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The role of governance in the effect of the internet on financial inclusion in Sub-Saharan Africa

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ABSTRACT

This paper analyses the role of governance quality in the relationship between the Internet and financial inclusion in Sub-Saharan African countries. The study uses data from the International Monetary Fund (IMF) database for indicators of financial inclusion, World Development Indicators (WDI) for Internet users and World Governance Indicators (WGI) for governance indicators from 2004 to 2020. Analyzing the data using the System Generalized Method of Moments (SGMM), the results show that the Internet can be effectively complemented with the quality of governance to improve financial inclusion. Thresholds of governance that are needed for the Internet to promote financial inclusion are provided. Policies aimed at reinforcing the quality of governance in SSA countries could help consolidate Internet infrastructure to promote Internet usage and, in turn, improve financial inclusion. Other policy implications are discussed.

KEYWORDS

Internet; financial inclusion; governance quality; sub-Saharan Africa

JEL CLASSIFICATION

O30; G20; H11

1. Introduction

This study explores the direct and indirect transmission mechanisms through which the internet can affect financial inclusion. While the internet can directly increase financial inclusion through the reduction of transaction costs, the indirect effect can also pass through the internet interacting with quality of governance because good quality of governance can promote better investment in ICT infrastructure (Asongu & Biekpe, 2017; Saba et al., 2024).¹

In economic theories, the development of financial services is essential for economic growth (Levine, 2005; Schumpeter, 1934). Moreover, the United Nations (UN) has made financial inclusion a priority for economic development since 2020 (Akpa et al., 2023; Senou et al., 2019). Likewise, the World Bank has placed universal access to finance at the heart of global poverty reduction pillars (Senou et al., 2019; World Bank, 2015). Similarly, financial inclusion (i.e. having a bank account) is the beginning of participation in finance or banking to finance economic activity

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(Witt, 2015). In SSA, about 42.6% of the population aged 15 years and more have an account with 32.8% in a financial institution and 20.9% using a mobile money account (World Bank, 2018). This low rate of financial inclusion is due to the weak use of the internet in financial institutions and to the weak digitalization of financial services (Akpa et al., 2024; Yeyouomo et al., 2023). It is worth noting that, only 7.6% of the SSA population use the internet to pay bills or to buy something online and 20.8% use a mobile phone or internet to access an account (World Bank, 2018). Other factors such as the rigidity of financial institutions, inadequate services, lack of outreach and openness, the cost of financial services, and bankers' risk aversion to operating owing to information asymmetry and underperforming institutions environment explain the low financial inclusion in Africa (Ongo Nkoa & Song, 2020).

According to Niu et al. (2022), the development of technology has created new opportunities to improve financial inclusion. For Shen et al. (2021), the use of digital technology has been an effective way to improve financial inclusion. According to Ongo Nkoa and Song (2020), mobile phones and other methods reduce distances between people and financial services. Therefore, information and communication technologies (ICT), including smartphones and broadband internet, are important for expanding access to safe and affordable financial services such as payments, domestic and international remittances, insurance, credit and savings (Alliance for Financial Inclusion [AFI], 2018; Patwardhan et al., 2018). In addition, many studies have highlighted the different channels through which ICT (mainly a robust telecommunications infrastructure) can contribute to economic growth, such as by improving efficiency, reducing transaction costs, increasing trade, enhancing innovation and development, increasing employment and demand, and developing the financial sector (Arvin et al., 2021; Arvin & Pradhan, 2014; Chatterjee, 2020; Pradhan et al., 2013, 2015, 2016, 2017, 2018a, 2018).

Even though mobile penetration in SSA in the last decade has been rapid, the use of the internet is still low. In 2020, while about 83% of inhabitants had mobile phones, only 30% of the population was using the internet (World Bank, 2022). Similarly, according to Demirgüç-Kunt and Klapper (2012) and Lashitew et al. (2019), while mobile phone penetration in SSA countries has reached 76%, less than 30% of people have bank accounts. This is because internet costs in African countries remain high. The mobile phone sub-basket in Sub-Saharan averages about US\$11.7/month, while the broadband sub-basket stands at US\$44.9/month (Akpa & Chabossou, 2024; MAEP et al., 2019). The high cost of the internet in SSA is due to a lack of good ICT infrastructure to provide good internet quality which is also traceable to the absence of high competition in the GSM (Global System for Mobile communication) network market. Good governance can improve economic conditions for investing in technology infrastructure to improve internet access and correspondingly, reduce internet access costs (Chinoda & Kwenda, 2019; Muriu, 2021). By reducing transaction costs and freeing up discussions, institutions promote financial inclusion through less restrictive procedures, giving consumers greater access to financial institutions and enabling them to benefit from the financial products offered (Anthony-Orji et al., 2019). Institutional quality increases households' direct access to banking and microfinance, consolidating incentives for personnel exchange, property rights protection, and innovation (Ongo Nkoa & Song, 2020).

Empirical evidence reveals a mixed relationship between the internet and financial inclusion. Thus, Lenka and Barik (2018) in the South Asian Association for Regional Cooperation (SAARC) countries, Okoroafor et al. (2018) in Nigeria using both time series data over 1990–2016 and employing the Error Correction Model (ECM) estimation technique and Chatterjee (2020) using a fixed effects panel data model on 41 developed and developing countries, found that internet users have positively and significantly influenced financial inclusion. According to Okoroafor et al. (2018), the internet has fundamentally reduced the cost of transactions through mobile and ATM (Automated Teller Machine) use. However, other studies undertaken by Senou et al. (2019) and Bayar et al. (2021) found an opposite relationship between the internet and financial inclusion. Senou et al. (2019) found in the WAEMU (i.e. the West African Economic and Monetary Union) using the Generalized Method of Moments (GMM) estimation technique that the internet negatively and significantly influences financial

inclusion. Similarly, Bayar et al. (2021) found in the EU (i.e. European Union) post-communist countries that there are both positive and negative relationships between internet usage rates and financial institutions and financial markets access. The authors suggested that by increasing internet usage, access to financial institutions can be improved in Bulgaria, Croatia, Czech Republic, Hungary, and Poland and financial markets access can be increased in Latvia and Slovenia.

As substantiated in Section 2.2, considering the mixed relationship between the internet and financial inclusion in the literature (Bayar et al., 2021; Chatterjee, 2020; Lenka & Barik, 2018; Okoroafor et al., 2018; Senou et al., 2019), governance quality can serve as a catalyst to improve the effect of the internet on financial inclusion. Otherwise, good quality of governance can, through the reduction of transaction costs and mismanagement, promote investment in good internet-quality infrastructure to reduce corresponding internet costs (Asongu & Biekpe, 2017; Saba et al., 2024). Empirical evidence around the world shows that good quality of governance improves financial inclusion (Ali et al., 2016; Anthony-Orji et al., 2019; Aymar & Fabrice-Gilles, 2021; Chinoda & Kwenda, 2019; Chu et al., 2019; Muriu, 2021; Ongo Nkoa & Song, 2020). Otherwise, the emergence of informal credit results from a low institutional quality which benefits not only households but also borrowers (Madestam, 2014). Aymar and Fabrice-Gilles (2021) found in Sub-Saharan Africa that good governance such as quality of regulation improved financial inclusion. Ongo Nkoa and Song (2020) showed in Africa that good institutional quality improves financial inclusion and in turn the penetration, accessibility, and financial services use. Chu et al. (2019) concluded that good institutional quality stimulates financial inclusion from a sample of 82 countries. Ali et al. (2016) found in 52 developing countries that financial inclusion is positively and significantly influenced by governance indicators such as absence of violence, government effectiveness, political stability, and regulatory quality. Anthony-Orji et al. (2019) found in Nigeria that institutional quality is positively associated with financial inclusion. Chinoda and Kwenda (2019) found from a sample of 49 countries that institutional quality and governance are positively related to financial inclusion. Muriu (2021) analyzed institutions' quality role in financial inclusion in 120 countries and found that the rule of law and regulatory quality are positively and significantly associated with financial inclusion. The result implies that an enforcement of the rule of law and regulatory quality leads to higher bank account penetration in SSA economies compared to the rest of the world.

Previous studies have analyzed the internet effect on financial inclusion (Bayar et al., 2021; Chatterjee, 2020; Lenka & Barik, 2018; Senou et al., 2019) or the governance effect on financial inclusion (Chinoda & Kwenda, 2019; Chu et al., 2019; Muriu, 2021; Ongo Nkoa & Song, 2020), but the effect of the internet and quality of governance interaction on financial inclusion has not been considered in the extant literature, to the best of knowledge.

In light of the above, the research question being answered in the present study is the following: how does governance moderate the effect of the internet on financial inclusion in SSA? To respond to the question, the empirical analysis is tailored such that the net effect of internet penetration on financial inclusion is provided. This net effect entails both the unconditional and conditional or interactive effects of the internet on financial inclusion. Moreover, given that governance is the moderating variable, thresholds of governance that are essential for governance to interact with internet penetration in positively influencing financial inclusion are also provided.

Specifically, the present study complements the extant literature by assessing the role of governance in the effect of the internet on financial inclusion in Sub-Saharan Africa (SSA). Accordingly, the present study aims to shed light on the theoretical and empirical links between the internet and financial inclusion in SSA: a geographical scope that is selected because of its documented comparatively high potential for internet penetration relative to other regions of the world (Saba et al., 2024). By situating the internet in the specific context of financial inclusion, we aim to provide policy makers with insights into how the internet can be used to promote financial inclusion, contingent on good governance.

It is relevant to note that the selection of SSA as a region for the study is motivated by the fact that compared to other regions of the world, it is the most financially excluded region (Ngono, 2021) and

host the highest number of poor people in the world (Nwani & Osuji, 2020). Understanding how the potential for internet penetration can be leveraged in order to boost financial inclusion has societal and economic significance when understood within the remit of the United Nations Sustainable Development Goals (SDGs). This is essentially because as documented in Asongu and Le Roux (2023), most SDGs are linked to financial inclusion.

The rest of the study is structured as follows. The second section provides theoretical and empirical literature on the effect of ICT on financial inclusion. The third section presents the method of analysis and the source of statistical data. The fourth section presents and discusses the results followed by the conclusion and policy implications.

2. Literature review

2.1. Theoretical underpinning

The rationale behind adopting new technologies is congruent with the theoretical foundations for using internet services for financial inclusion. The most well-known theories in this stream, according to the extant literature (Asongu & Asongu, 2018; Yousafzai et al., 2010), are the Theory of Reasoned Action (TRA), the Technology Acceptance Model (TAM), and the Theory of Planned Behavior (TPB). All of these theories have one thing in common: internet adoption is a complicated and multifaceted process that involves: (i) an approach from information managers and system developers that focuses on the formation of customers' beliefs rather than the influence of attitudes; and (ii) relevant features that involve composite considerations like social, psychological, utilitarian, and behavioral aspects of customers.

To be succinct, we provide a brief summary of the three theories. Firstly, in line with Yousafzai et al. (2010) and Asongu and Asongu (2018), the TRA proposed by Bagozzi (1982), Ajzen and Fishbein (1980), and Fishbein and Ajzen (1975) is primarily predicated on the notion that clients using the internet are agents who are highly rational when it comes to considering the consequences of their choices. Second, by expressing the lack of differences between customers who have conscious control over their behaviors and those who do not, the TPB, which was introduced by Ajzen (1991), has enhanced the TRA. Third, according to the Technology Acceptance Model (TAM) of Davis (1989), customers' voluntary intentions to embrace and use the underlying technology can largely explain the adoption process of such technology by them.

The study's viewpoint, which holds that users adopt internet services because they are aware of the potential benefits of internet service applications for inclusive financial inclusion, is consistent with the three engaged theories mentioned above. Moreover, as clarified in Section 2.2.2, the conceptual framework underlying the adoption of internet services by customers for financial inclusion is contingent on governance policies, especially as it pertains to political, economic and institutional governance dynamics.

2.2. Internet usage on financial inclusion

This part does a review of the nexus between internet usage and financial inclusion on the one hand and on the other, the relationship between institutional quality and financial inclusion. In this section, the first-two main paragraphs of the literature review focus on direct effects while the next-three main paragraphs discuss the indirect effects contingent on governance. The last-two paragraphs focus on a schematic presentation of the linkages.

2.2.1. Direct effect of internet usage on financial inclusion

In general, the influence of internet usage on financial inclusion was mixed in the extant literature. Some studies have shown that the internet positively influences financial inclusion. Thus, Lenka and Barik (2018) have shown in the South Asian Association for Regional Cooperation (SAARC) countries

a positive relationship between the growth of internet and financial inclusion. Evans (2018) demonstrates in Africa that the internet has a significant positive relationship with financial inclusion, indicating that higher levels of internet usage are associated with increased financial inclusion. This suggests that expanding internet usage plays a crucial role in enhancing financial inclusion. Okoroafor et al. (2018) have established in Nigeria that internet users have positively and significantly influenced financial inclusion. According to the authors, the internet has fundamentally reduced transaction costs through mobile and ATM use. Chatterjee (2020) has found from a sample of 41 developed and developing countries that internet users positively and significantly influence financial inclusion. However, other studies have found an opposite relationship between the internet and financial inclusion. Kouladoun et al. (2022) found that in Sub-Saharan Africa, an increase in the number of internet users correlates with a higher financial inclusion measured as number of bank accounts per 100,000 adults. This suggests that internet penetration in the region enhances financial sector inclusivity, which is further supported by the facilitation of e-banking through internet access. Al-Smadi (2023) has established that in MENA countries, the coefficient for internet use is positive, indicating the crucial role of internet diffusion in promoting financial inclusion.

However, other authors highlighted a negative link between internet usage and financial inclusion. Senou et al. (2019) have established in the WAEMU by using the GMM estimation technique, that the internet negatively and significantly influences financial inclusion while by using random effects regressions, the authors have shown that the internet negatively influences financial inclusion, though the result is not significant. Bayar et al. (2021) have established positive and negative relationships between internet usage rates and financial institutions and financial market access. The authors have suggested that increased internet usage improves access to financial institutions in Bulgaria, Croatia, Czech Republic, Hungary, and Poland and an enhancement of financial markets access in Latvia and Slovenia.

The present study extends the existing literature by using quality of governance as the moderating variable in the nexus between internet usage and financial inclusion.

2.2.2. Indirect effect of internet usage on financial inclusion, contingent on governance

The mixed relationship among internet usage and financial inclusion shows that only the internet usage is not sufficient to promote financial inclusion. Other factors such as governance quality can serve as catalysts to break down the gap between internet usage and financial inclusion. Several studies have shown in the extant literature that governance quality improves financial inclusion (Nsiah & Tweneboah, 2023; Ongo Nkoa & Song, 2020; Timbi et al., 2024; Zeqiraj et al., 2022). For example, Ongo Nkoa and Song (2020) found in African countries that institutional quality increases financial inclusion by reducing transaction costs. Moreover, institutions enable financial inclusion through less restrictive procedures, which provide consumers with better access to financial institutions and allow them to profit from the financial products provided (Anthony-Orji et al., 2019; Ongo Nkoa & Song, 2020). Nsiah and Tweneboah (2023) have found in 20 countries that institutional quality improves financial inclusion. This means that as institutions working within the economy function effectively, they promote households' self-confidence and trust in companies in the financial sector which ultimately boosts financial inclusion. Similarly, the authors by testing individually the effect of institutional quality indicators on financial inclusion found that only political stability improves financial inclusion, indicating that political regime stability is very important as it promotes peace and guarantees the citizenry trust in economic stability. It follows that in accordance with the present study, governance quality is also essential for favorable nexuses between macroeconomic variables, such as the internet and financial inclusion.

Aymar and Fabrice-Gilles (2021) found in SSA countries that the quality of regulation is the only institutional factor that influences financial inclusion since it is a financial inclusion driver. Nguyen and Ha (2021) showed in Asian countries the positive impact of institutions on financial inclusion while Zeqiraj et al. (2022) found across 73 developing countries that institutional quality promotes both the access to and the use of formal financial services. Timbi et al. (2024) found that governance

dimensions and their sub-dimensions favor financial inclusion in SSA countries. Therefore, sub-dimensions of governance such as political governance, economic governance, institutional governance, and general governance positively and significantly affect financial inclusion. In the same vein, an increase in political stability, voice and accountability, quality of regulation, effectiveness of government, control of corruption, and the rule of law increase financial inclusion.

From the mixed relationship between internet usage and financial inclusion which shows that internet usage solely cannot improve financial inclusion, this study seeks to contribute to the extant literature by analyzing the moderating effect of governance quality in this relationship. Thus, our study complements the extant literature by exploring the direct and indirect impacts of the internet on financial inclusion, using a system GMM model. The indirect impact is captured by using an interaction of the internet and governance quality. The choice of the interaction of the two variables (internet usage and governance quality) is motivated by several works such as that of Nsiah and Tweneboah (2023) which has established that governance quality such as political regime stability is very important as it promotes peace and guarantees the citizenry trust in the economy.

Figure 1 shows the schematic framework underlying the problem statement. Accordingly, as shown in the figure, the incidence of the internet on financial inclusion is contingent on governance which is the moderating variable. Accordingly, the main channel is internet penetration, the outcome variable is financial inclusion proxied with the index of financial inclusion while the moderators are governance dynamics in terms of political governance (i.e. political stability/no violence and 'voice & accountability'), economic governance (i.e. government effectiveness and regulatory quality) and institutional governance (i.e. corruption-control and the rule of law). It is relevant to note that while the literature review suggests that good governance directly improves financial inclusion, indicating that there could be a direct path between governance and financial inclusion in the model, the choice of governance as a moderator is motivated by the study's contribution of the literature discussed in the paper.

All governance types are intuitively linked to financial inclusion by means of internet penetration. The corresponding governance variables are defined in accordance with Tchamyu (2021), in the light of insights from World Governance Indicators of the World Bank. First, political governance (i.e. proxied with political stability and/or no violence and voice and accountability) is expected to influence the internet that is used for financial services, not least, because periods of political instability and violence have the tendency to affect internet distribution and hence, financial inclusion by means of internet penetration. It is worthwhile to note that political governance is understood in terms of the election and replacement of political leaders. Second, effective economic governance (i.e. proxied with regulatory quality and government effectiveness) obviously affects

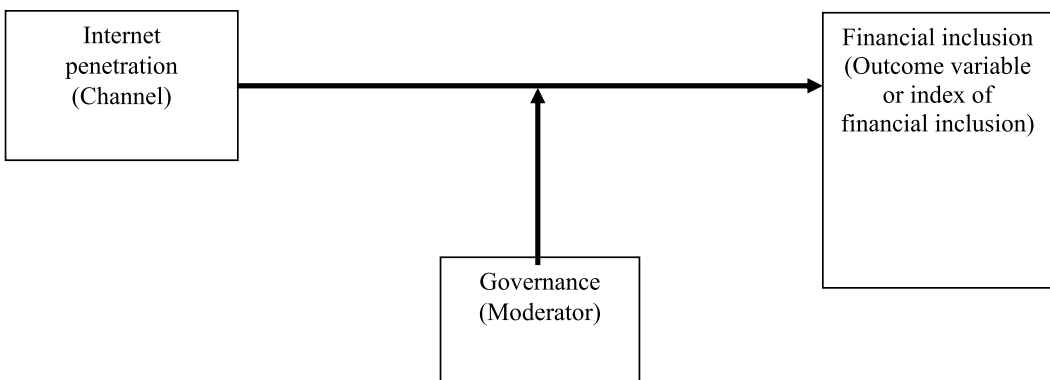


Figure 1. Schematic framework.

how internet services are distributed for inclusive outcomes such as financial inclusion, not least, because economic governance as is understood as the formulation and implementation of policies that deliver public commodities such as internet service. Third, institutional governance (i.e. proxied by corruption-control and the rule of law) is understood as a robust politico-economic atmosphere in which, both the State and citizens respect institutions that govern their interactions. It follows that good institutions avoid state capture of resources by a few individuals; resources which can be tailored toward improving financial inclusive avenues that are dependent on internet services.

3. Methodology

3.1. Data and variable selection

The study is based on an annual dataset of 42 Sub-Saharan African countries covering the period from 2004 to 2020. Data used in this model are extracted from many sources such as the International Monetary Fund (IMF), Financial Access Survey (FAS), World Governance Indicators (WGI), World Development Indicators (WDI) and UNDP databases. Data on financial inclusion such as number of commercial bank branches per 1000 km², number of commercial bank branches per 100,000 adults, number of ATMs per 1000 km and number of ATMs per 100,000 adults, used to compute the index of financial inclusion are obtained from the IMF FAS database. The choice of this variable is based on the studies of Akpa et al. (2023), Arshad (2022) and Abdelghaffar et al. (2023). Data on governance quality such as control of corruption, government effectiveness, rule of law, political stability, regulatory quality and voice and accountability are provided from the World Governance Indicators of the World Bank (World Bank, 2022). The choice of this variable is based on the studies by Asongu and Odhiambo (2020) and Asongu et al. (2018). Data on internet usage were measured as the individual using the internet (% of population) and sourced from the World Development Indicators (WDI) of the World Bank. Moreover, the choice of the indicator is informed by Okoroafor et al. (2018), Chatterjee (2020) and Bayar et al. (2021). Economic growth per capita is measured by gross domestic product per capita and are provided from WDI (World Bank, 2022). Its choice is informed by Lashitew et al. (2019), Senou et al. (2019) and Liu et al. (2021). The education index from the UNDP is measured by the combined primary, secondary and tertiary gross enrollment ratio and its choice is based on the studies of Lenka and Barik (2018), Chatterjee (2020), Huang et al. (2023) and Akpa et al. (2023). The variable is provided from the UNDP database. Trade openness is measured by the sum of exports and imports divided by gross domestic product and is sourced from WDI. The choice of this variable is informed by Chatterjee (2020) and Sikayena et al. (2022). Physical capital is measured by gross capital formation (formerly gross domestic investment) and is provided from WDI. The choice of the variable is motivated by studies from Sikayena et al. (2022) and Jayasuriya and Wodon (2003).

3.2. Dynamic panel data modeling approach

To analyze the internet effect on financial inclusion, we used dynamic panel data models to capture the relationship between internet and financial inclusion. The use of the GMM technique has several advantages. Firstly, it is widely used in finance due to the existence of endogeneity in financial decisions (Abdelghaffar et al., 2023; Ahmed et al., 2021). So, GMM allows to control for the potential endogeneity bias by the reduction of the correlation between endogenous variables and the error term (Abdelghaffar et al., 2023; Asongu et al., 2020; Asongu & Nwachukwu, 2016; Kim et al., 2018). Secondly, it is the most appropriate when the cross-sectional data (N) are larger than the time dimension (T) (Abdelghaffar et al., 2023; Asongu et al., 2020; Asongu & Nwachukwu, 2016). Thirdly, this technique allows for the removal of any bias created by unobserved country-specific effects (Asongu et al., 2020; Asongu & Nwachukwu, 2016). Consequently, the system GMM provides unbiased results due to the hypothesis that there is no existence of second-order autocorrelation

in addition to the absence of correlation between the instruments and the error terms (Ababio et al., 2021; Abdelghaffar et al., 2023).

The lagged variable of IFI is included in the model as financial inclusion tends to change slowly over time, and hence the persistence of financial inclusion is captured which makes the model dynamic (Abdelghaffar et al., 2023; Saptoka, 2014). Similarly, the lagged the dependent variable enables the study to correct for autocorrelation. Internet and quality of governance which are the independent variables of interest used in this study are interacted to analyze the indirect effect of the internet on financial inclusion. In addition, consistent with the extant financial inclusion literature covered, four other variables are incorporated as control variables, notably: gross domestic product per capita (GDPC), human capital (HCAP), trade openness (TRADE) and Gross capital formation (GFCF).

Referring to the studies undertaken by Andrianaivo and Kpodar (2012), Senou et al. (2019), Ongo Nkoa and Song (2020) and Bayar et al. (2021), the estimated regression equation is specified as follows:

$$\begin{aligned} \text{IFI}_{it} = & \alpha_0 + \alpha_1 \text{IFI}_{it-1} + \alpha_2 \text{INTERNET}_{it} + \alpha_3 \text{QG}_{it} + \alpha_4 (\text{INTERNET}_{it} \times \text{QG}_{it}) \\ & + \alpha_5 \ln(\text{GDPC}_{it}) + \alpha_6 \text{HCAP}_{it} + \alpha_7 \text{TRADE}_{it} + \alpha_8 \text{GFCF}_{it} + \mu_{it} \end{aligned} \quad (1)$$

$$i = 1, \dots, N \text{ and } t = 1, \dots, T$$

where IFI_{it} refers to financial inclusion index for country i at time t ; IFI_{it-1} is the index of financial inclusion for country i at time $t - 1$, INTERNET_{it} is the individual using the internet for country i at time t . QG_{it} represents the six governance indicators such as control of corruption, government effectiveness, rule of law, political stability, regulatory quality and voice and accountability bundled into political governance (political stability and voice and accountability), economic governance (regulatory quality and government effectiveness) and institutional governance (rule of law and corruption control) and general governance (PCA of the three dimensions), respectively, for country i at time t . GDPC_{it} is the gross domestic product per capita and HCAP_{it} represents the education index. TRADE_{it} is the sum of exports and imports divided by gross domestic product. GFCF_{it} is the gross capital formation. μ_{it} refers to the error term and $\alpha_0, \dots, \alpha_8$ refer to the coefficients to be estimated. A year lag of one is employed because one lag is enough to capture past information. The choice of this lagged structure confirms evidence of persistence in the outcome variable because from the estimated models, the lagged estimated dependent variable is between 0.800 and 0.999, which is a rule of thumb (Tchamyou, 2021).

In Equation (1), α_2 and α_3 respectively measure the direct impact of the internet and quality of governance while α_4 examines the simultaneous change in both the internet and quality of governance on financial inclusion. Partially differentiating Equation (1) with respect to the internet produces Equation (2) which is the unconditional effect of the internet on financial inclusion and the corresponding conditional effect from the interaction between the internet and governance quality:

$$\frac{\partial \text{IFI}_{it}}{\partial \text{INTERNET}_{it}} = \alpha_2 + \alpha_4 \text{QG}_{it} \quad (2)$$

Still considering Equation (2), the corresponding governance quality threshold is derived by taking the absolute value of the ratio of the unconditional to the conditional effect as follows in Equation (3):

$$\text{QG threshold} = \left| \frac{\text{unconditional impact}}{\text{Conditional impact}} \right| = \left| \frac{\alpha_2}{\alpha_4} \right| \quad (3)$$

Empirically, we estimated dynamic panel data models using the GMM technique proposed by Arellano and Bond (1991) and Arellano and Bover (1995) and extended by Blundell and Bond (1998) who suggest a GMM estimator that uses lagged levels of endogenous variables as instruments for equations in difference forms (Abdelghaffar et al., 2023; Tsionas, 2019).

It is relevant to note that the computation of governance threshold is to avoid pitfalls in interactive regressions documented in Brambor et al. (2006) as far as interpreting interactive regression models is concerned. Accordingly, it is to avoid the estimated coefficient being interpreted as in linear additive models that the thresholds (i.e. involving both the unconditional and conditional effects of internet penetration) are computed. In so doing, the concern of multicollinearity between the interactive terms and the unconditional effect of the main channel that is characteristic of interactive regressions is taken in account. The computed governance threshold is important because it shows the level of governance that should be reached in order for internet penetration to positively affect financial inclusion.

4. Results and discussion

4.1. Empirical results

The outcomes of the estimate of the role of governance quality in the relationship between the internet and financial inclusion are reported in this section in Table 1. The findings have been presented in three main groups corresponding to the three main governance dimensions, notably political governance (political stability and voice and accountability), economic governance (government effectiveness and regulatory quality) and institutional governance (corruption control and the rule of law), respectively. Each governance dimension is composed of two indicators of governance. Two main criteria are used to analyze the post-estimation validity of the GMM outcomes. Based on these criteria, the results also showed an absence of Arellano and Bond's second-order autocorrelation. The Sargan/Hansen test of over-instrumentation confirmed that the instrumental variables used are valid and correct the endogeneity of the lagged index of financial inclusion. The table shows that the lag of the dependent variable positively and significantly affects the dependent variable at a 1% level. This outcome was expected because financial inclusion is very persistent, therefore, the current level of financial inclusion is affected by the previous level of financial inclusion. This is why action should be taken to increase financial inclusion early on, as actions taken to increase financial inclusion today will help raise future financial inclusion (Table 2).

The outcome shows that the internet negatively and significantly affects financial inclusion at the 1% significance level. Otherwise, an increase in internet users by one person decreases financial inclusion in SSA countries. The outcome is not amazing because access to the internet in SSA countries on average is low on the one hand and on the other, in interactive regressions, the unconditional estimate of the internet should not be interpreted in isolation which is why net effects and thresholds are computed in a subsequent paragraph. These findings are consistent with Senou et al. (2019) who have found in WAEMU that the internet negatively and significantly influences financial inclusion and Bayar et al. (2021) who have established in the EU post-communist countries that the internet negatively and significantly influences financial inclusion in Estonia, Latvia, Lithuania, and Slovenia. But the findings are also in contrast to Lenka and Barik (2018), Okoroafor et al. (2018), and Chatterjee (2020) who have posited that the internet improves financial inclusion. Moreover, from the outcome, the interaction between the internet and governance indicators showed that only the interactions with regulatory quality, rule of law, voice and accountability and government effectiveness are significant and positive. A simultaneous increase in both the internet and governance indicators such as voice and accountability, regulatory quality, and government effectiveness increases financial inclusion, respectively. Similarly, a simultaneous increase both in the internet and rule of law increases financial inclusion. In short, our findings support the argument that the quality of governance can serve as a catalyst to reduce the gap between the internet and financial inclusion in SSA countries. The findings are similar to those of Aymar and Fabrice-Gilles (2021), Ongo Nkoa and Song (2020), Chinoda and Kwenda (2019) and Ali et al. (2016) who found that quality of governance improves financial inclusion.

Table 1. Estimation results.

	Dependent variable: financial inclusion					
	Political governance		Economic governance		Institutional governance	
	Political stability	Voice and accountability	Regulation quality	Government effectiveness	Rule of law	Corruption control
Financial inclusion (IFI) (–1)	0.941*** (0.000)	0.964*** (0.000)	0.928*** (0.000)	0.935*** (0.000)	0.937*** (0.000)	0.997*** (0.000)
Internet (INTERNET)	–0.0003*** (0.000)	–0.0003*** (0.000)	4.17e-06 (0.979)	–0.0003** (0.021)	–0.0002*** (0.007)	–0.0005*** (0.000)
Political stability (PS)	0.015 (0.318)					
Voice and accountability (VA)		0.003 (0.820)				
Regulation quality (RQ)			0.006 (0.721)			
Government effectiveness (GE)				0.012 (0.514)		
Rule of law (RL)					0.006 (0.666)	
Corruption control (CC)						0.016*** (0.003)
INTERNET × PS	–0.0001 (0.843)					
INTERNET × VA		0.001** (0.042)				
INTERNET × RQ			0.001*** (0.001)			
INTERNET × GE				0.001*** (0.005)		
INTERNET × RL					0.0008** (0.019)	
INTERNET × CC						–0.0004 (0.171)
Log economic growth	–0.007** (0.028)	–0.002 (0.366)	–0.009*** (0.002)	–0.001 (0.770)	–0.003 (0.106)	0.001 (0.123)
Education	0.046 (0.164)	0.052 (0.147)	0.153*** (0.000)	0.017 (0.460)	0.080*** (0.004)	0.004 (0.753)
Trade openness	0.008 (0.636)	0.013 (0.400)	0.053*** (0.000)	0.002 (0.817)	0.020* (0.090)	–0.016* (0.068)
Physical capital	0.002*** (0.000)	0.002*** (0.000)	0.002*** (0.000)	0.002*** (0.000)	0.002*** (0.000)	0.001*** (0.000)
Constant	0.005 (0.884)	–0.053* (0.092)	–0.077*** (0.005)	–0.026 (0.469)	–0.052 (0.110)	–0.014 (0.181)
Internet net effects	na	–0.0009	na	–0.001	–0.0008	na
Gov. thresholds	na	0.300	na	0.300	0.250	na
AR(1)	–3.18*** (0.001)	–2.88*** (0.004)	–2.70*** (0.007)	–3.06*** (0.002)	–3.08*** (0.002)	–3.37*** (0.001)
AR(2)	–1.38 (0.166)	–1.10 (0.272)	–0.93 (0.352)	–1.38 (0.168)	–0.92 (0.359)	–0.10 (0.916)
Sargan	2.37 (0.997)	1.42 (1.000)	0.62 (1.000)	0.62 (1.000)	1.56 (1.000)	4.19 (0.964)
Hansen	9.24 (0.600)	9.19 (0.604)	7.65 (0.745)	6.75 (0.749)	8.77 (0.643)	11.87 (0.373)
Fisher	991.53*** (0.000)	1137.26*** (0.000)	907.90*** (0.000)	855.04*** (0.000)	1674.59*** (0.000)	3463*** (0.000)
Number of instruments	20	20	20	19	20	20
Number of groups	42	42	42	42	42	42
Observations	426	426	426	435	426	426

Source: Authors' computation. *, **, ***: significance levels of 10%, 5% and 1%, respectively. Gov: governance. na: not applicable because at least one estimated coefficient needed for the computation of net effect and/or threshold is not statistically significant. The mean values of 'voice & accountability', government effectiveness and rule of law are respectively, –0.648, –0.760 and –0.748.

Table 2. Robustness check.

	Dependent variable: financial inclusion			
	Political governance	Economic governance	Institutional governance	General governance
Financial inclusion (IFI) (–1)	0.997*** (0.000)	0.873*** (0.000)	0.955*** (0.000)	0.932*** (0.000)
Internet (INTERNET)	–0.0002 (0.860)	–0.001*** (0.007)	–0.001*** (0.000)	–0.001*** (0.000)
Political governance (PG)	–0.009 (0.680)			
Economic governance (EG)		0.134 (0.107)		
Institutional governance (IG)			–0.008 (0.213)	
General governance (GG)				–0.002 (0.776)
INTERNET × PG	–0.0001 (0.886)			
INTERNET × EG		0.0004** (0.028)		
INTERNET × IG			0.001*** (0.000)	
INTERNET × GG				0.001*** (0.000)
Log economic growth	0.005 (0.292)	–0.003 (0.219)	–0.001 (0.766)	–0.003 (0.381)
Education	–0.105 (0.800)	0.063** (0.014)	0.088*** (0.004)	0.099** (0.016)
Trade openness	–0.004 (0.900)	0.018* (0.070)	0.023* (0.062)	0.028 (0.125)
Physical capital	0.001** (0.015)	0.002*** (0.000)	0.002*** (0.000)	0.002*** (0.000)
Constant	–0.011 (0.952)	–0.044* (0.061)	–0.086*** (0.002)	–0.083** (0.024)
Internet net effects	nsa	nsa	nsa	nsa
Governance thresholds	na	2.500	1.000	1.000
AR(1)	–3.22*** (0.000)	–3.11*** (0.002)	–2.57*** (0.010)	–2.27*** (0.023)
AR(2)	–0.42 (0.673)	–1.05 (0.293)	–1.09 (0.274)	–1.14 (0.253)
Sargan	1.40 (0.999)	0.84 (1.000)	1.23 (1.000)	0.68 (1.000)
Hansen	8.25 (0.604)	7.33 (0.694)	11.00 (0.443)	10.65 (0.473)
Fisher	1960.14*** (0.000)	968.94*** (0.000)	935.53*** (0.000)	643.32*** (0.000)
Number of instruments	19	19	20	20
Number of groups	42	42	42	42
Observations	426	435	426	426

Source: Authors' computation. *, **, ***: significance levels of 10%, 5% and 1%, respectively. na: not applicable because at least one estimated coefficient needed for the computation of threshold is not statistically significant. nsa: not specifically applicable because the mean values of the composite governance indicators are close to zero.

In order to assess the overall effect of governance quality in modulating the effect of the internet on financial inclusion, net effects and thresholds are computed. The corresponding net effects and thresholds entail both the unconditional and the conditional effects of the internet on financial inclusion. For instance, in the third column of Table 1, in the regressions pertaining to voice and accountability, the net effect of the internet from voice and accountability in moderating the effect of the internet on financial inclusion is -0.0009 ($[-0.0003] + [0.001 \times -0.648]$). In the computation, -0.648 is the mean value of voice and accountability; the unconditional effect of the internet is -0.0003 , whereas the conditional impact from the interaction between the internet and voice and accountability is 0.001 . This approach to establishing an overall incidence based on net effects is

consistent with contemporary interactive regressions literature (Asongu & Odhiambo, 2019b; Asongu & Odhiambo, 2020; Brambor et al., 2006; Tchamyou, 2017). Consistent with Asongu and Odhiambo (2019b), we compute the corresponding governance quality thresholds which are: (i) 0.300 (i.e. 0.0003/0.001) of 'voice and accountability' and 'government effectiveness', respectively, and (ii) 0.250 for the 'rule and law'. The attendant thresholds are obtained by dividing the unconditional effect with the conditional incidence as established in Equation (3).

It is also worthwhile to note that, the computation of the thresholds in absolute terms does not imply that the thresholds will also be understood as positive thresholds. Accordingly, the computation is in absolute value simply to make computation possible. The computed thresholds are interpreted in terms of differences in the signs of the unconditional and conditional effects. If the former is positive and the latter is negative, we talk of negative thresholds. If the former is negative and the latter is positive, we talk of positive thresholds (Asongu & Odhiambo, 2022, 2023).

In light of the above, the computed governance thresholds are levels of governance that should be attained in order for governance to effectively moderate the internet to ultimately engender an overall positive incidence on financial inclusion. Accordingly, whereas the net effects of the internet on financial inclusion are negative, the corresponding overall incidence of financial inclusion is positive once governance levels are above the established governance thresholds. In order to put this in more perspective, let us consider the same example used above for the computation of net effect in order to better articulate the relevance of the 'voice and accountability' threshold of 0.300. Accordingly, when 'voice & accountability' is above the threshold of 0.300 (e.g. 0.400), the overall incidence of internet on financial inclusion changes from negative to positive or 0.0001 ($[-0.0003] + [0.001 \times 0.400]$). Hence, it is recommended for policy makers to formulate and implement policies that enable the level of 'voice & accountability' in the country to be above 0.300 in order for the anticipated benefits of the internet in terms of financial inclusion to be achieved. This explanation can be extended to other established governance thresholds.

4.2. Robustness check

To assess if the outcomes in Table 1 withstand further empirical scrutiny, the six governance indicators are grouped into four additional governance dimensions, namely: political governance (political stability and voice and accountability), economic governance (government effectiveness and regulatory quality), institutional governance (rule of law and control of corruption), and general governance (political, economic, and institutional governance). Similarly, as in Tables 1 and 2, we also compute the governance thresholds. It is also worthwhile to emphasize that in the corresponding robustness check section, 'nsa' (i.e. 'not specifically applicable') is used when net effects cannot be computed because the mean values of the composite governance indicators are close to zero.

Consistent with Asongu and Odhiambo (2020), we use the Kaiser (1974) and Jolliffe (2022) criterion to select the main components in the principal component analysis. Based on this criterion, we retain only principal components with an eigenvalue greater than the mean (Asongu & Odhiambo, 2019a, 2020). In this study, this criterion has been adopted to retain the composite governance indicators. The use of the approach of clustering governance variables for robustness using principal component analysis is supported by extant studies (Asongu & Odhiambo, 2019b, 2020; Tchamyou, 2017). The results show that internet interaction with economic governance, institutional governance and general governance positively and significantly influence financial inclusion. On the other hand, an increase in institutional governance and general governance increases financial inclusion. Similarly, an increase in economic governance increases financial inclusion in SSA. The corresponding positive thresholds are (i) 2.500 of 'economic governance' and (ii) 1.000 of 'institutional governance' and 'general governance', respectively.

As clarified in the previous section, from the findings, it is shown that the incidence of the internet on financial inclusion cannot be interpreted in isolation. Hence, the fact that the internet is established to reduce financial inclusion is contingent on some levels of governance. This is why

governance levels that should be attained in order for the effect of the internet to boost financial inclusion are provided. Hence, above the established governance thresholds, the internet no longer contributes to reducing financial inclusion, not least, because the opposite effect is now shown.

5. Concluding implications and future research directions

5.1. Conclusion

This study contributes to the extant literature by assessing the role of governance in the effect of the internet on financial inclusion in Sub-Saharan Africa (SSA). It is built on the sparse literature on financial inclusion, especially as it pertains to efforts by governments to promote financial inclusion by means of ICT in the sub-region. Using data for the period 2004–2020 and employing the System Generalized Method of Moments (SGMM), the results show that the internet can be effectively complemented with the quality of governance to improve financial inclusion. Thresholds of governance that are needed for the internet to promote financial inclusion are provided. The established thresholds are as follows: (i) 0.300 ‘voice and accountability’ and ‘government effectiveness’, respectively; (ii) 0.250 ‘rule and law’; (iii) 2.500 ‘economic governance’ and (iv) 1.000 ‘institutional governance’ and ‘general governance’, respectively.

5.2. Practical and managerial implications

In terms of practical and managerial implications, governments of sampled countries should work toward making sure that internet penetration policies are tailored toward favoring financial inclusion policies. Within this remit, internet subscriptions that are oriented toward enhancing financial access, especially for poor segments of society should be considered and implemented. Moreover, given that the internet is a necessary and not a sufficient condition for the promotion of financial inclusion, complementing the relevant internet penetration policies with other measures of good governance is worthwhile. Accordingly, internet penetration policies should be engaged simultaneously with good governance measures, with particular emphasis on the considered good governance measures attaining some specific critical levels as established in the study. It follows that governments who have been viewing the promotion of financial inclusion as a mere consequence of higher ICT penetration, especially by means of the internet are getting their dynamics wrong.

In light of the above, all three dimensions of governance need to be consolidated, especially in view of (i) boosting the credibility and fairness of the process of political elections so that political leaders are elected and replaced after a robust competitive and fair democratic process (i.e. better political governance). (ii) Ensuring conducive policies that are consistent with inclusive-internet penetration are formulated and delivered as public commodities, especially to the fraction of the population that is financially-excluded (i.e. more economic governance). (iii) Providing enabling conditions that enforce the citizens’ and State respect of institutions that govern interactions between the State and citizens, such that financial inclusion policies by means of ICTs are not eventually captured by the already wealthy and financially-included fraction of the population (i.e. enhanced institutional governance).

Overall, our research findings suggest some policy implications that are worthwhile to increase financial inclusion in SSA countries. Policies aimed at reinforcing the quality of governance in SSA countries could help consolidate internet infrastructure to promote internet usage and in turn improve financial inclusion. ICT, notably the internet, is very important in the economic sector, especially in the development of financial services. Thus, SSA countries should reinforce policies aimed at improving the quality of governance, especially beyond the established governance thresholds in order to engender a positive nexus between internet penetration and financial inclusion. The investment in internet infrastructures through good quality governance will thus

improve the quality of the internet and in turn reduce internet costs. Accordingly, poor-quality internet represents an impediment to the development of financial services in SSA countries. Quality internet services can improve the quality of financial services and reduce the distance between customers and financial institutions. Policies aimed at reinforcing the quality of governance in SSA countries should also be tailored to consolidate and enhance internet infrastructure in order to reduce internet costs and in turn improve financial inclusion.

In terms of theoretical implications, the findings contribute to the ongoing technology acceptance models and theories discussed in Section 2.1 in the perspective that the theoretical model used to motivate the nexus between information technology acceptance and development outcomes should not be viewed as exclusively linear. As shown from the findings in this study, the theoretical models can only withstand empirical scrutiny contingent on some critical levels of other relevant policy or governance variables. It follows that the technology acceptance models and theories underlying the nexus between internet services and financial inclusion are valid above certain thresholds of governance variables and invalid below certain thresholds of governance. As a main theoretical implication, in order to improve the theoretical understanding of technology acceptance models, the attendant theories should not be exclusively viewed as connecting macroeconomic factors in a linear pattern.

5.3. Limitations and future research directions

The findings in this study, evidently provide space for future research, especially within the remit of considering how established nexuses influence the achievement of other United Nations' sustainable development goals (SDGs). In engaging these future lines of inquiry, emphasis should be placed on how country-specific economic development fundamentals influence the corresponding nexuses. This future research direction is motivated by a main shortcoming that the adopted GMM approach does not take into account country-specific effects which are eliminated in order to mitigate the correlation between the lagged outcome variable and attendant country-specific effects, which is a source of endogeneity. Furthermore, the results cannot be generalized to other regions unless such generalization is subject to empirical scrutiny and validity by further research.

Note

1. The terms governance, governance quality and governance dynamics are used interchangeably throughout the study.

Disclosure statement

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Appendix

Construction of IFI

The Financial Inclusion Index (IFI) was designed based on Sarma (2008) and Abdelghaffar et al. (2023). Accordingly, it is a composite index that is built using four main indicators of financial inclusion. First, we computed the dimension index for each financial inclusion indicator. We calculate the dimension index for the i th financial inclusion indicator, d_i , using the following formula:

$$d_i = \frac{A_i - m_i}{M_i - m_i} \quad (A1)$$

where i refers to the financial inclusion indicator number, A_i is the actual value of the financial inclusion indicator i in a certain country; m_i and M_i refers respectively to the minimum and the maximum values of financial inclusion indicator i in the group of selected countries. The value of the dimension (d_i) varies between 0 and 1 (i.e. $0 \leq d_i \leq 1$). The higher the value of d_i is, the higher the country's achievement in dimension i . The methodology we use to compute index of financial inclusion is consistent with the studies of Arshad (2022) and Abdelghaffar et al. (2023) and follows the methodology used by the United Nations Development Program (UNDP) to compute HDI and other similar indices.

The IFI_i for the i th country is computed by applying the following formula:

$$IFI_i = 1 - \frac{\sqrt{(1 - d_1)^2 + (1 - d_2)^2 + \dots + (1 - d_n)^2}}{\sqrt{n}} \quad (A2)$$

where n refers to the total number of financial inclusion indicators used in the study.

For the development of the financial sector and economic growth of a country, financial inclusion is known as an essential measure (Arshad, 2022; Sethy & Goyari, 2018). Many methods are used for the construction of financial inclusion index using its different indicators (Arora & Ratnasiri, 2015; Arshad, 2022; Chakravarty & Pal, 2013; Goel & Sharma, 2017). This study uses indicators such as banking penetration and availability of banking services and usage of the banking system to compute the IFI (Arshad, 2022; Goel & Sharma, 2017; Gupta et al., 2012; Sarma, 2008; Yorulmaz, 2013). In essence, banking penetration is measured by the number of accounts per 1000 people while the availability of banking services is referred to the number of ATMs per 100,000 people, number of bank branches per 1000 people, bank branches per 1000 square km and ATMs per 1000 square km. Similarly, borrowers from commercial banks per 1000 adults measure the usage dimension of financial inclusion. By following the study of Arshad (2022), we measure financial inclusion using some dimensions such as: (i) the number of commercial bank branches per 1000 km²; (ii) the number of commercial bank branches per 100,000 adults; (iii) the number of ATMs per 1000 km and, (iv) the number of ATMs per 100,000 adults.

The construction of IFI is composed of the four main aforementioned indicators, thus the second formula can be re-written as follows:

$$IFI_i = 1 - \frac{\sqrt{(1 - d_1)^2 + (1 - d_2)^2 + (1 - d_3)^2 + (1 - d_4)^2}}{\sqrt{4}} \quad (A3)$$

where $d_1, \dots, d_4$ represents the four dimensions of financial inclusion mentioned above, respectively.

Table A1. List of countries.

Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cabo-Verde, Chad, Central African Republic, Comoros, Congo, Democratic Republic of Congo, Cote d'Ivoire, Djibouti, Equatorial Guinea, Eswatini, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea Bissau, Kenya, Lesotho, Madagascar, Mali, Mauritius, Mauritania, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, South Africa, Sudan, Tanzania, Togo, Uganda, Zambia, Zimbabwe

Table A2. Description of financial inclusion variables.

Variables	Method of calculation (in each reporting country)
Number of commercial bank branches per 1000 km ²	1000*reported number of commercial bank branches/km ²
Number of commercial bank branches per 100,000 adults	100,000*reported number of commercial bank branches/adult population
Number of ATMs per 1000 km ²	1000*Number of ATMs/km ²
Number of ATMs per 100,000 adults	100,000*Number of ATMs/adult population

Table A3. Descriptive statistics.

Variables	Obs.	Mean	Std. Dev.	Min	Max
Index of financial inclusion	558	0.074	0.108	0.001	0.612
Political stability	714	-0.604	0.906	-2.880	1.200
Voice and accountability	714	-0.648	0.720	-2.19	0.979
Regulation quality	714	-0.708	0.597	-2.645	1.127
Government effectiveness	714	-0.760	0.597	-1.849	1.057
Rule of law	714	-0.748	0.648	-2.606	1.029
Corruption control	714	-0.652	0.620	-1.816	1.160
Political governance	714	9.17e-11	1.281	-3.440	2.746
Economic governance	714	2.52e-10	1.282	-2.604	4.307
Institutional governance	714	7.87e-10	1.316	-2.153	3.579
General governance	714	1.13e-10	1.627	-2.691	4.389
Internet	686	12.693	14.753	0.155	70.000
Economic growth per capita	714	2199.452	2976.927	128.337	22942.610
Education index	671	0.429	0.116	0.137	0.736
Trade openness	714	0.680	0.389	0.000	3.480
Physical capital	676	22.639	9.118	2.000	81.021

Source: Authors' computation.