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The role of mobile and broadband penetration in entrepreneurial activity for the sub-Saharan African region

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ABSTRACT

Purpose of the study: Entrepreneurship is highly relevant to sub-Saharan African (SSA) countries where policies have recently been implemented to facilitate new business start-ups by focusing on fixed and mobile broadband technology. This study investigates the extent to which mobile and broadband penetration in SSA countries is associated with entrepreneurial activity and new business density rates.
Design/methodology/approach: Data sets from the International Telecommunication Union, Global Entrepreneurship Monitor, and World Bank are analysed across thirteen SSA countries.
Findings: Broadband penetration has an increasing trend pattern over the years analysed. Results reveal a positive relationship between the rate of mobile penetration, broadband penetration, and new business density rates, while a negative relationship was detected between the rate of mobile penetration, broadband penetration and the rate of total entrepreneurial activity.
Recommendations/value: Policymakers and leaders must realise that as with other forms of infrastructure, broadband and mobile networks have a substantial impact on the entrepreneurial activity and are essential factors in the establishment of new businesses.
Managerial implications: Leaders and managers need to invest in infrastructure in terms of ICT which could reduce the cost of operations, distribution, and marketing for existing entrepreneurs and encourage potential entrepreneurs to engage in start-ups (Herrington & Kelly, 2013).

Keywords

Entrepreneurial activity; Information and communications technology; Mobile and broadband; New business density; Sub-Saharan African (SSA) countries.

JEL Classification: D8, J24

1. INTRODUCTION

Both researchers and practitioners note that entrepreneurship is becoming progressively more crucial in the value of creativity and innovation, where the *innovation highway* depends on the extent to which individuals can mobilise technology and knowledge resources and turn them into entrepreneurial activities and outcomes (Alves *et al.,* 2018; Bosma *et al.,* 2020; Kugler, 2019; Urban, 2021). The relevance of telecommunications impact on economic growth and innovation has been a topic of investigation since Hardy (1980) first published his seminal study on 60 nations showing the relationship between telecommunications and economic development. More recently, a stream of studies show that the changes brought about by the digital economy require technology and entrepreneurship for enterprises to improve their competitiveness, particularly in resource-scarce environments, such as developing countries (Ngoasong, 2018; Urban & Townsend, 2021). The information and communications technology (ICT) industry is one such technology characterised by rapid change and shortened product lifecycles, where entrepreneurs must adapt to ICT changes and constantly seek out new opportunities (Nokosi *et al.,* 2012; Alves *et al.,* 2018; Batyashe & Iyamu, 2020; Wrede *et al.,* 2020).

However, the role of ICT in fostering financial inclusion and growth in developing countries is not very promising (Danquah *et al.,* 2017; Urban, 2021). Indeed, it has been noted that the complex interplay between infrastructure, mobile phone ownership and usage, entrepreneurship and chronic poverty in Africa requires further investigation (Richardson, 2016; Bosma *et al.,* 2020). Although several prior studies have investigated the effect of ICT infrastructure on economic growth in general, there is little literature available regarding the relationship between ICT and entrepreneurship, from a mobile and broadband perspective, in developing countries, particularly in an African market context (Urban, 2021). While some studies report links between the mobile penetration rate and GDP growth per capita in studies on internationalisation of small and medium enterprises (SMEs) (Andrianaivo & Kpodar, 2012; Wright *et al.,* 2015), data on ICT is sorely lacking in sub-Saharan Africa (SSA) countries (Asongu *et al.,* 2018; Hagsten & Kotnik, 2017). This anomaly is particularly concerning,

considering that the SME sector is instrumental for economic growth and entrepreneurial development (Nokosi *et al.,* 2012; Hagsten & Kotnik, 2017).

Increasingly, it is acknowledged that the effects of emerging technologies influence the contemporary challenges and opportunities of doing business in Africa (Asongu *et al.,* 2018). Over the past few decades many countries in SSA are becoming less reliant on raw material, mineral extraction, and agriculture; and instead, are moving towards entrepreneurship, financial efficiency, and technological innovations (Herrington & Kelly, 2013; Urban & Townsend, 2021). In this African context, researchers find that the development of entrepreneurship and enterprise development is contingent upon SMEs adopting and adapting to innovative technologies (Danquah & Amankwah-Amoah, 2017). Moreover, with high unemployment and a growing youth population prevalent in all the SSA countries, entrepreneurship is highly relevant as it can positively contribute towards economic development and address issues of inequality (Bruton *et al.,* 2021; Urban, 2021).

1.1 Study problem and purpose

Recognising that SSA is emerging at the forefront of the debate about the adoption and adaption of recent technologies (Amankwah-Amoaha *et al.,* 2018), the purpose of this study is to understand the extent to which broadband penetration, along with associated mobile technology, are positively related with country rates of entrepreneurial activity. The study is motivated by the practical problem that while SSA countries are starting to implement mobile and broadband policies aimed at increasing knowledge transfer and economic growth (Tchamyou, 2017), the question remains; whether these policies and the rollout of broadband and mobile technology infrastructure will influence the levels of entrepreneurial activity in these countries. Furthermore, it is recognised that as a nascent stream of research, mobile and broadband penetration and entrepreneurship are still in the initial stages of development, where to date, there has been limited consideration of how wider and ongoing debates about ICT and entrepreneurship play out in African contexts (Nokosi *et al.,* 2012). Consequently, the research objectives of the study are: (a) to examine the relationship between broadband and mobile penetration and early-stage Total Entrepreneurial Activity (TEA) as measured by the Global Entrepreneurship Monitor (GEM) (Bosma *et al.,* 2020) series of reports for SSA countries (Herrington & Donna, 2013); and (b) to examine the relationship between broadband and mobile penetration and new business density (NBD) as measured by the series of World Bank (World Bank, 2018) reports for SSA countries.

1.2 Study contributions

The study makes the following important contributions to the contemporary management literature. First, it adds to the existing body of knowledge on entrepreneurship and development. This is achieved by recognising that prior studies have focused primarily on the association between mobile penetration and economic growth (Amankwah-Amoaha *et al.,* 2018), and instead, the focus of this study is on entrepreneurial activity. A key GEM indicator is the early-stage TEA rate in a country, which measures the percentage of the population aged between 18 and 64 years who are considered *"nascent entrepreneurs (individuals who have committed resources to starting a business but have not yet paid salaries or wages for more than three months*)" (Bosma *et al.,* 2020:26; Bowmaker-Falconer & Meyer, 2022:ii). TEA also measures the *"new business ownership rate (owners of a new business that is less than 42 months old)"* (Bosma *et al.,* 2020:26; Bowmaker-Falconer & Meyer, 2022:ii). A secondary measure of entrepreneurial activity is used to obtain a more nuanced understanding of entrepreneurial activity: the World Bank indicator for NBD. The World Bank defines this measure as *"…new business registrations per 1 000 working-aged people*" (those between the ages of 15 and 65 years) (World Bank, 2018:132).

Second, both mobile technology penetration and broadband penetration, in this study are measured in relation to TEA and NBD, as prior studies suggest that these technologies are even more significant in SSA, where the distance to market and other accessibility issues can be overcome using technology instead of physical infrastructure (Leitão & Baptista, 2011).

Third, the study is a multi-county study with a focus on SSA countries, which is important as scholars argue that mainstream management theories, which reflect the North American context, are not always applicable to different environments (Bruton *et al.,* 2021). Indeed, it is far from clear how mobile and broadband penetration influence entrepreneurship in SSA countries. In this regard, scholars point to a dearth of entrepreneurial research in emerging and developing economies resulting in an overemphasis on Western models and theories, which are not always pertinent to emerging and developing country contexts (Foo *et al.,* 2020). Despite its potential, entrepreneurial behaviour, in general, remains understudied in African countries, often resulting in inappropriate policy actions and insufficient support (Urban, 2021).

Lastly, the study findings will assist managers, policymakers, and agencies in understanding how much emphasis should be placed on mobile broadband to improve business density and entrepreneurial activity rates. Policymakers and researchers agree that technology is a key driver of the global economy and a critical factor in economic growth and development in both

developed and developing countries (Amankwah-Amoaha *et al.,* 2018). The study results could also inform important management decisions relating to the deployment and availability of mobile and broadband infrastructure as a way of enhancing entrepreneurial activity in a firm and at the country level.

The article starts with a brief review of prior research. The methodological design section follows, where data sources and data analysis techniques are evaluated. The findings are then presented and discussed. Study implications and recommendations are formulated, and the article ends with an overall conclusion.

2. THEORETICAL BACKGROUND

2.1 ICT and Entrepreneurship

In the 21st century, global economies are driven by technology and knowledge where entrepreneurs must recognise and employ technology that presents high growth opportunities (Asongu *et al.,* 2018). A key component of technological environments today is the development and proliferation of information technology, primarily using the internet, which is a key to growth for many small businesses (Hagsten & Kotnik, 2017). ICT can drive change in society and has transformed today's society into an information society (Alderete, 2017). The World Bank defines ICT as "*consisting of hardware, software, networks and media for collection, storage, processing, transmission, and presentation of information (voice, data, text, images)"* (World Bank, 2018:24). The impact of ICT on economic growth and development has been the focus of several studies with results showing that ICT positively impacts economic prosperity (Audretsch *et al.,* 2015), leads to improvements in living standards, boosts the performance of the banking sector, and provides a framework for sustainable development in developing nations (Foo *et al.,* 2020). The ICT sector in any country is pivotal to economic development, and innovation, particularly where national policy objectives strive to promote the convergence of telecommunications, broadcasting, and information technologies (Audretsch *et al.,* 2015). For instance, the liberalisation of the telecommunications industry has led to high growth in many Asian countries when firms used ICT for production and business optimisation (Alderete, 2017). Similar studies also identified ICT as playing a significant part in the socioeconomic development of countries such as China, Hong Kong, Indonesia, Japan, South Korea, Malaysia, the Philippines, Singapore, Taiwan, and Thailand (Torero *et al.,* 2001). Indeed, the increase in the use of ICT has transformed economies all over the world, from manufacturing to digital economies, providing technology

products and services such as hardware, software, and communications service (Alderete, 2017).

Past studies have used various theories and models to investigate ICT adoption and usage which include, among others, the technology acceptance model (TAM), theory of reasoned action (TRA), theory of planned behaviour (TPB), diffusion of innovation (DOI), technology-organisation-environment (TOE), unified theory of acceptance, and use of technology theory (UTAUT) (Nokosi *et al.,* 2012). These theories have been important in evaluating the development of ICT across a wide range of economies and industries (Kyari *et al.,* 2021). In this regard, research shows that the elevated levels of global mobile penetration and ICT are changing the behaviour of consumers and markets, thus creating new markets and marketing methods (Amankwah-Amoah *et al.,* 2018; Wrede *et al.,* 2020). Furthermore, with the evolution of technologies, technological opportunism empowers entrepreneurs and firms to exploit opportunities and manage such technological developments effectively and to their advantage (Maphumulo & Urban, 2022). By relying on these theoretical underpinnings, an improved understanding of ICT and entrepreneurship is envisaged through the formulation of the study hypotheses.

Several studies have linked ICT as one of the critical factors for entrepreneurship to flourish (Leitão & Baptista, 2011). The adoption and use of ICT have been shown to drive entrepreneurship in all market sectors by lowering costs and allowing entrepreneurs to develop new tools to organise and share information in local and global markets (Alderete, 2017). ICT has the capacity to coordinate other enablers of entrepreneurship by providing richer information that allows for better opportunity recognition processes and greater business success (Urban, 2021). Through the integration of smart devices, applications and internet data resources, technology is providing opportunities for learning and dissemination of knowledge (Asongu *et al.,* 2018). ICT, together with education and R&D, ICT forms the most critical element for creating a platform for entrepreneurship (Alderete, 2017).

A critical review of the literature available for SSA countries indicates the potential of ICT to drive openness in economies on the continent, and its essential role to foster entrepreneurship and address issues such as employment and development problems (Asongu *et al.,* 2018; Danquah & Amankwah-Amoah, 2017). The entrepreneurial ability to leverage technology under conditions of uncertainty has long been acknowledged as a critical resource for the growth and success of enterprises (Urban, 2021). For SMEs in emerging markets, the growing trend towards globalisation offers numerous opportunities for adopting technological practices,

which can provide the essential competencies and advantages to SMEs. Small enterprises that are *technologically opportunistic* have the ability to manage changes in technology and understand the fundamental impact of changing technologies on their strategic growth decisions and performance (Urban, 2021). Furthermore, studies indicate that ICT must be integrated with the core capabilities of the business and should form part of the firm's strategy, especially in the growth phases of business (Batyashe & Iyamu, 2020). Indeed, ICT investments need to be viewed as essential to the longer-term survival of SMEs by providing external knowledge and financial resources, creating legitimacy through the dissemination of information, and generating more network ties (Squicciarini, 2017).

Some scholars argue that the development of modern technologies has shifted from large corporations to SMEs as investments in ICT and a focus on fostering entrepreneurship supports the creation of smaller ventures to exploit technologically-based opportunities (Leitão & Baptista, 2011). Small business owners make use of mobile technology and social media by maintaining and growing an extensive network of ties to both collect information and identify resources, as well as to build a reputation and communicate with their customers (Shabbir *et al.,* 2016). Recent findings indicate that ICT capability and usage positively influence lending conditions provided by banks to SMEs (Asongu *et al.,* 2018; McCann & Barlow, 2015). For purposes of this study, both telephony and mobile broadband are incorporated in the term *use of mobile technology*. Mobile broadband refers to wireless internet access using devices such as USB wireless modems, tablets, smartphones, and other mobile devices. To incorporate both fixed broadband and mobile broadband, the term *broadband* will refer to high-capacity transmissions over the internet, which takes place at speeds higher than the original dial-up access.

2.2 A focus on mobile telephony and broadband

As formulated in the study objectives, the study focus is on the relationship between two components of ICT, namely mobile telephony and broadband, which are reported to be complementary in their effect on economic growth and development (Ghosh, 2016). Mobile phones have emerged as multifunctional devices that can transform people's lives and be extremely important for entrepreneurship. Growth in mobile phones and other mobile devices, such as tablets, have provided new opportunities for entrepreneurs by allowing them to bypass incumbent operators in markets with minimal capital requirements. Mobile phones, which include smartphones and tablets, are embedded in the daily work routines of many people that use these devices to communicate, share information, and network (Ghosh, 2016). However,

to be effectively exploited, these mobile devices must have access to the internet through mobile or other broadband services (Alderete, 2017).

Internet access allows individuals to access information in real-time and with increased speed, allowing for immediate responses to any changes in the markets (Ghosh, 2016). For many people in the developing world, mobile devices are the only way that they have connected to the internet (Asongu *et al.,* 2018). Along with mobile applications and extensive international networks, these devices now form an ecosystem that has become one of the most important platforms for bringing technological benefits to economies (Ghosh, 2016). Mobile phone penetration has been linked with many positive effects in African countries. For instance, in their study on the impact of mobile phones in the diffusion of knowledge, Asongu *et al.* (2018) found that mobile penetration has a positive effect on good governance and better knowledge diffusion. In this regard, knowledge diffusion variables are influenced through the reduction of information asymmetry and break information monopolies that create conditions for bad governance.

Furthermore, increased mobile penetration allows countries with low governance levels to catch up with other countries that exhibit higher governance levels (Andrianaivo & Kpodar, 2012). Additionally, research reveals that mobile banking services allow many people in SSA countries to access financial and banking services without the need for a physical bank. Bank-integrated services can be accessed through mobile devices allowing for more participation in financial services and more people able to access markets (Asongu *et al.,* 2018; Nokosi *et al.,* 2012). Mobile applications present a whole new market for entrepreneurs and marketplaces, like the Apple App Store and Google Play, which provides access to a global market through simple platforms. A typical application will require an average of three developers and three months of development time which requires minimal capital with a high potential payoff (Ghosh, 2016). With the growth of smartphones and tablets, the role of mobile applications has become a significant driver in the market through provision of specialised information and ability to interact with other stakeholders directly and in real-time (McCann & Barlow, 2015).

Broadband networks in the 21st century share some commonality with other infrastructure investments, such as transport and pipeline networks, water, and public health (Alderete, 2017). Research conducted by Audretsch *et al*., (2015) suggests that broadband infrastructure might be even more critical than highways and railroads in today's high-tech business environment. Broadband networks provide an infrastructure that supports a large variety of applications such as business processes, e-learning, and research, while also providing

essential benefits for information availability in thinly populated rural areas (Urban, 2021). Along with broadband adoption, mobile telephony has been shown to have a significant impact on economic growth as well as social transformation (Torero *et al.,* 2001; Ghosh, 2016). Mobile telephony and broadband usage have been shown to lower transaction costs and encourage manufacturing, innovation, and entrepreneurship in regions where technology is available (Ghosh, 2016). Studies have also established that the mobile phone can reduce government inefficiencies by reducing rents, bureaucracy, and transaction costs (Asongu *et al.,* 2018), as well as decreasing the time required to start a new business (Tchamyou, 2016).

The present study takes place across several SSA countries, who have recently implemented policies that promote investments to facilitate knowledge transfer and improve national efficiency and productivity (Danquah & Amankwah-Amoah, 2017). Furthermore, several SSA countries have also implemented national mobile and broadband policies to develop an ecosystem with clear targets for adoption, speed, and quality. The purpose of such polices is to create an environment for fixed and mobile broadband that can facilitate technology and lead to higher growth and innovation (Torero *et al.,* 2001; Ghosh, 2016). Based on this emerging stream of research, the high growth in mobile broadband is expected to have a positive relationship with entrepreneurial activity and consequently the first hypothesis is formulated as:

Hypothesis 1: There is a positive relationship between the rate of mobile penetration and (a) total entrepreneurial activity (TEA), and (b) new business density (NBD) in sub-Saharan African (SSA) countries.

Several studies have found that broadband plays a vital role in the modern economy (Andrianaivo & Kpodar, 2012). It has also been established that broadband coverage of a population is essential for universal access, but that the speed of broadband is crucial for business development and innovation (Asongu *et al.,* 2018). In this regard, Ghosh (2016) found that broadband can lower transactions costs and encourage countries to diversify away from primary commodities. Studies show that broadband access "*could lower costs for small businesses by 1.3 to 1.6 percent per annum, particularly for high-tech industries*" (Hagsten & Kotnik, 2017). The positive impact of broadband on the performance of businesses is supported by findings in a study by Squicciarini (2017) which suggests that broadband usage in firms is positively associated with sales to export markets.

Additional research findings suggest that broadband infrastructure supports and facilitates entrepreneurship, but also that the impact of broadband is more conducive to

entrepreneurship in innovative industries than industries lacking innovation (Audretsch *et al.,* 2015; Alderete, 2017). Ghosh (2016) reported on broadband penetration and economic growth in India, identifying that growth comes primarily from greater innovation and entrepreneurial activity. Such findings are supported by similar studies which suggest that broadband infrastructure enables the establishment of new types of business activity and provides support for entrepreneurial actions (Asongu *et al.,* 2018). Broadband can serve to reduce barriers, improve the exchange of ideas and knowledge, and potentially lead to more entrepreneurial ventures because of lower barriers to entry and increased information availability (Audretsch *et al.,* 2015). In view of the evolving research on establishing a link between broadband penetration and entrepreneurial activity, the second hypothesis for this study is formulated as:

Hypothesis 2: There is a positive relationship between the level of broadband penetration and (a) total entrepreneurial activity (TEA), and (b) new business density (NBD) in sub-Saharan African (SSA) countries.

3. RESEARCH METHODOLOGY

A quantitative research design was employed using secondary data sources published by international organisations. The secondary data was sourced from external sources, in particular global institutions that maintain and publish panel datasets annually and provide a longitudinal, accurate representation, and reliable coverage of the variables under investigation. The structure and the nature of the secondary data sources for this study included data sourced from the following institutions:

- International Telecommunication Union (ITU): An international organisation that is based in Geneva, Switzerland. ITU is a specialised agency of the United Nations that concerns itself with ICT and is considered the official source for global ICT statistics. The ITU publish several reports every year on technology trends and changes in the ICT space. All the information that is sourced for these reports are made available in the public domain and can be accessed using the ITU ICT statistics databases on the internet. This data source was used to provide all the information points that pertain to mobile and broadband penetration variables (International Telecommunication Union, 2018).
- World Bank: An international financial institution that provides funding and loans to countries around the world. The World Bank gathers and publishes several indicators, including measures on ICT and entrepreneurship. For the purposes of this study, the NBD

indicator was used where the World Bank defines this measure as "…new business registrations per 1 000 working-aged people" (those between the ages of 15 and 65 years) (World Bank, 2018:132).

- GEM: The GEM consortium gathers and publishes information on various entrepreneurial trends. The series of GEM reports include 18 years of data for entrepreneurial activity as well as a policy recommendations based on their entrepreneurial framework conditions. This study included and analysed data relating to the GEM entrepreneurial activity indicator in terms of their TEA rate, as previously conceptualised in this article (Bosma *et al.,* 2020).

The above-mentioned institutions all publish data in the public domain spanning several years, allowing access to all the raw data required for the purposes of this study. This secondary information, based on primary data collection among representative samples of adult individuals, is complimented with expert assessments on different framework conditions which are relevant factors of national and regional entrepreneurial ecosystems. The surveys administered are of a statistical nature, which implies that statistical characteristics of the country level results should be appreciated as such. The main methodological difference between the various databases used is the focus and in the building of some of the above-mentioned indicators. These institutional databases all involve larger samples that are representative of the target population, hence generating greater external validity as the various datasets often contain considerable breadth covering hundreds of variables. For instance, the GEM database examines individual attributes, which include several demographic factors (gender, age, geographic location), psychological factors (perceived capabilities, perceived opportunities, fear of failure) and motivational aspects (improvement-driven venturing, etc.) (Bosma *et al.,* 2020). Data collected for the thirteen SSA countries under observation resulted in a dataset of 98 country-year observations. The study focused on the period between 2010 and 2016 as this period contains the best data suitable for analysis in terms of the SSA countries analysed, namely Angola, Botswana, Cameroon, Ethiopia, Ghana, Madagascar, Malawi, Namibia, Nigeria, Senegal, South Africa, Uganda, and Zambia. There was a minimum of one observation for each of these countries.

This data was then converted to standard Excel formats, which were then imported into SAS Studio University Edition for statistical analysis. Data cleaning was required in both Excel and SAS, and a record of all activities and processes performed was maintained. The secondary data was initially analysed in terms of growth rate statistics of data sets and thereafter

correlational analyses followed to evaluate the study hypotheses. The TEA rate was measured using a percentage scale in line with the methodological stance adopted in the series of GEM reports (Bosma *et al.,* 2020). Measurements of mobile and broadband penetration were based on the number of individuals per 1 000 as part of the population of a country and was in line with the data series of the World Bank (World Bank, 2018) and ITU (ITU, 2018) publications where various statistical models are employed. Due to the lack of consistent data from the GEM datasets for SSA countries, the data analysis was limited to periods where the country data was available and matched with the mobile and broadband data to allow for comparable and demarcated time series data sets.

4. RESULTS

Table 1 shows the growth rate statistics of data for all the variables under investigation for the period 2010-2016. The TEA rate grew on average by 75 percent, while NBD declined by approximately 6 percent, while mobile penetration grew on average by 61 percent, and broadband penetration grew on average by 171 percent over the period.

Correlational analysis as a statistical technique was employed in measuring linear relationships between variables/datasets, which is in line with the study hypotheses. There are precedents in entrepreneurship research to check if time series datasets have a trend or not, by measuring the correlation between the variables (Bosma *et al.,* 2020). To test the hypotheses, correlational analysis was performed on data from countries which had values for TEA, and which were matched with each of the other variables, namely mobile penetration, and broadband penetration (see Table 2). The same procedure was conducted for the NBD (see Table 3).

Table 1: Growth rate statistics of data sets

	Average % change (2010-2016)	Minimum	Maximum
New business density (NBD)	0.75	4.78	41.46
Total entrepreneurial activity (TEA)	-0.06	0.01	10.22
Mobile penetration	0.61	4.22	159.16
Broadband penetration	1.71	0.00	16.84

Source: Developed by authors

Table 2: Correlational matrix for TEA and mobile and broadband penetration

	TEA	Mobile penetration	Broadband penetration
Total entrepreneurial activity (TEA)	1		
Mobile penetration	-.195	1	
Broadband penetration	-.594*	.793*	1

* Correlation is significant at the 0.05 level (2-tailed).

Source: Developed by authors

Table 3: Correlational matrix for NBD and mobile and broadband penetration

	NBD	Mobile penetration	Broadband penetration
New business density (NBD)	1		
Mobile penetration	.799*	1	
Broadband penetration	.515*	.494*	1

* Correlation is significant at the 0.05 level (2-tailed).

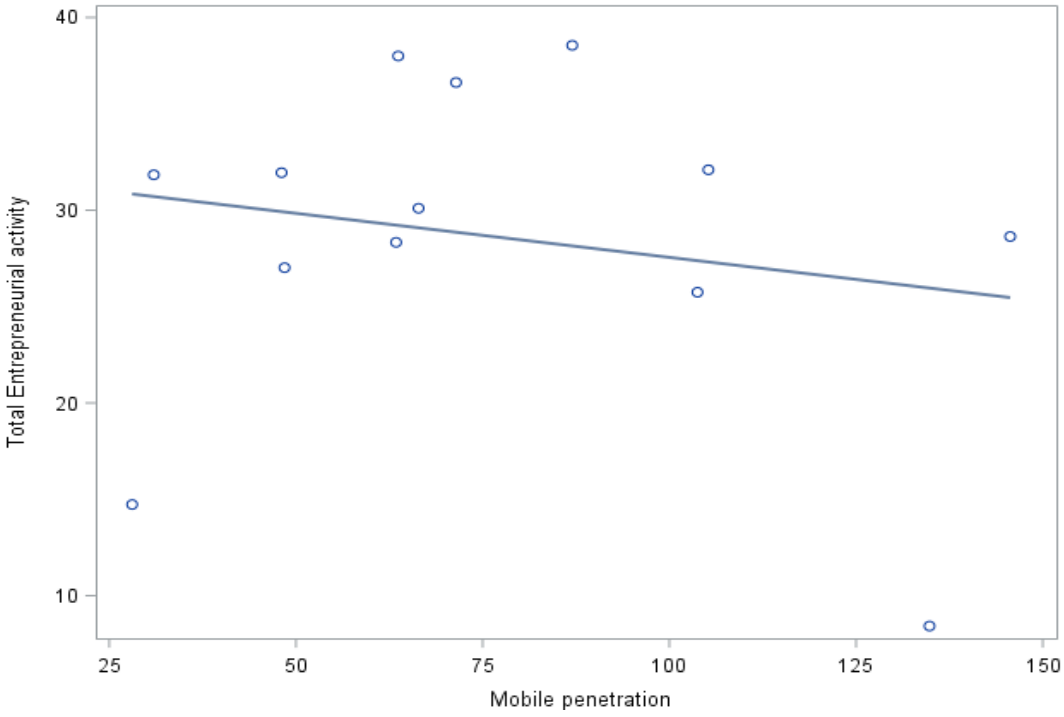
Source: Developed by authors

In terms of H1a and H2a, the correlational matrix (Table 2) shows a negative relationship between each of the independent variables and TEA. This means that TEA is negatively correlated with mobile penetration ($r = -0.195$, $p > 0.05$) and the magnitude of the correlation coefficient indicates a weak association between two variables. Similarly, Table 2 shows that TEA is negatively correlated with broadband penetration ($r = -0.594$, $p < 0.05$) and the magnitude of the correlation coefficient indicates a moderate association between the two variables, with a significance level of 0.05. Furthermore, the TEA scatterplot diagrams for mobile penetration and broadband penetration, shown in Figure 1 and Figure 2, respectively, indicate that the variables move in inverse, or opposite, directions; in other words, as one variable increases, the other variable decreases (Schindler, 2019). These results do not support H1a and H2a, both of which must be rejected.

In terms of H1b and H2b, the correlational matrix (Table 3) shows a positive relationship between each of the independent variables and NBD. This means that NBD is positively correlated with mobile penetration ($r = 0.799$, $p < 0.05$) as well as broadband penetration and NBD ($r = 0.515$, $p < 0.05$). The magnitude of the correlation coefficient indicates a strong

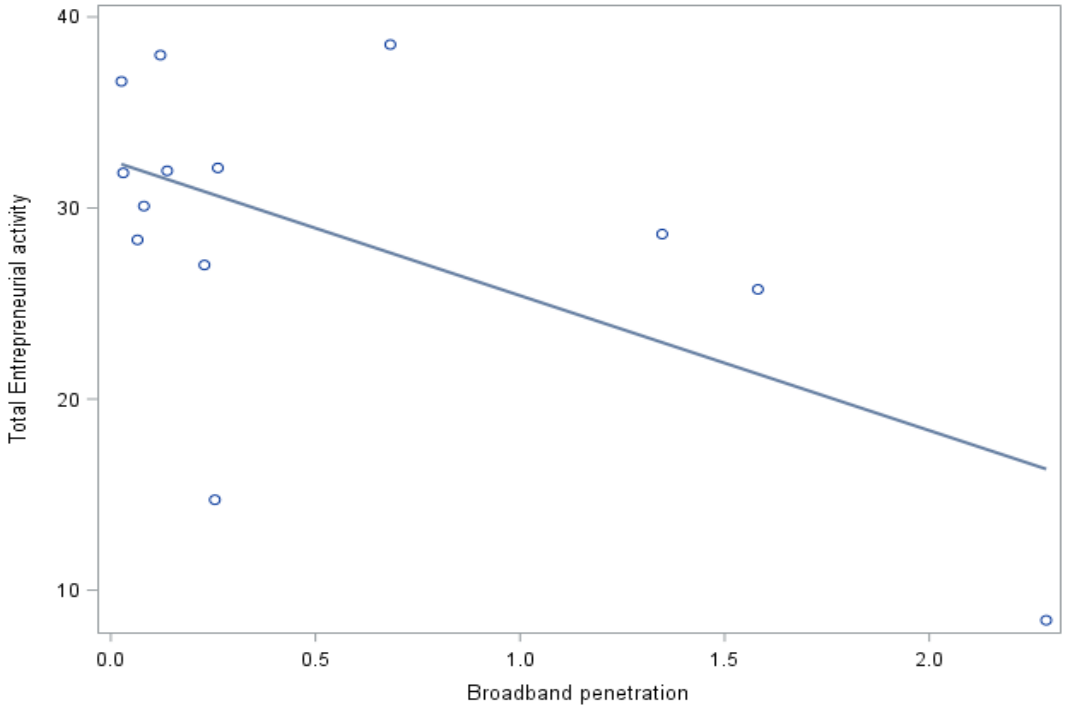
association between mobile penetration and NBD and a moderate association between broadband penetration and NBD. Furthermore, the NBD scatterplot diagrams for mobile penetration and broadband penetration, shown as per Figure 3 and Figure 4 respectively, indicate that there is a positive linear correlation when the variable on the x-axis increases as the variable on the y-axis increases, which corroborates the Pearson correlation coefficient results (Schindler, 2019). These results support H1b and H2b, both of which can then be accepted. Nonetheless it is recognised that for accurately and reliably analysing a trend, a large amount of data needs to be collected, which is both a time-consuming and costly affair (Schindler, 2019).

Figure 1: Scatter Plot of association between TEA and Mobile Penetration



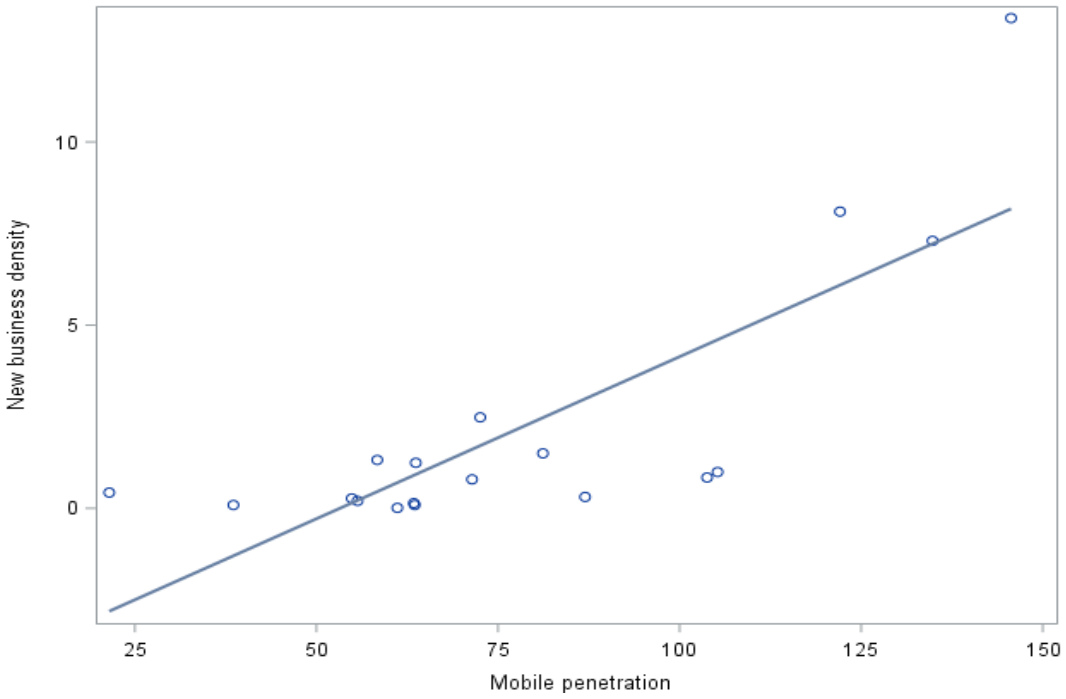
Source: Developed by authors

Figure 2: Scatter Plot of association between TEA and Broadband Penetration



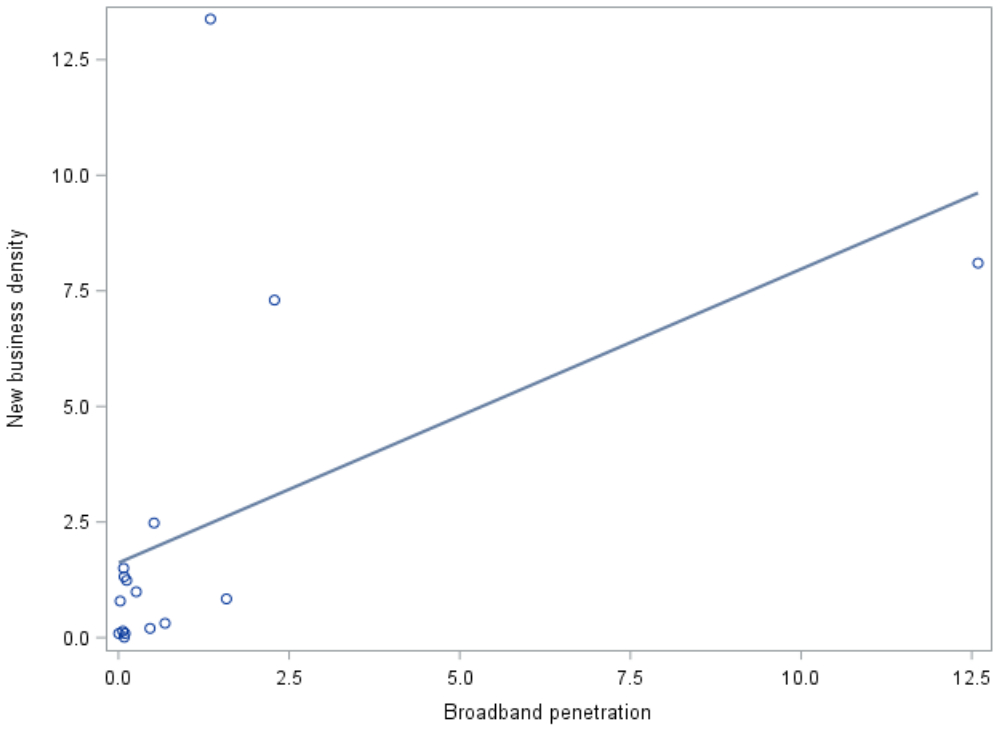
Source: Developed by authors

Figure 3: Scatter plot of association between NBD and Mobile Penetration



Source: Developed by authors

Figure 4: Scatter plot of association between NBD and Broadband Penetration



Source: Developed by authors

5. DISCUSSION AND CONCLUSION

Recognising that SSA countries are starting to implement mobile and broadband policies targeted to improve innovation and economic growth, the study focused on the relationship between mobile and broadband penetration and levels of entrepreneurial activity in these countries. Few empirical studies focus on the relationship between these ICT variables and entrepreneurship in the African context, which is surprising considering that the development of entrepreneurship is important in SSA countries and is contingent upon sound policies to support such entrepreneurial activity.

In terms of the study hypotheses, a positive relationship between the rate of (H1) mobile penetration, and (H2) broadband penetration and (a) rate of total entrepreneurial activity (TEA), and (b) new business density (NBD) in SSA countries were expected. The empirical evidence originating from this study supports H1b and H2b, in terms of a positive and significant relationship detected between mobile penetration, broadband penetration and NBD. These positive findings are in line with similar research that also reports a positive relationship between mobile usage and entrepreneurship in general (Alderete, 2017). The

rationale for this positive relationship is that ICT in general is a driving force of entrepreneurship and innovation and makes the identification of opportunities easier through the development and dissemination of ideas and information (Urban, 2021). Not only has ICT been identified as one of the most critical capabilities, along with education, training, and research and development, required to build an enabling environment for entrepreneurship to flourish, but ICT also enhances opportunity recognition among entrepreneurs leading to greater business success (Shabbir *et al.,* 2017). Moreover, ICT improves the conditions for entrepreneurship to take place by providing access to external knowledge and financial resources, creating legitimacy and trust, enabling longer-term planning, and enhancing entrepreneurial networks (Batyashe & Iyamu, 2020).

Mobile technology offers many opportunities for entrepreneurs to start and grow their businesses. Through the effective adoption of technology, the potential in SSA countries can be unlocked (Amankwah-Amoaha *et al.,* 2018). Mobile phones can enhance entrepreneurial performance and business opportunities through growing networks and opening opportunities across geographical and socio-economic barriers. Prior studies confirm the importance of the right quality of mobile technology necessary to further economic growth and allow countries in SSA to join the knowledge economy through entrepreneurial activities (Audretsch *et al.,* 2015).

Contrary to the study hypotheses for H1a and H2a, TEA was negatively correlated with mobile penetration as well as with broadband penetration. While some prior studies report a positive relationship between ICT and entrepreneurship in general (Alderete, 2017), the current study did not find a positive relationship in terms of the data set analysed. Although there is some evidence that ICT improves the conditions for entrepreneurship to increase in different countries, the focus of most studies on entrepreneurship in Africa have homed in on other topics such as legal challenges to doing business, costs of business start-ups, issues of motivation, and aspects related to poverty reduction (Asongu *et al.,* 2016). Consequently, little research and data are available on the specific influence of mobile and broadband penetration on any entrepreneurial activity in SSA countries. Several factors could explain why a negative relationship between mobile penetration and broadband penetration, and TEA was obtained in the present study. For instance, the bandwidth of the internet connectivity in Africa is weak, and this significantly affects the activities of different businesses. Another plausible explanation for a negative relationship between broadband penetration and entrepreneurship, in general, is that factors such as the quality and speed of broadband penetration, as well as

broadband coverage and pricing may all influence the rate of entrepreneurship either positively or negatively. With the relative newness of mobile broadband in SSA, the services available might be too costly or the coverage of the networks not broad enough to have a significant positive impact on entrepreneurial activity. However, the effect of these factors on the relationship was outside the scope of this study and as such, no definitive cause for the negative relationship could be identified.

Moreover, the available data from the series of GEM reports which cover SSA are significantly less comprehensive than coverage for other regions in the world. For instance, out of the forty-five countries that make up the SSA countries, TEA rates are only available for thirteen of those countries; less than one-third of the countries in the region (Herrington & Kelly, 2013). Whereas countries such as South Africa have data spanning all seven years of the GEM studies, countries such as Botswana and Senegal only have one or two data points. This difference in available data from individual countries such as Botswana could also cause countries with more complete data sets, such as South Africa, to skew the findings in favour of conditions in these countries and may explain the present study's findings.

5.1 Managerial and policy implications

In recent history, few technological advances have had the impact which ICT has had on society and economic development. As such, ICT today is a dominant factor in policy discussions and debates across different regions (Ghosh, 2016). Researchers and policymakers realise that, as with other forms of infrastructure, broadband and mobile networks have a substantial impact on the entrepreneurial ecosystem and are essential factors in establishing new ventures (Urban, 2021). Consequently, many governments in African countries are promoting policies and investments that aim to improve the facilitation of technology transfer and adoption of ICT to grow economies through entrepreneurial activity (Danquah & Amankwah-Amoah, 2017). Leaders and managers need to invest in infrastructure in terms of ICT, which could reduce the cost of operations, distribution, and marketing for existing entrepreneurs and encourage potential entrepreneurs to engage in start-ups (Herrington & Kelly, 2013).

In terms of policy implications, it is recommended that SSA countries strive to develop their potential as knowledge economies and invest in human capital to create a highly skilled labour force and provide infrastructure for high-technology industries through scientific and technological collaborations with developed and other African countries (Tchamyou, 2017). Considering the low levels of research and development in many countries in SSA, it is

essential that policies are implemented that promote technology transfer which can be adopted and applied to enhance the ability of these countries to absorb knowledge and adapt to innovative technologies (Danquah & Amankwah-Amoah, 2017). Many governments believe that SMEs can contribute towards the promotion of more equitable economic development, while enhancing the competitiveness of local players within a global economy. Governments should aim to use policy to chart technological trajectories that will sustain innovation and drive Africa towards the knowledge economy. Policies should take into account the high potential that mobile phones and broadband penetration offer for economic growth, entrepreneurship, and stable development (Asongu *et al.,* 2018). Recognising these potential positive ICT spin-offs, policy should support the development and enhancement of existing ICT networks and the expansion of those networks both in terms of coverage and quality. Specific emphasis should be put on using technology to solve problems in Africa relating to broader access, pricing, and education in using mobile technologies and broadband to address unemployment and liberalise infrastructure and ICT frameworks.

A strong body of evidence must support the effectiveness of policy in supporting SME growth. However, merely having policies in place is not effective, but ensuring that the right policy is in place is essential (Wright *et al.,* 2015). In this regard, scholars note that without context-specific benchmarks, policymakers are unlikely to be accurate in their assessment of the support mechanisms required by SMEs (Nokosi *et al.,* 2012). Consequently, policies must support entrepreneurs to adopt modern technologies that are more effective than those of competitors to ensure their sustainability. It is recommended that technology education focus specifically on mobile and broadband usage and optimisation to assist in growing the knowledge economy in SSA countries. Through carefully crafted policy interventions, governments can make mobile technology available to all young adults who can access these services, acquire skills, and build networks that promote entrepreneurial ventures and sustainable development. Future research is required to understand the impact of data costs, broadband bandwidth, and quality of mobile networks on entrepreneurial activity and their contribution to local entrepreneurial ecosystems in SSA countries.

Although many studies have investigated the economic and social impact of ICT in Africa, such as inequality, the role of ICT in the knowledge economy, and economic growth (Asongu *et al.,* 2018), very few studies have systematically examined the relationship between mobile and broadband penetration and entrepreneurial activity within the context of SSA countries. Consequently, the present study provides an important contribution in understanding the

relationship between crucial ICT factors and entrepreneurial activity in an under-researched SSA context, thereby advancing knowledge in this emerging stream of research.

5.2 Limitations and future research

The study is not without limitations, where for instance the available data on the SSA region from the series of GEM reports are less complete than coverage for other regions in the world. TEA rates were only available for thirteen SSA countries, which constitutes less than one-third of the countries in the region (Herrington & Kelly, 2013). Additionally, in terms of measurement related issues there was an absence of analysis of variables that were not available in the various datasets used, but which could influence entrepreneurial activity rates. Another limitation was that although SSA countries may share some similarities, they also have distinguishing characteristics, and future research could examine the idiosyncrasies of each country in this region. Also, no claims of any causal relationships between variables/datasets can be inferred using correlational analysis. Consequently, more fine-grained analyses of country differences are called for, and it is suggested that scholars and policymakers recognise the critical importance of the formal and informal institutional environments to further explain the complex and dynamic attributes of specific SSA country contexts

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