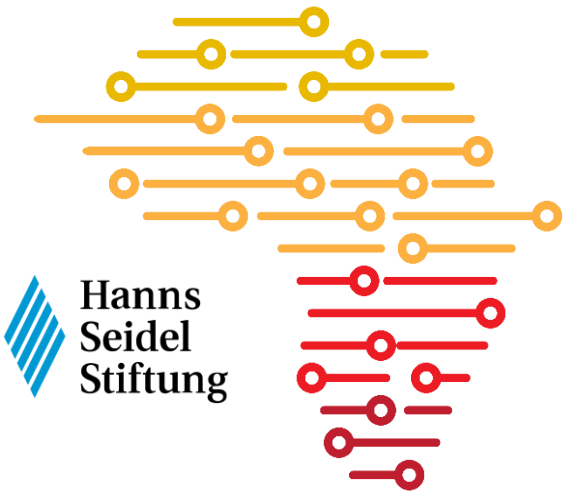
Tayarisha Working Paper Series | No:

2023/009

African Governance in the Digital Age



Entrepreneurship, digitalisation and productivity: Evidence from sub-Saharan African region

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September 2023

WITS SCHOOL OF GOVERNANCE
UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

TAYA RISHA
African Centre of Excellence in Digital Governance

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Abstract

Economic growth in Sub-Saharan Africa has been slow and the region has been struggling to address the mounting challenges, ranging from unemployment to poverty. While research, especially from advanced economies, suggests that entrepreneurship is regarded as a major driver of productivity growth, it is still unclear whether and how entrepreneurship promotes productivity in Sub-Saharan Africa. This paper fills the gap by examining the interconnected impact of entrepreneurship and digital infrastructure on productivity, using panel data from Sub-Saharan African countries. The econometric estimates reveal that digital infrastructure has moderating effects on the entrepreneurship—productivity nexus. Thus, these results imply that entrepreneurship does not promote productivity, except through the enabling effect of digital infrastructure. The study provides policy implications for governments and policymakers in the Sub-Saharan African countries.

Keywords: entrepreneurship, digital infrastructure, productivity, sub-Saharan Africa, developing countries.

Introduction

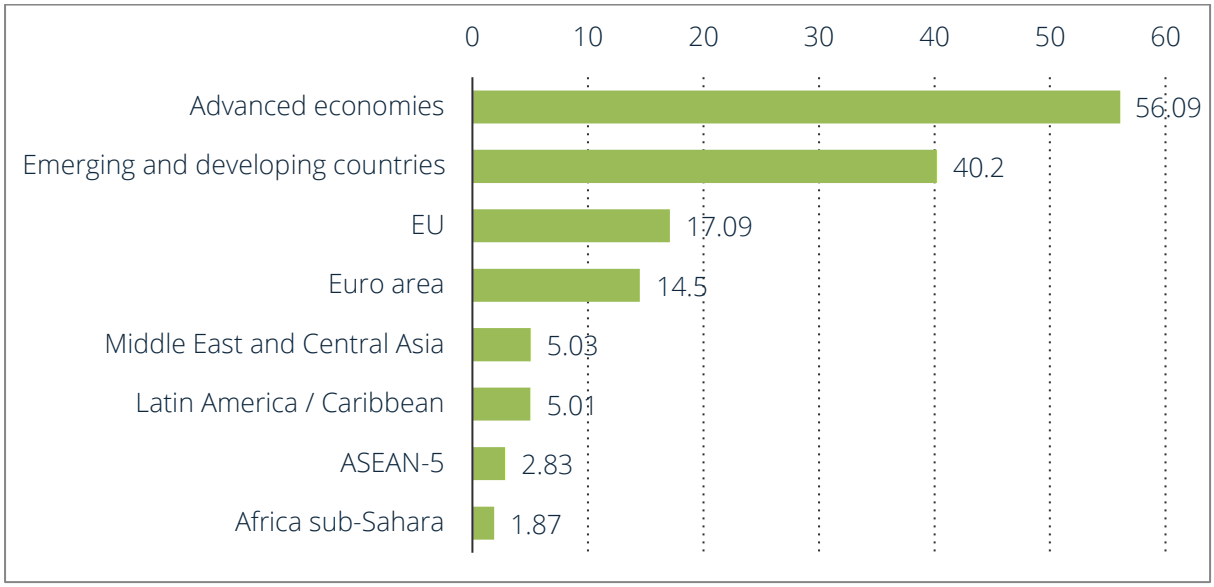
The literature highlights the important role of entrepreneurship in productivity (Ajide, 2022; Colino et al., 2014; Du and O'Connor, 2018; Urbano and Aparicio, 2016). This is consistent with the Schumpeterian theory that identified entrepreneurship as a key driver of economic growth (Ebner, 2006; Schumpeter, 1934). A robust body of empirical evidence, especially from developed economies, supports a positive link between entrepreneurship and productivity growth, at both national and regional levels (for example, Ghazy et al., 2022; Valliere and Peterson, 2009; Wong et al., 2005). However, despite their contributions, research on the entrepreneurship—productivity nexus in developing countries, in particular, the Sub-Saharan African (SSA) region, is still sparse. The weak institutions that characterise SSA countries, especially infrastructural quality, underline the need for conducting more studies in this region. Thus, this study fills this gap by focusing on the impact of new business venture creation on productivity.

Generally, productivity refers to the relationship between input resources and the output of goods and services (Tangen, 2005). Productivity growth is undoubtedly an important element of economic prosperity and, as such, is a key indicator for measuring a country's standards of living and quality of life. Moss (1979: 276) argues that 'efficient production of goods and services is a primary goal of economic effort, and statistical measurement of productivity is an important tool for monitoring and promoting its advances'. Productive countries can transform their inputs into economic values in the long run (Amato et al., 2022; Bisztray et al., 2022).

However, productivity growth differs significantly both over time and across countries. Prior studies reveal a ubiquitous, large and persistent productivity gap between high-income countries and low-income countries (Maddison, 1983). Factors such as infrastructure, informality, business regulations and human capital have been identified as some of the main drivers of the differences in productivity growth (Bloom et al., 2010; McCullough, 2017). The productivity gap is more pronounced in SSA countries as the region's rate remains low compared to the rest of the world. According to the World Economic Outlook Database published by the International Monetary Fund, the SSA region lags behind both other

developing countries and advanced economies in terms of gross domestic product (GDP) as shown in Figure 1.

Figure 1. GDP of selected global regions 2021 (in trillion US dollars)



Source: IMF, 2021

The aggregate GDP per capita of SSA countries amounted to 1.87 trillion US dollars, while those of Latin America/ Caribbean are 5.01 trillion US dollars and Middle East and Central Asia are 5.03 trillion US dollars. Research suggests that boosting productivity in SSA countries can help the region address development challenges linked to inadequate access to basic services, inequality, unemployment, poverty, etc. (Ivanic and Martin, 2018; Konte et al., 2022).

While there is no single path *per se*, evidence shows that entrepreneurship is an essential input factor for achieving productivity growth (Bajona and Locay, 2009; Neumann, 2022). For example, through entrepreneurship, SSA countries can leverage a low-cost base to create high-value goods and services (Du and O'Connor, 2018). In addition, employment opportunities created by new enterprises can increase national economic well-being (Dong et al., 2021; Reynolds et al., 2004). This claim is supported by Schmitz (1989) and Baumol (2014) who argue that entrepreneurship stimulates and creates economic growth, especially in challenging times.

However, the rapid advance in digital technologies is transforming the business environment and economies across the globe; this has deep implications for entrepreneurship (Elia et al., 2020; Song, 2019). Digital technologies are providing numerous opportunities for entrepreneurs, spurring innovation, generating efficiencies and enhancing economic prospects (Bukht and Heeks, 2017; Dahlman et al., 2016). Zahra et al. (2022) suggest that digitalisation promotes the creation of new businesses and processes that keep the entrepreneurial ecosystem vibrant.

Despite these developments, there is still little knowledge of how digitalisation affects entrepreneurship in SSA countries. Addressing this research gap is pertinent because of the differences in digital adoption across regions and countries. These differences are largely dependent on country-level factors, especially the quality of infrastructure. Research shows that infrastructure is the main engine of economic growth (Esfahani and Ramírez, 2003). In this regard, a country's quality of digital infrastructure significantly shapes entrepreneurial activity (Bennett, 2019; Lan et al., 2018). For example, using digital platforms or tools for entrepreneurial activities depends on the availability and quality of broadband infrastructure and related technologies (Hasbi, 2020). In a recent study, Luo et al. (2022) found that broadband infrastructure plays an important role in promoting entrepreneurship. In other words, entrepreneurs operating in a country with a well-developed digital infrastructure can better leverage digitalisation for their activities and, consequently, achieve superior performance. Conversely, a digital infrastructure deficit can negatively affect digital adoption rate and entrepreneurship.

Thus, given the specificity of the SSA region, it is still unclear whether digital infrastructure hinders or supports entrepreneurship. As a result, this study responds to the following question: *Does digital infrastructure enhance the effectiveness of entrepreneurship in promoting productivity growth in the SSA region?* This question is especially important as it can help governments and other stakeholders understand how the interplay of entrepreneurship and digitalisation enhances productivity growth. To answer this question, this study analyses nine countries from the SSA region, namely Benin, Cote d'Ivoire, Eswatini, Kenya, Lesotho, Nigeria, Senegal, Tanzania and Zimbabwe. The countries are classified by World Bank as lower-middle-income countries based on the gross national income (GNI) per

capita in the current USD. The countries provide an interesting context for this study due to the emerging entrepreneurial development trends in these countries. For example, based on the World Bank data, the number of new enterprises registered in Benin increased from 906 in 2013 to 4 034 in 2020; in Eswatini from 1 946 to 2 961; in Nigeria from 74 391 to 97 988; in Senegal from 2 116 to 4 284 and in Zimbabwe from 9 782 to 20 273. These contexts allow us to study how and whether entrepreneurial activities promote productivity growth.

The remainder of this paper is organised as follows: The next section presents the literature review and research questions. This is followed by the data and estimation methodology used in this study. The fourth section offers the empirical results of the regression analyses and discussions. The final section contains the conclusions and policy implications.

Literature review

Entrepreneurship and productivity

Entrepreneurship has attracted considerable attention from scholars and policymakers due to its link to economic growth (Doran, McCarthy, and O'Connor, 2016; Galindo and Méndez, 2014; Gu and Wang, 2022; Schmitz, 1989). However, entrepreneurship is a complex phenomenon. It has been defined in various ways, ranging from Cantillon's 'Undertaker', Jean-Baptiste Say's 'Resource Organizer' to Knight's 'Manager of Production'. For Schumpeter (1942: 132), the 'function of entrepreneurs is to reform or revolutionize the pattern of production by exploiting an invention or, more generally, an untried technological possibility for producing a new commodity or producing an old one in a new way, by opening up a new source of supply of materials or a new outlet for products, by reorganizing an industry and so on'. Schumpeter's view focuses on the 'creative destructive' role of young and entrepreneurial firms in the implementation of innovations (Pellegrino et al., 2012). In this model, economic growth is driven by the demand for innovative goods and services, and profit-seeking entrepreneurial firms lead this process by substituting old technologies with new ones (Acemoglu, 2009; Batabyal and Yoo, 2018).

This study adopts Dau and Cuervo-Cazurra's notion (2014: 670) of formal entrepreneurship, namely 'the creation of new businesses that are legally registered in a given country'. This is a stable collection of individuals who coordinate their efforts to generate new value-added

economic activity in a formal sector under a legal form of business' (Klapper et al., 2007: 131). Entrepreneurship is at the heart of economic well-being and a critical factor of country-level competitiveness. Scholars suggest that entrepreneurship increases the market scale and promotes productivity (Aparicio et al., 2016; Audretsch and Thurik, 2003; Fotopoulos, 2012).

More so, productivity is important because it not only reveals how a country efficiently transforms its input into output, but also indicates how microeconomic entities leverage available resources to create economic values (Aparicio et al., 2016; Fosu, 2013). Audretsch and Keilbach (2005) suggest that entrepreneurship capital, namely 'the capacity of a society to generate entrepreneurial activity', improves productivity and regional output. Wong et al., (2005) find that total entrepreneurial activity, that is, high growth potential new firms, has a positive and significant effect on new job creation and economic growth. Braunerhjelm and Borgman (2004) reveal that entrepreneurship significantly contributes to labour productivity. Using data from 26 Organization for Economic Cooperation and Development (OECD) countries from 1965 to 2010, Colino et al., (2014) find that there is a positive relationship between entrepreneurship and total factor productivity. Based on the Chinese regional-level data, Dai and Zheng (2018) examine the effect of entrepreneurship on productivity. These authors find that entrepreneurship positively affects total factor productivity. Similarly, Jiang et al. (2013) find that entrepreneurship drives productivity more in the eastern region of China and less in the central and western regions.

The relationship between entrepreneurship and productivity is not always straightforward, as shown by inconclusive evidence (Baumol, 1990; Poschke, 2013). For example, using data from 44 countries, Valliere and Peterson (2009) reveal that entrepreneurship has, on the one hand, a positive impact on productivity in developed economies, but an insignificant impact in emerging economies, on the other hand. These results are similar to a prior study conducted by Stel et al., (2005). They find that entrepreneurial activity has a negative impact on the national economic growth of relatively poor countries and a positive impact on wealthy countries.

Furthermore, other studies suggest that the relationship between entrepreneurship and productivity growth is nonlinear in nature. For example, based on the data from 12 OECD

countries (Organisation for Economic Cooperation and Development),Acs et al. (1994) find a U-shaped relationship between entrepreneurship and economic growth. Likewise, Wennekers et al. (2002) show that the relationship between entrepreneurship and economic growth is U-shaped. The results from Wang (2020), based on data collected from the Survey of Industrial Firms in China reveal that a significant U-shaped relationship exists between entrepreneurship and productivity.

Due to this mixed evidence and the institution-specific context in SSA countries, this study deems it important to examine whether entrepreneurship contributes to productivity, measured as the number of new enterprises registered in a given country. An empirical study in the context of the SSA region will shed light on the claim that the impact of entrepreneurship on productivity is context-based (Fritsch, 2008; Stel et al., 2005). In addition, understanding the entrepreneurship—productivity nexus can help governments and decision-makers in the SSA region design policies that alleviate challenges linked to unemployment, poverty, etc. and, consequently, promote their catch-up agenda and economic well-being. Thus, the first research question of this study is:

RQ1: Does entrepreneurship promote productivity among the SSA countries?

Entrepreneurship and productivity: Does digital infrastructure matter?

The global economy is experiencing the fourth industrial revolution (El Khoury et al, 2023). Digital technologies are permeating how individuals conduct their everyday activities as well as transforming various aspects of social and economic realities at national levels (Adeola et al., 2022). Digital technologies have been identified as 'general-purpose technologies' because of their ability to self-transform, branch out and improve productivity across all sectors and industries (David and Wright, 2006). As these technologies create new forms of opportunity, wealth and knowledge, they raise crucial implications for entrepreneurial activity (Ratten, 2022; Sedera et al. 2022). For example, digitalisation is an essential factor for successful entrepreneurship (Zahra et al., 2018). Studies show that entrepreneurial firms adopting and leveraging digital technologies can enhance resource acquisition, processes and outcomes (Giones and Brem, 2017; Van Veldhoven and Vanthienen, 2021). By adopting digital technologies and tools, entrepreneurs can exploit a wide range of growth opportunities,

develop new products and services, and expand their customer base beyond the classical physical reach (Zahra, et al., 2022; Zahra and Nambisan, 2012). Furthermore, digital platforms are creating new forms of marketplace for knowledge and innovations for entrepreneurship (Adeola et al. 2022; Dushnitsky and Klueter, 2011). Entrepreneurial opportunities are becoming greater in today's digitalised global economy. As a result, digitalisation is becoming a strategic imperative for any entrepreneurial firm that wants to survive and achieve economic growth in a highly dynamic marketplace (Strange and Zucchella, 2017). However, this trend has far-reaching implications for entrepreneurship in SSA due to the differences in the availability of digital resources as well as digital adoption.

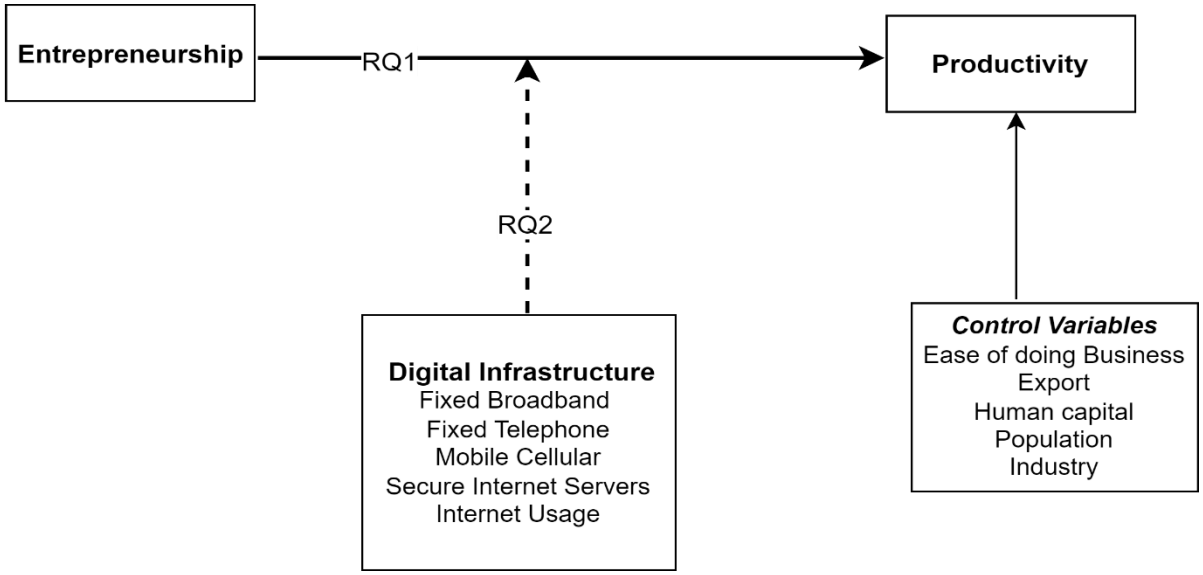
The ability to use digital technologies and digital platforms for entrepreneurial activities depends, to a great extent, on the quality of a country's digital infrastructure (Bharadwaj et al., 2013). Governments across the SSA region are increasingly acknowledging the pivotal role of digitalisation in driving entrepreneurship and economic growth. Therefore, it is not surprising that these governments are investing in digital infrastructure. For example, the Digital Economy for Africa initiative (DE4A), supported by the African Union's Digital Transformation Strategy, has the main objective of ensuring that all individuals, businesses and governments in Africa have digital access by 2030.

Research shows that enhancing the quality of digital infrastructure facilitates the digitalisation of entrepreneurial activities which in turn, contributes to economic growth (Hasbi, 2020). Audretsch et al. (2015) find that broadband infrastructure is more conducive to enhancing entrepreneurial activities than infrastructure such as highways and railroads. Alderete (2017), based on panel data from 58 countries, finds that digital infrastructure, measured in terms of mobile broadband, has a positive impact on entrepreneurship. Ghazy et al. (2022) suggest that digitalisation supports entrepreneurship and productivity in 27 European Union member countries. Using panel data from 45 SSA countries from 1996 to 2017, Ndubuisi et al. (2021) find that digital infrastructure contributes positively to regional growth in terms of job creation. Despite these contributions, there is little understanding of how digital infrastructure interacts with entrepreneurship to promote productivity growth in the SSA region. To fill this research gap, this study argues that the relationship between

entrepreneurship and productivity depends on the availability of relevant digital infrastructure. Therefore, the second question of this study is:

RQ2: Does digital infrastructure enhance the effectiveness of entrepreneurship in promoting productivity in SSA countries?

Figure 1: Conceptual framework



Data and methodology

Data source

The data used for this paper are drawn from two sources. First, the World Development Indicators (WDI) published by the World Bank, which provides information for entrepreneurship and a set of control variables. Second, the Penn World Table (PWT) 10.0, which provides data for productivity. The sample includes nine African countries and covers the period 2010–2020. These data sources have been widely used by previous studies on entrepreneurship, digitalisation and economic growth (for example, Haini and Pang, 2022; Okunade et al., 2022; Pradhan et al., 2018).

Variables

The dependent variable *Productivity* is measured as the output-based real gross domestic product (GDP) at chained Purchasing Power Parity (2017 US$) divided by the number of

persons engaged (in millions). The data for productivity are sourced from the PWT. Following other studies, the explanatory variable is *Entrepreneurship*, measured as new business density, that is, the number of new enterprises registered in the calendar year per 1000 people aged 15 – 64 (Ghazy et al., 2022). Furthermore, the moderating variable is *Digital Infrastructure*. Based on prior empirical research (for example, Ndubuisi et al., 2021), digital infrastructure is captured through the following variables: (1) Fixed broadband subscriptions (per 100 people), (2) Fixed telephone subscriptions (per 100 people); (3) Mobile cellular subscriptions (per 100 people); (4) Secure Internet servers (per 1 million people) and Internet usage (individuals using the Internet, % of the population).

This study includes a set of control variables. First, the *Ease of Doing Business*, which captures different aspects of business regulation across dimensions ranging from ease of starting a business, ease of enforcing contracts, and ease of getting credit to ease of resolving insolvencies. Second, *ICT Export* is measured as the Information and Communication Technology (ICT) goods exports (% of total goods exported). Third, *Human Capital* is measured as the government expenditure on education, total (% of GDP). Fourth, *Urbanisation* is measured as the urban population (% of the total population). Finally, *Industry* is measured as the annual growth rate for industrial value added, based on constant local currency. The data for these variables are from the database of WDI.

Model construction and econometric estimation approach

The objective of this study was to examine the impact of entrepreneurship on productivity and the interaction with digital infrastructure. The analysis was conducted at the country-level, across 9 SSA countries. Productivity *(PROD)* is specified as the function of entrepreneurial activities *(ENTR),* Digital infrastructure indicators *(DIGIs)* and a set of control variables *(X).* Thus, Equation (1) is specified as follows:

$$PROD=f(ENTR, DIGIs, X) \quad (1)$$

To examine the direct impact of entrepreneurship on productivity, Equation (1) is transformed into a linear equation by taking the natural logarithm on both sides of the equation. Thus, Equation (2) is stated as follows:

$$\mathrm{InPROD_{it}} = \alpha_0 + \beta_1 \mathrm{lnENTR_{it}} + \beta_2 \mathrm{lnDIGIs_{it}} + \emptyset_1 \mathrm{X_{it}} + \varepsilon_{it} \quad (2)$$

Furthermore, to investigate the moderating role of digital infrastructure on the entrepreneurship-productivity nexus, Equation (2) is extended to include the interaction term of digital infrastructure variables and entrepreneurship (*DIGIs* × *ENTR*). Thus, Equation (3) is stated as follows:

$$\mathrm{InPROD_{it}} = \alpha_0 + \beta_1 \mathrm{lnENTR_{it}} + \beta_2 \mathrm{lnDIGIs_{it}} + \beta_3 (\mathrm{lnDIGIs} \times \mathrm{lnENTR})_{it} + \emptyset_f \mathrm{X_{it}} + \varepsilon_{it} \quad (3)$$

Where i = 1,…., 9; t = 2010 – 2020; α_0 is a constant parameter; $\emptyset_f$ is the coefficient of the control variables and ε_{it} represents the stochastic error term.

Model estimation strategy

Even though techniques such as Ordinary Least Squares (OLS) or fixed-effect and random-effect methods are useful estimators, they may produce biased and inefficient outcomes. As a result, this study adopted the Instrumental Variable (IV) approach as the main estimation technique because it produces robust results. In addition, it is fitting for this study as it handles endogeneity issues that may arise from reverse causality between the dependent variable (productivity) and independent variable (entrepreneurship). Also, the IV approach can address biases linked to measurement errors (Arellano and Bond, 1991; Leszczensky and Wolbring, 2022). However, when using the IV approach to address endogeneity issues, it might be challenging to identify instruments that satisfy these conditions: (1) Instrument relevance ($\mathrm{Corr}\ (\mathrm{Z_i}, \mathrm{X_i}) \neq 0$) and (2) Instrument exogeneity ($\mathrm{Corr}\ (\mathrm{Z_i}, \mathrm{u_i}) = 0$) (Baum et al., 2012; Stock et al., 2002). To overcome this problem, this study uses the Lewbel (2012) two-stage least squares (2SLS) approach – the heteroscedasticity in the errors of mismeasured regressor or endogenous explanatory variables to construct instruments for those variables.

Empirical results and discussion

Table 1 and Table 2 present the descriptive statistics and correlation coefficients of variables.

Table 1: Descriptive statistics

	Mean	S. D	Min	Max
Productivity	11987.89	8594.166	4658.455	37021.86
Entrepreneurship	1.204336	1.106438	0	4.359444
Fixed Broadband	.5119324	.4473701	.0085386	1.901101
Fixed Telephone	1.451606	1.308749	.0519216	7.07301
Mobile Cellular	16.40964	1.475846	13.49503	19.13475
Secure Internet Servers	27.44565	50.94885	.1087045	248.1646
Internet Usage	18.94199	10.86875	2.7	43
Ease of Doing Business	55.15402	5.708898	47.79435	73.21648
ICT Export	17.17659	2.137361	10.01486	20.44317
Human Capital	18.70127	5.648466	5.131437	30.01515
Urbanisation	3.337283	1.289399	.8072086	5.360365
Industry	4.21897	7.642149	-11.9793	48.44432

Table 2: Matrix of correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) Productivity	1.000											
(2) Entrepreneurship	0.334	1.000										
(3) Fixed Broadband	-0.371	-0.112	1.000									
(4) Fixed Telephone	0.156	0.294	0.372	1.000								
(5) Mobile Cellular	0.043	-0.639	-0.020	-0.553	1.000							
(6) Secure Internet Servers	0.140	0.132	-0.198	-0.427	0.413	1.000						
(7) Internet Usage	0.327	0.437	-0.270	-0.003	-0.204	0.129	1.000					
(8) Ease of Doing Business	0.136	0.418	-0.109	-0.259	-0.126	0.406	0.339	1.000				
(9) ICT Export	0.007	-0.220	-0.096	-0.280	0.517	0.556	-0.044	0.502	1.000			
(10) Human Capital	-0.374	-0.173	0.737	0.538	-0.314	-0.500	-0.349	-0.153	-0.123	1.000		
(11) Urbanisation	-0.015	-0.684	-0.217	-0.644	0.643	0.201	-0.308	0.073	0.437	-0.262	1.000	
(12) Industry	-0.086	-0.394	0.425	0.190	0.091	-0.187	-0.183	0.024	0.133	0.440	0.259	1.000

Table 3 presents the results from the Lewbel 2SLS regression. The models were estimated in a hierarchical stepwise manner where productivity is, first, regressed on the control variables – Ease of Doing Business, ICT Export, Human Capital, Urbanisation, and Industry – as shown in Model 1. Model 2 includes entrepreneurship, while Models 3 to 7 include the interaction terms of digital infrastructure variables and entrepreneurship. Model 2 reveals that the coefficient for entrepreneurship is positive but insignificant (coef. 0.4625; $p < 0.143$). These results indicate that the creation of new enterprises does not contribute to the productivity of the countries under study. A possible explanation for these results may be due to the high rate of survival challenges faced by newly created ventures, which can lead to low productiveness and a high failure rate (Boeri and Cramer, 1992; Fritsch and Weyh, 2006; Valliere and Peterson, 2009). Research suggests that new ventures in developing countries are likely to experience more severe challenges linked to poor management and lack of finance, as well as insufficient human capital resources (Anosike, 2018; Edeh and Acedo, 2022; Wellalage and Fernandez, 2019). Moreover, even the business ventures that succeed in establishing themselves in the market are likely to face fierce competition from informal firms, a phenomenon that is prevalent in developing countries, such as SSA countries (Bu and Cuervo-Cazurra, 2020; Piperopoulos et al*.,* 2021). Taken together, these factors can negatively affect the effectiveness of entrepreneurship in promoting productivity in developing countries.

Table 3: Lewbel 2SLS results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Ease of Doing Business	.0167	.0027	.0524***	.0204	-.0113	.0389*	-.0014
	(.0132)	(.0167)	(.0126)	(.0124)	(.0136)	(.0203)	(.0112)
ICT Export	-.4895**	-.2024	-.5169***	-.0457	.0393	-.6326***	-.1961
	(.1961)	(.1475)	(.1261)	(.1422)	(.1352)	(.1441)	(.1663)
Human Capital	-.5071**	-.4269*	-.1522	-.851***	-.4973**	-.8119**	-.3534
	(.1944)	(.1905)	(.1571)	(.2234)	(.1716)	(.2424)	(.1968)
Urbanisation	-.2652*	.3231**	-1.1742**	.6274***	.4848***	-.2153	.5222*
	(.1367)	(.1042)	(.4711)	(.0661)	(.0725)	(.2636)	(.2712)
Industry	.0279**	.0283**	.0521***	.0095	.0137*	.0275**	.0202**
	(.009)	(.0085)	(.0123)	(.0078)	(.0071)	(.0083)	(.0062)
Entrepreneurship (ENTR)		.4625	-.2738**	.4038***	-1.9782*	-.8211	-1.0153
		(.1384)	(.0968)	(.0872)	(.9273)	(.4836)	(.8687)
Fixed Broadband (FB)			-.1337				
			(.1002)				
ENTR*FB			.5813**				
			(.2151)				
Fixed Telephone (FT)				.2403***			
				(.0551)			
ENTR*FT				.1627***			
				(.0416)			
Mobile Cellular (MC)					1.1711***		
					(.1909)		

ENTR*MC					.5537**		
					(.2178)		
Secure Internet Servers (SI)						-.1288**	
						(.0428)	
ENTR*SI						.2737***	
						(.0882)	
Internet Usage (IU)							.4915**
							(.2051)
ENTR*IU							.4308
							(.3112)
Constant	12.6731***	11.2393***	10.2188***	10.4507***	5.3985**	13.4016***	9.4321***
	(1.4004)	(1.3753)	(1.5945)	(.8218)	(1.6194)	(1.2119)	(1.3077)
R-squared	.3791	.4581	.5849	.5785	.5354	.6001	.4455

Heteroscedasticity robust standard errors in parentheses.

*** p<.01, ** p<.05, * p<.1*

Table 3 presents the results of the interaction terms between entrepreneurship and digital infrastructure variables. Model 3 shows a positive and significant coefficient (coef. 0.5813; p <0.014), indicating that fixed broadband positively moderates the impact of entrepreneurship on productivity. These findings are consistent with other studies that highlight the importance of fixed broadband access in promoting productivity (Jung and López-Bazo, 2020; Zhang et al., 2022). The results in Model 4 reveal that fixed telephone subscriptions positively moderate the relationship between entrepreneurship and productivity (coef. 0.1627; p <0.001). Likewise, Model 5 shows that mobile cellular subscriptions positively moderate the effect of entrepreneurship on productivity (coef. 0.5537; p <0.043). More so, Model 6 reveals a positive and significant coefficient (coef. 0.2737; p <0.001). These results demonstrate that secure internet servers moderate the impact of entrepreneurship on productivity in SSA. Finally, Model 7 shows a positive and insignificant coefficient (coef. 0.4308; p <0.164). Thus, except for internet usage, the results of the analysis generally validate the claim that digital infrastructure enhances the contribution of entrepreneurship to productivity. In other words, the findings are in line with other studies emphasising the vital role of digital infrastructure in promoting entrepreneurship and, in turn, productivity (Gomes and Lopes, 2022; Yunis et al., 2018; Zhang and Li, 2018).

Conclusions and policy implications

Entrepreneurship plays an important role in the economic growth of nations across the globe (Faggio and Silva, 2014). Thus, it is not surprising that considerable efforts, especially from high-income countries, have been directed at enhancing our understanding of the entrepreneurship—productivity nexus (Galindo and Méndez, 2014). Despite their contributions, it is still largely unclear under which conditions entrepreneurship promotes productivity (Fritsch, 2008), especially in the SSA region. Therefore, this study fills this knowledge gap by exploring the impact of entrepreneurship on productivity and its interaction with digital infrastructure using panel data from nine lower-middle-income countries from the SSA region. The findings reveal that entrepreneurship alone does not promote productivity in these countries, except through the impact of digital infrastructure.

As entrepreneurship has been identified as a crucial factor of productivity, the main policy implication of this research is that governments and policymakers in SSA countries should put more effort into promoting the creation, survival and success of new business ventures. To this end, the following specific guidelines should receive proper attention:

1) Favourable business environments, institutional arrangement and market structure are key to stimulating productivity. According to Fritsch (2008:2), 'New firms represent an entry of new capacities into the market and are, therefore, an essential element of the market process'. This highlights the importance of strong institutions in promoting entrepreneurship and economic growth (Crouch, 2005; North, 1990; Rodríguez-Pose and Zhang, 2020). The presence of persistent weak institutions that characterise most of the SSA countries is imposing additional costs and constraints on entrepreneurial growth (Alhassan and Kilishi, 2019; Moulick et al., 2019). Improving the business environment and regulations will lower the administrative costs faced by new business ventures, discourage informality as well as promote open and competitive markets in SSA countries. This study expects that the design and implementation of such policies will improve the business environment and, in turn, stimulate economic growth through entrepreneurship.

2) The importance of digitalisation in stimulating entrepreneurship and economic growth is receiving sustained attention from both scholars and policymakers (Fossen and Sorgner, 2021; Kraus et al., 2019; Nambisan, 2017). According to World Economic Forum (2014), digital infrastructure is the driver of digitalisation, new business creation and productivity. This claim is validated by prior empirical studies establishing that the successful digitalisation of entrepreneurial activities, to a large extent, depends on digital infrastructure (Schade and Schuhmacher, 2022; Audretsch et al., 2015). Thus, as the results of this study show that the entrepreneurship—productivity nexus depends on digital infrastructure, governments and other stakeholders should invest effectively in developing, upgrading and expanding the digital infrastructures, as well as providing digital resources, that will facilitate the rapid digital transformation of entrepreneurial activities across the SSA region.

This study has some limitations, however. First, it focused on lower-middle-income countries from the SSA region. As a result, the findings of this study cannot be fully generalised. More empirical studies are required to validate the impact of entrepreneurship and digital infrastructure on productivity in low-income and upper-middle-income African countries. Second, the relationship between entrepreneurship and productivity may be bidirectional. More studies are needed to explore how productivity influences the entrepreneurial processes and performance in developing economies.

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