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IMPACTS OF FINTECH ON FINANCIAL INCLUSION: THE CASE OF SUB-SAHARAN AFRICA

Keywords: FinTech, financial inclusion, Lewbel 2SLS.

J E L Classification: G20, G21, G23, E42, O33.

Abstract: The objective of this paper is to determine the impact of FinTech on the financial inclusion of populations in sub-Saharan Africa where financial education is still low. To do so, data were collected on a sample of 35 countries over a period from 2011 to 2020. Estimates were made using two-stage least squares models and the Lewbel 2LS model. It is clear from the results that fintech contributes significantly to the financial inclusion of people in sub-Saharan Africa. Mobile phone ownership facilitates the use of financial services. It is noted that a 1% increase in the number of people using a phone would contribute to a 0.67% increase in the financial inclusion rate. The Driscoll-Kraay technique consolidated these results by showing that with 1% of people

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having access to fintech tools, there is an improvement in the financial inclusion rate of about 0.70%.

Introduction

The African Union's Agenda 2063 (www1), followed by the global Sustainable Development Goals, aim to improve people's well-being. However, these goals can only be achieved by significantly reducing poverty and increasing the financial inclusion of people who have so far been excluded from the mainstream financial system. In fact, financial inclusion is the provision of low-cost financial services to middle-income people who are disadvantaged by the traditional financial system (Ozili, 2018). According to Dev (2006), these disadvantaged people are mainly women, the elderly and people living in rural areas.

Nowadays, technology has evolved a lot, in all fields including finance. These technologies applied to finance (FinTech) can be understood through technological innovation in financial services that has led to new business models, new products and even new ways of doing finance through decentralized finance. With FinTech, it is now possible to send and receive payments anywhere in the world with a smartphone connected or not to the Internet. According to Global Findex (2017), financial inclusion is growing exponentially worldwide. Its statistics show that 1.2 billion adults (people over 15) opened a bank account between 2011 and 2017, including 515 million since 2014. Between 2014 and 2017, the proportion of adults with an account at a financial institution or a mobile bank increased from 62% to 69% worldwide and from 54% to 63% in sub-Saharan African countries.

The coronavirus health crisis that the world is currently experiencing is likely to have influenced financial technologies to the extent that relationships between people are limited. In the face of these constraints, digital and digital payment methods are those that have made a valid contribution to contactless payments worldwide. In fact, digital and digital finance are financial services provided via payment gateways, mobile applications, smartphones and computers connected to the Internet. They encompass a multitude of new financial products, finance-related software, new forms of communication and interaction, and the provision of financial services that help to further integrate those excluded from traditional finance. Thus, FinTech plays a significant role in financial inclusion (Manyika, Lund, Singer, White & Berry, 2016). This is why FinTech is an accelerator of financial inclusion and an opportunity for poor peo-

ple, women and rural populations excluded from the financial system (Gomber, Koch & Siering, 2017).

In emerging countries like in sub-Saharan Africa, Fintech is poised to accelerate financial inclusion (Khatun & Tamanna, 2020). During the COVID-19 pandemic, technology has further created new opportunities for digital financial services to accelerate and enhance financial inclusion, amid social distancing and lockdown measures (Sahay, Eriksson, Allmen, Lahreche, Khera, Ogawa, Bazarbash & Kim, 2020). However, these opportunities are not perceived in the same way because not only is the degree of contamination of the pandemic different, but also the level of financial literacy varies across the world. The level of financial inclusion in this region is still significantly low compared to the world average of indicators (Djoufouet, 2019). Due to their low-income level, people do not find it necessary to seek certain financial services such as setting up a bank account or transferring funds (Djoufouet, 2019). In addition, a large proportion of the population who do not have any form of identification do not fully trust financial technologies because of the omnipresence of scammers.

In the face of these various factors that could hinder the deployment of Fintech in sub-Saharan Africa, it is necessary to question the impact of Fintech on financial inclusion, as access to financial services is not an end in itself, what matters is the use of these services. In other words, the objective of this paper is to examine the contribution of Fintech in improving the financial lives of people living in sub-Saharan Africa.

After this introductory part, the rest of the document is structured as follows. Sections 2 and 3 present respectively the literature review and the methodology adopted. Section 4 presents and discusses the main empirical results obtained. The conclusion and policy implications are given in Section 5.

Review of the literature

Most researchers agree that financial development stimulates long-term economic growth, as a well-developed financial system encourages savings, investment, risk diversification and discourages moral hazard (Puatwoe & Piabuo, 2017; Junior, Andoh, Gatsi & Kawor, 2021; Song, Chang & Gong, 2021). To this end, the financial inclusion of people remains a major economic policy objective for governments in all countries. For almost a decade, the international community and governments have been making concerted efforts to develop financial inclusion. The challenge is to build a financial system that is accessi-

ble to all and that promotes stability and the equity of progress. To achieve this, new technologies improve digitalization and lower the cost of financial services. However, the theoretical underpinnings of the relationship between financial technologies and financial inclusion assume that a large proportion of the population excluded from the formal financial system owns at least one mobile phone. According to the World Bank (2016), the provision of financial services via mobile phones and related devices can make it easier and cheaper for people to access financial services. Information and Communication Technologies (ICT) and FinTech are therefore important drivers of financial inclusion (Tchamyou, Erreyger & Cassimon, 2019).

FinTech: an opportunity for financial inclusion

Most studies have found that FinTechs and ICTs are key drivers of financial inclusion (Ghosh, 2018; Gosavi, 2018; Tchamyou et al., 2019). FinTechs enable financial services to be offered to all social strata, regardless of their locations. According to Bhandari (2018), middle-income people are the ultimate beneficiaries of financial inclusion because, lacking access to traditional financial services, they can now benefit from low-cost micro-services. Ghosh and Vinod (2017) instead believe that women are the main beneficiaries of financial inclusion outcomes as they are considered among the vulnerable and poor. In any case, the economy and the financial system as a whole are the main beneficiaries of financial inclusion (Mehrotra & Yetman, 2015; Swamy, 2014; Ozili, 2018).

According to some studies in Europe and Asia (Andrianaivo & Kpodar, 2012; Ghosh, 2016), there is evidence of a positive correlation between the level of mobile phone penetration that would facilitate access to financial services and financial inclusion. According to Morawczynski (2009); Mbiti and Weil (2011); Ouma, Odongo and Were (2017), the use of mobile money promotes and accelerates financial inclusion of households and businesses. Therefore, households with a mobile money account tend to be banked, receive or send money more frequently and accumulate more savings (Morawczynski, 2009; Mbiti & Weil, 2011; Ouma et al., 2017). An individual with a current account will be more likely to use other financial services, such as credit or insurance, to start or expand a business, to invest in education or health, to manage risk and to overcome financial shocks, all of which will improve their overall standard of living.

However, the FinTech-financial inclusion link might differ depending on the dimensions of financial inclusion (access versus use), in addition to the type of financial service (payments, savings, credit and insurance). As mentioned in the introduction, the link between FinTech and financial inclusion may also vary according to the level of financial education of the populations. For this reason, the results of the various studies are inconclusive and mixed. Kochar (2011) studied the relationship between financial inclusion and household income inequality in the Indian state of Uttar Pradesh and concluded that increased access to formal financial services through local bank branches did not translate into an increase in the actual use of these financial services by poor households. Zhang and Posso (2019) found that financial inclusion has a positive effect on household income in China and that this effect is larger for households in the lower quantiles of the income distribution, indicating that it reduces inequality.

In contrast, six randomised controlled trials conducted in Mexico, Mongolia, Bosnia, India, Ethiopia and Morocco; found no robust evidence of a positive impact of household participation in microcredit programmes on household income (Angelucci, Karlan & Zinman, 2015; Augsburg, De Haas, Harmgart & Meghir, 2015; Banerjee & Newman, 1993).

FinTech's contribution to financial inclusion during the coronavirus pandemic

Access to financial services is also considered one of the main challenges that communities face during crises such as COVID-19. Al-Nawayseh's (2020) study analysed the role of FinTech applications in building resilience during the COVID-19 pandemic on the one hand, and the determinants of the use of these applications by Jordanian population on the other. Her results indicate that the competitive advantages of FinTech applications and social norms significantly affect the intention to use these applications. Fu and Mishra (2020) use mobile app usage data from 74 countries to document the effects of the COVID-19 pandemic on FinTech adoption. They find that the spread of COVID-19 and government blockades led to an increase of 24% to 32% in the daily download rate of FinTech apps. It can be seen that even technological risks do not seem to dampen the intention to use these FinTech applications (Al- Nawayseh, 2020).

In this time of COVID-19 health crisis, FinTech not only facilitates access to financial services (contactless payments, withdrawing and depositing funds, sending and receiving funds), but also saves money and time. Financial transactions with FinTech applications are faster and can be done remotely. Furthermore, Najaf, Subramaniamb and Atayah (2021) explain that peer-to-peer lending platforms attracted more borrowers with little or no access to credit facilities offered by conventional banks during the pandemic. Their results indicate that FinTech Peer to Peer lending has become the most viable alternative credit option available to borrowers. Krasnyuk, Tkalenko and Krasniuk (2021) showed that the presence of COVID-19 contributed to the growth of FinTech and financial inclusion in different countries.

From the above, it can be said that the impact of FinTech on financial inclusion would vary according to certain well-determined contingency factors. The present study thus focuses on sub-Saharan Africa where the level of financial literacy is still low.

Research methodology

This section presents the research methodology used in this study. It includes the presentation of the study data and variables, the estimation techniques and the econometric model.

Descriptions of the study data and variables

To meet the target, data was collected on 35 sub-Saharan African countries over a period from 2011 to 2020. It is important to note that the database requested for this work (Global Findex) presents three-yearly data. Thus, to have a panel spread over our study period, we had to apply the exponential smoothing method. Data on Fintech and financial inclusion were collected from the International Telecommunication Union and Global Findex databases, respectively. Data on control variables were collected from the World Development Indicator and Worldwide Governance Indicators databases.

In this study, financial inclusion, a dependent variable, is measured by the population's access to and use of financial services (Allen, Demirguc-Kunt, Klapper & Martinez Peria, 2016). Based on the work of OECD and JRC (2008), Sarma (2012), Yorulmaz (2018) and Tram, Lai and Nguyen (2021), a financial

inclusion index was constructed from six financial inclusion variables. The construction technique of this index followed four main steps: multivariate analysis, normalisation, weighting and aggregation.

As in the work of Andrianaivo and Kpodar (2012), Ghosh (2016) and Demirgüç-Kunt, Klapper, Singer, Ansar and Hess (2018), Fintech, as an independent variable, is measured by the mobile and fixed-line telephone penetration rate, and the broadband internet penetration rate. In order to strengthen the analyses, control variables have been introduced. The first is the growth rate measured by the Gross Domestic Product (GDP) per capita. According to Beck, Demirgüç-Kunt and Levine (2007), Ayyagari and Beck (2015), growth in GDP per capita can increase the number of people with access to basic financial services, through the increase in national wealth if households excluded from the formal system manage to integrate into it. The second control variable is the employability rate of the population as measured by the number of young self-employed entrepreneurs. According to Geng and He (2021), the level of employability of the population positively affects financial inclusion, especially in developing countries. Levels of education, broadband internet penetration and remittances were then selected as control variables as they facilitate access to formal finance (Xu, 2020; Gautam, 2019). Finally, the level of political stability and control of corruption were also taken into account. According to Emara and El Said (2021), the quality of governance in a country can influence the number of people excluded from the financial system. The table below presents the description of the variables of the study.

Table 1. Description of study variables

Variables	Obs	Mean	Std.Dev.	Min	Max
Financial Inclusion Index	350	-0.001143	0.0702675	-1	0.22
Fixed Telephone	330	2.267025	5.633058	0	37.64051
Mobile Phone	335	81.27403	36.16261	15.67192	165.5999
Gross Domestic Product	350	3.663748	4.642932	-36.39198	20.71577
Employability level	315	1.998698	1.588087	0.04	6.63
Level of education	188	46.40826	20.83743	13.88327	109.4441
Funds transfer	346	1.09E+09	3.54E+09	0	2.43E+10

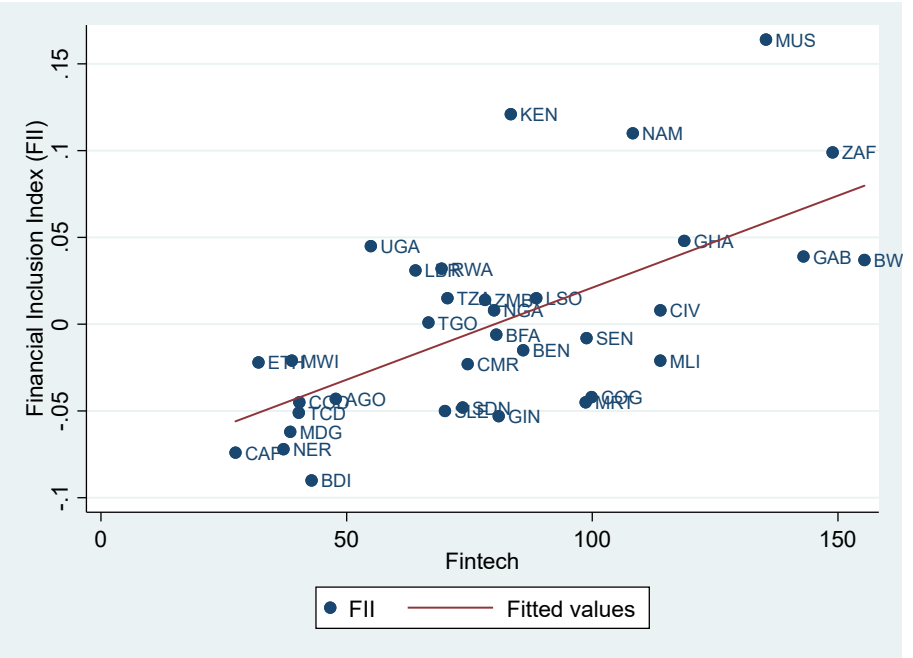
Table 1. Description of study variables

Variables	Obs	Mean	Std.Dev.	Min	Max
Internet Penetration level	285	17.64338	15.57777	0.9	68.2
Control of Corruption	350	0.1476224	0.0154324	0.1200679	0.1867942
Political Stability	350	30.11242	21.83542	0.4761905	90.56604
List of countries: Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Congo, Dem. Rep. Congo, Rep. Cote d'Ivoire, Ethiopia, Gabon, Ghana, Guinea, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, South Africa, Sudan, Tanzania, Togo, Uganda, Zambia.					

S o u r c e : table drawn by the authors using Stata V15.

A descriptive and summary analysis of the relationship between fintech and financial inclusion shows a positive correlation between the two variables for all sub-Saharan African countries.

Figure 1. Correlation between Fintech and the Financial Inclusion Index



S o u r c e : graph drawn by the authors using Stata V15.

Estimation techniques and econometric model

The estimation of the econometric model is based on the work of Driscoll and Kraay (1998). This work, based on a non-parametric time series covariance matrix estimator, assumes that the error structure is heteroskedastic, auto-correlated up to a certain lag and possibly correlated between panels. Furthermore, the non-parametric Driscoll-Kraay estimator produces robust results in terms of cross-sectional and time dependence and is able to handle missing data series (Hoechle, 2007). To ensure the endogeneity of the results, the instrumental variable approach was adopted. The adoption of this approach requires that appropriate instruments have a significant correlation with the endogenous variable, satisfy the orthogonality condition and must be properly excluded from the model so that its effect on the response variable is only indirect (Baum, Cristina & Rother, 2012).

However, finding appropriate instruments that simultaneously satisfy these conditions is oftendifficult and poses a serious problem for the use of instrumental variable estimators in most applied research (Baum et al., 2012; Stock, Wright & Yogo, 2002). Therefore, the two-stage least squares (2SLS) technique of Lewbel (2012) solves this problem.

The econometric model of this study is inspired by those of Demir, Gozgor, Lau and Vigne (2019) and Banna, Hassan and Rashid (2021) which analyse the impact of FinTech on reducing inequality. Overall, the model is as follows:

$$FII_{i,t} = \alpha + \beta\, Fintech_{i,t} + \gamma\, X_{i,t} + v_i + \delta_t + \varepsilon_{i,t} \quad (1)$$

Where:

$\boldsymbol{FII_{it}}$, Represents the financial inclusion index, which was constructed from a set of six financial inclusion variables,

$\boldsymbol{x_{it}}$, the control variables of a country $\boldsymbol{i}$ at a period $\boldsymbol{t}$,

$\boldsymbol{v_i}$, the unobserved country specific effects; $\boldsymbol{\delta_t}$, the common time specific effect for all countries and $\varepsilon_{i,t}$, the error term. Thus, $\boldsymbol{\alpha}$, $\boldsymbol{\beta}$, $\boldsymbol{\gamma}$ and $\boldsymbol{\delta}$ are the parameters to be estimated.

In more detail, the econometric model for this study is as follows:

$$FII_{i,t} = \alpha_{i,t} + \beta_1 MP_{i,t} + \beta_2 GDP/h_{i,t} + \beta_3 Empl_{i,t} + \beta_4 School_{i,t} + \beta_5 TF_{i,t} + \varepsilon_{i,t} \quad (2)$$

Where:

$\boldsymbol{MP_{i,t}}$, Average mobile phone penetration rate,
$\boldsymbol{GDP/h_{i,t}}$, GDP per heads,
$\boldsymbol{Empl_{i,t}}$, The employability rate of independent contractors,
$\boldsymbol{School_{i,t}}$, Represents the average level of education of the populations,
$\boldsymbol{TF_{i,t}}$, Reference to the transfer of funds.

Presentation and interpretation of results

The econometric model of this study is estimated using the Ordinary Least Squares technique, fixed effects and the Driscoll-Kraay (1998) method. In order to account for endogeneity and heteroscedasticity problems, the econometric model was subsequently estimated by applying two-stage ordinary least squares and Lewbel 2LS. Lewbel (2012) provides an estimator for linear regression models containing an endogenous regressor, when no outside instruments or other such information is available. The method works by exploiting model heteroscedasticity to construct instruments using the available regressors. Some authors have considered the method in empirical applications where an endogenous regressor is binary, without proving validity of the estimator in that case. Table 2 below presents the results of the baseline estimates of the relationship between FinTech and financial inclusion using mobile phone and fixed phone as variables of interest. Table 3 tests the robustness of these results by incorporating the additional variables. Table 4 presents the results of the estimations that take into account the endogeneity and heteroscedasticity problems that may exist in the data. The latter results seek to confirm the previous ones.

Table 2. Baseline Estimation

Variables	Financial Inclusion Index														
	OLS					Driscoll-Kraay					Fixed-effect				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Mobile Phone	0.00143***	0.00137***	0.00125***	0.00123***	0.00124***	0.00117***	0.00115***	0.00103***	0.000826***	0.000944***	0.00157***	0.00149***	0.00142***	0.00136***	0.00136***
	(0.000131)	(0.000133)	(0.000129)	(0.000142)	(0.000155)	(0.000102)	(8.71e-05)	(0.000110)	(0.000142)	(0.000125)	(0.000159)	(0.000161)	(0.000151)	(0.000158)	(0.000174)
Fixed Phone	0.0105***	0.00832***	0.00913***	0.00463***	0.00417**	0.0116***	0.0110***	0.0110***	0.00626***	0.00687***	0.00949***	0.00623**	0.00843***	0.00351*	0.00290
	(0.00186)	(0.00188)	(0.00193)	(0.00161)	(0.00176)	(0.00209)	(0.00225)	(0.00171)	(0.00135)	(0.00119)	(0.00241)	(0.00241)	(0.00247)	(0.00201)	(0.00308)
Gross Domestic Product		-0.00129***	-0.000245	0.000654	0.000972			0.000564	0.000942	0.00170*		-0.00128***	-0.000170	0.000821	0.00113*
		(0.000480)	(0.000482)	(0.000543)	(0.000597)		(0.000950)	(0.000441)	(0.000697)	(0.000820)		(0.000486)	(0.000481)	(0.000555)	(0.000614)
Employability level			0.0128***	0.00280	0.00281			0.00606***	-0.00215	-0.00165			0.0273***	0.00419	0.00494
			(0.00397)	(0.00451)	(0.00493)			(0.00110)	(0.00185)	(0.00133)			(0.00615)	(0.00801)	(0.0101)
Level of education				0.000514	0.000655				0.00140***	0.00137***				0.000321	0.000455
				(0.000375)	(0.000403)				(0.000129)	(0.000101)				(0.000501)	(0.000531)
Funds transfer					-0.000291					-0.00290					-0.000313
					(0.00226)					(0.00366)					(0.00262)
Constant	-0.117***	-0.107***	-0.131***	-0.147***	-0.153***	-0.0953***	-0.0913***	-0.103***	-0.146***	-0.103	-0.128***	-0.117***	-0.174***	-0.149***	-0.153***
	(0.0131)	(0.0136)	(0.0146)	(0.0157)	(0.0448)	(0.00678)	(0.00775)	(0.00481)	(0.00710)	(0.0630)	(0.0131)	(0.0137)	(0.0177)	(0.0227)	(0.0520)
Observations	335	335	307	181	162	335	335	307	181	162	335	335	307	181	162
R-squared						0.353	0.356	0.371	0.621	0.626	0.247	0.264	0.296	0.421	0.435
Number of id	35	35	35	29	27						35	35	35	29	27

Standard errors in parentheses ***, significance 1% ; **, significance 5% ; *, significance 10%.

S o u r c e : table drawn by the authors using Stata V15.

The results of our baseline model confirm the fact that technology tools such as the fixed telephone have a positive effect on financial inclusion in sub-Saharan Africa. Thus, this further confirms the previous results found by Tchamyou et al. (2019), who found that ICTs contribute positively to the access of financial products by African populations. Similarly, Abor, Amidu and Issahaku (2018), Ozili (2017), Gabor and Brooks (2017), Demir, Bilgin, Karabulut and Doker (2020) and Senyo and Osabutey (2020) have shown beneficial effects of FinTech on the level of financial inclusion of populations in different contexts. Thus, analysing the effect of FinTech on financial inclusion in this period of COVID-19 finds that the fixed-line telephone variable, considered as a proxy for FinTech, acts positively on financial inclusion (Asongu & Odhiambo, 2018; Asongu, Nwachukwu & Orim, 2018; Demir et al., 2020). This measure of FinTech has positive and significant effects on the financial inclusion index. For example, a 1% increase in the number of people using fixed-line phones would contribute to a 0.67% increase in financial inclusion according to the OLS estimates. In the fixed effect estimates, a 1% increase in FinTech would contribute to a financial inclusion of about 0.33%. The Driscoll-Kraay (1998) technique consolidates these results by showing that with 1% of people having access to FinTech tools, there is an improvement in the financial inclusion rate of about 0.70%. These results reflect the rapid evolution of technology tools in the financial sector in both developed and developing countries.

For the control variables, gross domestic product remains positive overall but insignificant, regardless of the estimation method. This result is consistent with those of Abor et al. (2018), Kim, Yu and Hassan (2018) and Usman, Makhdum and Kousar (2021). Employment is also a channel through which FinTech is able to increase the number of people with access to financial services (Beck, Demirgüç-Kunt & Levine, 2007; Geng & He, 2021). The results also show that the average level of education of the population has significant positive effects on financial inclusion in sub-Saharan Africa. Similar results have been found by authors such as Ozili (2021); Were, Odongo and Israel (2021). In addition, remittances have a positive effect on financial inclusion. Several other authors in the literature have shown this, such as Chuc, Li, Phi, Le, Yoshino and Taghizadeh-Hesary (2021) and Barnabe (2021). Table 3 below tests the robustness of the results by incorporating the additional variables.

Table 3. Robustness test by integration of additional variables

Variables	Financial Inclusion Index																	
	OLS						Driscoll-Kraay											
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Mobile Phone	0.00143***	0.00125***	0.00123***	0.000488***	0.000410**	0.000398**	0.00117***	0.00103***	0.000826***	0.000219***	0.000216***	0.000180**	0.00157***	0.00142***	0.00136***	0.000591***	0.000490**	0.000420**
	(0.000131)	(0.000129)	(0.000142)	(0.000159)	(0.000163)	(0.000163)	(0.000102)	(0.000110)	(0.000148)	(4.79e-05)	(4.82e-05)	(6.72e-05)	(0.000159)	(0.000151)	(0.000158)	(0.000182)	(0.000190)	(0.000192)
Gross Domestic Product		-0.000245	0.000654	0.00101**	0.000975*	0.000967*		0.000564	0.000942	0.00184*	0.00184*	0.00138**		-0.000170	0.000821	0.00106**	0.00101*	0.000999*
		(0.000482)	(0.000543)	(0.000509)	(0.000502)	(0.000512)		(0.000441)	(0.000677)	(0.000873)	(0.000867)	(0.000452)		(0.000481)	(0.000555)	(0.000524)	(0.000521)	(0.000516)
Employability level		0.0128***	0.00280	-0.00282	-0.00355	-0.00361		0.00606***	-0.00215	-0.00157	-0.00181	-0.00296		0.0273***	0.00419	-0.00821	-0.00790	-0.00713
		(0.00397)	(0.00451)	(0.00402)	(0.00406)	(0.00386)		(0.00110)	(0.00184)	(0.00147)	(0.00215)	(0.00238)		(0.00615)	(0.00801)	(0.00893)	(0.00886)	(0.00880)
Level of education			0.000514	0.000306	0.000401	0.000409			0.00140***	0.000263**	0.000286**	-2.00e-05			0.000321	0.000118	0.000151	9.55e-05
			(0.000375)	(0.000332)	(0.000335)	(0.000333)			(0.000148)	(0.000112)	(0.000106)	(9.71e-05)			(0.000501)	(0.000455)	(0.000452)	(0.000449)
Funds transfer				-0.00389**	-0.00432**	-0.00426**				-0.00357	-0.00372	-0.00138				-0.00421*	-0.00411*	-0.00392*
				(0.00194)	(0.00193)	(0.00193)				(0.00295)	(0.00322)	(0.00306)				(0.00230)	(0.00229)	(0.00227)
Internet Penetration level				0.00254***	0.00249***	0.00251***				0.00335***	0.00334***	0.00321***				0.00244***	0.00238***	0.00239***
				(0.000306)	(0.000303)	(0.000306)				(0.000362)	(0.000352)	(0.000496)				(0.000331)	(0.000330)	(0.000327)
Fight against corruption					0.512**	0.513**					0.0456	0.244					0.540*	0.522*
					(0.255)	(0.256)					(0.166)	(0.203)					(0.311)	(0.308)
Country stability level						6.79e-05						0.000825**						0.000585*
						(0.000241)						(0.000286)						(0.000331)
Constant	-0.117***	-0.131***	-0.147***	-0.0355	0.0527	0.0501	-0.0953***	-0.103***	-0.146***	-0.0336	-0.0242	-0.0412	-0.128***	-0.174***	-0.149***	-0.0111	0.0733	0.0913
	(0.0131)	(0.0146)	(0.0157)	(0.0398)	(0.0590)	(0.0588)	(0.00678)	(0.00481)	(0.00731)	(0.0505)	(0.0738)	(0.0577)	(0.0131)	(0.0177)	(0.0227)	(0.0481)	(0.0681)	(0.0682)
Observations	335	307	181	153	153	153	335	307	181	153	153	153	335	307	181	153	153	153
R-squared							0.353	0.371	0.621	0.773	0.773	0.804	0.247	0.296	0.421	0.623	0.632	0.641
Number of id	35	35	29	27	27	27							35	35	29	27	27	27

S o u r c e: table drawn by the authors using Stata V15.

Table 4. Taking into account endogeneity and heteroscedasticity problems

Variables	Financial Inclusion Index							
	2SLS				Lewbel 2LS			
	1	2	3	4	5	6	7	8
Mobile Phone	0.000636***	0.00136***	0.000908***	0.00114***	0.000726***	0.00134***	0.000743***	0.000968***
	(0.000147)	(0.000122)	(0.000257)	(0.000355)	(0.000142)	(0.000119)	(0.000225)	(0.000238)
Gross Domestic Product	-0.00129*	0.000657	0.000949	0.00176*	-0.00120*	0.000649	0.000935	0.00171*
	(0.000726)	(0.000732)	(0.000852)	(0.000950)	(0.000711)	(0.000725)	(0.000840)	(0.000924)
Employability leve		0.00356	-0.00225	-0.00169		0.00375*	-0.00206	-0.00166
		(0.00217)	(0.00238)	(0.00256)		(0.00215)	(0.00234)	(0.00250)
Level of education			0.00130***	0.00113**			0.00150***	0.00134***
			(0.000360)	(0.000486)			(0.000327)	(0.000359)
Funds transfer				-0.00371				-0.00300
				(0.00243)				(0.00213)
Constant	-0.0474***	-0.125***	-0.148***	-0.0912**	-0.0550***	-0.123***	-0.144***	-0.102**
	(0.0132)	(0.0101)	(0.0101)	(0.0438)	(0.0128)	(0.00990)	(0.00975)	(0.0398)
Observations	335	307	181	162	335	307	181	162
R-squared	0.287	0.342	0.620	0.621	0.309	0.346	0.620	0.626
F	12.90	57.85	64.53	45.31	16.58	57.70	64.05	46.92

Standard errors in parentheses ***, significance 1% ; **, significance 5% ; *, significance 10%.

S o u r c e : table drawn by the authors using Stata V15.

This table shows that the level of broadband penetration in a country enables FinTech to be financially inclusive and effective. Other elements such as the political stability of a country and the level of education of the population also favour financial inclusion. However, these results do not take into account the problems of endogeneity and heteroscedasticity of the data. To this end, table 4 below presents the results of the two-stage least squares (2LS) and Lewbel (2012) estimations that take these issues into account.

The results in this table show that, even taking into account possible endogeneity and heteroscedasticity issues, FinTech contributes significantly to improving financial inclusion of people in sub-Saharan Africa.

Conclusion

The objective of this paper was to determine the impact of FinTech on the financial inclusion of populations in sub-Saharan Africa where financial literacy is still low. In this study, financial inclusion was defined as access to financial services at lower costs and FinTech as the application of new technologies in the provision of financial services. However, several studies in Europe and Asia have shown that FinTech to financial services. In sub-Saharan Africa, the level of FinTech penetration is still relatively low and a large proportion of the population is still excluded from the mainstream financial system. Thus, this study sought to make a contribution to understanding financial inclusion through FinTech.

To do so, data were collected on a sample of 35 countries over a period from 2011 to 2020. Estimates were made using two-stage least squares models and the Lewbel (2012) model. It isclear from the results that FinTech contributes significantly to the financial inclusion of people in sub-Saharan Africa. The possession of a mobile phone facilitates the use of financial services. Furthermore, a 1% increase in the number of people using fixed-line phones would contribute to a 0.67% increase in financial inclusion according to the OLS 2LS estimates. In the fixed effect estimates, a 1% increase in FinTech would contribute to a 0.33% increase in financial inclusion. The Driscoll-Kraay (1998) technique consolidated these results by further showing that with 1% of people having access to FinTech tools, there is an improvement in the financial inclusion rate of 0.67%. These results reflect the rapid evolution of technology tools in the financial sector in both developed and developing countries.

However, it can be seen that FinTech is not the only variable that influences financial inclusion in sub-Saharan Africa. The broadband penetration rate, the level of education and the political satiability of a country also have an impact on financial inclusion.

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