Economics Bulletin

Volume 40, Issue 3

The effect of information and communication technologies on foreign direct investments attractiveness in africa

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Abstract

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Authors wish to thank the two anonymous referees for the comments and suggestions that allowed to substentially improve the quality of the paper. We also thank Ongo Nkoa Bruno Emmanuel and Nsoga Nsoga Mermoz Homère III for their valuable comments on the previous version of this paper. All errors remain ours.

Citation: Avom Désiré and Melingui bate Adalbert Abraham Ghislain, (2020) "The effect of information and communication technologies on foreign direct investments attractiveness in africa", *Economics Bulletin*, Volume 40, Issue 3, pages 2304-2319

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Submitted: June 20, 2020. **Published:** August 24, 2020.

Economics Bulletin

Submission Number: EB-20-00618

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1. Introduction

African countries continue to increase efforts and strategies aimed at driving long-term growth and economic development. For this purpose, Foreign Direct Investment (FDI) is an opportunity that these countries should rely on, given the increasing volume of foreign capital flows towards Africa. Several studies conclude that FDI is a source of prosperity for host countries. Adams et al. (2017) and Ongo (2016) show that FDI inflows reduce unemployment and complete national saving to finance economic activity. Similarly, Markusen and Venables (1999) show that the location of foreign firms in a country offers opportunities for technology transfer that benefit to local firms, thereby increasing their level of competitiveness. FDI also promotes the integration of the host countries into the global economy and promotes the diversification of local production (Devarajan and Fengler, 2013). These advantages offered by FDI have led several authors to focus on the factors determining foreign capital attractiveness, which appear to be a major challenge for developing countries (Wheeler and Mody, 1992; Shatz and Venables, 2000; Ostadi, 2014; Asamoah et al., 2016).

Most research examining the contribution of ICTs to development in Africa focuses mainly on their effects on economic growth (Chavula, 2013; Batuo, 2015; Asongu and Le Roux, 2017; Ejemeyovwi and Osabuohien, 2018). Other studies show that the diffusion of ICTs, especially the Internet, positively affects trade (Freund and Weinhold, 2000). Although ICTs offer enormous opportunities in terms of reducing transaction costs, improving productivity and facilitating payment means through mobile banking, mobile money, electronic trading and others related services, their effect on FDI attractiveness in Africa has not retain particular attention in the literature. However, the number of mobile phone and internet services subscribers has grown exponentially since the early 2000s in Africa (**See Figure 1**). In addition, recent works show that ICTs affect FDI flows (Choi, 2003; Ko, 2007). Using a gravity model, Choi (2003) clearly shows that increasing Internet use significantly increases FDI inflows into a country. On the other hand, Ko (2007) argues that the link between the Internet and FDI attractiveness can be positive or negative, according to the presence of network externalities. Thus, the impact of ICTs on FDI is not unanimous in the literature. Moreover, this relationship has not been explicitly tested in the framework of African countries.

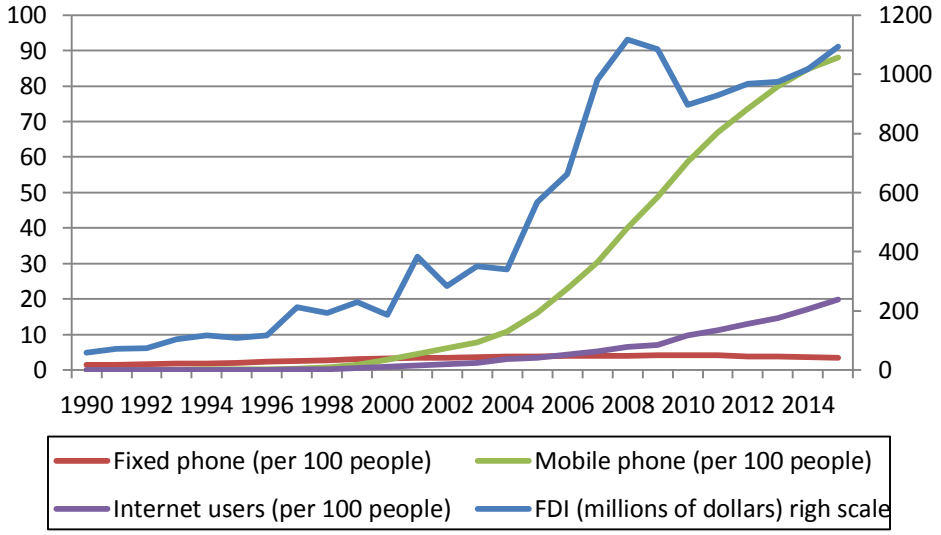
The purpose of this paper is to empirically evaluate and analyze the effect of the rapid ICTs diffusion since 2000s in Africa on FDI attractiveness. Based on a panel data econometric modeling using Pooled Ordinary Least Squares (POLS), Fixed Effect (FE) and Random Effect (RE) and system Generalized Method of Moments (system-GMM), our results show that the diffusion of mobile phone and Internet services positively and significantly affect FDI flows in Africa. In addition, we show that these results vary across sub-regions. Central, East and North Africa stand out as the three main sub-regions that best benefit from the opportunities offered by ICTs diffusion in terms of FDI attractiveness.

The rest of the paper is structured as follows: Section 2 presents stylized facts on ICTs diffusion and FDI inflows in Africa. Section 3 reviews the existing literature on the determinants of FDI and the effects of ICTs on economic activity. Section 4 presents the methodology used and describes the variables. Basics results and robustness checks are presented in section 5. Section 6 discusses the channels through which ICTs can affect FDI attractiveness. Section 7 concludes the paper and proposes some recommendations.

2. ICTs and FDI in Africa: some stylized facts

Since the beginning of the 1990s, Africa has become increasingly coveted in terms of FDI and also represents a vast market for ICTs development. According to UNCTAD (2018) statistics, foreign capital flows to African countries have rapidly increased over the past two decades, from US $ 2.84 billion in 1990 to nearly US $ 59.37 billion in 2016. However, Ongo and Song (2018) show that these FDI inflows in Africa are characterized by high volatility. According to the authors, the African continent attracts 9.65 billion USD in 2000, 19.97 billion USD in 2001, 14.7 billion USD in 2002, 57.7 billion USD in 2008, 58.29 billion USD in 2014 and 54.07 billion USD in 2015. However, Africa is not the preferred destination for FDI among developing regions. In this perspective, Asia and Latin America and the Caribbean are the regions that attract the most FDI, as shown in **Table A4** in the Appendices. Thus, FDIs represent on average only 4.80% of the GDP of the countries in our sample between 2000 and 2015[1]. **Figure 1** below shows the evolution of foreign capital inflows and ICTs diffusion in Africa between 1990 and 2015.

Figure 1: Evolution of digital technologies and FDI in Africa (1990-2015)



Source: Author's construction using World Bank and UNCTAD data.

This low proportion of FDI in African total production justifies the focus of these countries on policies that can attract more foreign investment. According to Ecofin[2] agency, FDI in Africa until 2016 goes mainly to the clothing, furniture and manufacturing sectors, textiles, machinery and agriculture. The survey by the United Nation Organization for Industrial Development (UNOID, 2003) shows that most of these investments come from American, French, Chinese, English and United Arab Emirates firms.

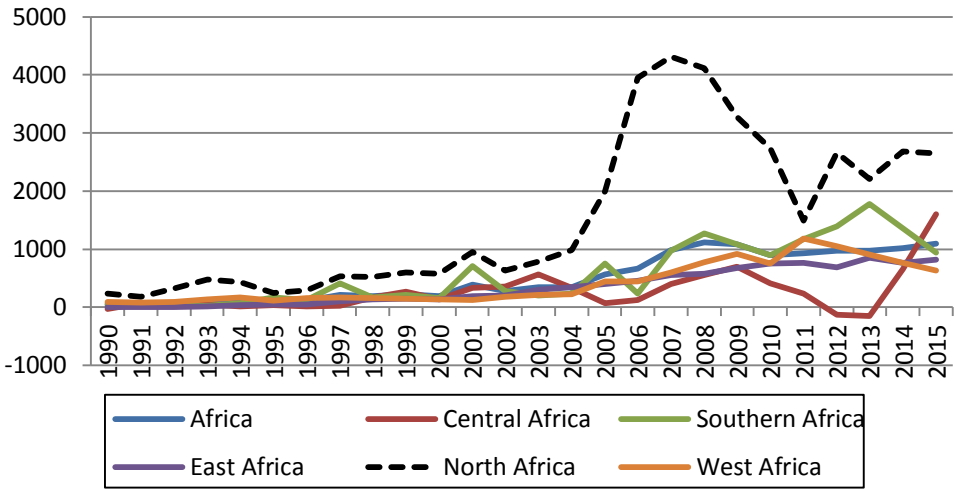
During the same period, Africa has experienced a rapid development and diffusion of ICTs. The fixed phone which was the first form of telecommunication to appear in Africa in the earliest of 1990s is today largely dominated by the other two forms of ICTs, namely Mobile and Internet. The number of mobile subscribers is the fastest growing especially since the 2000s, reaching in 2015 the average ratio of more than 87 subscribers per 100 people. Between 1990 and 1999, Africa has an average of 0.31 (less than 1 person) Mobile subscribers and only 3.4 out of 100 people use the Internet. From 2000 to 2015, these statistics have more than quadrupled and the data show that the number of Internet users has

[1] Author's calculation using data from UNCTAD (2018).
[2] For more details, see https://www.agenceecofin.com/economie/1505-47355-les-15-sources-d-investissements-directs-etrangers-en-afrique-en-2016-selon-ernst-young.

reached the average ratio of 20 per 100 population, while Mobile exceeds 91 per 100 inhabitants in 2015. Thus, FDI and ICTs penetration in Africa show similar evolutions, suggesting that the growing trends in FDI flows in Africa can be correlated to the spread of ICTs penetration.

However, both FDI inflows and ICTs diffusion in Africa show large disparities between sub-regions (**Figure 2 and 3**). North Africa is the most attractive sub-region for FDI followed by Southern Africa. While the other sub-regions barely exceed the average of 1500 million USD, North Africa has seen a rapid flow of FDI since 2000 and peaked in 2009 at almost 4318.44 million USD.

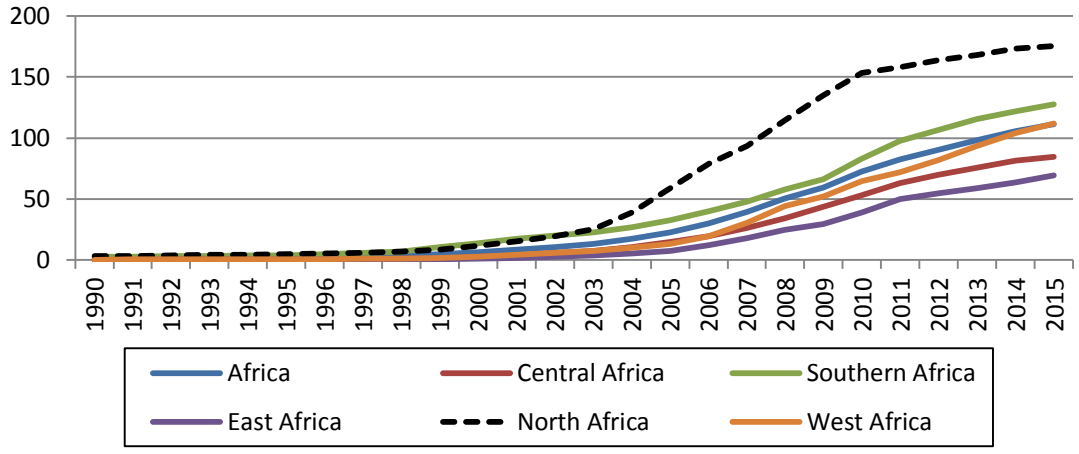
Figure 2: Foreign Directs Investments inflow in African Sub-regions



Source: Author's construction using World Bank data.

In addition, Central Africa is the sub-region that attracts the least FDI with high volatility. This sub-region nonetheless experienced a recovery in foreign capitals inflows in 2013 and exceeded all other sub-regions in 2015, except North Africa (See **Figure 2**).

Figure 3: ICTs diffusion in African sub-regions



Source: Author's construction using World Bank data

The ICTs pattern in Africa shows that North Africa remains the most dynamic sub-region where telecommunications are growing faster. **Figure 3** shows that in North Africa, the composite index[3] of ICTs which includes Mobile, Telephone and Internet services is well above the Africa and all other sub-region's averages.

The graphical analysis' show that in Africa, FDI and ICTs diffusion present similar evolutions, suggesting that there can exist a positive causal relationship between these two indicators. Indeed, sub-regions with high levels of ICTs development also account for the Africa's largest FDI inflows. **Table 1** presents the correlation matrix between ICTs and FDI. We also find that FDI is positively correlated with all ICTs indicators, but more strongly with mobile phone and Internet.

Table 1: Correlation matrix

	FDI	*MOB*	*INTER*	*FIXE*	*GFCF*	*EDUC*	*NR rent*	*GDP*	*INFL*	*INSTI*	*FINDEV*
FDI	*1.00*										
MOB	*0.43*	*1.00*									
INTER	*0.34*	*0.86*	*1.00*								
FIXE	*0.16*	*0.39*	*0.57*	*1.00*							
GFCF	*0.38*	*0.36*	*0.30*	*0.22*	*1*						
EDUC	*0.58*	*0.08*	*0.06*	*-0.12*	*-0.13*	*1*					
NR rent	*0.15*	*-0.12*	*-0.31*	*-0.53*	*-0.06*	*0.40*	*1*				
GDP	*0.39*	*0.43*	*0.54*	*0.71*	*0.33*	*-0.12*	*-0.25*	*1*			
INFL	*-0.03*	*-0.01*	*0.001*	*0.02*	*-0.16*	*0.04*	*0.03*	*-0.03*	*1*		
INSTI	0.23	0.24	0.33	0.39	0.33	0.21	-0.51	0.31	*1.00*	*1.00*	
FINDEV	0.24	0.39	0.56	0.59	0.22	0.10	-0.49	0.365	-0.14	0.465	*1.00*

Source: Authors' construction

Note: *FDI: Foreign Direct Investments; FIXE: fixed phone; MOB: mobile phone; INTER; internet; INFL: Inflation; NR rent: Natural resources rents; EDUC: Education; GDP: Gross Domestic Product per capita; GFCF: Gross Fixed Capital Formation; FINDEV: Financial Development; INSTI: Institution.*

However, graphical analysis' and correlations alone are not enough to derive rigorous conclusions and recommendations on the link between ICTs and foreign capital flows in Africa. Therefore, an empirical analysis using appropriate econometric methods is needed to measure the real effect of ICTs diffusion on the FDI attractiveness in Africa.

3. ICTs and economic activity: selective review of the literature

The literature on the impact of ICTs diffusion on economic activity is fairly recent and focuses mainly on economic growth, with no particular interest in their impact on FDI attractiveness. Several authors show that the development and diffusion of ICTs affect economic development indicators such as economic growth and inclusive growth (Jorgenson and Vu, 2005; Niebel, 2014; Asongu and Le Roux, 2017; Ngozi and Chiamaka, 2019). For other authors, ICTs enhance human capital (Chavula, 2013, Papaioannou and Dimelis, 2007). Niebel (2014) shows that the effects of ICTs on economic growth are more pronounced in developed countries than in emerging and developing countries. This result confirms the conclusions of Dedrick et al. (2013) whose results cover 45 developed and high-income countries.

[3]This index is calculated by summing annual arithmetic averages of ICTs indicators for each sub-region.

However, studies analyzing the impact of ICTs diffusion on economic development in Africa are limited. Chavula (2013) is one of the first to empirically analyze this issue for African countries. Using an endogenous growth model of 49 countries, Chavula (2013) shows that mobile and fixed phones improve the standard of living of the population while the diffusion and use of Internet services has a positive impact on human capital productivity. Batuo (2015) in his study selects a sample of 44 African countries and using OLS and system GMM over the period 1990-2010 shows that investment in telecommunications has positive effects on economic growth. More recently, Asongu and Le Roux (2017) show that the sustainability of development in Sub-Saharan Africa after 2015 should go through policies that boost the diffusion of ICTs. They find that ICTs positively and significantly affects inclusive growth in Africa. Ejemeyovwi and Osabuohien (2018) from a sample of 15 West African countries also reach to similar results. According to them, ICTs diffusion is beneficial for inclusive growth. Thus, the existing literature on African countries does not consider the development and diffusion of ICTs as an important factor attracting FDI and do not take into account sub-regional specificities. Our study fills these gaps using appropriate econometric techniques and distinguishing the effect of ICTs on FDI in different African sub-regions.

4. Methodology

4.1. Empirical model and variables

Several studies analyze the determinants of FDI for both developed and developing countries. In this article, we empirically analyze the impact of ICTs on FDI in Africa by estimating the following equation:

$$lnFDI_{it} = \alpha_0 + \delta lnFDI_{it-1} + \beta lnICT_{it} + \theta X_{it} + \varepsilon_{it} \quad (1)$$

$lnFDI_{it}$ represents natural logarithm of Foreign Direct Investments inflows in country i at year t, in millions of USD. Parameter δ captures the inertial effect of FDI, that is, the influence of FDI in the previous year, as investors prefer to operate in a familiar environment (Ongo and Song, 2018). This parameter also takes into account factors influencing FDI in the past which are not introduced in the model (Singh and Jun, 1995).

X is the matrix of control variables containing Gross Fixed Capital Formation (**GFCF**), human capital (**Education**) approximated by the rate of primary school enrollment, the per capita Gross Domestic Product (**GDP**), the total Natural Resources rent (**NR rent**). The choice of these variables is inspired by the existing literature on the determinants of FDI. Barrios et al. (2005) show that GFCF positively impacts FDI insofar as it captures the accumulation of physical capital and gives an indication of the productive capacity of an economy. GDP per capita approximately measures the size of the market and the level of domestic production is also an important determinant of FDI (Shatz and Venables, 2000; Artige and Nicolini 2005). Investors are also concerned about the level of education of the population, which is an absorption factor of new technology, the use of physical capital and has lower learning costs (Cleeve et al., 2015) and by the level of financial development (**FINDEV**). In the existing literature, natural resources are also presented as attractive for foreign investments in the extent that they constitute an available supply of raw materials that foreign firms often need (Dupasquier and Osakwe, 2006). Finally, we add institutional indicator (**Institution**) which data are from World Governance Indicators (WGI, 2018), measuring the capacity of governments to design and implement policies conducive to private sector development. The model also accounts for inflation (**Inflation**) and the level trade

openness (**Trade**). Our main ICTs variables of interest are captured by three indicators: **Mobile**, **Internet** and **Telephone**.

In the model, ε_{it} represents the error term, which is composed of μ_i which captures the unobserved specific effects of each country and another part ω_t that allows to take into account the temporal specific effect common to all country while α, β and θ are the parameters to be estimated. The data used are obtained from World Development Indicators (2018) and UNCTAD (2018) for the period from 2000 to 2015 in 52 African countries. This study period is justified by the availability of data and by the particularly expansive nature of ICTs penetration in Africa over the period selected. In the stylized facts section, the evolution of the variables of interest (FDI and ICTs) over the period 1990 to 2015 is presented in order to better highlight the more rapid evolution of ICTs diffusion between 2000 and 2015. The paper is therefore particularly interested in this sub-period in order to empirically test the impact of this acceleration of ICTs use on FDI attractiveness in Africa. The descriptive statistics of the variables used in this study are presented in **Table A2** of Appendices.

4.2. Estimation strategy

The empirical analysis of the impact of ICTs diffusion on FDI attractiveness in Africa conducted in this paper begins with basic econometric strategies on a static model[4], that is, Pooled Ordinary Least Squares (POLS) as well as Fixed Effects (FE) and Random Effects (RE) models. Thus, parameter β measures the effect of ICTs on FDI. Based on stylized facts presented in **Figure 1**, one would expect a significant positive coefficient in equation (1). However, these technics can lead to biased results because of endogeneity problems which can originate from multiple sources.

First, this could be caused by the existence of a dual causality between dependent and some explanatory variables. Indeed, FDI can also explain some of the ICTs to the extent that telecommunication infrastructures in Africa very often benefit from foreign investments. In Africa, some mobile phone companies or other telecommunication service providers are somewhere owned by foreign firms. This fact is supposed to cause dual causality between ICTs indicators and FDI inflows. Secondly, unobserved specificities of each country such as geography, demography or socio-cultural habits can be correlated with the explanatory variables of the model.

Third, introducing lagged values of the dependent variable in the model raises the problem of autocorrelation of the error terms[5]. In addition, omitted variables such as institutional quality indicators or other variables that may affect FDI as well as measurement errors can lead to biased results.

To correct these potential endogeneity problems, Arellano and Bover (1995) and Blundell and Bond (1998) have developed system GMM, especially for panel data where the temporal dimension is sufficiently smaller than the individual dimension ($N > T$). This method has the advantage of combining both the level and difference equations, which permits the use of lagged values of the level variables as instruments in equation (1) and the lags of differentiated variables as reliable instruments in differentiated equation. This method also controls unobserved specific effects of each country and corrects the problem of endogeneity of the explanatory variables.

[4] In the static model, the lagged dependent variable is excluded from the equation to be estimated which allows to take into account the inertia effect in the dynamics of FDI flows.
[5] That is known as the Nickel (1981) bias.

5. Presentation and discussion of results

5.1. Basic findings

The results obtained by estimating the static model are presented in Table 2. It shows that ICTs is a factor of FDI attractiveness in Africa. Giving that all variables are expressed in natural logarithm – exception for inflation – parameters give the elasticities of FDI vis-à-vis of explanatory variables. According to the results for the Fixed Effects model (column 1), a 1% increase in the number of Mobile subscribers per 100 inhabitants leads to an increase of 0.38% in the FDI amount inflows to Africa, *ceteris paribus*. For internet users per 100 inhabitants (column 2), increasing the number of users by 1% leads to an increase of 0.42% in the FDI inflow. Our results also show that Telephone does not have statistically significant effects on FDI inflows in Africa. According to the results, FDI inflows in Africa are not sensitive to Telephone. These results are close to those obtained with random effects model (columns 4, 5 and 6). The respective elasticity coefficients of Mobile and Internet from all specification in Table 2 highlight the "leapfrogging" potential for digital technologies on FDI attractiveness for African countries.

Table 2: The effect of ICTs on FDI using FE and RE estimations

	Dependent variable: Log (FDI)					
	Fixed Effects			***Random Effects***		
Variables	(1)	(2)	(3)	(4)	(5)	(6)
GFCF	0.059	0.149	0.114	0.142	0.247	0.294
	(0.239)	(0.235)	(0.265)	(0.231)	(0.222)	(0.257)
NR rent	-0.018	0.065	0.085	0.159	0.244**	0.324***
	(0.119)	(0.131)	(0.118)	(0.104)	(0.114)	(0.104)
GDP/capita	0.402	0.021	2.431***	0.333	0.181	1.078***
	(0.769)	(0.844)	(0.702)	(0.237)	(0.254)	(0.316)
Inflation	0.003***	0.003**	0.003**	0.002**	0.002*	0.002**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Trade	0.782**	0.664**	0.933**	0.585*	0.531**	0.563
	(0.371)	(0.310)	(0.384)	(0.304)	(0.263)	(0.366)
Education	0.783	1.433**	2.310***	0.458	1.018**	2.294***
	(0.542)	(0.543)	(0.626)	(0.507)	(0.502)	(0.595)
Institution	0.779**	0.606**	0.307	0.749***	0.577**	0.437
	(0.300)	(0.294)	(0.389)	(0.262)	(0.257)	(0.349)
Fin. Dev.	0.020	0.194	0.471**	0.001	0.141	0.588***
	(0.167)	(0.157)	(0.217)	(0.141)	(0.146)	(0.169)
Mobile	0.381***			0.387***		
	(0.068)			(0.062)		
Internet		0.427***			0.421***	
		(0.078)			(0.063)	
Fixe			-0.113			-0.299***
			(0.139)			(0.116)
Constant	-5.170	-5.264	-28.14***	-2.953	-4.475*	-18.03***
	(6.414)	(6.572)	(5.381)	(2.649)	(2.624)	(2.673)
Observations	*572*	*579*	*568*	*572*	*579*	*568*
R^2	*0.460*	*0.449*	*0.383*			

Wald chi2/F	*22.49*	*23.99*	*20.67*	*200.66*	*203.04*	*306.67*
Prob > chi2/F	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*

Source: Authors

Note: Robust standard errors are reported in brackets. (***, **, *) indicate statistical significance at 1%, 5% and 10%. The Wald chi2 statistic corresponds to the random effects and all the variables are expressed in natural logarithm, excepted for inflation and institution. **Fin**. **Dev**.: Financial Development.

Although the results of the two models appear similar, Hausman tests suggest that the fixed-effects model is more appropriate for empirical analysis of the impact of ICTs on FDI attractiveness in Africa. However, results previously presented have some shortcomings, given that they do not take into account inertial effects in the dependent variable. Foreign firms prefer to invest in a regular environment. Thus, current flows of FDI can also be affected by is past values. To take this memory effect into account, we proceed to econometric analysis using system Generalized Method of Moments (system-GMM), which is better adapted for dynamic panels where the sample size is greater than the period of study as it is the case in this paper.

5.2. Robustness checks: System GMM estimation

In this section, we discuss the tests applied to assess further robustness of our baseline regression results. To test whether the results are sensitive to the estimation method, we use alternatively system-GMM to control endogeneity problems, omitted variables, double causality and heteroscedasticity biases. The results presented in Table 3 suggest that FDI is positively and significantly responding to the spread of Mobile and Internet services penetration in African countries. These results confirm those previously obtained by the static model and converge with those of other authors who have analyzed the impact of ICTs on economic activity, particularly on economic growth in Africa (Asongu and Le Roux, 2017; Ngozi and Chiamaka, 2019). Column 3 also shows that Telephone has no significant effect on FDI attractiveness in Africa. This result is justified by the fact that this mode of telecommunications offers less opportunity for innovation and does not offer online payment opportunities as it is the case with Mobile and Internet. In addition, fixed telephones are not very popular nowadays and constitute a dying part of ICTs in the world and particularly in Africa.

Table 3: Robustness checks

	Dependent Variable : Log (FDI)		
	Estimation method: System GMM		
Variables	(7)	(8)	(9)
FDI (-1)	0.364***	0.509***	0.432***
	(0.087)	(0.095)	(0.154)
GFCF	-0.128	-0.0773	0.237
	(0.429)	(0.410)	(0.442)
NR rent	0.507**	0.575***	0.397
	(0.190)	(0.130)	(0.258)
GDP/capita	0.544	0.328	-0.537
	(0.687)	(0.619)	(0.676)
Inflation	0.006	0.010*	-0.004
	(0.006)	(0.005)	(0.012)

Trade	-0.629	-0.880	2.280
	(0.808)	(0.755)	(1.704)
Education	-0.514	-1.107	0.244
	(0.785)	(0.736)	(0.978)
Institution	1.730**	2.186**	-0.734
	(0.839)	(0.893)	(1.333)
Financial development	-0.003	-0.136	0.068***
	(0.039)	(0.710)	(0.022)
Mobile	0.294**		
	(0.141)		
Internet		0.355*	
		(0.207)	
Fixe			-0.0145
			(0.558)
Constant	4.294	9.495*	-7.148
	(4.457)	(5.494)	(8.077)
Observations	*520*	*526*	*515*
Number of instruments	*36*	*36*	*36*
AR(1)	*0.000*	*0.000*	*0.008*
AR(2)	*0.482*	*0.285*	*0.848*
Sargan	*0.230*	*0.227*	*0.703*

Source: Authors

Note: Robust standard errors are reported in brackets. (***, **, *) indicate statistical significance at 1%, 5% and 10%.

According to results in columns 7 and 8, a 1% increase in the number of mobile telephone subscriptions or the number of internet users per 100 inhabitants leads to an average increase of 0.29% or 0.35% of FDI in Africa, *ceteris paribus*. These results are quite interesting for economies in full mutation, looking for long-run development strategies. Thus, African countries should take advantage of the potential offered by ICTs to stimulate FDI attractiveness by improving Mobile and internet network coverage and by a greater supply of electrical energy. Indeed, the use of ICTs is highly dependent on the availability of electric energy, which is still very limited and non-permanent in some African countries. Several authors have investigated the effect of ICTs diffusion on economic growth without seeking to identify the channels through which these digital technologies can promote economic activity. This article provides an early response arguing that ICTs would affect economic growth through their impact on FDI attractiveness. However, these results need to be qualified, in line with the work of Ko (2007). According to the author, the effect of ICTs on FDI attractiveness depends on the presence of network externalities, especially in developing countries where the presence of negative externalities discourages FDI.

5.3. Robustness checks: sub-regional analysis

The stylized facts presented above show that in Africa, sub-regions with a high ICTs diffusion also remain the most attractive for foreign investments. This correlation is confirmed by the empirical analysis which results are presented in **Table A3** of Appendices. We have obtained these results using Pooled Ordinary Least Square (POLS) as samples for sub-regions analysis are considerably reduced.

As we have shown in the graphical analysis of our data, empirical results confirm that the effect of ICTs diffusion is not the same in all African sub-regions. Indeed, the effect of Mobile and Internet on FDI attractiveness is highest in Central, East and North Africa than in other sub-regions. This difference in results by sub-regions may have several explanations, including the level and quality of infrastructures that facilitate the use of ICTs such as electricity access, coverage of remote areas by telecommunication networks and even acquisition costs of electronic equipment. The level of education can also explain this differentiation of the effects of ICTs on FDI attractiveness as we have shown that the level of education positively affects FDI inflow. A population with a high level of education is able to understand and exploit all the opportunities offered by ICTs which can be more attractive for foreign investors. In addition, certain structural specificities and the availability of natural resources such as oil, minerals and timber may also explain the fact that the effect of ICTs on FDI attractiveness is higher in some African sub-regions than in others. As in the studies by Vadlamannati et al. (2009), Buchanan et al. (2012), Asamoah et al. (2016) and Komlan (2016), the quality of institutions can also be a condition of the effect of ICTs diffusion on FDI inflows, particularly in Africa where institutional qualities are different from one sub-region to another.

6. ICTs and FDI: discussion on the channels of transmission

Empirical investigation in this paper reveals that ICTs has a positive and significant impact on FDI attractiveness in Africa. This impact can pass through many channels, notably the improvement of productivity, the reduction of costs and the facilitation of trade. Concerning the channel of productivity, Wadhwani (2000) argued that internet is likely to significantly impact productivity and inflation during the next few years after 2000. In addition, ICTs diffusion can improve productivity indirectly by reducing corruption practices as economic agents have the possibility to interact directly through internet or mobile communications without intermediaries (Vinod, 1999). According to Choi (2003), ICTs and internet in particular can lower prices by lowering costs in Business-to-costumer (B2C), Business-to-Business (B2B) and Business-to-Government (B2G) nexus. The author also argued that productivity can be improved by market competition intensification as ICTs reduce search costs and entry barriers in some markets. In this line, DePrince and Ford (1999) also argued that the acceleration of internet use can cut the cost of holding inventories by allowing large panel of suppliers to bypass retailers and connect directly sellers and customers.

In addition, ICTs can impact FDI attractiveness through trade acceleration. Indeed, financial capital owners look for the level of commercial flow of a country before engage investments. According to this argument, Freund and Weinhold (2000) performed the cross-countries regressions based on the gravity model and find that internet positively and significantly impacts bilateral trade. Internet and mobile also offer the possibility of sailing and buying on line, with low physical movement of persons but with an important gain of time and efficiency. ICTs can also improve trade through electronic payment. In this line, internet online selling and mobile money, mobile banking and payment offer opportunities to accelerate trade and finally attract more foreign investors.

7. Conclusion

The aim of this article was to empirically assess if ICTs diffusion enhances FDI attractiveness in African from 2000 to 2015. Using Pooled Ordinary Least Squares, Fixed Effects and Random Effects models and the system-GMM estimator, our results suggest that ICTs penetration positively and significantly affect FDI attractiveness in Africa, especially the use

of Mobile and Internet. Based on the "leapfrogging" hypothesis, this article suggest that African countries could make considerable time savings if they efficiently use the opportunities offered by Mobile phone and Internet, not only in terms of FDI attractiveness, but also through other aspects such as electronic trading, mobile banking and payment and the reduction of transaction costs. However, our results show that the use of Telephone does not have any positive and significant effect on FDI attractiveness in Africa, probably because Telephone is a dying part of telecommunications in the world and especially in Africa.

This paper points out some policy implications drawn from its findings and analyses. First, we recommend improving the conditions for accessing ICTs and reducing the cost of acquiring and using telecommunication services. These measures involve policies that reduce the cost of purchasing mobile phones, computers and subscription fees for Internet packages and services. Second, public policy makers also have to invest more on infrastructure, especially access to electricity in order to expand telecommunication networks. In Africa, the access rates to electricity for several countries are still very low. Finally, African countries have to invest more in human capital through a qualitative and quantitative improvement of education, which is an important factor of FDI attractiveness as shown by our results but also because education facilitates the use of ICTs.

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Appendices

Table A1: List of countries

Central Africa	**West Africa**	**Southern Africa**	**East Africa**	**North Africa**
Angola, Burundi, Cameroon, Central Africa	Benin, Burkina Faso, Cape Verde, Côte d'Ivoire, Gambia, Ghana,	Botswana, Eswatini, Lesotho, Madagascar, Malawi, Mauritius,	Comoros, Djibouti, Eritrea, Ethiopia,	Algeria, Egypt, Libya, Morocco, Tunisia

Republic, Chad, Congo, Democratic Republic of Congo, Equatorial Guinea, Gabon, Rwanda, Sao-Tome and Principe	Guinea, Guinea Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra-Leone, Togo	Mozambique, Namibia, Seychelles, South Africa, Zambia, Zimbabwe	Kenya, Somalia, Sudan, Tanzania, Uganda	

Source: Authors' construction

Table A2: Descriptive statistics

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Log FDI	799	5.237	2.072	-3.853	9.357
Log Mobile	816	2.766	1.829	-3.982	5.195
Log Internet	829	0.9160	1.712	-5.132	4.062
Log Telephone	812	0.323	1.488	-5.096	3.450
Log GFCF	747	2.955	0.500	0.092	4.982
Log NR rent	760	1.937	1.609	-6.774	4.489
Log GDP/capita	823	7.103	1.107	5.269	10.156
Inflation	787	65.968	996.79	-35.837	24411.03
Log Trade	776	4.217	0.458	2.950	5.741
Log Education	806	4.552	0.250	3.476	5.006
Log Fin. Dev.	793	2.745	0.954	-1.618	5.075
Institution	832	-0.660	0.595	-2.243	1.127

Source: Authors' calculations

Table A3: Robustness checks: sub-region estimations by POLS

		Africa			**Central Africa**	
Variables	(10)	(11)	(12)	(13)	(14)	(15)
Mobile	0.435***			0.739***		
	(0.052)			(0.113)		
Internet		0.516***			0.574***	
		(0.054)			(0.104)	
Telephone			-0.182**			-0.751***
			(0.081)			(0.181)
Constant	1.862	2.617	-6.346***	-0.790	-4.210	-19.76***
	(1.654)	(1.699)	(1.824)	(3.133)	(3.566)	(3.530)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	597	605	594	120	120	116
R-squared	0.375	0.391	0.305	0.719	0.666	0.686
F Statistic	73.59	71.23	32.49	32.15	24.46	29.61
Prob. F	0.000	0.000	0.000	0.000	0.000	0.000
		East Africa			**North Africa**	
Variables	(16)	(17)	(18)	(19)	(20)	(21)

Mobile	0.236			0.310***		
	(0.185)			(0.054)		
Internet		0.367*			0.397***	
		(0.205)			(0.053)	
Telephone			-0.730**			0.378
			(0.322)			(0.341)
Constant	-3.998	4.774	-17.19	17.27**	24.68***	8.672
	(14.18)	(15.40)	(11.79)	(8.126)	(7.109)	(9.868)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	48	50	50	68	68	68
R-squared	0.737	0.775	0.784	0.684	0.695	0.541
F Statistic	21.54	26.64	23.54	46.81	57.46	16.78
Prob. F	0.000	0.000	0.000	0.000	0.000	0.000
	Southern Africa			**West Africa**		
Variables	(22)	(23)	(24)	(25)	(26)	(27)
Mobile	0.694***			0.307***		
	(0.081)			(0.072)		
Internet		0.698***			0.335***	
		(0.085)			(0.090)	
Telephone			-0.518**			-0.559***
			(0.245)			(0.116)
Constant	19.65***	16.34***	7.807*	-3.541	-4.161	-14.82***
	(3.594)	(3.802)	(4.568)	(2.269)	(2.586)	(2.034)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	152	151	152	209	216	208
R-squared	0.560	0.525	0.360	0.593	0.563	0.557
F Statistic	27.18	27.94	11.59	38.35	36.89	40.94
Prob. F	0.000	0.000	0.000	0.000	0.000	0.000

Source: Authors

Note: Robust standard errors are reported in brackets. (***, **, *) indicate statistical significance at 1%, 5% and 10%.

Table A4: FDI inflows and projections, by group of countries and region, 2017-2019 and forecast 2020 (billions of dollars).

Group of countries/region	**2017**	**2018**	**2019**	**Forecast for 2020**
World	**1 700**	**1 495**	**1 540**	**920 to 1 080**
Developed economies	**950**	**761**	**800**	**480 to 600**
Europe	570	364	429	240 to 300
North America	304	297	297	190 to 240
Developing economies	**701**	**699**	**685**	**380 to 480**
Africa	42	51	45	25 to 35
Asia	502	499	474	260 to 330
Latin America and Caribbean	156	149	164	70 to 100
Transition economies	**50**	**35**	**55**	**30 to 40**

Source: Authors' construction using data from UNCTAD (2019).

Note: Projections are based on UNTAD's forecasting model and expert judgment.