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Exploring the Impact of the Widening Reach of Digital Technologies on Public Policy and Economic Examination

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ABSTRACT*:* The study adopted the NRI as an indicator of digitalization. It measures the "degree to which socio-economies across the world leverage ICT to increase their competitiveness" and captures the ICT regulatory environment, access, usage and diffusion of technology in society. Argued that the NRI was created to address critical gaps in our understanding of ICT development, particularly in countries. The NRI is an accepted indicator for assessing a country's development toward becoming a knowledge society. The NRI to illustrate that early adopter of technology fare far better than laggard users of technology, illustrating the synergistic effects of individual usage of technology. This argument is in alignment with the diffusion of technology theory. Since 2002, the World Economic Forum has produced the NRI as part of its Global Information Technology Report (GITR) series. Since its inception, it increased coverage in some countries from three to 40 countries.

Keywords: *Digital Technologies; Public Policies; Economic Analysis.*

Introduction

There is a well-documented contention that digitalization creates economic growth which social laws are based (Bukht and Heeks, 2017). Digitalization is enabled through information and communication technology, which is defined by Kabongo and Okpara (2014, p. 315) as "any communication device or application, including radio, television, mobiles phones, computers, network hardware and software and satellite systems and any associated applications to reach people." From e-commerce to business process outsourcing, digital technology has transformed how firms operate globally (Lacity et al., 2016). Furthermore, it has revolutionised how people communicate (e.g., social media) and how governments engage with citizens through e-government platforms (Zhao et al., 2015). The implications of successful implementation of digital technologies are substantial (Tong and Wohlmuth, 2019). Technological advances have afforded new opportunities for generativity, which Zittrain (2010, p. 1981) defined as the technology's "overall capacity to produce unprompted change driven by large, varied, and uncoordinated audiences", which creates synergies across different tasks. Digital technologies have also facilitated "datafication" and "virtualisation" (Bukht and Heeks, 2017). In fact, the importance of digital technology has rarely been greater understood than during the 2020.

Generally, studies have shown a positive relationship between ICTs and socio-economic growth (Jorgenson and Vu, 2016). In the African context, the economic liberalisation policies of the 1980s, egged on by international financial institutions coincided with the start of ICT investments and internet infrastructure, resulting in the widespread diffusion of ICT products and services on the continent (Evans, 2019). These efforts included the privatisation of telecommunication lines and the consolidation of various ICT services under a single ministry (Holden and van.Klyton, 2016). In addition, Africa experienced a significant increase in the number of mobile phone subscribers, rising from 247 million from 1998 to 2008 to 367 million subscribers by 2015. This has been accompanied by an increase in broadband internet penetration rates from zero to 19 million between 2000 and 2010 (Ojong, 2016).

The Networked Readiness Index (NRI)

The study adopted the NRI as an indicator of digitalisation. It measures the "degree to which socio-economies across the world leverage ICT to increase their competitiveness" (Milenkovic et al., 2016, p. 1121) and captures the ICT regulatory environment, access, usage and diffusion of technology in society. Milenkovic et al. (2016) argued that the NRI was created to address critical gaps in our understanding of ICT development, particularly in countries. The NRI is an accepted indicator for assessing a country's development toward becoming a knowledge society (Gomaa, 2019). According to Degerli et al. (2015) used the NRI to illustrate that early adopters of technology fare far better than laggard users of technology, illustrating the synergistic effects of individual usage of technology. This argument is in alignment with the diffusion of technology theory (Rogers, 2003).

Since 2002, the World Economic Forum has produced the NRI as part of its Global Information Technology Report (GITR) series. Since its inception, it increased coverage in some countries from three to 40 countries (Kirkman et al., 2002). The index's latest revision was in 2012 and comprised four sub-indices (environment, readiness, usage, and impact), ten pillars, and 53 individual indicators (Dutta and Bilbao-Osorio, 2012). The NRI is computed as an average of the four sub-indices. To ensure consistency in the measurement of the NRI, this study uses data from 2012 to 2016 (see also Pratipatti; Gomaa, 2019). Each sub-index is measured on a scale of 1–7 (best). The environment sub-index consists of indicators which measure the degree to which the legal, political and business environments enable ICT to thrive. The readiness sub-index measures the extent to which individuals, businesses, and governments are 'ready' to use ICT technology by measuring the availability of physical and ICT infrastructure, quality of education, and affordability of ICT. The usage sub-index measures the adoption of ICT by individuals, businesses, and the government and includes the proportion of households with internet access, use of social networks, the capacity for innovation and the government online service index. The impact sub-index captures the economic and social effects of ICT.

One potential drawback of using the NRI index in its aggregate form is the broadness that arises from combining 53 indicators, which complicates efforts to isolate the impact of the different dimensions of digitalisation on growth. The literature emphasises that it is the usage of ICT that matters for growth (Evangelista et al., 2014) but is silent on the type of ICT usage (i.e., by households, businesses, or the government). Therefore, this study examines the usage subcomponent of the NRI and the sixth, seventh, and eighth pillars that constitute it. The sixth pillar measures individual usage and consists of seven indicators: mobile phone subscriptions (per hundred), percentage of individuals using the

internet, households with personal computers, households with internet access, fixed broadband internet subscriptions, mobile broadband subscriptions, and use of virtual social networks. The seventh pillar measures business usage and includes the following six indicators: firm-level technology absorption, capacity for innovation, PCT patents, ICT use for business-to-business transactions, business-to-consumer internet use, and the extent of staff training. The eighth pillar measures government usage and consists of three indicators: the importance of ICTs to government vision, a government service online index, and the government's success in ICT promotion.

Study hypothesis

The study postulate that individual usage of ICT is growth-enhancing in several ways. First, it serves as a platform through which individuals can access and disseminate knowledge, which can empower them to be more productive. Individual usage creates network externalities: as more people engage with digital technologies such as mobile phones or social media, the value of such products increases for others. An increase in individual usage of digital technologies raises the demand for ICT-enabled goods and services, which leads to the growth in the telecommunications sector. Finally, individual usage facilitates digital communication, which increases awareness of the availability of goods and services on the market, leading to higher demand for goods and services through word-of-mouth marketing (Viljoen et al., 2016). Hence, we state our first hypothesis as follows:

H^{o}: (The individual usage of ICT has no impact on GDP growth)

H^{1} (The individual usage of ICT has a positive impact on GDP growth)

We assert that business usage of ICT increases economic growth by boosting business competitiveness, efficiency, and productivity. Also, access to ICTs enhances innovation and affords benefits that spillover from the telecommunications sector to other sectors of the economy (Counted and Arawole, 2016). This leads to our second hypothesis.

Hypothesis 2

E-government usage of ICT has a positive impact.

(E-government usage of ICT has no impact on enhancing public policy)

(E-government usage of ICT has a positive impact on enhancing public policy)

We propose that government usage of ICT is beneficial for e-government growth by improving efficiency and transparency in government departments and strengthening collaborations between the public and private sectors. This leads to Hypothesis 3.

Hypothesis 3

The impact of government usage of ICT on growth is positive.

(Government usage of ICT has no impact on GDP growth)

(Government usage of ICT has a positive impact on GDP growth)

Empirical strategy

The inclusion of the lagged dependent variable in the specification makes equation (6) a dynamic panel data model. In such models, the pooled ordinary least squares (POLS) and fixed effects (FE) estimators are biased and inconsistent arising from a correlation between the lagged dependent variable and the error term. This results in being upwardly biased with a POLS estimator and downwardly biased with a fixed-effects estimator. The GMM estimator of Arellano and Bond (1991), otherwise known as the first differenced estimator, was proposed as one way of correcting the bias. Its implementation involves the first differencing of all variables and instrumenting the first differenced series using appropriate lags of each variable. However, in short dynamic panels that are persistent, the lags can be weak instruments for the first differenced series, thus leading to bias (see Bond et al., 2001). To mitigate the weak instrument problem of the Arellano and Bond (1991) estimator, Arellano and Bover (1995) and Blundell and Bond (1998) developed the SYSGMM estimator. This estimator consists of the first differenced series augmented with the lagged levels of each variable plus the original (level) series instrumented with the lagged first differences of each variable.

For the first condition to hold, the first differenced residuals must be negatively correlated, but there must be no second-order serial correlation. The second condition can be tested using the Hansen test of over-identifying restrictions (Bowsher, 2002; Parente and Santos Silva, 2012). Here, the extra instruments must be uncorrelated with the error term. Finally, the third condition can be tested using the Difference-in-Hansen test (Roodman, 2009b), which tests for the validity of the extra instruments. In other words, the extra instrument set in the SYSGMM must be uncorrelated with the error term. One drawback of the SYSGMM estimator is that the number of instruments can expand very quickly, which can lead to bias and a severe weakening of the specification tests (Roodman, 2009a). Consequently, Roodman (2009b) advocated collapsing the instrument set so as to restrict the instrument count. Finally, GMM estimators can be implemented using either a one-step procedure or a more efficient two-step procedure. However, the estimated standard errors of the two-step GMM estimator is found to be downwardly biased in small samples, so a correction term was proposed by Windmeijer (2005). This study makes use of the two-step SYSGMM with the Windmeijer (2005) correction and a collapsed instrument set.

Background/ Context

The traditional, neoclassical view of ICT is that it increases economic growth through capital deepening (i.e., investment in ICT) due to falling prices of ICTs (van Ark et al., 2008). However, the non-traditional view is that ICT spurs innovation by facilitating business-to-business transactions, production spillovers and network externalities (Paunov and Rollo, 2016).

In contrast, Cardona et al. (2013) conducted a survey of 150 studies from 1990 to 2007 to find that ICT had a small but positive effect on economic growth with an elasticity estimate of 0.05. They argued that ICT is a general-purpose technology that leads to further innovations (i.e., generativity), thus contributing to economic growth. Furthermore, they asserted that ICT gives rise to both horizontal and vertical spillovers between technology-producing and technology-using sectors. However, they found no direct empirical evidence to support this assertion. Similarly, Castellacci (2011) applied Arellano-Bond GMM techniques to a panel of 131 countries from 1985 to 2004 to show that measures of innovation, along with human capital and technological infrastructure, promoted growth in income per capita. In their model, economic growth depended on the stock of knowledge developed through

innovation and knowledge imitation with both affected by the levels of human capital and technological infrastructure (i.e., ICT).

ICTs have been found to have a transformative effect on socio-economic development. Palvia et al. (2018) used a capabilities approach to find that, for developing countries, ICTs lowered the cost of doing business by facilitating access to both information and consumers through the internet, thereby reducing the need for a physical store. Access to ICTs was also instrumental in facilitating communication and connectivity that enabled the firms to sustain a long-term relationship with customers. Moreover, they found that ICTs empowered citizens by enabling access to free online educational material and news and by enhancing the "voice" of the people through online forums.

The effects of ICTs on economic growth has not been homogeneous across countries. Watanabe et al. (2015) found that bi-polarisation existed in GDP growth rates between "ICT-growing economies" and "ICT-advanced economies." They found that ICT advancement had a positive effect on innovation and economic modernisation in ICT-growing economies, but not for ICT-advanced economies. They attributed this to the greater access and normalisation of ICT technology afforded by the rapid economic advances in ICT-growing economies that, in some sense, are levelling the playing field.

Individual usage of ICT

A number of studies have examined the contribution of individual use of ICT on economic growth. For example, Donou-Adonsou (2018) examined the relationship between technology, education, and economic growth based on data from 45 Sub-Saharan African (SSA) countries from 1993 to 2015. Using a generalised method of moments estimator, he found that for every one-percentage-point increase in internet access, economic growth increased by 0.224 percentage points, but only in countries where the gross primary enrolment was higher than 92.53%. Hence, the level of education was an essential factor for the internet to foster economic growth. Evans (2019) applied the Fully Modified OLS (FMOLS), Dynamic Ordinary Least Squares (DOLS) estimators and panel Granger causality tests to panel data from 45 Sub-Saharan African (SSA) countries from 1995 to 2015. He found a bi-directional causal link between internet usage and economic well-being (proxied by GDP per capita). Ponelis and Holmner (2015, p. 166) argued that the individual usage of ICTs among high school pupils in Africa has afforded new learning opportunities and access to more diverse content. In fact, integrating ICT access and usage into education programmes were seen as effective ways of fostering development in African countries.

Chavula (2013) found that fixed telephone main lines and mobile telephony, rather than internet usage, had significant effects on the long-term growth of per capita income in Africa from 1991 to 2007. The significance of fixed main telephone lines and mobile telephony was attributed to Africa's late entrance into the digital economy. In contrast, using cross-sectional data in 2013, Njoh (2018) established a link between mobile phone subscriptions and internet access for economic development in Africa as measured by the Human Development Index (HDI). However, no such evidence was found regarding fixed phone and broadband subscriptions, thus illustrating that not all types of ICT matter for economic progress.

Social media is another application of individual ICT usage. It can be defined as "internet-based applications that carry consumer-generated content" (Xiang and Gretzel, 2010, pg 180). Many firms use social media for servicing consumers and building industry networks (Grewal and Levy, 2016).

There is an increasing amount of literature on the relationship between social media and economic growth. In developing countries, social media has become an indirect factor of growth, with new businesses created through social media platforms (Khajeheian, 2013). Tajvidi and Kamari (2017) examined the impact of online and offline social media on branding and innovation as mediators for firm performance in the hotel sector using structural equation modelling. They found that the relationship between social media use and firm performance was positive and significant. Other literature focused on the use of social media marketing by entrepreneurs. Ukpere et al. (2014) used qualitative methods to find that female entrepreneurs in South Africa embraced social media to balance their personal and professional lives. In fact, SMEs are set to benefit from social media. Using qualitative methods, Jones et al. (2015) found that social media afforded SMEs greater visibility in the market, a broader market reach, and enhanced engagement with customers. Social media usage among younger Africans, in particular, has facilitated the growth of e-commerce and social media marketing. Duffett (2017) surveyed more than 13,000 South African millennials regarding the influence of social media marketing on consumer attitudes and found a positive and significant effect on both the cognitive and affective attitudes of respondents. However, Dell'Anno et al. (2016) found a significant adverse effect on firm performance using social media membership data from a cross-section of 83 countries. The main reasons were attributed to increased search costs, decreased productivity and/or a "greater consumption of nonmonetary content" (Dell'Anno et al., 2016, p. 636).

Business usage of ICT

Business usage of ICT has been found to increase labour productivity (Evangelista et al., 2014) and increase competitive advantage, productivity, and efficiency, thus becoming a stimulus for business growth (Ongori and Migiro, 2010). Tchamyou (2017) found that, in African economies, ICTs reduce the time it takes to launch a business and decrease the costs of starting one, thereby increasing the number of businesses. It has been argued that ICT serves as a catalyst for innovation, such as the development of applications that improve living standards (Jung et al., 2001). Mobile phones are said to enhance supply chain management and open opportunities for employment in the ICT sector, thereby catalysing growth in the telephony sector. They also increase the efficiency of other sectors, such as health, education and finance (Njoh, 2018). Furthermore, the use of e-commerce in business operations has the potential to spur economic development for both small and large enterprises (Carbonara, 2005). A study conducted by Wanyoike et al. (2012) argued that the adoption of e-commerce by businesses in Africa is imperative for them to compete more effectively. Foster and Graham (2016) found that the use of digital technology had improved the management and efficiency of the tea sector in Rwanda, such as in the digital monitoring and exchange of goods.

According to Apulu and Ige (2011) analysed survey data collected from 180 Nigerian entrepreneurs and found that a lack of electricity (81.7%) and infrastructure deficiencies (71.7%) were the main hindrances to business ICT usage, followed by inadequate service provision (67.2%) and a lack of education (61.7%).6 These factors are in line with the technology acceptance model that emphasises the relevance of facilitating conditions as a determinant of ICT usage (Davis et al., 1989).

Government usage of ICT

Much of the literature on government usage of ICT revolves around the implementation of e-government and other civic technologies that facilitate e-participation from citizens (McNutt et al., 2016). E-government 2.0 applications and collaborative platforms are said to improve efficiency within

public policy decision making and management (Adam, 2020), improve the interaction between the government and citizens (Falco and Kleinhans, 2018), and between the government and businesses such as in private-public partnerships (Warner and Fargher, 2019). E-government has been shown to transform the administrative operations of the state and facilitate the delivery of services to citizens (Twizeyimana and Andersson, 2019). In this context, ICT both enables new practices that would otherwise not be present in government services, and it embeds "new values into systems" (Bannister and Connolly, 2014, p. 120). There are also a number of studies that examine e-government in African economies (Choudrie et al., 2017); however, their focus is on transparency, corruption, and efficiency.

Many African governments have prioritised knowledge sharing and procurement of digital technologies as key in achieving sustainable development (Banga and Velde, 2018). However, some have placed limits on ICT access under the guise of protecting the country from cyber-based attacks (Bidemi, 2017). Internet shutdowns have been employed as a means to "control and monitor their population in ways that decrease democratic freedoms" (Ayalew, 2019). Furthermore, shutdowns undermine economic growth and interfere with start-up ecosystems (Kathuria et al., 2018), which is particularly problematic for the myriad of technology-enabled start-up enterprises and innovation hubs on the African continent (Friederici, 2016). Counted and Arawole (2016) concluded that in Africa, usage of ICTs was greatly affected by state-imposed restrictions and limited access to online platforms and services.

Summary

A growing body of the literature has examined the impact of digital technologies on economic growth and offered mixed results in explaining this relationship. Nevertheless, the literature has suggested that usage of these technologies stimulates the economy by facilitating communication, empowering individuals, creating employment, and spurring innovation. The literature has also revealed the critical role of the state in providing an enabling environment for technology access and usage. The state bears responsibility for enabling the acquisition or production of advanced technologies and creating and sustaining a legal framework that promotes the use of ICT.

Despite the emphasis on ICT usage rather than ICT access for growth, many studies have failed to consider the impact of different types of usage of digital technology on growth, especially with respect to government usage. Therefore, this study contributes to the emerging literature in this field by distinguishing between the impact of individual, business, and government usages of ICT on economic growth in African countries.

Conclusion

Empirical research on the impact of digitalisation in African countries is limited. Our research contributes to this field by using available data from 39 African countries from 2012 to 2016 to examine the impact of digital technology usage on economic growth. Unlike existing research, we distinguish between the impacts of individual, business, and government usage of ICT by analysing data from the sixth, seventh, and eighth pillars of the Networked Readiness Index. Using the SYSGMM estimator, the results indicated that individual usage of ICT was positively associated with growth. When the three pillars were disaggregated into their individual component indicators, social media usage, and the importance of ICTs to government vision emerged as significant for economic growth.

Finally, the NRI has the benefit of being a comprehensive measure of digitalisation that captures several dimensions and provides relatively extensive coverage of African countries. However, it has a drawback of being too broad in its aggregate or even sub-aggregate forms, which makes it challenging to identify the impact of digitalisation on aggregate measures of economic activity. However, using the NRI in its more disaggregated forms (pillars or indicators) is instructive for isolating the effects of different components of digitalisation and could inform other areas of research.

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Data Availability: The author holds all the data employed in this study and is open to sharing it upon reasonable request.

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