20	Bhutan	LMI	85	Ireland	HI	150	Saudi Arabia	HI
21	Bolivia	LMI	86	Israel	HI	151	Senegal	LI
22	Bosnia and Herzegovina	UMI	87	Italy	HI	152	Serbia	UMI
23	Botswana	UMI	88	Jamaica	UMI	153	Seychelles	HI
24	Brazil	UMI	89	Japan	HI	154	Sierra Leone	LI
25	Brunei Darussalam	HI	90	Jordan	UMI	155	Singapore	HI
26	Bulgaria	UMI	91	Kazakhstan	UMI	156	Slovak Republic	HI
27	Burkina Faso	LI	92	Kenya	LMI	157	Slovenia	HI
28	Burundi	LI	93	Kiribati	LMI	158	Solomon Islands	LMI
29	Cabo Verde	LMI	94	Kosovo	LMI	159	South Africa	UMI
30	Cambodia	LMI	95	Kuwait	HI	160	South Korea	HI
31	Cameroon	LMI	96	Kyrgyz Republic	LMI	161	Spain	HI
32	Cayman Islands	HI	97	Lao PDR	LMI	162	Sri Lanka	LMI
33	Central African Republic	LI	98	Latvia	HI	163	St. Kitts and Nevis	HI
34	Chad	LI	99	Lebanon	UMI	164	St. Lucia	UMI
35	Chile	HI	100	Lesotho	LMI	165	St. Vincent and the Grenadines	UMI
36	China	UMI	101	Liberia	LI	166	Sudan	LMI
37	Colombia	UMI	102	Libya	UMI	167	Suriname	UMI
38	Comoros	LI	103	Lithuania	HI	168	Sweden	HI
39	Congo, Dem, Rep.	LI	104	Luxembourg	HI	169	Switzerland	HI
40	Congo, Dem. Rep.	LI	105	Macao SAR, China	HI	170	Tajikistan	LI

Table A1. *Cont.*

S/No.	Country	Group	S/No.	Country	Group	S/No.	Country	Group
41	Congo, Rep.	LMI	106	Madagascar	LI	171	Tanzania	LI
42	Costa Rica	UMI	107	Malawi	LI	172	Thailand	UMI
43	Cote d'Ivoire	LMI	108	Malaysia	UMI	173	Timor-Leste	LMI
44	Croatia	HI	109	Maldives	UMI	174	Togo	LI
45	Cuba	HI	110	Mali	LI	175	Tonga	UMI
46	Curacao	HI	111	Malta	HI	176	Trinidad and Tobago	HI
47	Cyprus	HI	112	Marshall Islands	UMI	177	Tunisia	LMI
48	Czech Republic	HI	113	Mauritania	LMI	178	Turkey	UMI
49	Denmark	HI	114	Mauritius	UMI	179	Turkmenistan	UMI
50	Djibouti	LMI	115	Mexico	UMI	180	Tuvalu	UMI
51	Dominica	UMI	116	Moldova	LMI	181	Uganda	LI
52	Dominican Republic	UMI	117	Mongolia	LMI	182	Ukraine	LMI
53	Ecuador	UMI	118	Montenegro	UMI	183	United Arab Emirates	HI
54	Egypt, Arab Rep.	LMI	119	Morocco	LMI	184	United Kingdom	HI
55	El Salvador	LMI	120	Mozambique	LI	185	Uruguay	HI
56	Equatorial Guinea	UMI	121	Myanmar	LMI	186	Uzbekistan	LMI
57	Estonia	HI	122	Namibia	UMI	187	Vanuatu	LMI
58	Eswatini	LMI	123	Nauru	UMI	188	Venezuela, RB	UMI
59	Ethiopia	LI	124	Nepal	LI	189	Vietnam	LMI
60	Fiji	UMI	125	Netherlands	HI	190	West Bank and Gaza	LMI
61	Finland	HI	126	New Zealand	HI	191	Yemen, Rep.	LI
62	France	HI	127	Nicaragua	LMI	192	Zambia	LMI
63	French Polynesia	HI	128	Niger	LI	193	Zimbabwe	LI
64	Gabon	UMI	129	Nigeria	LMI			
65	Gambia, The	LI	130	North Macedonia	UMI			

Note: HI: High Income; LI: Low Income; LMI: Lower-middle Income; UMI: Upper-middle Income Source: Authors' Compilations.

Notes

1. Measured by human development Index.
2. Measured by the average of the six dimensions of institutional quality.
3. See Appendix B Table A1 for the list of countries and their respective classifications.
4. Voice and accountability, rule of law, control of corruption, regulatory quality, government effectiveness and political stability.
5. This stepwise regression approach is taken to observe the marginal effect of each ICT indicator on inclusive growth and to avoid biased inferences due to high collinearity between MOB/FTEL (See Table 3).
6. Mean, minimum or maximum values can be used.

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