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Fostering Integrated Governance Quality through Technology Penetration: Thresholds of Democracy in Sub-Saharan Africa

Jeremiah O. Ejemeyovwi
Department of Economics & Development Studies, & Research Fellow, Centre for Economic Policy and Development Research (CEPDeR), Covenant University, Ota, Nigeria
E-mail: jeremiah.ejemeyovwi@covenantuniversity.edu.ng

Alex Adegboye
Department of Accounting, College of Management & Social Sciences, Covenant University, Ota, Nigeria
E-mail: adegboyea1@gmail.com

Olaoluwa Umukoro
Department of Accounting, College of Management & Social Sciences, Covenant University, Ota, Nigeria
E-mail: olaoluwaumukoro@gmail.com

Simplice A. Asongu
African Governance and Development Institute,
P.O. Box 8413, Yaoundé, Cameroon
E-mails: asongusimplice@yahoo.com, asongus@afridev.org

Abstract

In the quest for the attainment of democracy with its fully unleashed potentials, the role of information and communication technology (ICT) is integral within this current knowledge economy disposition. The study explores the effect of mobile technology penetration on governance quality from the unconditional and marginal effects of mobile phones and diverse democracy indicators. The analysis is carried out by applying the instrumental variables (IV) Tobit regression to the data to examine the relationship among the variables of interest with a view to handling possible endogeneity issues in the empirical model. The study finds that weak democracy is detrimental to the effect of mobile phone penetration on integrated governance quality and that the higher the mobile phone penetration, the lower the weak democracy quality in SSA. The study concludes by recommending efforts and policies to be enacted and implemented such as the enhancement of mobile technology for concise quality governance.

***Keywords*:** Democracy; Information and Communication Technology; Governance; Instrument Variables

***JEL Codes*:** O3; O15; O55, Q55

1. Introduction

In Sub Saharan Africa (SSA), institutions have now been identified as vital in the accomplishment of the post-2015 sustainable development agenda, and such developed political institutions reflect directly on the degree of democracy practices and experienced by the people (Asongu & Nwachukwu, 2019). Scholars have opined that constitutional democracy is important as it provides economic freedom through protection of civil liberties and political rights (Gwartney & Lawson, 2006). It is associated with governance – outcome level with emphasis on transparency, accountability and empowerment. Gwartney and Lawson (2006) also argued that democracy is far-reaching when you have, *inter alia*, the right to exchange goods and services with each other on mutually agreed terms, the right to enter into your business or to compete. Other important rights include the right to keep what you earn and the right of other parties, including the government to protect your property against confiscation.

In the quest for the attainment of democracy with its fully unleashed potentials or developed political institutions, the role of information and communication technology (ICT) is integral within this current knowledge economy disposition (Ejemeyovwi & Osabuohien, 2018). Abramson (1988) attempted to clarify the technologies that are important to democratic politics. In that attempt, six properties characterize ICTs that make them relevant to political activity: The ICT that: (i)exceeds all previous limits on the volume of information that can be exchanged; the ICT that enables the exchange of information with disregard for real time and space; (ii) increases the control a consumer has over messages received and when; (iii) enhances the control senders have over which audiences receive which message; (iv) decentralizes control over mass communication and (v) enables two way interactive capability across space in real time (Abramson 1988; Horrocks & Pratchett, 1995).

Many have claimed that the current rate of globalisation would have been unachievable if the Internet technology was not established in the 1950s (Competition Policy Review Panel, 2008). The advent of the internet inspired the breakdown of geographical boundaries, leading to increased interactions, trade and among others, capitalism, thereby encouraging choice and democracy (Ejemeyovwi, Osabuohien, Johnson & Bowale, 2019). However, ICT utilisation has also been observed to pose

threats that undermine democracy by encouraging existing biases in knowledge and information distribution, thereby encouraging marginalised votes and fragmenting discourses between increasingly differentiated policy areas (Horrocks & Pratchett, 1995). This raises seemingly unanswerable questions in the mind of researchers such as whether ICT actually enhances integrated governance quality.

Mobile technology in literature has been tested to contribute enormously to different economic variables including financial development (Osabuohien, 2008, Ejemeyovwi, Osabuohien, & Bowale, 2020), inclusive human development, inclusive growth (Asongu& Le Roux, 2017) and scarcely institutional quality (Asongu & Nwachukwu). However, from the scarce literature on governance quality nexus, the specific role on democracy has not received the attention it deserves in SSA. To the best of our knowledge there are currently only six studies that have attempted an empirical discuss on the impact of mobile phones on institutional quality in Africa. The first study by Snow (2009) found a negative link between the mobile penetration rate of a nation and perceived local corruption. A similar study by Matthias (2012) emphasized on the growing role of mobile and internet connectivity in associating accountability in Africa. A third study by Gagliardone (2015) assessed the nexus between government quality and mobile–radio interactions within the region also. Meanwhile, a recent study by Asongu and Nwachukwu (2016) has investigated the importance of mobile telephone penetration knowledge for institutional quality in sub-Saharan Africa (SSA)and the role of ICT penetration on governance quality alongside trade and financial openness in the subregion.

Unarguably, there is opportunity for improvement in a few areas in the literature discussed: First, unlike country-specific studies, which are characterized with policy implications of limited scope and the few panel studies, it is important to position more robust inquiries on broader sets of countries such as the SSA region for results with policy outcomes of greater application (Porter et al., 2016; Asongu & Nwachukwu, 2017). Second, several investigations did not directly focus on using mobile phones as an instrument to increase the quality of government as well as democracy (see Gagliardone, 2015). Third, some findings have cautious policy implications because the empirical investigations are statistically not reliable such as Snow (2009) who stated that mobile telephones have a negative association to corruption using correlation analysis

as the technique of empirical investigation. Fourth, motivated by the extant literature on the bundling and unbundling of governance indicators (Asongu & Nwachukwu, 2017), the present study contributes to the attendant literature by unbundling various indicators of democracy in order to provide empirical insights into the nexus between democratic quality and governance, contingent on levels of ICT penetration. Accordingly, this study argues that, providing direct nexuses between ICT and development outcomes as apparent in the engaged prior studies is less relevant to policy makers, not least, because within an interactive regression analytical framework (i.e. as apparent in this study), the main channel being investigated is complemented with a policy variable in order to either provide policy thresholds or thresholds for complementary policies. These thresholds are actionable critical masses that policy makers can build upon to either influence the targeted outcome variables in positive or negative directions, contingent on whether the attendant outcome variables are negative or positive macroeconomic signals.

In the light of the above, this study's objective is to compute thresholds and net effects in order to explore the effect of mobile technology penetration on governance quality from the unconditional and marginal effects of mobile phones and the diverse democracy indicators. The study analyzes the literature's consistency with SSA experience, thereby examining the nature of the link between various blends of ICT parameters, democracy patterns and governance quality variations. The objectives of the study are essential and timely due to the following reasons: first, the emergence of the Internet technology marked the birth of a revolution that would afterwards prove to be a difference maker between developed and developing countries (Ejemeyovwi *et al*, 2019). Second, ICT and governance in Africa have not been given the attention it deserves from literature (Asongu & Nwachukwu, 2019). Few studies established the relationship between governance quality and mobile-radio interactions. The study builds on the studies of Asongu and Le Roux (2017) as well as Asongu and Nwachukwu (2019).

To achieve the study's objective, the paper structure is as follows: a review of theoretical issues and empirical issues in literature as a basis for the study is presented in the next section. The study further presents information about the data, estimation technique and other related methodological concerns associated with the

study in section three. For the analysis, the study utilises instrumental variables (IV) Tobit regression to analyse the data for examining the relationship among the variables of interest to deal with any problems, such as endogeneity in the empirical model. The results and discussions from the analyses are displayed in section four. Finally, the paper concludes by making recommendations on leveraging on ICT for enhancing governance quality, given the threshold of democracy in SSA.

2. Materials and Methods

2.1. Materials

Democracy is perceived to give citizens of Sub-Saharan Africa (SSA) a way of life that permits growth, goal congruence, economic stability and freedom to engage intellectual and natural resources in a way that permits her citizens to receive maximum benefits. Prior research such as Adesida (2001) mentioned that ICT offers Sub-Saharan Africa (SSA) considerable and financially savvy apparatuses for quickened improvement and holistic advancements. The role of ICT in expanding business and fostering global interactions cannot go unnoticed as millions of humans in under-developed regions have helped better their lots through the use of ICTs methods to aid various business transactions and human endeavors such as research publications, academic curriculum, science, medicine, human resource tools, *inter alia*.

Asongu and Nwachukwu (2019) stated that ICT can be utilized by SSA to address their various economic and infrastructural problems and accomplish advancement results in light of the fact that there is a high potential for its entrance in SSA. Their study examined how ICT is relevant to primary educational quality. This position is similar to studies by Ejemeyovwi, Osabuohien and Osabohien (2018); Ejemeyovwi, Adiat, and Ekong (2019); Ejemeyovwi et al. (2019). This study would however access a different angle as our focus is narrowed to how democracy aids the utilization on ICT in Sub-Saharan Africa as most African countries have gained full independence from their colonial masters.

Citizens of North Korea have been banned from accessing the internet, a totalitarian dictatorship is practiced by their government and this has affected how the utilization of the global web can be accessed and in the long run. This would have an effect on the governance quality and way of life of her citizens. Adesida (2001) stated that although ICT would yield maximum benefit where governance is concerned for

developing countries, the paper noted that for any ICT tool to be effective in enhancing governance quality, the human factor must be considered as ICT is merely an apparatus and can be controlled in any way deemed fit by humans.

Abor et al. (2018) investigates how ICT penetration has helped households in Ghana navigate their income out of poverty or vice versa. The study concluded that the penetration of ICT in Ghana has aided growth and added more advantages to financial development and consumption patterns. The study did not take into cognizance the role democracy plays in ICT penetration in Ghana. However, this study is closing that gap as Ghana is one of the countries in SSA and is therefore part of the sample size of this research.

The World Bank (2016) stated that research has not done justice in investigating the dividends of ICT in less developed countries as ICT has fostered global inclusion which was absent in era where pure capitalism and nepotism were dominant paradigms for economic development. This study takes a deeper look into how democracy has interacted with the advancement of ICT in SSA to influence governance outcomes. Since democracy permits creative and political freedom, it is believed that SSA now benefits from the global markets as all prior restrictions have been cut to their barest minimum through the penetration of ICT. This study assesses how democracy has fostered ICT growth and inclusion in SSA and how the underlying interaction has affected governance quality.

Aker and Mbiti (2010) revealed that the decrease in the fees charged by ICT operators has aided agricultural, economic and work-force growth and advancement. They further stated that the penetration of mobile phones and globalization in SSA has more economic benefits for the producer- markets and consumer welfare. Although the study identified that ICT has a positive effect on the economic state of SSA, it suggested and advocated for a deeper penetration of ICT tools as this would increase the benefits and have a holistic impact on all countries in the region. It was beyond the scope of the above study to investigate the effect the democracy enjoyed by SSA has on ICT penetration and how this has aided or improved governance quality.

The literature reviewed above show cases various studies that attest to the hypothesis that ICT penetration in SSA has yielded positive effects on various aspects of the

economy. Moreover, some authors are of the opinion that before the effects of ICT can be fully experienced in all spheres in SSA, a deeper and wider coverage or connection must be put in place. This is because ICT flourishes where an effective and efficient system is running and for this kind of system to be set in motion, ICT tools are needed to activate various sub-systems. Simply put, ICT utilization is necessary for the improvement of governance quality.

There's a gap in literature as regards the role democracy plays in ICT penetration and how this role has affected governance in SSA. It is perceived that the democracy enjoyed by SSA permits the use of methods and tools developed by ICT and this has aided growth and awareness in some aspects of their economy. Prior studies dwelled on other aspects such as education, business, research publications, inclusive growth, agricultural and consumer welfare, *inter alia*.

It is against this gap identified from prior research that this study has empirically delved into the role of democracy on ICT advancement on governance in Sub-Saharan Africa. This is to add to the body of knowledge and statistically ascertain if democracy is truly a blessing or a curse where ICT and governance quality are concerned.

2.2 Mobile Penetration and Governance Quality

Asongu and Biekpe (2017) concluded that a stable political atmosphere and the rule of law have positive short-run and negative long-term effects on the penetration of mobile phones. Their results also statistically validated that the rule of law has a positive (negative) short-run (long-term) effect on internet penetration. They rounded up their results by concluding that the measurements of government effectiveness and corruption-control have positive short-run and long-term effects on telephone penetration. Institutional governance appears to be most relevant in evaluating ICT adoption in Sub Saharan Africa. Other aspects of democracy and how they affect mobile penetration in SSA were not included in this study.

Asongu, Roux, Nwachukwu and Pyke (2018) examined the above sub-heading and empirically discovered that the use of mobile phones energized good governance except for the guidelines the economic governance aspect is plagued with. The researchers further realized that when all indicators employed in the study were

combined, it birthed a triple effect on general governance than on institutional governance. The final statistical result revealed that countries with lower governance pointers have a tendency to excel in the rapidly changing world of technology and advancement. This study intends to delve deeper into other styles of democracy such as liberal, electoral, participatory, deliberative and egalitarian democracy. This is to enable the study decipher what type of democracy energizes mobile penetration in SSA.

Asongu and Odhiambo (2019) assessed the statistical connection between social media and governance dynamics in Sub-Saharan Africa. It was discovered that the use of social media which is powered by mobile penetration and increased internet availability in the region has a relevant effect on governance dynamics. The study failed to consider other aspects of governance and democracy. This study is bridging the gap by including other governance and democracy indicators.

Likewise, Stodden and Meier (2009) delved into the statistical effect that the use of internet technology has on democratic tendency. They stated that the use of the internet has enhanced the voice and accountability aspect of democracy. In contrast, political stability decreases with the use of the heightened utilization of the internet. The interesting part of this study reveals that the countries experience increases in 'voice and accountability' through higher utilization of the internet and this call to mind the demand law. It further implies that the use of the internet makes citizens aware of the happenings in their political space so that they are able to air their opinions through the use of the internet. Sadly, 'Rule of Law' was not affected by the use of the internet. The study went further to reveal that cell phone penetration was not affected by any of the democratic tendencies. However, when the style of governance was switched to autocratic regime, an inverse and relevant statistical figure was obtained when internet and mobile phone penetration were regressed with political stability. Metrics such as 'Rule of Law' and 'Political Stability' drove ICT adoption up the scale. The short fall of this research is that it did not include other aspects of democratic indicators and the sample size did not include Sub-Saharan Africa.

The need to examine how mobile penetration has aided governance and what style of democracy supports transparent and effective governance at its best has become a necessity. Hellstrom (2008) empirically stated that the accessibility and availability of ICT

to the populace has energized better governance. This is because comparison can be easily made from one country's governance style to another and disgruntled citizens can voice their opinions out through the use of various ICT tools. Similarly, Snow (2009) theoretically corroborates prior researches that the use of mobile phones has helped put those in charge of governance in Africa in check and democracy has enhanced the populace to exercise the freedom of speech that was silenced during prior regimes. This study takes this research a notch higher by delving deeper into the various types of democracy (Egalitarian, Deliberative, Participatory, Electoral, Liberal) available in SSA and how the use of mobile phones through the invention of penetration of ICT has aided governance.

2.3. Data

This study entails 44 Sub-Saharan African countries for the period of 2000-2018. The periodicity of the study is restricted by the data availability. We use 44 out of 49 Sub-Saharan African countries after eliminating countries such as Sudan, South Sudan, Somalia and Eswatini as a result of data inconsistencies and unavailability. In addition, we extract relevant dataset from verified databases namely; World Development Indicators (WDI), World Governance Indicators (WGI) and Varieties of Democracy (V-Dem). The respective databases provide data for the information and technology measure, democracy index, governance indicators and other economic characteristics variables.

Our dependent variables of interest – Governance Quality measures – are extracted from the World Governance Indicators of the World Bank database. We adopt six governance measures such as Control of Corruption, Rule of Laws, Government Effectiveness, Regulation Quality, Political Stability and Voice & Accountability. The governance indicators originally range from -2.5 to 2.5 with higher values depicting strong governance quality. We modify the original value and rescale the variable in that it ranges from 0-10, with lower values depicting severe problematic governance in accordance with studies of (Ojeka et al., 2019; Thakur & Kannadhasan, 2019). Following (Asongu & Nwachukwu, 2016) study, we then bundle the six governance indicators

using the Principal Component Analysis to develop three composite measures namely; Institutional Governance, Economic Governance and Political Governance.

In accordance with (Adegboye, Ojeka, Adegboye, Ebuzor, & Samson, 2019), Principal Component Analysis (PCA) is used to reduce the dimensionality of variables that are highly correlated in order to retain factors or composite indicators in the dataset that are not correlated. Thus, the PCA helps to transform the initial variables by creating mirrored variables such that multicollinearity issues are eliminated. We categorize and develop condensed governance indicators such as Institutional Governance (Rule of Laws and Control of Corruption); Economic Governance (Government Effectiveness and Regulation Quality); and Political Governance (Political Stability and Voice & Accountability). Following the definitions of (Asongu & Nwachukwu, 2016): (i)institutional governance is the respect by the citizens and the State of institutions that govern interactions between them; (ii) economic governance is policy formulation and implementation that deliver public goods; and (iii) the political governance is the replacement of political leaders through electoral processes.

The dataset for democracy indicators is extracted from the Varieties of Democracy (V-Dem) database. The Varieties of Democracy database produces the indications for adequate democracy. The social science database covers over 350 indicators on democracy and political system with worldwide coverage from year 1789. Interestingly, the procedures underlying the construction of the data process are more transparent (Dom, 2018). From this database, we take the five macro-level indicators that describe the qualities of democracy at the highest level namely: the electoral democracy index, liberal democracy index, participatory democracy index, deliberative democracy index and egalitarian democracy index.

In accordance with the Varieties of Democracy codebook, the electoral democracy index employs the electoral principle of democracy that seeks to ensure politicians are responsive to the electorates through electoral channels for the citizens' approval. The liberal democracy index employs the principle of liberal democracy that emphasizes the necessity for protecting the individual especially the minority rights against the State and majority tyranny. The participatory democracy index employs the participatory democracy principle that ensures active citizens' participations in any political, electoral and non-electoral processes. The deliberative democracy index adopts the

deliberative democracy principle that focuses on the decision processes in the polity and ensures such decisions are characterized with good motivates as opposed coercion. Lastly, the egalitarian democracy index adopts the egalitarian democracy principle that ensures individual rights and freedoms are equally protected in all social group, equal distribution of resources and equal access to power by individuals. The original democracy indexes range from 0-1 with the higher values indicating better democracy quality. However, we rescale the index and reverse it to range from 0-10 with the higher value indicating weak democracy quality for better results. Thus, we expect that higher weak democracy quality will negatively influence the integrated governance quality.

Given a recent study on knowledge economy in Sub-Saharan Africa (Tchamyou, 2017), we adopt only the mobile penetration rate (per 100 people) as a proxy for information and communication technology. As there is an enormous potential for mobile phone penetration in SSA, it is necessary to explore whether the use of the mobile phone for information diffusion will enhance democracy for strong governance in SSA.

To account for omitted variables, we have three battery of control variables namely; gross domestic product growth, population growth and foreign aid following the study of (Asongu & Nwachukwu, 2016) while their effects on integrated governance quality remain debatable. In addition, Appendix 1 reports the definitions of the relevant variables and descriptive summary whereas the Appendix 2 discloses the correlation matrix. The summary statistic provides information on (i) the comparable mean of the variables and (ii) the standard deviations from which it can be assessed if reasonable relationships can be established from the variables. The correlation matrix discloses possible multicollinearity issues and the multicollinearity concern apparent in the governance quality variables is dealt with via the principal component analysis while the perceived multicollinearity in democracy indicators is eliminated by estimating the democracy indicators separately in our specifications.

2.4. Methodology

This study employs Tobit regression that controls for limited range within the dependent variables. The restricted dependent variable emphasizes boundaries on the dependent

variable while some observations possibly hit such limit (Ariss, 2010). The limited variable could either be censored or truncated. The limited variable is censored when the limit observations are within the sample while truncated limited variable occurs when the observations are not within the sample. Accordingly, governance indicators originally range from -2.5 to 2.5 with higher value depicting strong governance quality. We modify the original data and rescale the variable, which ranges from 0-10(see Thakur & Kannadhasan, 2019). Thus, we use a double-censored Tobit regression as it accounts for the dependent variable with limited range. Normality is assumed in Tobit model.

The censored normal regression is presented below in Model 1:

$$y^*_{it} = \beta_1 X_{it} + \varepsilon_{it} \quad (1)$$

Where y^*_{it} is the dependent variable. The variable X_{it}depicts the observed vector of independent variables andε_{it} is the error team, which is assumed to be normally distributed. Under the Tobit approach, the dependent variable is censored from below at zero in following pattern:

$$y = \begin{cases} y^* if\ y^* > 0 \\ 0 if\quad y^* \le 0 \end{cases}$$

Where the dependent variable is expressed as y=maximum (y^*, 0)

In accordance with recent technology and institutional quality literature (Asongu & Nwachukwu, 2016), we tackle the concern of causality or simultaneity issues by engaging the instrumental variable Tobit approach. Simultaneity effect is a concern because it is logical that technology affects institutional quality through information diffusion while the reverse is also possible. Thus, the instrumentation procedure for the variables of interest (i.e., democracy indicators and mobile phones penetration) is presented in following Models respectively.

$$Democracy_{it} = \beta_0 + \beta_j (Democracy_{it-1}) + \alpha_i + \varepsilon_{it} \quad (2)$$

Where $Democracy_{it}$denotes the democracy index adapted (i.e., Liberal Democracy Index, Electoral Democracy Index, Participatory Democracy Index, Deliberative Democracy Index, Egalitarian democracy Index) respectively for country *i* in period *t*.β_0 is the constant coefficient whereas variable $Distribution_{it-l}$ depicts the democracy index

adapted for country *i* in period *t*-1, a_i is the country-specific intercept that captures heterogeneities across the countries and$\varepsilon_{it}$is the error term.

$$Mobile_{it} = \beta_0 + \beta_j(Mobile_{it-1}) + \alpha_i + \varepsilon_{it} \quad (3)$$

Where $Mobile_{it}$denotes the mobile phones penetration for country *i* in period *t*. β_0 is the constant coefficient whereas variable $Mobile_{it-l}$ depicts the mobile penetration for country *i* in period *t-1*, $a_i$is the country-specific intercept that captures heterogeneities across the countries and $\varepsilon_{it}$is the error term.

Taking cognizance of the above issue, the Model 2 and 3 instrumented procedure estimates the lag of the independent variables of interest in theregression (i.e., Democracy Index and Mobile phone penetration). We thereafter save the respective fitted values, which are then used as proxies for the democracy (i.e., Liberal Democracy Index, Electoral Democracy Index, Participatory Democracy Index, Deliberative Democracy Index, Egalitarian democracy Index) and mobile phone penetration indicators.

In addition, we interpret our results based on interactive regressions and critical thresholds. The interactive regression has a limitation because the issue of multicollinearity becomes apparent during estimations. We deal with corresponding concern by computing the net effect and/or thresholds to ensure that both the conditional and unconditional or interactive effects are taken into account in the estimations (see Brambor et al., 2006). We compute the net effects by employing the marginal and the unconditional impacts of the mobile phones penetration whereas the interactive regression is interpreted as marginal or conditional effects for economic denotation. Whereas the critical threshold from which modifying democracy indicators can complement the mobile phones penetration to have impact on integrated governance quality should range within the maximum and minimum values provided in the summary statistics.

3. Results and Discussions

This section discloses the empirical results based on instrumental variable Tobit regression.The information criteria employed to establish the validity of the Tobit regression is the Pseudo R^2 where the R^2 discloses explanatory power of the estimation

strategy. Based on the information criteria, Tobit regression has an important explanatory power across our specifications. Tables 1-5 present the findings based on the instrumental variable's procedures. In addition, Tables 1-5 present the findings related to mobile phones penetration, diverse democracy indicators (i.e., Liberal Democracy, Electoral Democracy, Participatory Democracy, Deliberative Democracy, and Egalitarian Democracy) and governance quality (i.e., Institutional Governance, Economic Governance and Political Governance) respectively. In order to establish the role of democracy in modulating the effect of mobile phones penetration on governance quality, we compute both the net effects and thresholds.

Henceforth, we compute net effect to explore the effect of mobile phones penetration on the governance quality from the unconditional and marginal effects of mobile phones and the diverse democracy indicators. For example, in the Column 1 of Table 1, the net effect from mobile phones penetration is0.0023 ([-0.00131x6.782] + [0.0112]). The mean value of liberal democracy (IV) used in the computation is 6.782, whereas the unconditional impact of mobile phones penetration is 0.0112 and the marginal impact of mobile phones penetration and the liberal democracy index is -0.00131. In the column 6 of Table 1, the net effect from mobile phones penetration is 6.7869 ([-0.000563x6.782] + [0.00549]). The mean value of liberal democracy (IV) used in the computation is 6.782, whereas the unconditional impact of mobile phones penetration is 0.00549 and the marginal impact of mobile phones penetration and the liberal democracy index is -0.000563.

Table 1: Mobile Penetration, Liberal Democracy and Governance Quality

	Dependent Variable: Governance Quality								
	Institutional Governance			Economic Governance			Political Governance		
	CC	RL	IG	GE	RQ	EG	PS	VA	PG
Mobile (IV)	0.0112***	0.00386	0.00900***	0.0102***	0.00659***	0.00549***	-0.00701	0.0000888	0.0000215
	(0.00259)	(0.00247)	(0.00209)	(0.00256)	(0.00254)	(0.00211)	(0.00438)	(0.00169)	(0.00117)
Liberal (IV)	-0.318***	-0.462***	-0.256***	-0.323***	-0.395***	-0.329***	-0.568***	-0.691***	-0.479***
	(0.0269)	(0.0256)	(0.0217)	(0.0266)	(0.0263)	(0.0219)	(0.0456)	(0.0176)	(0.0122)
Mobile (IV) xLiberal (IV)	-0.00131***	-0.000249	-0.00106***	-0.00128***	-0.000676*	-0.000563*	0.00154**	0.000169	0.000125
	(0.000392)	(0.000374)	(0.000316)	(0.000388)	(0.000384)	(0.000320)	(0.000664)	(0.000256)	(0.000178)
GDP	0.0177***	0.0162***	0.0142***	0.0215***	0.0159***	0.0133***	0.00996	0.0133***	0.00920***
	(0.00613)	(0.00585)	(0.00494)	(0.00606)	(0.00600)	(0.00500)	(0.0104)	(0.00400)	(0.00277)
Population	-0.327***	-0.0944***	-0.263***	-0.209***	0.0534	0.0445	-0.0626	-0.0739***	-0.0539***
	(0.0379)	(0.0361)	(0.0305)	(0.0375)	(0.0371)	(0.0309)	(0.0645)	(0.0247)	(0.0173)
Aid	0.00649*	-0.0129***	0.00523*	-0.0182***	-0.0227***	-0.0189***	-0.0206***	-0.00126	-0.000551
	(0.00344)	(0.00328)	(0.00277)	(0.00341)	(0.00337)	(0.00281)	(0.00590)	(0.00225)	(0.00158)
Net Effect	0.0023	N/A	0.0018	0.0015	0.0020	6.7869	N/A	N/A	N/A
Thresholds	8.550	N/A	8.491	7.969	9.749	9.751	N/A	N/A	N/A
Constant	6.471***	6.964***	2.161***	6.210***	6.248***	2.137***	8.086***	8.734***	3.304***
	(0.213)	(0.203)	(0.172)	(0.211)	(0.209)	(0.174)	(0.361)	(0.139)	(0.0965)
Observations	736	736	736	736	736	736	734	736	734
Pseudo R2	0.264	0.295	0.304	0.259	0.250	0.283	0.113	0.561	0.708
LR chi-squared	634.9	710.5	634.9	613.2	580.2	580.2	322.8	1460	1456
Prob > chi2	0	0	0	0	0	0	0	0	0

Standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1. Note: CC: Control of Corruption; RL: Rule of Laws; IG:

Institution Governance; GE: Government Effectiveness; RQ: Regulation Quality; EG: Economic Governance; PS: Political Stability; VA: Voice & Accountability; PG: Political Governance and N/A: Not Applicable because at least one estimated coefficient needed for the computation of net effects or thresholds is not significant. Mean of Liberal Democracy (IV) is 6.782; Electoral Democracy is 5.357; Participatory Democracy is 7.331; Deliberative Democracy is 6.447; Egalitarian Democracy is 6.835.

Table 2: Mobile Penetration, Electoral Democracy and Governance Quality

	Dependent Variable: Governance Quality								
	Institutional Governance			Economic Governance			Political Governance		
	CC	RL	IG	GE	RQ	EG	PS	VA	PG
Mobile (IV)	0.0120***	0.00676***	0.00967***	0.0113***	0.00841***	0.00700***	-0.00439	0.00280*	0.00186*
	(0.00234)	(0.00231)	(0.00189)	(0.00235)	(0.00225)	(0.00188)	(0.00380)	(0.00158)	(0.00110)
Electoral (IV)	-0.252***	-0.385***	-0.203***	-0.246***	-0.347***	-0.289***	-0.522***	-0.665***	-0.461***
	(0.0289)	(0.0285)	(0.0233)	(0.0290)	(0.0278)	(0.0232)	(0.0471)	(0.0195)	(0.0136)
Mobile (IV) xElectoral (IV)	-0.00172***	-0.000762*	-0.00139***	-0.00170***	-0.00116***	-0.000970***	0.00159***	-0.000309	-0.000198
	(0.000449)	(0.000443)	(0.000361)	(0.000450)	(0.000432)	(0.000360)	(0.000729)	(0.000304)	(0.000211)
GDP	0.0226***	0.0222***	0.0182***	0.0268***	0.0205***	0.0171***	0.0165	0.0197***	0.0136***
	(0.00658)	(0.00649)	(0.00530)	(0.00660)	(0.00633)	(0.00528)	(0.0107)	(0.00445)	(0.00308)

Population	-0.402***	-0.180***	-0.324***	-0.292***	-0.00925	-0.00771	-0.154**	-0.152***	-0.108***
	(0.0401)	(0.0396)	(0.0323)	(0.0402)	(0.0386)	(0.0321)	(0.0656)	(0.0271)	(0.0189)
Aid	0.00907**	-0.00963***	0.00731**	-0.0153***	-0.0203***	-0.0170***	-0.0172***	0.00179	0.00143
	(0.00370)	(0.00365)	(0.00298)	(0.00371)	(0.00356)	(0.00296)	(0.00608)	(0.00250)	(0.00176)
Net Effect	5.3673	0.0027	0.0022	0.0022	0.0022	0.0018	N/A	N/A	N/A
Thresholds	6.977	8.871	6.957	6.647	7.250	7.216	N/A	N/A	N/A
Constant	5.771***	6.016***	1.597***	5.451***	5.524***	1.534***	7.159***	7.729***	2.614***
	(0.197)	(0.194)	(0.158)	(0.197)	(0.189)	(0.157)	(0.320)	(0.133)	(0.0923)
Observations	736	736	736	736	736	736	734	736	734
Pseudo R2	0.219	0.230	0.253	0.205	0.215	0.243	0.0962	0.500	0.631
LR chi-squared	526.6	553	526.6	485.2	498.7	498.7	274.7	1301	1297
Prob > chi2	0	0	0	0	0	0	0	0	0

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Note: CC: Control of Corruption; RL: Rule of Laws; IG: Institution Governance; GE: Government Effectiveness; RQ: Regulation Quality; EG: Economic Governance; PS: Political Stability; VA: Voice & Accountability; PG: Political Governance and N/A: Not Applicablebecause at least one estimated coefficient needed for the computation of net effects or thresholds is not significant. Mean of Liberal Democracy (IV) is 6.782; Electoral Democracy is 5.357; Participatory Democracy is 7.331; Deliberative Democracy is 6.447; Egalitarian Democracy is 6.835.

Table 3: Mobile Penetration, Participatory Democracy and Governance Quality

	Dependent Variable: Governance Quality		
	Institutional Governance	Economic Governance	Political Governance

	CC	RL	IG	GE	RQ	EG	PS	VA	PG
Mobile (IV)	0.0125***	0.00445	0.0101***	0.0127***	0.00969**	0.00807**	-0.0148**	-0.00551*	-0.00388*
	(0.00438)	(0.00430)	(0.00353)	(0.00437)	(0.00413)	(0.00344)	(0.00728)	(0.00320)	(0.00222)
Participatory (IV)	-0.408***	-0.581***	-0.329***	-0.398***	-0.531***	-0.442***	-0.689***	-0.968***	-0.670***
	(0.0412)	(0.0405)	(0.0332)	(0.0411)	(0.0388)	(0.0324)	(0.0687)	(0.0301)	(0.0210)
Mobile (IV) xParticipatory (IV)	-0.00120**	-0.000116	-0.000969**	-0.00132**	-0.000929	-0.000774	0.00276***	0.00114**	0.000801***
	(0.000611)	(0.000600)	(0.000492)	(0.000610)	(0.000576)	(0.000480)	(0.00102)	(0.000447)	(0.000310)
GDP	0.0238***	0.0229***	0.0192***	0.0278***	0.0211***	0.0176***	0.0176	0.0213***	0.0147***
	(0.00657)	(0.00645)	(0.00529)	(0.00655)	(0.00618)	(0.00515)	(0.0109)	(0.00480)	(0.00333)
Population	-0.429***	-0.207***	-0.346***	-0.314***	-0.0268	-0.0224	-0.203***	-0.209***	-0.147***
	(0.0394)	(0.0387)	(0.0318)	(0.0393)	(0.0371)	(0.0309)	(0.0660)	(0.0288)	(0.0201)
Aid	0.00934**	-0.00947***	0.00752**	-0.0151***	-0.0204***	-0.0170***	-0.0161***	0.00247	0.00200
	(0.00369)	(0.00362)	(0.00297)	(0.00368)	(0.00348)	(0.00290)	(0.00622)	(0.00270)	(0.00190)
Net Effect	0.0037	N/A	0.0037	0.0030	N/A	N/A	0.0054	0.0028	0.0020
Thresholds	Outliner	N/A	Outliner	9.621	N/A	N/A	5.362	4.833	4.844
Constant	7.451***	8.247***	2.950***	7.083***	7.576***	3.244***	9.475***	11.34***	5.105***
	(0.325)	(0.320)	(0.262)	(0.324)	(0.306)	(0.255)	(0.542)	(0.238)	(0.165)
Observations	736	736	736	736	736	736	734	736	734
Pseudo R2	0.220	0.233	0.253	0.209	0.229	0.259	0.0847	0.456	0.576
LR chi-squared	528.3	560.9	528.3	494.5	531.1	531.1	241.7	1187	1183
Prob > chi2	0	0	0	0	0	0	0	0	0

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Note: CC: Control of Corruption; RL: Rule of Laws; IG: Institution Governance; GE: Government Effectiveness; RQ: Regulation Quality; EG: Economic Governance; PS: Political Stability; VA: Voice & Accountability; PG: Political Governance; Outliner – does not fall within the minimum and maximum value and N/A: Not Applicablebecause at least one estimated coefficient needed for the computation of net effects or thresholds is not significant. Mean of Liberal Democracy (IV) is 6.782; Electoral Democracy is 5.357; Participatory Democracy is 7.331; Deliberative Democracy is 6.447; Egalitarian Democracy is 6.835.

Table 4: Mobile Penetration, Deliberative Democracy and Governance Quality

	Dependent Variable: Governance Quality								
	Institutional Governance			Economic Governance			Political Governance		
	CC	RL	IG	GE	RQ	EG	PS	VA	PG
Mobile (IV)	0.0109***	0.00539**	0.00875***	0.0110***	0.00806***	0.00672***	-0.00704	0.00112	0.000790
	(0.00276)	(0.00267)	(0.00223)	(0.00273)	(0.00263)	(0.00219)	(0.00462)	(0.00190)	(0.00131)
Deliberative (IV)	-0.283***	-0.413***	-0.228***	-0.280***	-0.366***	-0.305***	-0.505***	-0.658***	-0.456***
	(0.0284)	(0.0274)	(0.0229)	(0.0281)	(0.0270)	(0.0225)	(0.0476)	(0.0195)	(0.0135)
Mobile (IV) xDeliberative (IV)	-0.00123***	0.000413	-0.000987***	-0.00138***	-0.000903***	-0.000752**	-0.00180**	-0.0000877	-0.0000594
	(0.000441)	(0.000426)	(0.000356)	(0.000436)	(0.000419)	(0.000349)	(0.000737)	(0.000303)	(0.000210)
GDP	0.0200***	0.0184***	0.0161***	0.0236***	0.0171***	0.0143***	0.0136	0.0152***	0.0105***
	(0.00645)	(0.00623)	(0.00520)	(0.00637)	(0.00613)	(0.00510)	(0.0108)	(0.00443)	(0.00307)
Population	-0.408***	-0.182***	-0.329***	-0.287***	-0.0130	-0.0108	-0.177***	-0.181***	-0.126***
	(0.0389)	(0.0375)	(0.0313)	(0.0384)	(0.0369)	(0.0308)	(0.0654)	(0.0267)	(0.0186)
Aid	0.00875**	-0.0103***	0.00705**	-0.0159***	-0.0208***	-0.0173***	-0.0170***	0.00172	0.00152
	(0.00362)	(0.00349)	(0.00291)	(0.00357)	(0.00343)	(0.00286)	(0.00612)	(0.00248)	(0.00174)
Net Effect	0.0030	N/A	0.0024	0.0021	0.0022	0.0019	N/A	N/A	N/A
Thresholds	8.862	N/A	8.865	7.971	8.926	8.936	N/A	N/A	N/A

Constant	6.279***	6.651***	2.006***	5.960***	6.058***	1.979***	7.677***	8.497***	3.137***
	(0.220)	(0.213)	(0.177)	(0.217)	(0.209)	(0.174)	(0.368)	(0.151)	(0.105)
Observations	736	736	736	736	736	736	734	736	734
Pseudo R2	0.232	0.256	0.268	0.228	0.237	0.268	0.0929	0.504	0.636
LR chi-squared	558.7	616.7	558.7	540.1	549.8	549.8	265.3	1310	1307
Prob > chi2	0	0	0	0	0	0	0	0	0

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Note: CC: Control of Corruption; RL: Rule of Laws; IG: Institution Governance; GE: Government Effectiveness; RQ: Regulation Quality; EG: Economic Governance; PS: Political Stability; VA: Voice & Accountability; PG: Political Governance and N/A: Not Applicablebecause at least one estimated coefficient needed for the computation of net effects or thresholds is not significant. Mean of Liberal Democracy (IV) is 6.782; Electoral Democracy is 5.357; Participatory Democracy is 7.331; Deliberative Democracy is 6.447; Egalitarian Democracy is 6.835.

Table 5: Mobile Penetration, Egalitarian Democracy and Governance Quality

	Dependent Variable: Governance Quality								
	Institutional Governance			Economic Governance			Political Governance		
	CC	RL	IG	GE	RQ	EG	PS	VA	PG
Mobile (IV)	0.0131***	0.00437	0.0105***	0.0128***	0.00961***	0.00801***	-0.0109**	-0.000843	-0.000651
	(0.00322)	(0.00311)	(0.00259)	(0.00335)	(0.00329)	(0.00274)	(0.00546)	(0.00253)	(0.00175)
Egalitarian (IV)	-0.412***	-0.576***	-0.332***	-0.377***	-0.459***	-0.382***	-0.746***	-0.827***	-0.572***
	(0.0331)	(0.0321)	(0.0267)	(0.0344)	(0.0339)	(0.0282)	(0.0563)	(0.0260)	(0.0181)
Mobile (IV)xEgalitarian (IV)	-0.00161***	-0.000323	-0.00130***	-0.00160***	-0.00110**	-0.000918**	0.00208**	0.000388	0.000280
	(0.000489)	(0.000473)	(0.000394)	(0.000508)	(0.000500)	(0.000416)	(0.000828)	(0.000383)	(0.000266)

GDP	0.0195***	0.0195***	0.0157***	0.0245***	0.0192***	0.0160***	0.0135	0.0198***	0.0137***
	(0.00599)	(0.00579)	(0.00483)	(0.00622)	(0.00612)	(0.00510)	(0.0101)	(0.00470)	(0.00325)
Population	-0.300***	-0.0710**	-0.242***	-0.208***	0.0630*	0.0525*	-0.0185	-0.0733**	-0.0533***
	(0.0374)	(0.0361)	(0.0301)	(0.0388)	(0.0382)	(0.0318)	(0.0638)	(0.0293)	(0.0205)
Aid	0.00580*	-0.0132***	0.00467*	-0.0179***	-0.0226***	-0.0188***	-0.0215***	-0.000663	-0.000128
	(0.00337)	(0.00326)	(0.00272)	(0.00350)	(0.00345)	(0.00287)	(0.00579)	(0.00264)	(0.00186)
Net Effect	0.0021	N/A	0.0016	0.0019	0.0021	0.0017	0.0033	N/A	N/A
Thresholds	8.137	N/A	8.077	8.000	8.736	8.725	5.240	N/A	N/A
Constant	7.070***	7.702***	2.643***	6.567***	6.663***	2.483***	9.230***	9.643***	3.932***
	(0.248)	(0.240)	(0.200)	(0.257)	(0.253)	(0.211)	(0.421)	(0.194)	(0.135)
Observations	736	736	736	736	736	736	734	736	734
Pseudo R2	0.277	0.300	0.320	0.243	0.237	0.268	0.123	0.470	0.593
LR chi-squared	666.3	722.2	666.3	574.2	549.1	549.1	351.3	1223	1218
Prob > chi2	0	0	0	0	0	0	0	0	0

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Note: CC: Control of Corruption; RL: Rule of Laws; IG: Institution Governance; GE: Government Effectiveness; RQ: Regulation Quality; EG: Economic Governance; PS: Political Stability; VA: Voice & Accountability; PG: Political Governance and N/A: Not Applicablebecause at least one estimated coefficient needed for the computation of net effects or thresholds is not significant. Mean of Liberal Democracy (IV) is 6.782; Electoral Democracy is 5.357; Participatory Democracy is 7.331; Deliberative Democracy is 6.447; Egalitarian Democracy is 6.835.

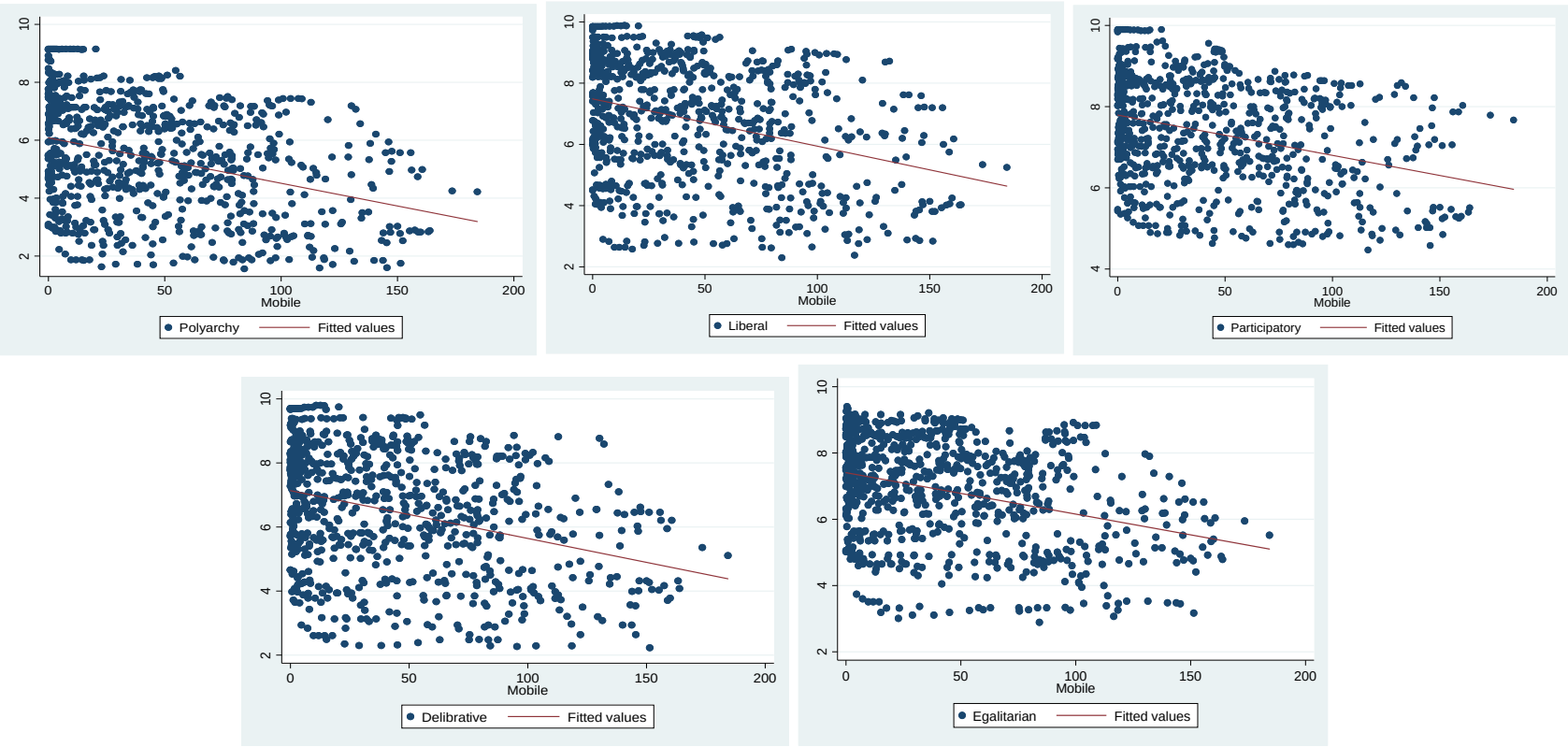

Figure 1: The tipping point for Mobile phones penetration and Democracy Index Indicators

From the empirical findings in Table 1-5, it is evident that weak democracy decreases the positive relevance of mobile phones penetration on integrated governance quality. These main findings are understood from the democracy quality perspective represents economic policy because of the way it is calculated. Notably, the original democracy indicators range from 0-1 with the higher values indicating better democracy quality. However, we rescale the index and reverse it to range from 0-10 with the higher value indicating weak democracy quality for better results. Thus, this follows that the increasing weak democracy diminishes the positive impact of mobile phones penetration on governance quality. This tendency is consistent across the conditional distribution of governance quality with some exemptions.

Given the main objective of this study (i.e. the democracy threshold that dampens the significance of technology penetration in fostering the governance quality), we follow the study of (Asongu & Nwachukwu, 2018) approach in estimating the maximum critical mass of democracy quality before the mobile phone penetration exerts negative impact on the governance quality.Thus, the threshold value is established such that the critical mass of the weak democracy quality should not be exceeded if mobile phone penetration will exhibit positive effect on governance quality. We expect positive unconditional impacts from mobile phone penetration on governance quality and a negative interactive effect between the mobile phone penetration and democracy indicators on governance quality. Hence, with the negative unconditional effect, it is expected that there exists critical threshold at which further increasing weaken democracy diminishes the positive unconditional effect of mobile phone penetration on governance quality.Notably, the critical thresholds are expected to fall within maximum value and minimum value of the democracy indicators in Appendix 1 – the descriptive statistics.

In light of the above, in the column 3 of Table 1, 8.491 (0.00900/0.00106) discloses the critical threshold of liberal democracy that should not be exceeded for mobile phones penetration to have a positive unconditional impact on institutional governance quality. Whereas 0.00900 is the unconditional consequence of mobile phones penetration on institutional governance, the 0.00106 represents the absolute value of the interactive effect between the liberal democracy and mobile phone penetration. Thus, it means that the calculated critical threshold that the liberal democracy of

above 8.491 is unfavorable for mobile phone penetration to exert a positive impact on institutional governance quality.

We establish the following findings. First from Table 1, 8.550 and 8.491 are liberal democracy thresholds that should not be exceeded for mobile phone penetration to exert positive impact on corruption control and institutional governance respectively. Second, 7.969, 9.749 and 9.751 are liberal democracy thresholds that should not be exceeded for mobile phone penetration to exert positive influence on government effectiveness, regulation quality and economic governance respectively. Third, no threshold is established for political stability, voice & accountability and political governance as one of the interested variables remains insignificant.

In Table 2, 6.977, 8.871 and 6.957 are electoral democracy thresholds that should not be exceeded for mobile phone penetration to have positive impact on corruption control, rule of law and institutional governance respectively. Second, 6.647, 7.250 and 7.216 are electoral democracy thresholds that should not be exceeded for mobile phone penetration to exert positive influence on government effectiveness, regulation quality and economic governance respectively[1]. Third, no threshold is established for political stability, voice & accountability and political governance as one of the interested variables remains insignificant. The results in Table 3 are inconsistent with our expectations and it is unreasonable to infer decisions based on the results.

Based on the findings in Table 4, 8.862 and 8.865 are weak deliberative democracy thresholds that should not be exceeded for mobile phone penetration to have positive impact on corruption control and institutional governance respectively. Second, 7.971, 8.926 and 8.936 are weak deliberative democracy thresholds that should not be exceeded for mobile phone penetration to exert a positive influence on government effectiveness, regulation quality and economic governance respectively. Third, no

[1] The original democracy indexes range from 0-1 with the higher values indicating better democracy quality. However, we rescale the index and reverse it to range from 0-10 with the higher value indicating weak democracy quality for better results. Thus, we expect that higher weak democracy quality will negatively influence the integrated governance quality. The threshold value is established such that the critical mass of the weak democracy quality should not be exceeded if mobile phone penetration will exhibit positive effect on governance quality

threshold is established for political stability, voice & accountability and political governance as one of the interested variables remains insignificant.

Lastly, the findings in Table 5 disclose that 8.137 and 8.077 are weak egalitarian democracy thresholds that should not be exceeded for mobile phone penetration to have a positive impact on corruption control and institutional governance respectively. Second, 8.000, 8.736 and 8.725 are weak egalitarian democracy thresholds that should not be exceeded for mobile phone penetration to exert positive influence on government effectiveness, regulation quality and economic governance respectively, while no threshold is established for voice & accountability and political governance as one of the interested variables remains insignificant.

In addition, we provide perception for the correlation (scattered plot Figure 1) between the mobile phone penetration and the democracy indicators (i.e.,Liberal Democracy Index, Electoral Democracy Index, Participatory Democracy Index, Deliberative Democracy Index, Egalitarian democracy Index) respectively. The scattered plot discloses a negative correlation between mobile phone penetration and the democracy measures. This implies that the higher the mobile phone penetration, the lower the weak democracy quality in Sub-Saharan Africa.

4. Conclusion

This study was motivated by the debate on the role of mobile technology on integrated governance quality estimating the threshold for democracy. The study provides an empirical investigation utilizing panel data consisting of 44 Sub-Saharan Africa (SSA) for the period 2000 to 2018. This is deemed crucial based on data availability as well as the need to capture recent happenings reflected in the data selectivity. The empirical argument is based on the Instrumental variable (IV) Tobit regression technique of estimation.

This study finds that first, weak democracy is detrimental to the effect of mobile phone penetration on integrated governance quality. This implies that a weak democratic system decreases the positive relevance of mobile technology within the SSA region. Second, the study computes various thresholds that should not be exceeded given the various weak democracy classifications, which include weak liberal democracy, weak

electoral democracy, weak deliberative democracy, and weak egalitarian democracy. Third, the study finds that the higher the mobile phone penetration, the lower the weak democracy quality in SSA. Thus, efforts and policies such as the enhancement of the mobile technology and concise democracy are recommended as the study contributes practical and theoretical postulations to literature.

As suggestions for future studies, literature can be improved upon by establishing linkages between technology adoption shocks and integrated as well as disintegrated institutional quality in SSA. Such techniques of estimation include the Bayesian Vector Autoregressive (VAR) model, and the Structural VAR along with the related impulse response functions and variance decompositions. Also, cross-sectional and comparative studies could be carried out on the theme of this study for comparative and further robust policy affirmation.

Appendix 1: Definitions of Variables and Descriptive Statistics

Variable	Acronym	Description	Obs	Mean	Std.Dev.	Min	Max
Corruption control	CC	Control of corruption (estimate): captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests'	792	3.789	1.241	1.347	7.433
Government effectiveness	GE	'Government effectiveness (estimate): measures the quality of public services, the quality and degree of independence from political pressures of the civil service, the quality of policy formulation and implementation, and the credibility of governments' commitments to such policies.	792	3.543	1.213	1.232	7.114
Political stability	PS	Political stability/no violence (estimate): measured as the perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional and violent means, including domestic violence and terrorism'	790	4.082	1.702	.047	7.564
Regulatory quality	RQ	'Regulatory quality (estimate): measured as the ability of the government to formulate and implement sound policies and	792	3.683	1.2	.513	7.255

		regulations that permit and promote private sector development'					
Rule of laws	RL	Rule of law (estimate): captures perceptions of the extent to which agents have confidence in and abide by the rules of society and in particular the quality of contract enforcement, property rights, the police, the courts, as well as the likelihood of crime and violence'	792	3.67	1.257	.983	7.154
Voice and accountability	VA	Voice and accountability (estimate): measure the extent to which a country's citizens are able to participate in selecting their government and to enjoy freedom of expression, freedom of association and a free media'	792	3.963	1.443	.548	6.995
Mobile Penetration	Mobile	Mobile cellular subscriptions (per 100 people)	826	44.511	42.042	0	184.298
Mobile (Instrumental)	Mobile (IV)	Mobile cellular subscriptions (per 100 people) Instrumented	788	46.968	41.452	4.131	179.909
Electoral Democracy	Electoral	Electoral democracy index employs the electoral principle of democracy that seeks to ensure politicians are responsive to the electorates through electoral channels for the citizens' approval.	836	5.384	1.87	1.56	9.15
Electoral Democracy (Instrumental)	Electoral (IV)	Instrumented	792	5.357	1.808	1.658	8.971

Liberal Democracy	Liberal	The liberal democracy index employs the principle of liberal democracy that emphasizes the necessity for protecting the individual especially the minority rights against the state and majority tyranny.	836	6.801	1.9	2.3	9.89
Liberal Democracy (Instrumental)	Liberal (IV)	Instrumented	792	6.782	1.867	2.362	9.803
Participatory Democracy	Participatory	The participatory democracy index employs the participatory democracy principle that ensure active citizens' participations in any political, electoral and non-electoral processes.	836	7.349	1.313	4.47	9.9
Participatory Democracy (Instrumental)	Participatory (IV)	Instrumented	792	7.331	1.278	4.525	9.803
Deliberative Democracy	Deliberative	The deliberative democracy index adopts the deliberative democracy principle that focuses on the decision processes in the polity and ensures such decisions are characterized with good motivates as opposed coercion.	836	6.468	1.883	2.23	9.8
Deliberative Democracy (Instrumental)	Deliberative (IV)	Instrumented	792	6.447	1.846	2.338	9.696
Egalitarian Democracy	Egalitarian	The egalitarian democracy index adopts the egalitarian democracy principle that ensures individual rights and freedoms are equally protected in all social group, equal distribution of resources and equal	836	6.85	1.529	2.89	9.4

		access to power by individuals						
Egalitarian Democracy (Instrumental)	Egalitarian (IV)	Instrumented	792	6.835	1.506	2.935	9.335	
Gross Domestic Product Growth	GDP	GDP growth (annual %)	826	4.559	5.343	-36.392	63.38	
Population growth	Population	Population growth (annual %)	829	2.521	.923	-2.629	5.605	
Foreign Aid	Aid	Net ODA received (% of GNI)	827	9.335	9.387	-.251	92.141	

Appendix 2
Correlation Matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

1.laws	1																	
2.corruption	0.883***	1																
3.institution	0.883***	1	1															
4.regulatory	0.864***	0.738***	0.738***	1														
5.effectiveness	0.907***	0.850***	0.850***	0.869***	1													
6.economic	0.864***	0.738***	0.738***	1	0.869***	1												
7.stability	0.744***	0.668***	0.668***	0.576***	0.637***	0.576***	1											
8.accountability	0.817***	0.733***	0.733***	0.757***	0.739***	0.757***	0.627***	1										
9.political	0.817***	0.733***	0.733***	0.757***	0.739***	0.757***	0.627***	1	1									
10.mobile	0.358***	0.330***	0.330***	0.356***	0.357***	0.356***	0.289***	0.346***	0.346***	1								
11.participatory	-0.690***	-0.627***	-0.627***	-0.667***	-0.613***	-0.667***	-0.488***	-0.890***	-0.890***	-0.319***	1							
12.delibrative	-0.728***	-0.654***	-0.654***	-0.687***	-0.649***	-0.687***	-0.518***	-0.910***	-0.910***	-0.332***	0.929***	1						
13.liberal	-0.770***	-0.710***	-0.710***	-0.698***	-0.700***	-0.698***	-0.575***	-0.935***	-0.935***	-0.342***	0.935***	0.964***	1					
14.electoral	-0.700***	-0.633***	-0.633***	-0.657***	-0.613***	-0.657***	-0.535***	-0.920***	-0.920***	-0.350***	0.935***	0.966***	0.965***	1				
15.egalitarian	-0.777***	-0.730***	-0.730***	-0.683***	-0.682***	-0.683***	-0.599***	-0.905***	-0.905***	-0.344***	0.906***	0.948***	0.959***	0.948***	1			
16.GDP	0.0511	0.0206	0.0206	0.0613	0.0466	0.0613	0.0326	0.0524	0.0524	-0.0518	-0.0449	-0.0549	-0.0462	-0.0361	-0.0196	1		
17.Population	-0.405***	-0.501***	-0.501***	-0.298***	-0.461***	-0.298***	-0.280***	-0.430***	-0.430***	-0.252***	0.369***	0.376***	0.427***	0.392***	0.446***	0.205***	1	
18.Aid	-0.146***	-0.0436	-0.0436	-0.213***	-0.207***	-0.213***	-0.148***	-0.0550	-0.0550	-0.347***	0.0228	0.0279	0.0236	0.0312	0.0277	0.0588	0.204***	1

*p< 0.05, **p< 0.01, ***p< 0.001

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The authors have declared that no competing interest exist.

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Highlights

A weak democratic system decreases the relevance of mobile technology with SSA region
Higher mobile phone penetration implies improved democracy quality in SSA
Thresholds exist that should not be exceeded for the various weak democracy classifications
Weak liberal democracy's threshold is higher than weak deliberative democracy's threshold
Weak deliberative democracy's threshold is higher than weak electoral democracy's threshold

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