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Broadband Network, Governance and Inclusive Growth: New Evidence from Selected Asian and African Economies

[*]Azuka Ozegbe
Nkemdilim Iheanachor

Pan Atlantic University, Lagos, Nigeria

This study examined the link between broadband networks, governance, and inclusive growth in Africa and Asia. The motivation arises from the unequal distribution of high-speed broadband in many low-income countries, which risks widening income inequality and increasing poverty. Using panel least squares estimation for 20 countries from 1996 to 2022, we investigated how broadband penetration and governance influence inclusive growth outcomes. The findings show that inclusive growth is positively affected by broadband access, governance, and trade, while population growth has a negative impact. Specifically, a 1% rise in broadband provision boosts inclusive growth by 0.089% in Africa and 0.044% in Asia. However, governance quality shows contrasting effects: in Africa, weak institutional frameworks negatively impact inclusive growth, whereas in Asia, stronger institutional structures make governance a positive factor. Overall, the study concludes that expanding broadband supports inclusive growth in both regions, with a more significant effect in Africa. These results imply that governments should prioritize not only developing broadband infrastructure but also enhancing institutional quality. Effective, transparent, and corruption-free governance is vital for ensuring that broadband investments lead to sustainable and inclusive growth outcomes across Africa and Asia.

Keywords: Broadband network, inclusive growth, governance, Africa, Asia, pooled panel least squares

JEL: J24, O3, O11, O43, O47

Information and communication technology (ICT) has emerged as a dominant phenomenon in every aspect of human endeavor (Saba *et al.*, 2023). It is a critical diffuser of knowledge, generator of values, globalizer of local activities, regulator, and transformer of social conditions and our beliefs (Touri, 2024). The growing interdependence amongst various critical sectors in the global economy, such as education, healthcare, the financial and banking industry, and public administration, provides avenues for development and inclusive economic growth (van Niekerk, 2020). Therefore, access to high-speed broadband network penetration and high-quality governance are considered key factors for the socioeconomic development of countries, regions, and communities worldwide (Cardona *et al.*, 2013; Fisher *et al.*, 2020).

However, there is no even distribution of high-speed broadband networks in various low-income countries, and this can worsen the current level of income inequality and exacerbate the poverty inciden-

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Publisher: UCHPRO, USA
*Corresponding author: eozegbe@pau.edu.ng

ce in the affected countries (Lucendo-Monedero *et al.*, 2019). Low-income economies suffer unfairly from the digital divide, which denies them the opportunity to take part in the digital economy actively and hinders their growth potential, which can largely be attributed to weak political governance. The presence of broadband infrastructural divide and weak governance quality amongst frontier economies has become more glaring in recent years, with Sub-Saharan Africa and some Asian regions being at the forefront of this quagmire (Ferrandis *et al.,* 2021).

As such, this study is motivated by the quest to examine the role of broadband network infrastructure and governance in accelerating inclusive growth in selected Sub-Saharan African and Asian countries that have suffered from poor broadband network infrastructure and weak governance systems over the years.

Examining the determinants of a nation's economic emancipation or retrogression has been the primary thrust of economists and other policymakers. Stemming from the groundbreaking studies of Trist and Bamforth (1951), the socio-technical theory can be traced to the study by the UK Tavistock Institute based on the mining of coal, which resulted in an interrelation between society and technology. The socio-technical theory has been useful in designing and implementing novel digital technologies and in understanding how such technologies drive human welfare through inclusive economic growth (Sony and Naik, 2020). When considering the interrelation between technical and human systems, the socio-technical systems theory suggests that productivity can be maximized through joint optimization (Sony and Naik, 2020).

While socio-technical theory continues to influence our understanding of digital technological advancement and economic growth, other prominent scholars have introduced information and communication technology and governance (quality of institutions) as critical growth enhancers (Adeleye *et al.,* 2023; Ofori and Asongu, 2021; Stylianou *et al.,* 2023). Since the inception of the new millennium, economic experts across the globe have focused attention on inclusive growth as a dimension of growth (Adeleye *et al.,* 2021; Asongu and Le Roux, 2017; Ofori and Asongu, 2021; Ozegbe *et al.,* 2019).

Political and economic gladiators in every region of the world are perturbed that positive economic growth does not trickle down to the base of the economy (i.e., the masses of the people). This scenario is more evident at a point where the growth of several frontier and emerging economies is accompanied by widening inequality stemming from the twin cankerworms of unemployment and poverty. In addition, some studies have argued that nations with a substantial level of technical progress and good governance experience a high level of inclusive growth irrespective of their geographical location (Achuo *et al.,* 2024; Aslam *et al.,* 2021; Asongu and Le Roux, 2017; Nguyen *et al.,* 2022). In contrast, poor technological advancement and a weak governance system are connected with the absence of inclusive

growth (Aziz and Sarwar 2023; Scholl and Schermuly, 2020; Williamson, 2009). Based on the ongoing debate in the literature, the novelty and distinction between this study and the previous studies lie in the following strands.

First, this inquiry differs from previous studies (d'Agostino *et al.,* 2016; Cieślik and Goczek, 2018; Iheanachor and Ozegbe, 2023; Noja *et al.,* 2019; Ozegbe and Kelikume, 2022; Singh, 2022), as it focuses on exploring the effects of broadband network and governance from the purview of inclusive growth obtained from the UNDP's human development index (2022). The justification for adopting HDI as the proxy for inclusive growth stems from the fact that it is based on three cardinal foundations of human development which are standard of living, life expectancy, and education, adjudged the most appropriate indicator of inclusive growth (Adeleye *et al.,* 2023; Stylianou *et al.,* 2023). Policymakers are now paying adequate attention to inclusive growth as it focuses on bridging income inequality gaps and poverty alleviation, unlike economic growth, which solely focuses on income measures (Ajide *et al.* 2021).

Second, previous studies (Gründler and Potrafke, 2019; Islam and McGillivray, 2020; Iheanachor *et al.,* 2023) used a single governance indicator to capture the concept of governance; however, this study contributes to the body of literature by developing a component index for governance using the six governance indicators. The rationale behind this decision stems from the fact that there are six different indicators of governance, and ascertaining the most appropriate indicator for empirical investigation is difficult. Therefore, the principal component analysis was conducted for this purpose. This study also examined the interactive effects of broadband network and governance on inclusive growth with a view to ascertaining if the net impact of broadband network infrastructure and governance accelerates or retards inclusive growth.

From the preceding discussion, the following research questions would guide this investigation: (i) What are the effects of broadband networks on inclusive growth? (ii) Does governance influence inclusive growth? (iii) Does the interaction between broadband network and governance affect inclusive growth?

The rest of the paper is structured as follows. Section 2 reviews the relevant literature, while Section 3 outlines the research methodology. Sections 4 and 5 present and the results and discussion, and Section 6, 7, and 8 concludes with key findings, implications, limitations and the direction for future research.

LITERATURE REVIEW

Theoretical Underpinnings

-The Socio-Technical Theory

The socio-technical theory was developed in the 1950s at the Tavistock Institute in London (Ropohl, 1999). It was anchored by Trist and Bamforth (1951) due to an industry-based inquiry centered on coal exploration (van Eijnatten, 2013). The theory is an offshoot of the open system model (Von Bertalanffy, 1950) which advocated a 'new paradigm' that simultaneously propagated technological advancement and human interaction in the attainment of modern socio-economic objectives rather than developing a system where people were merely considered as 'resources to be developed' (Trist, 1981: p. 42). Van Eijnatten (2013) further asserted that socio-technical theory was founded on the premise of mutual benefits originating from the interaction between technical and social phenomena. This interaction stresses the reciprocity between technical and human resources in which both resources align to drive social and economic objectives.

Therefore, socio-technical theory is useful in designing and implementing novel digital technologies that incorporate governance and other human interactions to drive inclusive economic growth and sustainable development (Kamran *et al.,* 2023). When considering the interrelationship between technical and human systems, the socio-technical theory suggests that productivity can be maximized through joint optimization (Kamran *et al.,* 2023).

In addition, the socio-technical theory underscores the mutual dependence of social and technical systems, arguing that technological progress, exemplified by broadband infrastructure, requires harmonization with societal and institutional contexts to produce substantial impacts, including economic expansion (Williamson, 2009; Scholl and Schermuly, 2020). A strong broadband infrastructure is key to driving digital transformation, boosting productivity, and fostering innovation. Nevertheless, the economy is impacted by how strong institutions are and how adaptable social systems are.

According to socio-technical theory, technological systems (e.g., broadband networks) interact with social systems to shape performance and outcomes (Trist and Bamforth, 1951). Broadband penetration enhances access to information, financial services, and markets, thereby expanding opportunities for marginalized groups. Thus, broadband is expected to positively influence inclusive growth. Similarly, the institutional theory (North, 1990) emphasizes that institutions and governance structures determine how effectively resources and technologies are transformed into growth. Good governance enhances transparency, accountability, and efficiency, which improves the inclusiveness of growth. In contrast, weak governance may limit the benefits of technological investments. Therefore, the debate in the literature about the likely effect of governance on inclusive growth is inconclusive.

Empirical Review and Hypotheses Development

-Broadband Networks Infrastructure and Inclusive Growth

Through a theoretical lens, it is evident that broadband networks and other ICT infrastructure can provide

positive externalities to economic growth at the micro and macro levels. Empirically, causal linkages between broadband networks and economic growth have been found at national and cross-national levels. However, the direction of the relationship remains inconclusive. Some studies affirm the theoretical postulation of a positive relationship between broadband networks and economic growth.

For instance, Andrianaivo and Kpodar (2011) used different measures of ICT, including fixed telephone penetration rate, mobile phone, and cost of local calls, to examine the nexus between broadband networks and inclusive growth and reported that broadband networks contributed positively to economic growth in Africa within the period under review. Also, Mutiiria *et al.* (2020) used the generalized method of moments (GMM) technique to examine the causal connection between broadband networks and inclusive growth in Sub-Saharan Africa and found evidence of a strong positive impact of broadband penetration on inclusive growth in SSA. Nchake and Shuaibu (2022) used the Blundell-Bond system estimator to examine how broadband networks and ICT drive inclusive growth using a data set covering 46 African countries from 2000 to 2019. The study reported that broadband networks and ICT infrastructure have a positive and significant impact on inclusive growth in Africa. De Clercq *et al.* (2023) employed the dynamic fixed effects estimator to investigate the regional impact of high-speed broadband networks on the growth of 1348 regions across Europe from 2011 to 2018. The study revealed that the expansion of access to lower-speed broadband increased annual growth per capita in the rural and urban regions through diminishing returns to scale. However, high-speed broadband networks could only have a positive influence on growth per capita in the rural region and no significant impact on their urban counterpart. Koutroumpis (2019) assessed the effects of broadband speed on the economic growth of 35 Organization for Economic Co-operation and Development (OECD) nations from 2002 to 2016. The authors incorporated a quadratic term of broadband speed in their model and revealed that broadband speed has a declining effect on growth. Edquist (2022) used the fixed-effect regression modeling approach to estimate the effects of broadband speed on labor productivity growth by employing country-level panel data from 116 economies between 2014 and 2019. The study reported that a 10% rise in broadband speed in the previous period led to an increase in labor productivity growth of 0.2%.

Mayer *et al.* (2015) used quarterly data from 29 OECD nations to uncover whether broadband network penetration influences growth. They contended that the dynamics in broadband networks can have a positive and significant influence on growth. They further reported that expansion in broadband network penetration will influence growth positively because of innovation, learning, and reorganization. Jung and Lopez-Bazo (2020) employed the ordinary least squares data estimation technique to examine the regional impact of the broadband network on labor productivity using data from 27 Brazilian regions

from 2007 to 2011. The study revealed that broadband network penetration has a positive and significant impact on labor productivity, which implies that broadband networks can accelerate labor productivity growth.

Mayer *et al.* (2020) used a dynamic panel data threshold model to estimate how broadband network penetration determines growth. The study found that broadband penetration is statistically insignificant with speed (positively) and its interaction with penetration (negatively) and significantly impacts growth.

Bánhidi (2021) examined the impact of broadband networks on the expansion of South America's economic growth and development. The finding shows that expanded broadband penetration is directly linked with significant spillover effects and surplus social benefits over and above the anticipated returns of other investments in physical capital. Camba and Camba (2020) employed a panel-based vector error correction model to explore the connections between broadband subscription and internet penetration on the growth of ASEAN economies from 2000 to 2016. The study reported that there is a long-run causality running from broadband subscription and internet penetration to growth. This implies that broadband connection and internet penetration are critical drivers of growth among ASEAN countries.

On the contrary, Ejemeyovwi and Osabuohien (2020) examined the usefulness of broadband network adoption on inclusive growth among West African states using a System Generalized Method of Moments (SGMM) technique and reported that broadband networks and mobile technology adoption have an insignificant impact on inclusive growth in West Africa.

Based on the empirical examination of the relationship between broadband network and inclusive growth in the section above, hypothesis one is proposed below:

H_{01}: Broadband networks do not have a significant effect on inclusive growth

Governance and Inclusive Growth

The linkages between governance and growth were initially investigated theoretically by Olson (1982) and North (1990) before the emergence of other studies. The pioneer studies posited that the quality of governance determines a nation's capacity to drive economic progress. For instance, according to North (1990), a nation's governance quality influences the nature of rules guiding economic players. Recently, George *et al.* (2021) argued that market regulations, price systems, and the actions of economic players are guided by the quality of governance in the economy.

Sondermann (2018) affirmed that countries with strong governance structures resist economic shocks. Additionally, Arogundade *et al.* (2021) emphasized that quality governance is crucial for enhancing the impact of cross-border capital inflows on inclusive growth and human development in

Africa. Doumbia (2019) used the panel smooth transition regression (PSTR) technique to examine the role of governance in driving inclusive growth using a sample of 112 countries from 1975 to 2012. The result showed that growth is generally pro-poor but not inclusive growth. It further indicated that the indicators of governance, the rule of law, and government effectiveness drive inclusive growth. Stylianou *et al.* (2023) explored the causal nexus between governance and inclusive growth in 24 selected Asian countries using panel data from 2010 to 2017. The result revealed that there is a bidirectional causality between governance and inclusive growth. As such, inclusive growth drives more government investment in physical development, whereas governance quality enhances inclusive growth. Kesar and Jena (2022) investigated the effects of governance and inclusive growth, and human development and found that three indicators of governance have a significant positive impact on inclusive growth.

Ouma and Nadzanja (2019) employed the random effect model and the two-stage generalized method of moments (GMM) to ascertain the effect of governance on inclusive growth in 19 common markets of the eastern and southern African nations. The study revealed that governance and fiscal policy exerted a significant positive impact on inclusive growth. Keser and Gokman (2018) studied the linkage between governance and inclusive growth and development of 33 European Union member countries from 2002 to 2012. The result showed that good governance impacted inclusive growth and human development positively.

Nevertheless, despite the robust support for the growth-accelerating effects of governance, some previous empirical studies could not find a strong relationship between governance and growth (Williamson, 2009; Scholl and Schermuly, 2020). They contended that various nations have distinct growth trajectories and, as such, governance should not be a determinant of national growth and human development (Xu *et al.,* 2021). Similarly, Scholl and Schermuly (2020) explored the connection between governance and inclusive growth and found that governance has a significant negative impact on inclusive growth, while growth has a positive impact on inclusive growth.

Breda (2019) examined the nexus between governance and inclusive growth in 45 low-income countries from 1990 to 2018. The results indicated that countries with weak governance received less FDI and that economic growth has a significant positive relationship with inclusive growth. On the other hand, governance has an adverse effect on inclusive growth. As such, this study proposes to test the null hypothesis based on the discussion above:

H_{02}: Governance does not have a significant effect on inclusive growth

METHODOLOGY

–Sample and Procedure

This study employed 7 variables across 20 selected Asian and African countries, namely: Afghanistan, Pakistan, China, India, Nepal, Qatar, Bahrain, Iraq, Oman, and Thailand. Others are Nigeria, Niger, Egypt, Mauritania, Cameroon, Botswana, Rwanda, Burkina Faso, South Africa, and Benin, from 1996 to 2022, to attain its objective. The choice of variables and countries from both regions is based on their economic and political peculiarities and data availability.

Variables	Description	Sign	Source
HDI (Inclusive Growth)	Human Development Index	+	UNDP
GOV (Governance)	Regulatory Quality	+	WGI
Broadband Network	Fixed broadband subscriptions (per 100 people)	+	WDI
TOP (Trade Openness)	Trade (% of GDP)	+	WDI
GCF (Gross Capital Formation)	Gross capital formation (% of GDP)	+	WDI
POPG (Population Growth)	Population growth (annual %)	N/A	WDI
INF (Inflation)	Inflation, consumer prices (annual %)	+	WDI

Source: Authors' presentation

Table 1: Variables and Measurements

Measurement of Variables

As depicted in Table 1 above, the dependent variable for the study is inclusive growth, which has been proxied by different indicators in some previous empirical and theoretical investigations (Acemoglu and Robinson, 2010; Asongu and Le Roux, 2017; Elvis *et al.,* 2019; Oyinlola *et al.,* 2020; Ofori and Asongu, 2021; Tella and Alimi, 2016).

Nevertheless, this study used the Human Development Index (HDI) from the UNDP as a proxy for inclusive growth. The justification for this choice is based on the diverse nature of the index, which is built on three foundations of human development, namely human welfare, education, and health outcomes like life expectancy (Adeleye *et al.,* 2023). Similarly, fixed broadband subscriptions (per 100 people) and mobile-cellular subscriptions are used for broadband in this study. While the former is employed commonly among individuals at different income levels, such that owning a mobile phone permit those at the bottom of the pyramid to have access to information. The latter predominantly captures formal entities. As such, adopting these two variables as broadband network indicators guarantees that broadband networks are adequately spread across different sections of the selected countries (Adeleye and Eboagu, 2019; Edquist, 2022; Adeleye *et al.,* 2023). Governance, which is regulatory quality, reflects the perception of the ability of the state to formulate and execute sound policies and regulations that permit private sector development (Scholl and Schermuly, 2020).

The control variables used include trade openness (Huchet-Bourdon *et al.,* 2018; Kong *et al.,* 2020), gross capital formation (Aslan and Altinoz, 2021; Ebire *et al.,* 2021), inflation (Azam and Khan, 2022; Khan and Hanif, 2020), and population growth (Suluk, 2021).

–Model Specification

The empirical model for this study is situated on Acemoglu *et al.* (2009), Iheanachor and Ozegbe (2023), and Aziz and Sarwar (2023) frameworks, which propagated governance as a critical driver of growth, and *Stein et al.* (2018), Adeleye *et al.* (2023), and Stylianu *et al.* (2023), who advanced the role of ICT in the economic prosperity of nations. The functional model for the study presents inclusive growth as a function of broadband network penetration, governance quality, trade openness, gross capital formation, population growth, and inflation.

The functional model is specified as:

$$lHDI = \mathrm{f}(lBroadband, GOV, lTOP, lGCF, lPOPG, lINF),$$

The econometric forms of the models are stated as:

$$lHDI\_Africa = \gamma_1 + \gamma_2 lBroadband\_Africa_t + \gamma_3 GOV\_Africa_t + \gamma_4 lTOP\_Africa_t + \gamma_5 lGCF\_Africa_t + \gamma_6 POPG\_Africa_t + \gamma_7 INF\_Africa_t + \mu_t \ldots\ldots\ldots\ldots (1)$$

$$lHDI\_Asia = \gamma_1 + \gamma_2 lBroadband\_Asia_t + \gamma_3 GOV\_Asia_t + \gamma_4 lTOP\_Asia_t + \gamma_5 lGCF\_Asia_t + \gamma_6 POPG\_Asia_t + \gamma_7 INF\_Asia_t + \mu_t \ldots\ldots\ldots\ldots (2)$$

Where $lHDI$ represents the Log of Human Development Index, γ_1 represents the constant term, $\gamma_2 lBroadband_t$ is the Log of Broadband Penetration, $\gamma_3 GOV_t$ is the Governance Indicator, $\gamma_4 lTOP_t$ is the Log of Trade Openness, $\gamma_5 lGCF_t$, is the Log of Gross Capital Formation, $\gamma_6 POPG_t$ depicts Population Growth Rate while, $\gamma_7 INF_t$ means Inflation Rate and μ_t captures the error term.

Equation 2 below shows the interacting effect of governance with broadband network penetration.

$$Africa = \gamma_1 + \gamma_2 lBroadband\_Africa_t + \gamma_3 GOV\_Africa_t + \gamma_4 lTOP\_Africa_t + \gamma_5 lGCF\_Africa_t + \gamma_6 POPG\_Africa_t + \gamma_7 INF\_Africa_t + + \gamma_8 (lBroadband\_Africa * lGOV\_Africa) + \mu_t \ldots (3)$$

$$Asia = \gamma_1 + \gamma_2 lBroadband\_Asia_t + \gamma_3 GOV\_Asia_t + \gamma_4 lTOP\_Asia_t + \gamma_5 lGCF\_Asia_t + \gamma_6 POPG\_Asia_t + \gamma_7 INF\_Asia_t + \gamma_8 (lBroadband\_Asia * lGOV\_Asia) + \mu_t \ldots\ldots\ldots (4)$$

Where $lHDI$ represents the Log of Human Development Index, γ_1 represents the constant term, $\gamma_2 lBroadband_t$ is the Log of Broadband Penetration, $\gamma_3 GOV_t$ is the Governance Indicator, $\gamma_4 lTOP_t$ is the Log of Trade Openness, $\gamma_5 lGCF_t$, is the Log of Gross Capital Formation, $\gamma_6 POPG_t$ depicts Population

Growth Rate while, $\gamma_7 INF_t$ means Inflation Rate and μ_t captures the error term.

–Data Analysis Technique

The study employed a panel data analytical framework to examine the relationship between broadband network infrastructure, governance quality, and inclusive growth across selected African and Asian countries. The choice of panel estimation techniques was informed by the dataset's cross–sectional and time–series nature, which enables control for country–specific heterogeneity and dynamic effects over time. Descriptive statistics were first conducted to summarize the central tendencies, dispersion, and distributional properties of the variables. Correlation analysis was then used to examine the preliminary relationships among variables and detect potential multicollinearity issues.

To ensure the validity of the estimations, panel unit root tests, specifically the Im, Pesaran and Shin (IPS) and Levin, Lin and Chu (LLC) tests were applied to determine the stationarity properties of the variables. Subsequently, Pooled Ordinary Least Squares (POLS), Fixed Effects (FE), and Random Effects (RE) models were estimated to evaluate the determinants of inclusive growth. The Hausman specification test was employed to select the most appropriate model between FE and RE estimators. Additionally, an interaction term between broadband infrastructure and governance quality was introduced to assess the moderating role of governance on the broadband–inclusive growth nexus.

RESULTS

This sub–section provides the summary of all results of the variables being examined, such as inclusive growth (HDI), governance (GOV), broadband network penetration (Broadband), Trade Openness (TOP), gross capital formation (GCF), population growth (POPG), and inflation (INF).

Variables	Mean	Std.	Min.	Max.	Skew.	Kurtosis	JB
HDI_Africa	-0.667	0.233	-1.287	0.3	-0.437	2.633	7.112
$Broadband\_Africa$	3.814	1.145	-0.499	5.129	-1.487	4.715	92.813
GOV_Africa	-0.789	0.702	-2.55	0.85	-0.131	3.569	3.106
$lTOP\_Africa$	4.038	0.367	3.378	4.385	0.318	2.02	10.81
$lGCF\_Africa$	3.096	0.306	2.492	3.895	0.408	2.584	6.646
$POPG\_Africa$	2.525	0.685	0.387	3.867	-0.44	3.285	6.777
INF_Africa	1.385	1.069	-3.207	3.385	-1.293	5.587	96.967
HDI_Asia	0.69	0.125	0.455	0.888	-0.175	1.671	13.447
$Broadband\_Asia$	4.147	1.186	-1.219	5.359	-2.503	9.866	514.16
GOV_Asia	-0.276	0.683	-1.65	0.86	0.193	1.756	12.09
$lTOP\_Asia$	4.23	0.544	3.205	5.257	-0.096	1-803	10.47
$lGCF\_Asia$	3.324	0.345	2.234	3.889	-0.541	2.64	9.254
$POPG\_Asia$	2.403	3.12	-2.649	19.36	2.668	12.397	832.01
INF_Asia	1.214	1.073	-2.729	3.975	-0.704	4.389	25.576

Source: Authors' Computation

Table 2: Descriptive Statistics

Table 2 above presents the descriptive statistics of the variables employed in the study. A comparison of the results between Africa and Asia shows that inclusive growth over the sample period is higher in Asia than in Africa. The mean growth for Africa over the period is −0.667, indicating a decline, while the mean growth for Asia is 0.669, suggesting a rise.

Tables 3 and 4 present the correlation coefficients for Africa and Asia, respectively. In Table 3, the estimates show that inclusive growth proxied by HDI is positively and significantly correlated with broadband, governance quality, and trade openness. This implies that broadband penetration and governance quality promote inclusive growth. Further, the results show a significant negative relationship between HDI and population growth rate, implying that a higher population growth rate reduces inclusive growth.

Variables	*HDI*	*Broadband*	*GOV*	*lTOP*	*lGCF*	*POPG*	*INF*
HDI	1						
lBroadband	0.663***	1					
	(0.00)						
GOV	0.145**	0.205**	1				
	(0.06)	(0.01)					
lTOP	0.30***	0.432***	0.051	1			
	(0.00)	(0.00)	(0.51)				
lGCF	-0.047	0.283***	-0.074	0.685***	1		
	(0.54)	(0.00)	(0.33)	(0.00)			
POPG	-0.825***	-0.407***	-0.282***	-0.22***	0.162**	1	
	(0.00)	(0.00)	(0.00)	(0.00)	(0,03)		
INF	0.386***	0.118	-0.081	0.273***	0.092	-0.411***	1
	(0.00)	(0.12)	(0.289)	(0.00)	(0.23)	(0.00)	

Source: Authors' Computation

**p<.01, ***p<.001

Table 3: Correlation Matrix for Africa

In Table 4, the estimates show that HDI is positively and significantly correlated with broadband, governance quality, trade openness, and inflation. This implies that broadband networks and governance promote inclusive growth. This result indicates the rejection of the null hypothesis, which states that broadband networks and governance have no significant impact on inclusive growth.

Further, the results show a significant negative relationship between HDI and population growth rate, implying that a higher population growth rate reduces inclusive growth.

Using Im *et al.* (2003) and Levin *et al* (2002), Table 5 (see Appendix-I) presents the unit root test results used to check the integration order of each variable. The test statistics show that some of the variables are stationary at levels, while others are stationary at first differences.

Table 6 presents the results using the pooled panel least squares technique. The estimated coefficient

of broadband networks is positive and statistically significant for Africa and Asia.

Variables	*HDI*	*lBroadban*	*GOV*	*lTOP*	*lGCF*	*POPG*	*INF*
HDI	1						
lBroadband	0.644***	1					
	(0.00)						
GOV	0.599***	0.326***	1				
	(0.00)	(0.00)					
lTOP	0.771***	0.307***	0.356***	1			
	(0.00)	(0.00)	(0.00)				
lGCF	0.40***	0.167*	0.407***	0.144†	1		
	(0.00)	(0.04)	(0.000)	(0.07)			
POPG	0.357***	0.158*	0.44***	0.325***	0.069	1	
	(0.00)	(0.05)	(0.00)	(0.00)	(0.39)		
INF	-0.542***	-0.349	-0.283***	-0.299***	-0.125	0.074	1
	(0.00)	(0.00)	(0.00)	(0.00)	(0.12)	(0.36)	

Source: Authors' Computation

†p<.10, *p<.05, ***p<.001

Table 4: Correlation Matrix for Asia

	Africa			Asia		
Ind. Variables	**Coeff.**	**Std. err.**	***t*-ratio**	**Coeff.**	**Std. err.**	***t*-stat**
lBroadband	0.089***	0.008	11.447	0.044***	0.002	18.667
GOV	-0.041***	0-011	-3.729	0.048***	0.012	3.933
lTOP	0.021	0.03	0.684	0.094***	0.014	6.866
lGCF	-0.08**	0.036	-2.225	0.046***	0.016	2.965
POPG	-0.213***	0.015	-14.357	0.002	0.001	1.379
INF	0.015*	0.008	1.805	-0.021***	0.003	-6.945
Constant	-0.354***	0.091	-3.91	-1.087***	0.073	18.667

Source: Authors' Computation

*p<.05, **p<.01, ***p<.001

Table 6: Pooled Panel Least Squares Results: Dependent Variable: lnHDI

Table 7 presents the results using the fixed-effect technique. The estimated coefficient of broadband networks is positive and statistically significant for Africa and Asia.

	Africa			Asia		
Ind. Variables	**Coeff.**	**Std. err.**	***t*-ratio**	**Coeff.**	**Std. err.**	***t*-stat**
lBroadband	0.072***	0.003	23.867	0.039***	0.002	16.266
GOV	-0.032***	0.009	-3.447	-0.031	0.019	-1.622
lTOP	-0.025	0.017	-1,468	-0.057**	0.02	-2.73
lGCF	-0.014	0.016	-0.871	0.025	0.018	1.381
POPG	-0.017	0.014	-1.26	-0.001	0.001	-0.851
INF	-0.004	0.003	-1.251	-0.008**	0.003	-2.312
Constant	-0.758***	0.072	10.473	-0.407	0.096	-4.266

Source: Authors' Computation

**p<.01, ***p<.001

Table 7: Fixed Effect Results: Dependent Variable: lnHDI

Table 8 presents the results of the governance interaction with broadband network penetration. This is to evaluate whether governance influences the effect of broadband on inclusive growth in Africa and Asia.

	Africa			Asia		
Ind. Variables	**Coeff.**	**Std. err**	***t*-ratio**	**Coeff.**	**Std. err**	***t*-stat**
$lBroadband$	0.082***	0.012	6.692	0.068***	0.007	9.999
GOV	-0.016	0.036	-0.442	-0.08**	0.035	-2.272
$lTOP$	0.018	0.031	0.593	0.157***	0-011	14.982
$lGCF$	-0.082	0.031	0.593	0.105***	0.015	6.939
$POPG$	-0.215**	0.015	-14.097	0.005**	0.002	2.647
INF	0.015*	0.008	1.893	-0.043***	0.005	-8.466
$Broadband * GOV$	-0.007	0.009	-0.733	0.027***	0.008	3.506
$Constant$	-0.304***	0.113	-2.687	-1.645***	0.067	-24.659

Source: Authors' Computation

*p<.05, **p<.01, ***p<.001

Table 8: Pooled Panel Least Squares Results: Dependent Variable: lnHDI

Table 9 represents the estimates for fixed effects on the interaction of broadband network penetration with governance quality, which shows that broadband has a significant positive effect on inclusive growth. This implies that broadband will improve inclusive growth with quality governance. Similarly, the results for Asia with the interaction of governance quality and broadband show that broadband has a significant positive effect on inclusive growth. Thus, we reject the hypothesis that the interaction between broadband penetration and governance has no significant effect on inclusive growth. Good governance quality increases inclusive growth in Africa and Asia.

	Africa			Asia		
Ind. Variables	**Coeff.**	**Std.err**	***t*-ratio**	**Coeff.**	**Std. err**	***t*-stat**
$lBroadband$	0.081***	0.005	16.87	0.063***	0.003	18.412
GOV	-0.062***	0.016	-3.888	-0.149***	0.021	-7.095
$lTOP$	-0.025	0.017	-1.502	-0.095***	0.018	-5.428
$lGCF$	-0.009	0.016	-0.576	-0.004	0.015	-0.288
$POPG$	-0.024*	0.014	-1.729	-0.0002	0.001	-0.022
INF	-0.005	0.003	-1.553	-0.011***	0.003	-3.857
$Broadband * GOV$	0.008**	0.004	2.303	0.035***	0.004	8.4
$Constant$	-0.787***	0.073	-10.856	-0.24***	0.081	-2.953

Source: Authors' Computation

*p<.05, **p<.01, ***p<.001

Table 9: Fixed Effect Results: Dependent Variable: lnHDI

The test summary results for Africa and Asia reveal statistically significant outcomes. For Africa, the cross-section random effects test produced a Chi-square value of 38.76 with 6 degrees of freedom (*df*)

and a p-value < 0.01, indicating a strong rejection of the null hypothesis at the 1% significance level. Similarly, for Asia, the Chi-square statistic was 16.87 with 6 degrees of freedom and a p-value < 0.01, also confirming statistical significance. These findings suggest that the random effects model is appropriate, as unobserved heterogeneity across cross-sections is significant in both regions.

DISCUSSION

The results obtained from the pooled panel least squares analysis indicated that the estimated coefficient of broadband networks is positive and statistically significant for Africa and Asia. This implies that increasing broadband penetration can increase inclusive growth on both continents. A one percent increase in broadband provision will increase inclusive growth by 0.089% and 0.044% in Africa and Asia, respectively.

These findings resonate with the socio-technical theory developed by Trist and Bamforth (1951) at the Tavistock Institute in London, which emphasizes the interdependence of social and technical systems in shaping organizational and societal outcomes. Broadband networks represent the technical subsystem, while governance structures, institutions, and human capabilities constitute the social subsystem. When effectively integrated, these systems enhance productivity, participation, and inclusiveness. Thus, the positive impact of broadband on inclusive growth demonstrates how technological advancement, when embedded within supportive social structures, can foster equitable economic development. This result is consistent with the findings of Adeleye *et al.* (2023). This also indicates that broadband penetration will contribute more to inclusive growth in Africa than in Asia. From the findings, hypothesis 1, which states that broadband network infrastructure has no significant relationship with inclusive growth, is rejected for Africa and Asia.

Further, governance quality has a significantly negative effect on inclusive growth in Africa, but a positive and significant effect on inclusive growth in Asia. This implies that an improvement in governance quality reduces inclusive growth in Africa, while it increases inclusive growth in Asia. The negative effect of governance quality on inclusive growth in Africa differs from the existing studies. The results reveal that Asian countries with more robust institutional quality systems can minimize widening gaps in income distribution, reduce poverty, and improve inclusive growth (Nawaz *et al.,* 2014; Nguyen *et al.,* 2018; Tran *et al.,* 2021). Therefore, we reject hypothesis 2, which posits that governance is not significantly related to inclusive growth.

Gross capital formation and population growth rate have a significant negative effect on inclusive growth in Africa. This implies that a rise in capital formation reduces inclusive growth. This may be attributed to the adoption of labor-saving capital, which reduces demand for labor, increases unemplo-

yment, and reduces inclusive growth. Similarly, a rise in population reduces inclusive growth through the unemployment channel. This result is in line with the empirical outcome of Adeleye *et al.* (2021a) and Ongo and Vukenkeng (2014). However, the estimates show that gross capital formation has a significant positive effect on inclusive growth in Asia. This suggests that a rise in capital investment and infrastructure creates a favorable business climate, which positively affects productivity and enhances inclusive growth. This result conforms to the findings by Roztocki *et al.* (2019). Trade openness has an insignificant positive effect on inclusive growth in Africa, but a significant positive effect on growth in Asia. This implies that trade openness does not influence inclusive growth in Africa, but it influences inclusive growth in Asia. This shows that trade has positive benefits and promotes inclusive growth in Asia.

Finally, inflation has a significant positive effect on inclusive growth in Africa but a significant negative effect on inclusive growth in Asia. The results for Africa imply that rising inflation increases inclusive growth through investment channels. This supports the structuralists' hypothesis that inflation is necessary for economic growth. The estimates for Asia imply that rising inflation reduces inclusive growth through a decline in consumer real income and economic growth. This is consistent with Vanlaer *et al.* (2020) and Dilanchiev and Taktakishvili (2021), who stated that a rise in consumer prices reduces household savings, availability of resources for domestic investment, and inclusive growth.

The interaction of governance quality with broadband network penetration is insignificant in Africa but significantly positive in Asia. The results for Africa with the interaction of governance revealed that broadband network penetration has a positive and significant effect on inclusive growth. This implies that broadband network penetration will improve inclusive growth when interacting with governance. Similarly, the result for Asia with the interaction between governance and broadband network penetration shows that broadband network penetration has a significant positive effect on inclusive growth. Thus, we reject the hypothesis that the interaction between broadband network penetration and governance has no significant effect on inclusive growth. Good governance increases inclusive growth in Africa and Asia.

CONCLUSION

Using the pooled panel least squares method, this study examined the effect of broadband penetration and governance quality on inclusive growth in select African and Asian countries from 1996 to 2022. The Human Development Index was chosen as a proxy for inclusive growth, as it is a diverse indicator that shows progress in welfare, health, and education. The broadband network was proxied by mobile cellular

subscriptions and fixed broadband subscriptions. Lastly, governance was measured by the governance indicator sourced from the World Governance Indicators.

The coefficients between the variables are mixed, as some show a positive correlation while others show a negative correlation. In Africa, inclusive growth (HDI) was positively and significantly correlated with broadband, governance quality (GOV), and trade openness (TOP), but was negatively correlated with population growth rate (POPG). For Asia, the results for the correlation matrix are similar.

In summary, this study concludes that broadband networks are essential to spur inclusive growth in Africa and Asia. However, its contribution to inclusive growth is more significant in Africa than in Asia. The impact of governance quality on inclusive growth in both regions is bidirectional. While possible factors such as weak institutional frameworks and ineffective policy reforms can account for the negative effect in Africa, governance quality has a positive effect in Asia, likely due to the region's institutional quality, among other factors. In addition, the interactive effect of governance quality and broadband provision was investigated, and the findings suggest that government quality influences the way broadband affects inclusive growth. In regions where governance is not strong, the broadband's ability to spur inclusive growth will be constrained, which is in line with the findings from the literature (Ahmad and Saleem 2014; Bhanumurthy *et al.,* 2018; Mohammadi *et al.,* 2017). Thus, to promote inclusive growth, efforts to improve broadband provision must be complemented by governmental reforms.

In light of the findings from this study, it is therefore recommended that the governments in the regions prioritize the development of broadband infrastructure. Likewise, governmental reforms to eliminate corruption often associated with bureaucratic practices must be embarked on (Khan *et al.,* 2016; Ngepah, 2017). This will enable investments in broadband development to trickle down to the masses. We can conclude that if the government implements policies in the people's best interests, the HDI index will grow over the years in both regions.

IMPLICATIONS

From a theoretical purview, the socio-technical theory emphasizes the mutual dependence of social and technical systems, suggesting that technological progress, such as broadband infrastructure, must be harmonized with societal and institutional contexts to generate substantial developmental outcomes (Trist and Bamforth, 1951; Williamson, 2009; Scholl and Schermuly, 2020). The theory argues that technical innovations cannot operate in isolation; their full benefits are realized only when embedded within effective governance structures, adaptive institutions, and supportive human capabilities. In the context of this study, broadband networks represent the technical subsystem, while governance quality, institutional frameworks, and social structures constitute the social subsystem. The interaction of these

subsystems determine the extent to which digital technologies contribute to inclusive growth.

The findings of this study reveal that broadband networks significantly spur inclusive growth in both Africa and Asia, but with stronger effects in Africa. This suggests that in regions where digital infrastructure is relatively underdeveloped, incremental broadband expansion delivers larger marginal benefits by opening new avenues for access to information, financial inclusion, education, and participation in economic activities. In Asia, where broadband penetration is comparatively higher, the additional gains are smaller, pointing to diminishing marginal returns once basic connectivity is widespread. The divergent role of governance quality between the two regions further underscores the socio-technical perspective: strong institutions in Asia enhance the positive impact of broadband, while weak governance in Africa constrains its full potential.

The practical implications are twofold. First, governments must prioritize broadband development not merely as a technical investment but as part of a socio-technical transformation. Second, complementary reforms to strengthen institutional quality, ensure transparency, and curb bureaucratic inefficiencies are essential. When broadband infrastructure is aligned with effective governance and inclusive policies, the resulting synergy can drive inclusive growth, reduce inequality, and foster sustainable development across both continents.

LIMITATIONS AND FUTURE DIRECTIONS

The first limitation of this study lies in its narrow focus on regulatory quality as the sole indicator of governance. While regulatory quality is undeniably important, reflecting the ability of governments to formulate and implement sound policies and regulations does not fully capture the multidimensional nature of governance. Other key indicators, such as voice and accountability, rule of law, control of corruption, government effectiveness, and political stability, as well as the absence of violence, also play crucial roles in shaping the socio-economic environment and can significantly influence the outcomes of broadband infrastructure investments. By excluding these variables, the study may overlook broader institutional dynamics that affect inclusive growth.

Secondly, the study's empirical analysis is limited to a selection of Sub-Saharan African and Asian countries, which, while relevant due to their development challenges and growing digital economies, restricts the external validity of the findings. These regions may have unique socio-political and economic structures that do not reflect conditions in other parts of the world, such as Latin America or Eastern Europe.

To contribute more meaningfully to the literature, future research should aim to incorporate a more holistic set of governance indicators, enabling a more nuanced understanding of how institutional quality

moderates the relationship between digital infrastructure and economic inclusivity. Additionally, future studies could explore sector-specific governance reforms, particularly in public service delivery, to assess their impact on the equitable distribution of broadband-related benefits. Expanding the geographic scope of the analysis to include a more diverse set of countries would also enhance the generalizability of the results.

Moreover, future research could investigate the synergistic effects of complementary policies, such as human capital development in education and healthcare, and financial inclusion initiatives, which are increasingly recognized as key enablers of inclusive digital economies. These elements can amplify the socio-economic returns of broadband access by ensuring that marginalized populations are equipped and empowered to participate in the digital economy, thus fostering more sustainable and inclusive growth.

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Appendix-I

Im, Pesaran & Shin				
Variable	**Africa**		**Asia**	
	Level	1st difference	Level	1st difference
$lHDI$	-1.544*	-0.134	-0.359	-1.004
$lBroadband$	-6.955***	-1.388*	-8.026***	-2.523**
$Gov\ qual$	-1.146	-6.796***	-3.842**	-5.617***
$lopenness$	-0.827	-4.716***	-2.991***	-6.073***
$lcapital$	-1.837**	-7.134***	-1.691*	-4.388***
$popgr$	-1.027	-4.302***	1.43	-3.189***
$inflation$	-3.679***	-7.459***	1.195	-3.072***
Levin, Li & Chu				
	Africa		**Asia**	
$lHDI$	-4.851***	0.341	-4.059***	-0.832
$lBroadband$	-8.881***	-3.588***	-8.035***	-4.646***
$Gov\ qual$	-0.61	-5.2**	-4.067***	-6.828***
$lopenness$	-0.919	-4.239***	-3.09***	-6.673***
$lcapital$	-3.124***	-8.105***	0.85	-3.488***
$popgr$	-0.875	-4.206***	1.808	-3.924***
$inflation$	-3.562***	-8.819***	2.261	-3.173***

Source: Authors' Computation

*p<.05, **p<.01, ***p<.001

Table 5: Unit Root Tests