Overcoming the Underdevelopment Challenge in Africa Through Digital Technological Progress and Entrepreneurship Development

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Abstract

This current study investigates the impact of digital technology and entrepreneurship development on economic development in SSA as applicable in the COVID-19 pandemic era. Based on regression models with Drisco-Kraay standard errors and the causal mediation analysis, we noted that both entrepreneurship development and digital technological advancements have the ability to enhance human development in Sub-Sahara Africa. The moderation outcomes show that the interaction between entrepreneurship development and digital technological advancement is positive, indicating that the economic development enhancing effect of entrepreneurship development in Sub-Sahara Africa is stronger in African countries with higher levels of digital technological application.. In light of this, 30% of the national budget should be allocated to funding education, with the remaining 70% going to other purposes. In order to prevent excessive reliance on foreign technologies and increased inflation, we also advocate for directed openness policies. Thus, Africans should foster a desire for domestically made goods by enhancing their quality and longevity. In this sense, the market share of African products on the African market ought to be higher than 7:3 on 1. Which we have now.

Key Words: Under Development Challenge, Entrepreneurship Development, Technological Progress, ICT, Inflation, Human Capital, Education and Training.

Resume

Cette étude examine l'impact du développement de l'entrepreneuriat et des technologies numériques sur le développement économique en Afrique Sub-saharienne à l'aune de la pandémie de la Covid-19 en utilisant les erreurs standards de Drisco-Kraay et l'analyse de médiation causale. Les résultats des recherches menées montrent que le développement de l'entrepreneuriat et les progrès des technologies numériques améliorent le développement humain en Afrique du Sud du Sahara. L'interaction entre le

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développement de l'entrepreneuriat et les progrès des technologies numériques est positive. Ce qui indique que le développement économique impliquant l'amélioration de l'entrepreneuriat est plus fort dans les pays africains qui ont un niveau élevé des progrès des technologies numériques. La relation entre le développement de l'entrepreneuriat et du capital humain, le taux d'inflation, l'ouverture financière et commerciale à l'échelle mondiale sont significatifs, ce qui implique l'effet positif du développement de l'entrepreneuriat en Afrique. L'effet négatif de l'inflation sur le développement humain est atténué par le développement de l'entrepreneuriat. Modérer l'effet des technologies numériques avec le vecteur de contrôle des variables suggère que les progrès des technologies numériques ne sont pas assez consistant pour pouvoir inhiber l'effet négatif de l'inflation sur le développement humain. De l'analyse de la médiation causale, le recours aux technologies de l'information et de la communication réduit indirectement le développement économique du continent à travers une nouvelle densité d'affaires. Comme recommandations, nous proposons que des efforts soient axés sur l'enseignement technique professionnel et commercial pour la création d'emplois. Par ailleurs, nous conseillons l'allocation d'au moins 30 % du budget de l'Etat au financement de l'éducation, et, afin d'éviter une dépendance excessive aux technologies étrangères, des politiques dirigées sont indispensables. Les Africains devraient développer le désir de consommer les produits locaux en améliorant leur qualité et leur longévité afin d'accroitre la part de marché des produits locaux sur le marché Africain.

1. Introduction

Economic development remains a fundamental objective of all nations. Fostering development through entrepreneurship development and technological progress, especially Information and Communication Technologies (ICT) is crutial. For instance, the Sustainable Development Goals see entrepreneurship development and technological progress as pivotal in fostering economic development. It can equally be noted from the traditional neoclassical view of ICT that it can increase growth and development through capital deepening (van Ark *et al.,* 2008). Conversely, the non-traditional view has it that ICT spurs innovation by facilitating business-to-business transactions, production spillovers and network externalities (Cardona *et al.*, 2013; Paunov and Rollo, 2016; Stiroh, 2002). Therefore, the non-traditional neoclassical view claims that higher levels of ICT investments are associated with higher levels of entrepreneurship development through new business creation and hence higher levels of development. This is supported by statistics from the World Bank Entrepreneurship database, 2020 which indicates that the highest levels of entrepreneurship were observed in ICT advanced economies such as Hong Kong, China, Estonia and New Zealand. The year 2018 witnessed about 151,739 new limited liability companies registered in Hong Kong and China. This represents an average of 28.6 new limited liability companies per 1,000 adults. This is the highest new business entry density rate in the world, followed by Estonia with about 23.6 new limited liability companies per 1,000 adults, and New Zealand with about 17.8 new limited liability companies per 1,000 adults.

It is recognised across the globe that entrepreneurship is not only a source of national development but sustainable development. This is why there is a recent wave in the literature investigating the role of entrepreneurship in national development (Acs, 2006; Carree and Thurik, 2010; Lopes *et al.* 2018a). In this light, entrepreneurship is seen to have contributed to growth and development (Urbano and Aparicio 2016; Acs *et al.* 2012; Audretsch & Keilbach 2004). Recent studies such as Stoica *et al.* (2020) and Stam & Van Stel (2011) have noted that

findings of studies vary with regard to the impact entrepreneurship on economic growth and development due to differences in the types of entrepreneurships and the characteristics of the macroeconomic environment. These recent studies are induced by the fact that there are improvements in the level of entrepreneurship development across the globe. For instance, in Sub-Saharan Africa, the number of new limited liability companies registered per year jumped in Rwanda from 252 in 2006 to 10,635 in 2018, and from 875 to 3,725 over the same period in Lesotho. Countries that joined the European Union such as Malta, saw the biggest absolute increase in entry density rate between 2006 and 2018, with entry density rate rising from 3.9 new LLCs per 1,000 adults to 17.5 new LLCs per 1,000 adults.

As concerns digital technological advancement, studies have shown that ICTs have a positive relationship with economic growth and development across the globe (Jorgenson and Vu, 2016; Niebel, 2018; Romer, 1990). This wave of studies on the role of ICT on development particularly in Africa is due to the economic liberalisation policies of the 1980s which coincided with the start of ICT investments and internet infrastructure, resulting in the widespread diffusion of ICT products and services to the African continent (Babb and Kentikelenis, 2018; van Klyton et al., 2019; Chavula, 2013; Evans, 2019; Ojong, 2016). For instance, statistics reveal that 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 was accompanied by an increase in broadband internet penetration rates from zero to 19 million between 2000 and 2010 (Ojong, 2016). Given these statistics, it is therefore well-documented that digitalisation creates economic growth and development (Bukht and Heeks, 2017; Kabongo & Okpara, 2014; Lacity *et al.,* 2016; Liu & Aron, 2014; Tong & Wohlmuth, 2019; Zhao *et al.,* 2015; Bukht & Heeks, 2017).

Despite the efforts to improve on the level of entrepreneurship development across the globe, entrepreneurial activity rates remain unstable with some countries experiencing drops in the rate of entry of new businesses, with entrepreneurship ecosystem remaining largely unstable (Díez-Martín *et al.* 2016; Acs *et al.* 2018; Lopes & Franco 2019; Cavallo *et al.* 2019; Sitaridis & Kitsios 2020; Steigertahl & Mauer 2021). Statistics from the World bank entrepreneurship database reveals that the number of new firms dropped by more than half in Zimbabwe in ten years-from 39,266 new firms in 2008 to 16,810 in 2018. Maliszewska *et al.* (2020) noted that the decline in the entrepreneurial activity rates will lead to a decline in human development indicators such as life expectancy, especially as the COVID-19 pandemic has greatly deteriorated human development indicators.

It is evident that digital technology has never been understood better than during the 2020 global economic shutdown as a result of the COVID-19 pandemic when governments authorized social distancing measures to slow the spread of the virus, catalysing the use of digital technology for the virtual delivery of school classes and for remote working (De' *et al.,* 2020; Brynjolfson *et al.,* 2020; Prasad *et al.,* 2020; Willcocks, 2020). Despite these investment efforts in ICT, African countries have hesitated in securing the expected economic development associated with digitalisation (Banga & Velde, 2018; Melia, 2020; Yoon, 2020; Arawole 2016; UNIGF, 2017; Bührer and Hagist, 2017; Rifkin, 2015; UNCTAD, 2017; Valenduc; Vendramin, 2017). This is corroborated by the fact that despite the theoretical and empirical claim that ICTs boost entrepreneurial growth, the average business entry density in Africa still remains low. For instance, low-income countries

had an average entry density of 0.7, whereas middle and high income nations had average entry densities of 2.5 and 7.2, respectively.

Evidently, it appears all efforts in terms of policies put in place by African governments towards African growth and development via enhancing ICT usage, human development and stabilization of the economies, external supplus gains, institutional reglations among others have come and gone, yet, African development remains infinitesimal. It is on this note that this study is designed to answer the following questions. What are the effects of digital technological advancement on human development in Sub-Sahara Africa? What is the role of entrepreneurship development on human development in Sub-Sahara Africa? And to what extent does digital technological advancement improve on the effect of entrepreneurship development on human development in Sub-Sahara Africa?

2. Literature Review

2.1 Theoretical Review

Numerous scientific arguments point to the fact that entrepreneurship growth is important in a nation's overall development drive (Stevenson & Jarillo 1990, Schumpeter, 1934, and Drucker, 1985). According to these scholars, innovation entails the introduction of new goods of new quality, the discovery of new production methods, the opening of new markets, the location of new sources of supply, the implementation of new industry organization, the development or dissolution of monopoly powers and the removal of structural rigidities in an economy. The Solow (1956) growth model that incorporates technology change was empirically advanced by Barro (1991), Barro and Sala-i-Martin (1991, 1992), and Mankiw *et al.* (1992), who recognized technical advancement as one of the key drivers of economic growth.

However, in the Solow growth model, technological progress is seen to be exogenous, which gives rise to another strand of the literature known as the new growth theory. This theory endogenizes technological change as determined by human capital (Lucas 1988), the search for new ideas by researchers interested in making profit (Romer 1990), innovations or improvement in the quality of existing products (Grossman and Helpman, 1991; Aghion and Howitt, 1992), and infrastructures (Aschauer 1989). Of interest in this study is the introduction of telecommunication infrastructure into the growth model. Jorgenson and Stiroh (1995, 1999) and Oliner and Sichel (1994, 2000) are among the first to incorporate information technology into the growth model. In particular, Oliner and Sichel (1994) developed a growth model based on the neoclassical framework as cited by Prescott (1988) wherein they separated computer equipment from the other types of physical capital.

2.2 Empirical Review

Literature on technological progress such as those of Oliner and Sichel (2000) on the contribution of information technology on labour productivity growth in the second half of 1990s shows that communication equipment contributed about 0.1 percentage points annually to output growth. Related studies to those of Oliner and Sichel (2000) have been done in other developed countries, such as the United Kingdom (Correa, 2006), Japan (Jorgenson and Motohashi, 2005), Spain (Martínez *et al.,* 2008), and Singapore (Vu, 2013).

For developing countries, a study by Chakraborty and Nandi (2009) examined the growth impact of telecommunication infrastructure investment

using 30 developing countries in Asia, Europe, and Latin America. Using mainline tele-density as proxy for telecommunication infrastructure and panel cointegration approach with Granger causality, they confirmed that countries that are relatively less developed within the group show stronger bidirectional causality between mainline tele-density and per capita growth than countries that are relatively more developed (emerging economies). Sridhar and Sridhar (2007) found that mainline and mobile phones have significant growth effects for developing countries, but these effects are smaller compared to those of the developed countries.Bon (2007) analyzed the relationship between internet use in tertiary education and development and noted that poor internet connectivity hampers the transition to the global economy.

There are also a handful of studies on entrepreneurship in Africa which support the fact that entrepreneurial activities is an important pillar for African development (Black & Castaldo 2009, Kayanula & Quartey 2000, and Herrington & Kelley, 2013). But at the same time, some researchers recognize that entrepreneurship development in Africa is still facing some challenges which ranges from instability, structural rigidity, institutional difficulties among others. This is why Herrington and Kelley (2013) asserted that most entrepreneurial activities are developed in the agricultural and mining sectors and the lack of a developed industry negatively influences the economic development of Africa. Also, Kauffman (2005) argued that inadequate financial resources constraints the emergence and future development of Small and Medium Size Enterprises in Africa. Alby, Auriol and Nguimkeu (2013) asserted that some social norms such as social networks have a negative influence on the development of Africa. Goudon and Kafando (2011) concluded that African sub-Sahara region need a suitable strategy of industrialization to ensure its economic development.

Nevertheless, Africa has the needed strength that could favour the development of entrepreneurial activities. April (2009) proposes that the diverse culture could be an advantage for creativity and innovation for young people in Namibia while De Klerk and Havenga (2004) observed that the building of institutional frameworks for entrepreneurship could contribute to growth and sustainable development in Africa.

Despite the established link between digital technology uage and productivity in several studies (Baquero Forero, 2013; Castellacci, 2011; Evangelista et al., 2014), there is a deficit of knowledge about this relationship for African countries, particularly regarding the impact of the usage of digital technology on economic development, employment, and trade (Myovella et al., 2020). In fact, Wamboye *et al.* (2015) called for more research to be conducted on these relationships in an African context due to the rapid growth in ICT and the use of cellular technology in the expansion of digital financial transactions. Evangelista *et al.* (2014) and Counted and Arawole (2016) suggested that ICT usage rather than access is what matters for growth without distinguishing between the impacts of individual, business, and government ICT usage in a comparative context.

3. Analytical Methodology

This study makes use of panel data collected from the World Bank's Entrepreneurship Database, World Bank Development Indicators, World Governance Indicators, Database (WDI, 2021) spanning from 2010 to 2020 for 38 Sub Saharan African countries including Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Central African Republic, Comoros, Congo Rep., Equatorial Guinea, Eritrea, Eswatini, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius,

Mozambique, Namibia, Niger, Nigeria, Rwanda,Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, South Africa, South Sudan, Sudan, Tanzania, Togo, Uganda, and Zimbabwe on the basis of availability of data. Given that we have 38 countries, we therefore have 418 panel data space which are sufficient for the realisation of findings for realistic outcomes. These countries were selected based on availability of the ICT data and new business creation data. The selected 38 countries out of 56 legitimate African countries have all the characteristics of African countries, as such, the findings of this study can be generalised in terms of policy implementation. The model specified in this paper follows a variant of the AK model of Frankel (1962) where there are two types of capital: physical and human capital modified to incorporate certain important variables that have the ability to overcome the underdevelopment challenge in Africa. Noting that the two types of capital are produced with the same technology, the level of development in Sub Saharan African countries is specified as a general functional relationship as follows;

$$Q_{ti} = F(K_{ti}, H_{ti}) = F(K_{ti}, h_{ti}L_{ti}) \dots\dots\dots\dots (3.1)$$

Where, F is a neoclassical production function, K_{ti} is the aggregate capital in period t, h_{ti} is human capital per worker, and $H_{ti} = h_{ti}L_{ti}$ is the effective labour. Following the Cobb-Douglas specification, this general functional relationship is stated as follows;

$$Q_{ti} = A_{ti}L_{ti}^{\alpha}K_{ti}^{\beta}h_{ti}^{\gamma} \dots\dots\dots\dots\dots\dots\dots (3.2)$$

Where: A is the level of technology, L is labour input, K is capital input, α, β and γ are elasticities of production with respect to labour, capital and human capital respectively. Human Development Index (HDI) is the total output (Q). Following the neoclassical view that ICT increases economic development through capital deepening (i.e., investment in ICT) due to falling prices of ICTs, and that ICT spurs innovation by facilitating business-to-business transactions, production spillovers and network externalities (van Ark et al., 2008; Cardona et al., 2013; Paunov and Rollo, 2016; Stiroh, 2002), investments in ICT is the capital input(K) and the human capital input (h). For a new firm to be created, several factors such as labour are key. Therefore, entrepreneurship development measured in terms of new business density is the labour input (L). We include some control variables such as trade openess, financial openess, the inflation rate and control of corruption. This can therefore be specified in the functional relationship that follows;

$$HDI_{ti} = A_{ti}(ICT_{ti}^{\alpha}, NBD_{ti}^{\beta}, \chi_{ti}^{\gamma}) \dots\dots\dots\dots\dots (3.3)$$

Linearizing this functional display and taking care of the error term (μ), the technical link is quantitatively stated in the model as follows:

$$InHDI_{ti} = InA_{ti} + \alpha InICT_{ti} + \beta InNBD_{ti} + \gamma In\chi_{ti} + \mu_{ti} \dots (3.4)$$

Let $InA_{ti} = \partial$ then;

$$InHDI_{ti} = \partial + \alpha InICT_{ti} + \beta InNBD_{ti} + \gamma In\chi_{ti} + \mu_{ti} \dots\dots (3.5)$$

In the above equation, ∂, α, β, and Υ are the parameters or coefficients to be estimated. The a priori theoretical expectations of this technical link are such that: $\partial \neq 0$,α>0, β>0, and Υ>0.

For moderation, we specifically include interaction terms in the regression to capture the feedback effects of the endogenous variables among themselves. As such, we have:

$$InHDI_{ti} = \partial + \alpha InICT_{ti} + \beta InNBD_{ti} + \delta(ICT_{it} * Z) + \gamma In\chi_{ti} + \mu_{ti} \dots (3.6)$$

Where Z is the interaction variable which is a measure of macroeconomic conditions in SSA. When Z is NBD for example, then the interaction term enables us to assess whether ICT usage has a stronger effect on economic development in countries with high levels of entreprenurship development than it does in countries with lower levels of entreprenurship development.

To estimate this model, we opt for Driscoll and Kraay's covariance matrix estimator which corrects for heteroskedasticity and autocorrelation. Driscoll and Kraay (1998) showed that this consistency result holds even for

the limiting case where N (countries) $\rightarrow \infty$. Furthermore, estimating the covariance matrix with this approach yields standard errors that are robust to general forms of cross-sectional and temporal dependence.

In this study, we verified whether entrepreneurship development and some of our control variables have a mediating effect on the development of SSA economies using the causal mediation analysis (Baron and Kenny, 1986; Zhao et al., 2010; Noubissi & Asongu, 2022). Mediation analysis is established by estimating the following model:

$$In\kappa j_{ti} = \gamma_0 + \alpha' InICT_{ti} + \mu_{ti} .. (3.7)$$

Where κj is the jth channel, α is the effect of ICT usage on the transmission channel. We estimate Equation (3.7) to determine the impact of ICT usage on each transmission channel. If is statistically significant, then we proceed to calculate the indirect effects of ICT usage on development. By replacing Equation (3.7) in Equation (3.5), we obtain:

$$InHDI_{ti} = \partial + \gamma_0\gamma + (\alpha + \alpha'\gamma)InICT_{ti} + \mu_{ti} \ldots\ldots (3.8)$$

α is the direct effect of ICT usage on economic development; $\alpha'\gamma$ is the indirect effect of ICT usage on economic development; and $(\alpha + \alpha'\gamma)$ is the total effect of ICT usage on economic development. In this study, we estimate these effects using the structural equation modelling approach.

4. Findings and Discussions

Digital technological progress spurs business transactions and hence new business creation which enhances development (Paunov and Rollo, 2016). The findings from the summary statistics indicate that on average, human development in Africa stood at 0.469, less than 50%, suggesting that the level of development in Africa in terms of human development is below average. At the same time, the per capita income in Africa on average is 2869.329 while the life expectancy at birth in years in 56.607 years, compared to those of advanced countries standing above 99 years.

Table 4.1: Summary Descriptive Statistics of Variables used in the Study

VARIABLES	Obs	Mean	Std. Dev.	Min	Max
Human Development Index (HDI)	418	.468788	.1103656	.229	.797
GDP per capita (current US$) [GDPPC]	418	1853.125	2869.329	102.598	22942.61
Life expectancy at birth, total (years) [Life Exp]	418	56.60691	7.349731	31.037	74.51463
New business density (new registrations per 1,000 people ages 15-64) (NBD]	418	2.082727	3.434282	0	20.09059
Individuals using the Internet, total (%) [ICT USE]	418	17.98395	16.31873	.6	79
Human capital Development [HCD]	418	7.448651	7.344044	.32069	44.39153
Control of Corruption [CC]	418	-.5768168	.6846502	-1.905176	1.230001
Inflation, consumer prices (annual %) [INFLA]	418	18.20291	154.1734	-9.616154	4145.106
Trade openness [TOPEN]	418	.6434947	.4020968	0	3.113541
Financial openness [FIN_OPEN]	418	.0475151	.1187259	-.3131656	1.793369

Source: Computed by Author(s) Using Stata 14.0, 2022

The value of entrepreneurship development measured in terms of new business density in this paper is 2.0827%, representing the percentage of newly registered businesses per thousand people aged 15 years to 64 years. At the same time, the average rate of ICT usage in Africa is 17.984%. This confirms the claim that the rate of entrepreneurship development in less developed countries is lower than that in technologically advanced economies (Babb and Kentikelenis,

2018; Van Klyton *et al.,* 2019). The control variables such as human capital development as measured in terms of tertiary school enrolment rate, the inflation rate, trade openness, global financial openness, and control of corruption present weak average values.

Table 4.2: Measuring the role of Entrepreneurship Development and Digital Technological Progress on Economic Development in Sub-Sahara Africa

	(Pool OLS)	(Fixed Effect)	(Random Effect)	(Driscoll-Kraay)
VARIABLES	HDI	HDI	HDI	HDI
New Business Density	0.00234***	0.00456***	0.00424***	0.00234***
	(0.000655)	(0.000596)	(0.000598)	(0.000225)
ICT Use	0.00266***	0.000979***	0.00101***	0.00266***
	(0.000249)	(6.47e-05)	(6.78e-05)	(0.000858)
Human capital development	0.00367***	0.00169***	0.00181***	0.00367***
	(0.000493)	(0.000238)	(0.000247)	(0.00111)
Control of Corruption	0.0403***	0.0104**	0.0174***	0.0403***
	(0.00575)	(0.00493)	(0.00491)	(0.0113)
Inflation rate	-0.000132	0.000121***	0.000133***	-0.000132*
	(0.000141)	(3.98e-05)	(4.16e-05)	(7.02e-05)
Trade openness	0.000391	2.89e-05	6.07e-05	0.000391*
	(0.000449)	(0.000122)	(0.000127)	(0.000210)
Financial openness	-0.00936	-0.00622	-0.00658	-0.00936
	(0.0215)	(0.00581)	(0.00610)	(0.0230)
Constant	0.453***	0.480***	0.483***	0.453***
	(0.00850)	(0.00447)	(0.0108)	(0.0141)
Observations	418	418	418	418
F Statistics	F(7, 410)= 99.23	F(7,373)= 58.00	Wald chi2(7) =	F(7, 37) = 5665.8
	Prob > F =0.0000	Prob > F =0.0000	408.11, p 0.000	Prob > F =0.0000
R-squared	0.629	0.521		0.629
Number of groups		38	38	38
Hausman Test Statistics = 114.11				
Prob>chi2 = 0.0000				
Breusch-Pagan LM test of independence: chi2(703) = 2855.371, Pr = 0.0000				
Modified Wald test for groupwise heteroskedasticity				
in fixed effect regression model				
chi2 (38) = 4104.32				
Prob>chi2 = 0.0000				
Pesaran's test of cross sectional independence = 29.834, Pr = 0.0000				
Average absolute value of the off-diagonal elements = 0.545				

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Computed by Author(s) Using Stata 14.0, 2022

We note from the tests reported on bottom table 4.2 that the Hausman Test Statistics is significant at the 1% level. This invalidates the reliability of the random effect model in favor of the fixed effect model results for inferences. Further tests such as the Breusch-Pagan LM test of independence and the Modified Wald test for groupwise heteroscedasticity with significant tests statistics at the 1% levels invalidates the fixed effects model for inferences. Again, we note from the Pesaran (2015) cross sectional dependence test that the CD test strongly rejects the null hypothesis of no cross-sectional dependence in our regression model. Chudik *et al.,* (2013) explained that the presence of the problem of cross sectional dependence is due to the interaction among the countries and other unobserved factors. Failure to address the problem of cross sectional dependence (CD) produces biased and inconsistent parameter

estimates. We therefore estimates reliable parameter estimates based on the Drisco-Kraay standard errors estimators that have the ability to eliminate such problems in econometric analysis.

The Drisco-Kraay regression coefficients suggests that both entrepreneurship development in terms of new business creation and digital technological advancements in terms of ICT usage have the ability to enhance human development in Sub-Sahara Africa. Both coefficients are statistically significant at the 1% level. The results are consistent with the literature that supports the fact that entrepreneurial activities are important pillars for Africa's economic development (Black & Castaldo 2009, Kayanula & Quartey 2000, and Herrington & Kelley, 2013). Again, the use of ICT influences African development positively. This is in line with Myovella *et al.,* (2020) and Arawole (2016) who have suggested that ICT usage rather than access is what matters for economic growth and development.

The coefficient of human capital development, control of corruption and trade openness are seen to have a positive and significant effect on human development in Africa while the inflation rate and global financial openness are seen to negatively impact economic development in Sub-Sahara Africa. The coefficients of human capital development and control of corruption are significant at 1% while the coefficient of the inflation rate and trade openness are significant are the 10%. This in line with the Donou-Adonsou *et al.,* (2016) and Ekpo and Chuku (2017) who concluded that human capital index and real sector openness variables are positively related to GDPpc growth and development in Africa. This result is 99% reliable for a policy. With an adjusted R square of 62.9%, variations in human development in Africa is due to joint variations in entrepreneurship development, digital technological progress and other control variables as specified in the model.

Table 4.3: Robustness Test of the Effects of Entrepreneurship Development and Digital Technological Progress on Economic Development in Sub-Sahara Africa

VARIABLES	(2) HDI	(3) Per Head Income	(4) LIFE EXP
New Business Density	0.00234***	21.60**	0.0334*
	(0.000225)	(9.516)	(0.0187)
ICT Use	0.00266***	75.55**	0.118***
	(0.000858)	(33.33)	(0.0295)
Human capital development	0.00367***	99.34***	0.0460***
	(0.00111)	(29.48)	(0.0165)
Control of Corruption	0.0403***	246.6	2.619***
	(0.0113)	(363.3)	(0.170)
Inflation rate	-0.000132*	-12.39**	0.00668*
	(7.02e-05)	(5.360)	(0.00348)
Trade openness	0.000391*	-21.55**	0.0709*
	(0.000210)	(8.194)	(0.0381)
Financial openness	-0.00936	284.7	0.904
	(0.0230)	(421.0)	(0.539)
Constant	0.453***	289.7	60.10***
	(0.0141)	(559.6)	(0.966)
Observations	418	418	418
R-squared	0.629	0.305	0.354
Number of groups	38	38	38

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Source: Computed by Author(s) Using Stata 14.0, 2022

We tested for the robustness of the results by altering our measure of economic development, using human development index, per head income growth rate and total life expectancy at birth. The results show that the coefficients of entrepreneurship development, digital technological progress and human capital development remains positive and significant on the different variables of economic development. This justifies the consistency of the results with theoretical expectations. The coefficient of the inflation rate shows that countries with higher levels of macroeconomic instability reduces the potentials of the growth of per head income and also human development. These results are supported by the work of Black & Castaldo (2009), Kayanula & Quartey (2000), Herrington & Kelley (2013), Myovella *et al.,* (2020), Arawole (2016) Ekpo and Chuku (2017).

Table 4.4: Moderating the Effect of Entrepreneurship Development on Economic Development in Sub-Sahara Africa

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	HDI	HDI	HDI	HDI	HDI	HDI	HDI	HDI
NBD	0.00213***	0.00234***	0.00161	-0.00346*	0.000484	-0.00101	-0.00142*	-0.00762***
	(0.000285)	(0.000225)	(0.00227)	(0.00205)	(0.000885)	(0.00140)	(0.000706)	(0.000574)
ICT(A)	0.00329***	0.00266***	0.00322***	0.00334***	0.00324***	0.00330***	0.00328***	0.00264***
	(0.000962)	(0.000858)	(0.000834)	(0.000972)	(0.000961)	(0.000947)	(0.000972)	(0.000857)
HCD(B)	0.00446***	0.00367***	0.00450***	0.00371**	0.00451***	0.00442***	0.00438***	0.00310***
	(0.00142)	(0.00111)	(0.00133)	(0.00163)	(0.00144)	(0.00143)	(0.00142)	(0.00108)
INFLA(C)		-0.000132*			-0.000732***			
		(7.02e-05)			(0.000232)			
TOPEN (D)		0.000391*				-0.00170***		
		(0.000210)				(0.000470)		
FINOPE(E)		-0.00936					-0.0167	
		(0.0230)					(0.0231)	
CC(F)		0.0403***						0.0600***
		(0.0113)						(0.0108)
NBD*A			5.23e-05					
			(0.000210)					
NBD*B				0.000689***				
				(0.000238)				
NBD*C					0.000804***			
					(0.000260)			
NBD*D						0.00318**		
						(0.00142)		
NBD*E							0.0192***	
							(0.00201)	
NBD*F								-0.0102***
								(0.000789)
Constant	0.409***	0.453***	0.410***	0.415***	0.413***	0.412***	0.415***	0.476***
	(0.00537)	(0.0141)	(0.00691)	(0.00650)	(0.00574)	(0.00507)	(0.00511)	(0.0126)
Observations	418	418	418	418	418	418	418	418
R-square	0.577	0.629	0.577	0.586	0.591	0.584	0.598	0.676
Groups	38	38	38	38	38	38	38	38

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Computed by Author(s) Using Stata 14.0, 2022

The moderation results show that the interaction between entrepreneurship development and digital technological advancement is positive but insignificant. Though the coefficient is insignificant, it is positive as expected. This shows that the economic development enhancing effect of entrepreneurship development on human development in Sub-Sahara Africa is stronger in African countries with digital technological advancement. This results confirms with that of Bertschek *et al.* (2013). The interaction of entrepreneurship development with human capital development, the inflation rate, trade openness and global financial openness are all positive and significant, showing that human capital development, the inflation rate, trade openness, and global financial openness improves on the positive effect of entrepreneurship development on economic development in Africa. We further note that the negative effect of inflation on human development is mitigated/moderated by entrepreneurship development. Therefore, countries with higher levels of entrepreneurship development will experience lower levels of inflation and economic instability. These findings are consistent with Tokarick(2003); Cline (2004) and World Bank (2004) which concluded that trade liberalization improves efficiency and resource allocation in an economy.

Table 4.5: Moderating the Effect of Digital Technological Progress on Economic Development in Sub-Sahara Africa

VARIABLES	(1) HDI	(2) HDI	(3) HDI	(4) HDI	(5) HDI	(6) HDI	(7) HDI
New business density	0.00213***	0.00234***	0.00217***	0.00192***	0.00222***	0.00203***	0.00233***
	(0.000285)	(0.000225)	(0.000307)	(0.000302)	(0.000283)	(0.000276)	(0.000219)
ICT Use	0.00329***	0.00266***	0.00282**	0.00336***	0.00311***	0.00314***	0.00301***
	(0.000962)	(0.000858)	(0.00118)	(0.00107)	(0.000955)	(0.00100)	(0.000832)
Human capital development(A)	0.00446***	0.00367***	0.00338***	0.00450***	0.00467***	0.00454***	0.00326***
	(0.00142)	(0.00111)	(0.000907)	(0.00146)	(0.00143)	(0.00141)	(0.00106)
Inflation rate(B)		-0.000132*		-0.000141			
		(7.02e-05)		(0.000166)			
Trade openness(C)		0.000391*			-0.000546		
		(0.000210)			(0.000358)		
Financial openness(D)		-0.00936				-0.00281	
		(0.0230)				(0.0390)	
Control of corruption(E)		0.0403***					0.0237**
		(0.0113)					(0.00946)
ICT Use*A			3.67e-05				
			(2.62e-05)				
ICT Use*B				-2.69e-05			
				(1.93e-05)			
ICT Use*C					8.90e-05***		
					(1.67e-05)		
ICT Use*D						0.00221	
						(0.00286)	
ICT Use*E							0.00794***
							(0.000166)
Constant	0.409***	0.453***	0.419***	0.412***	0.408***	0.410***	0.444***
	(0.00537)	(0.0141)	(0.00613)	(0.00504)	(0.00548)	(0.00706)	(0.0124)
Observations	418	418	418	418	418	418	418
R-squared	0.577	0.629	0.580	0.586	0.582	0.579	0.634
Number of groups	38	38	38	38	38	38	38

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Computed by Author(s) Using Stata 14.0, 2022

Table 4.5 reveals that the effect of digital technological progress in terms of internet usage does not have the strength to moderate or inhibit the negative effect of inflation on human development in Sub-Sahara Africa. The interaction between ICT used and the human capital development indicates that the human development enhancing effect of ICT is stronger in African countries with higher levels of human capital development. Therefore, for African countries to benefit more from the usage of ICT, there is need to improve on human capital development. At the same time, the interaction of ICT usage with trade openness, global financial openness, and control of corruption all gives positive coefficients. The coefficient of the interaction of ICT usage with global financial openness is positive. This supports the idea that the use of ICT will benefit more on human development in countries with financial openess. The findings are consistent with Edo *et al.*, (2019), Choi (2010) and Yushkova (2014) who established that ICT boosts trade flows in many countries, hence the effect of trade openness on human development.

The findings so far have not shown the significance of the channels through which ICT usagte affects the level of human development in SSA. This study therefore uses causal mediation analysis to unmask the significance of the different channels through which ICT usage affects human development in SSA. On this note, the effect of ICT usage on each transmission channel is shown in table 4.6 based on the analysis of the structural model.

Table 4.6: Structural Model Analysis

VARIABLES	(2) ICT Use	(3) Constant	(4) Observations
New Business Density	0.0405***	3.170***	418
	(0.00924)	(0.394)	
Human Capital Development	0.279***	5.265***	418
	(0.0286)	(0.479)	
Control of Corruption	0.0205***	-0.955***	418
	(0.00203)	(0.0403)	
Inflation Rate	-0.128**	10.506***	418
	(0.0640)	(2.283)	
Trade Openness	0.00780***	-0.428***	418
	(0.00185)	(0.0395)	

Bootstrap standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Computed by Author(s) Using Stata 14.0, 2022

The findings reported on table 4.6 suggests that the use of ICT exerts a positive influence on new business density, human capital development, control of corruption and on trade openness but has a negative influence on the inflation rate. A percentage increase in the usage of internet in Africa will lead to an increase in new business density, human capital development, control of corruption and on trade openness by 4.05%, 27.9%, 2.05%, and 0.7% respectively. At the same time, a percentage increase in internet usage exhibits a decreasing influence on the rate of inflation by 12.8%. All coefficients are statistically significant at the 1% level except for the coefficient of the inflation rate that is significant at 5%.

The variations in the transmission mechanisms is accountable for by digital technological advancement, allowing us to estimate the direct and indirect impact of digital technological advancement on economic development in SSA.

The ICT coefficients reported on table 4.2 includes both the direct and the indirect impact (total effect of ICT) on development in SSA. Therefore, by means of the product-of-the-Sobel coefficients with standard errors corrected by means of the bootstrap procedures, we estimate the indirect impact of ICT on development in Africa. These indirect impacts are reported on table 4.7 that follows:

Table 4.7: Indirect Effects of Digital Technological Advancement on Human Development in SSA

	(2)	(3)	(4)
VARIABLES	Transmission Channels	Indirect Effect	% of the mediated effect
	New Business Density	-0.000095*	4%
		(0.0000532)	
	Human capital development	0.00105***	29%
		(0.0002145)	
ICT Usage	Control of Corruption	0.00105***	23%
		(0.000164)	
	Inflation rate	0.000017	1%
		(0.0000209)	
	Trade openness	0.000118***	4%
		(0.000038)	

*** p<0.01, ** p<0.05, * p<0.1

Source: Computed by Author(s) Using Stata 14.0, 2022

Table 4.7 reveals that paradoxically, the usage of ICT in SSA indirectly reduces the development of the continent through new business density, significant at the 1% level. Furthermore, the usage of ICT in SSA indirectly enhances the development of the continent through human capital development, control of corruption, the inflation rate, and the openness of the continent to foreign trade. The contribution of each of the mechanisms to the total impact of ICT usage in the development of SSA is thus computed, showing that 4% of the indirect negative impact of ICT usage on the development of SSA economies is due to variations in new business density in SSA. Also, 29%, 23%, 1%, and 4% of the indirect positive impact of ICT usage on development in SSA is accountable for by changes in human capital development, control of corruption, the variations in inflation rate, and in the regulations on openness in Sub-Sahara African economies to foreign trade.

5. Conclusion and Policy Suggestions

This study observed that SSA has for the first time in history massively experienced an increase in the use of digital technology for the delivery of services due to the hit of the COVID-19 pandemic. At the same time, the continent has been struggling to improve on human development indicators which are still dismal in performance. Even though the traditional theoretical and the non-traditional neoclassical theories which claim that higher levels of ICT penetration are associated with higher levels of entrepreneurship development, the rate of entrepreneurship activities in Africa remains insignificant. From the empirical analysis, the study draws some key conclusions:

The baseline model findings show that both entrepreneurship development in terms of new business creation and digital technological advancements in terms of ICT usage all can enhance human development in Sub-Sahara Africa. For the vector of control covaraiatess, human capital development as measured in terms of tertiary school enrolment rate, control of

corruption, and trade openness are seen to have a positive significant effect on human development in Africa while the inflation rate and global financial openness are seen to have negatively impacted development in Sub-Sahara Africa.

The moderation outcomes show that the interaction between entrepreneurship development and digital technological advancement is positive indicating that the economic development enhancing effect of entrepreneurship development in Sub-Sahara Africa is stronger in African countries with higher levels of digital technological application. Moderating the effect of digital technological application with the vector of control covariates suggests that digital technological progress does not have the strength to inhibit the negative effect of inflation on human development in Sub-Sahara Africa. From the causal mediation analysis, the structural model findings have shown that the use of ICT exerts a positive effect on new business density, human capital development, control of corruption, and on trade openness but has a negative effect on the inflation rate in SSA.

From the finding, we recommend that efforts in terms of national budget should be directed to commercial, vocational, and technical education for job creation, contrary to general education for job seekers. In this light, more than 30% of the national budget should be directed to education with 20% of budget directed to commercial, industrial, and technical education.

We also recommend guided openness policy to avoid excess dependency on foreign technologies and imported inflation. In this light, Africans should develop the interest of consuming home-produced goods by improving on their quality and life span. In this regard, the market share of African goods in the African market should be more than what we are experiencing today, about 7:3 on 1.

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