Does Financial innovation improve Financial Inclusion in African countries?

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Abstract

This paper aims to investigate the link between financial innovation and financial inclusion as measured by the number of depositors in commercial banks per 1000 adults, and financial innovation, as assessed by the number of ATMs and the ratio of bank credit to the private sector. Cross-sectional data for six African nations from the years 2006 to 2020 were used to specify and evaluate an econometric model based on previous studies. It was performed using the SUR (Seemingly Unrelated Regression) approach. The results demonstrate the beneficial role played by financial innovation in advancing the financial inclusion process in Africa, including the development of new services via ATMs and the issuance of credit to the private sector. Few studies concentrate on the link between financial innovation and financial inclusion, despite the theoretical and empirical literature focusing more on their determinants. This study intends to enrich the field by exploring the link between financial innovation and financial inclusion in six African economies during the period from 2006 to 2020.

Keywords: Financial innovation; Financial inclusion; Fintech; Africa; Cross-sectional data

1. Introduction

International organizations, governments, central banks, and financial institutions are becoming more and more focused on the issue of financial inclusion.
Because there is still little interaction between traditional financial systems and people, financial inclusion (FI) is vital for developing countries (households or businesses).
Ensuring that the majority of individuals can utilize a range of financial services is the objective of inclusive financial systems. To do this, financial innovation is seen as a conduit to FI. Financial innovation includes the creation of new financial products as well as new financial institutions or new payment mechanisms[30].

FI has historically allowed the marginalized community to integrate with the formal financial system. It encourages the majority of families which are those in poverty, to take part in initiatives that promote economic growth and development [38]. The inherent potential of these population groups can encourage economic growth.

Additionally, the issue of FI has received a great attention during the pandemic and post-pandemic periods. On the one hand, the most vulnerable segments of the population suffer the most from the

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economic crisis brought on by the Covid-19 pandemic. On the other hand, the Covid-19 pandemic has encouraged many customers to use online banking services to pay or receive money [1]. Internet users are using digital payment methods more frequently during the pandemic crisis.
Although this transition to digital payments is not entirely unexpected, the current financial crisis has accelerated it. The rigidity of these easy payment alternatives will cause long-term behavior modification for many people, who are driving this revolutionary change of payments due to shifting payment needs and habits [36].

This paper seeks to verify the assumed link between financial innovation and FI in African countries. Consequently, we anticipate that an innovative financial system will advance the progress of FI in African countries.
Thus, the fundamental question of this paper is: To what extent does financial innovation foster financial inclusion in African countries? To put it another way, to what extent does financial innovation contribute to financial inclusion in African economies?

2. Literature review

The use of this digital services is accelerating global mobile inclusion and significantly impacting the rise of financial services in the digital age, in both developing and developed economies, which can have a similar effect on FI.
Furthermore, it has only been a short while since the link between financial innovation and FI became the focus of researchers, many of whom have demonstrated a great interest in examining the impact of FI and financial innovation on a variety of economic aspects.

A. The economy's impact of financial inclusion

FI has received a lot of attention from politicians and academics for several reasons. FI is part of the United Nations 2030 Sustainable Development Goals and is considered a driver of progress [51]; through access to banking services, FI contributes to promoting financial stability, leading to increased bank resilience [24, 50]; also, FI helps to reduce poverty [39] and income inequality in developing economies [33] controlling fiscal policy and economic development [49]; FI helps, as well, to promote economic development [29, 46].
Indeed, policymakers, in various economies, continue to engage significant resources to promote FI strategies in their countries, in order to reduce financial exclusion. These strategies include: (i) the creation of a favorable institutional context, which relates to the business climate, the quality of governance, the protection of investors' property rights and macroeconomic stability, are the basis for promoting financial inclusion [23], (ii) the adoption of regulatory and structural reforms enabling access to innovative financial services [37], (iii) the promotion of economic development, FI is encouraged by greater per capita income [20, 39, 46], (iv) the strengthening of financial education and consumer protection; completion of financial education increases consumption of financial services [6, 10] and (v) utilizing banking services without an agency, based on information and communication technology (ICT), supports IF since ICT revolutionize access to and use of financial services. [15, 17].

B. The economy's impact of financial innovation

Users of online banking are growing at an incredible rate [14]. As a result, the traditional banks' already-solid ecology is becoming unstable.
Due to their cheaper costs and creative technology solutions that raise the quality of services provided to customers, remote banking services stand out [12, 44].
The use of digital financial services frequently demonstrates that improved solutions for regional requirements can be achieved. According to Serval researchers, innovative financial services can boost people's income potential and hence reduce poverty.
Based on their considerable experience, Bara et al [7] confirmed that the implementation of innovative financial services could help to fight poverty and promote economic development in 15 Southern African Development Community (SADC) countries.

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For a sample of 32 countries, the study supported the positive impact of financial innovation on economic growth [8]. Qamruzzaman and Jianguo [42] argued that financial innovation promotes economic growth. In contrast, Bernier and Plouffe [9] found no clear correlation between financial innovation and economic growth.

Moreover, digital financial services can also reduce the cost of receiving payments. For example, in a five-month relief program in Niger, beneficiaries were able to save an average of 20 hours of transportation and waiting time by making monthly government social benefit payments via cell phone instead of cash [3].

Furthermore, Qamruzzaman [40] focused on the role of financial innovation in loan performance. The author claims that the use of innovative financial services promotes the performance of loans made by banks, to the extent that banking financial institutions understand that excessive innovation in the credit portfolio is an important factor in loan performance.

C. Financial innovation and FI: Relationship

According to the World Bank, negative perceptions about banking experiences are one reason why an estimated 2 billion adults worldwide do not have accounts in formal financial institutions. In recent years, there has been a lot of mobility among people entering the financial world as a result of advancements in mobile banking and the spread of digital payment platforms. Additionally, the financial sector is not exempt from the technology invasion since a variety of financial services are provided to satisfy customer expectations.

Payments made on banking apps are facilitating account usage in large emerging economies such as China, where 57% of account holders use mobile to make purchases or pay bills, roughly double the share recorded in 2014 [13].

Although the link between financial innovation and FI has not yet undergone in-depth empirical investigation, recent literature has severely highlighted financial technology as a crucial success factor for achieving FI goals [8, 38].

Allen et al [4] showed that innovation in financial services overcomes infrastructure challenges and improves access to financial system in a few African countries.

Evans [19] analyzed the link between cell phones, internet and FI in Africa, his results confirmed that the use of cell phones and internet, to make payments, have improved access to basic financial services and increased the degree of FI.

Ozili [38] argued that digital finance promotes FI and stability in developing and emerging countries.

Qamruzzaman [43] supported that FI has been achieved through financial innovation, the author argued that innovative products and processes need to be used in the financial system, so the contribution of financial innovation and FI can promote the development and dynamism of financial sector in six countries in South Asia.

The study conducted by Otekunrin et al. [34] on FI in African countries looked at how financial innovation influences the degree of FI using the vector error correction model on a panel of 30 economies from 2004 to 2018. The findings confirm the causal link among financial innovation and FI; they affect each other.

3. Methodology

This study aims to analyze the impact of financial innovation on FI in six African economies.

A. Data and variable

According to the major empirical researchers work that examined the link between financial innovation and FI, the following variables were included in this research:

- Measures of financial inclusion

The empirical literature review identifies two groups of studies relevant to understanding FI. The first group measures FI using the index developed by Sarma [45]. The other group uses a single proxy to measure FI. This empirically study followed the reasoning of the second group of researchers, FI is

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represented by the number of depositors with commercial banks per 1000 adults, this variable has been widely used in previous research [2, 4, 18, 21].

- Measures of financial innovation

There is no agreed proxy to measure financial innovation, thus, over the past decade, researchers have used different indicators to measure it, among these indicators the ratio of broad money to narrow money [7, 16, 40–42], the ratio of bank credit to the private sector [7, 27, 31, 40], Mobile Banking [7, 28], research and development (R&D) spending [8, 9] and also the number of ATMs [11, 22, 32, 48, 52].
According to Laeven et al [30], financial innovation involves both the creation of new financial processes and the introduction of new financial products. Therefore, the measurement of financial innovation should address different aspects of the financial system. This study uses the number of ATMs and the ratio of bank credit provided to the private sector as proxies for the financial innovation variable due to the availability of data for these two variables.
As for the control variable, per capita remittances received was added in the model, the variable relates to personal transfers and compensation of employees, foreign remittances abroad are supposed to promote the demand for innovative financial services and products [43]. Personal transfers concern all current transfers between resident and nonresident population. It is expected that continued flows of remittances into the economy can improve the level of financial inclusion in the economy.

B. Sampl and model specification

This paper attempts to verify whether financial innovation accelerates FI.
Our dataset is a balanced panel of 6 countries in Africa, covering the period 2006-2020. All data are sourced from the World Bank indicators.
For each country we have collected data on financial inclusion (FI), which is captured by the number of depositors with commercial banks per 1000 adults, financial innovation, measured by the number of automated teller machines (ATM) and by the ratio of bank credit to the private sector (CPS), and we also include per capita remittance received (REM) as a control variable.
The study utilizes panel data for six African countries, Morocco, Egypt, Kenya, Mauritius, Namibia, and South Africa, which are ranked among the most innovative in Africa in the Global Innovation Index database published by the World Intellectual Property Organization in 2021, and for which data is available for the period 2006-2020.
The specified model can be written as follows (1):

$$FI_{it} = a_{0i} + a_{1i}ATM_{it} + a_{2i}\,CPS_{it} + a_{3i}REM_{it} + \varepsilon_{it} \quad (1)$$

Where a_i are the coefficients to be estimated and ε_{it} : the error term.
The variables:
FI_{it}: Financial inclusion (FI) for country i in year t.
ATM_{it} : the number of ATMs for country i in year t.
CPS_{it}: the ratio of bank credit to the private sector for country i in year t.
REM_{it} : per capita remittance received for country i in year t.
With N= 6 countries and T= 15 years, the total number of observations is therefore n= 90 (N*T).

4. Results

The following treatments have been performed using overall sample of all countries over the period 2006–2020, which totals 90 observations.

A. Descriptive statistics

Table 1 summarizes the variables' descriptive statistics. The statistical results show great differences between the minimum and maximum values, as the data are aggregated from the samples of different countries.

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Table 1: Descriptive statistics, 2006-2020 (6 countries)

	FI	ATM	CPS	REM
Mean	1109.216	32.00027	54.72333	2.900233
Maximum	2274.500	72.78120	106.2600	10.49380
Minimum	157.5440	2.919400	21.79440	0.004506
Std. Dev	647.0820	21.48619	21.74962	2.957151
Observations	90	90	90	90

Source: developed by us, under Eviews 12

To guarantee the robustness of the estimators, all variables were transformed to logarithms [47].

B. Correlation

The correlation matrix for financial innovation indices and FI is shown in Table 2, and it is positive, while it is negative between the per capita remittance received and financial inclusion.

Table 2: Results of the Spearman correlation test

Variables	LFI	LATM	LCPS	LREM
LFI	1.0000			

LATM	0.8713	1.000000		
	0.0000	-----		
LCPS	0.9322	0.8541	1.000000	
	0.0000	0.0000	-----	
LREM	-0.3495	0.3116	0.3944	1.000000
	0.0000	0.0000	0.0000	-----

Source: Results from Eviews 12

C. Homogeneity tests

The objective is to test whether the panel hypothesis should be accepted. We applied the Hsiao test, which is based on Fisher's statistics. It consists of verifying whether the elasticities of the different FI factors are identical for all countries, or on the contrary, whether there are specificities for each country.

The results of this test, carried out on the software Eviews 12, are presented in the table 3.

Table 3: Results of the Hsiao homogeneity tests

Hypothesis to be tested	Test statistics	Decision
H_0^1 : Complete homogeneity: $a_{0i} = a_0$ and $a'_i = a'$ $\forall$ i	$F_1 = 87.87$	F_1= 62,41 > F (5%, 20, 66)= 1, 73 so we reject H_0^1 then there is an absence of total homogeneity, so we move on to the second test.
H_0^2 : Partial homogeneity: a_{0i} they are specific; $a_{1i} = a_{1i} \ldots a_{10i} = a_{10}$ $\forall$ i ϵ *[1,T]*	$F_2 = 0.02$	F_2= 0.02 < $F_{(5\%,15,66)}$= 1,82 so we accept H_0^2 of homogeneity of the coefficients a'_i
H_0^3 : Partial homogeneity: $a_{0i} = a_0$ $\forall$ i ϵ *[1,T]*	$F_3 = 1.99$	F_3= 4.99 > $F_{(5\%,5,123)}$= 2,28 we reject H_0^3 of homogeneity of the intercepts a_{0i} we obtain an individual effect model.

Source: Results from Eviews 12

Based on the homogeneity tests, we found that the appropriate model for our data types is the individual effects model. Thus, it appears that there are country-specific effects between the six African countries that explain their level of FI, so these models assume that the estimated models

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differ by individual only by the value of the intercept. We will go through the Hausman [25] specification test which will allow us to determine the best model between a fixed individual effects model and a random effects model.

D. Estimation of individual effects models

The following table displays the results of the estimation using the fixed and random effects methods:

Table 4: Results of the individual effects models' estimations

	LFI- fixed effects model	LFI- random effects model
Intercept	-0.584976 (0.5054)	4.172680 (13.42932)***
LATM	0.868780 (11.43994)***	0.316931 (6.232603)***
LCPS	1.186347 (5.618854)***	0.418719 (4.298527)***
LREM	-0.023169 (-0.938210)	-0.054075 (-3.206145)***
R^2	0.842606	0.530126
R^2 $ajust$ed	0.827061	0.513735
F-statistic	54.20411***	32.34258***
Observations	90	90

Source: Results from Eviews 12

The Hausman specification test should be performed to distinguish between the random effects model and the fixed effects model.

E. Hausman test

Hausman test [25] examines the specification for individual effects. The tested hypothesis refers to the correlation between the individual effects, or the model error, and the explanatory variables.
According to table 5, the results of Hausman test give the statistic of χ^2= 159,05, with a probability less than 0,05, which allows us to don't accept the null hypothesis and use the estimators of the fixed individual effects model which are unbiased.

Table 5: Result of the Hausman test

Summary of test		χ^2 value	χ^2. d.f.	Probability
Cross-section random		159.057477	3	0.0000
Variable	Fixed	Random	Var (Diff.)	P-value
LATM	0.868780	0.316931	0.003182	0.0000
LCPS	1.186347	0.418719	0.035090	0.0000
LREM	-0.023169	-0.054075	0.000325	0.0866

Source: Results from Eviews 12

However, to ensure consistency and validation of fixed-effects model results, we will use error diagnosis tests.

F. Diagnostic tests for fixed effects model

Tests on model errors were performed to ensure that the estimate did not violate conventional assumptions. The method was conducted by testing the classical assumptions of the fixed effects model, as shown in table 6.
The autocorrelation test, according to the Breusch-Pagan LM procedure, provides a non-significant probability at the 5% level, which violates the ordinary least squares (OLS) hypothesis concerning the non-autocorrelation of errors.
The test of heteroscedasticity was carried out according to White's procedure, the result obtained confirms the violation of another OLS hypothesis, namely the homoscedasticity of errors. The Jarque-

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Bera normality test shows a non-significant probability at the 5% level; therefore, it was concluded that the error is not normally distributed, and the normality assumption is also violated.

Table 6: Diagnostic test

Diagnostic test	Probability	Conclusion
Breusch-Pagan LM	0.00	Errors are autocorrelated
Test de White tes	0.00	Errors are heteroscedastic
Normality test	0.00	Errors are not normally distributed

Source: Results from Eviews 12

In order to account for various findings from the previous tests, we will re-estimate our model using the generalized least squares estimator on the SUR (Seemingly Unrelated Regression) cross-sectional data.

G. Generalized Least Squares (GLS) estimators

The GLS estimator is an OLS estimator on a transformed model with homoscedastic and autocorrelated errors.

After correcting for heteroscedasticity and auto-correlation, as well as taking into account the contemporaneous correlation, The GLS estimator's findings (Table 7) demonstrate that each coefficient is statistically significant. As a result, the R squared has become 99.21%.

The results are consistent with the signs expected from a review of the previous theoretical and empirical researchers, except for per capita remittance received.

Table 7: Results of the GLS estimator

	LFI- fixed effects model
Intercept	0.500368 (1.250191)
LATM	0.804744 (25.36577)***
LCPS	0.961131 (10.73367)***
LREM	-0.034869 (-6.004059)***
R^2	0.992861
R^2 $ajust$ed	0.992156
F-statistic	1408.213***
Observations	90

Source: Results from Eviews 12

5. Discussion

The econometrics results, derived from generalized least squares estimation, reveal the relationship between FI and variables that measured financial innovation in six African countries. This allows us to identify the factors that promote FI in these countries. These factors are the number of ATMs and the ratio of bank credit provided to the private sector.

Therefore, an increase in the number of ATMs by one unit in these countries leads to an increase in the number of depositors with commercial banks per 1,000 adults of 0.8 units at a significance level of 1%. This means that a high number of ATMs promotes FI in this economies, this finding is consistent with Fernandes et al [22].

Stimulating the speed of the FI process is seen through the availability of financial services via ATMs, which will ensure accessibility and efficiency of services and thus encourage access by vulnerable and marginalized populations. Because ATMs are considered an innovation in the financial sector [5], they are widely used by financial institutions to mobilize cash from accounts held by individuals, or to make remittances.

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Also, the increase in FI level is the result of an increase in the ratio of bank credit provided to the private sector, so an improvement in the ratio of bank credit provided to the private sector of one unit increases the number of depositors with commercial banks per 1000 adults by 0.96 units at a significance level of 1%. The literature shows that bank credit provided to the private sector promotes FI, Otekunrin et al [35] showed that bank credit provided to the private sector is a key factor in promoting the FI process.

In contrast, per capita remittance received exert impacts negatively the FI process; when remittance received increase by one unit, the number of depositors with commercial banks per 1000 adults decrease by 0.03 units at a significance level of 1%. This result does not consistent with the finding of Fernandes et al [22], who confirmed that remittance received can accelerate the speed of FI in South Asia. The authors claim that household remittances encourage them to use banking services like mobile banking and internet banking, etc.

However, it should be noted that the identified factors are common to all countries. Thus, since the model was estimated using panel data approach, each country has specificities that are unique to its FI process. These specificities would reside in the omitted variables, both quantitative and qualitative, and are represented in the country fixed effects.

Many factors can indeed explain the differences observed among the countries included in the study: the high rate of GDP per capita [39, 46]; the significant percentage of urban population [26]; the high number of internet users [46], ect.

6. Conclusion

Throughout our investigation, we looked to verify the supposed link between financial innovation and FI in six African countries.

From this analysis, we have identified a number of findings:

- The first finding is that econometric modeling was conducted on panel data for six African countries over the period 2006-2020. We measured financial innovation by the number of ATMs and the ratio of bank credit provided to the private sector, while FI was measured by the number of depositors with commercial banks per 1000 adults. The results indicate a significantly positive relationship between the two variables of financial innovation and FI. Indeed, an increase in the number of ATMs and also the ratio of bank credit to the private sector improves the FI process in these countries.
- The second finding is that according to the estimation results, the coefficient of the ratio of bank credit provided to the private sector (0.96) is greater than that of the number of ATMs (0.80), this shows that the process of FI improves with more bank credit provided to the private sector, so the granting of credit explains the easy access to financing by companies, all sizes, which are the engine of economic growth especially in developing countries.

From the findings discussed above, the following recommendations are drawn:

. FI is a process that enables individuals to access financial services, such as savings, investment, borrowing and insurance [4, 38], it is the provision of credit to the private sector, with innovative processes or products, that advances FI;

. On the supply side, FI is promoted through access to financial services through traditional channels: branches and ATMs. To this end, increasing the number of ATMs that provide customers with innovative services (ATM bill payments) can certainly accelerate the FI process in these countries;

. The financial innovation process, adopted by African countries, should not only focus on promoting FI, but also aim to promote financial market development then to stimulate economic growth in these countries;

. In addition to these innovation factors, other regulatory, social and cultural factors must be addressed in order to advance the process of FI in these countries. Additionally, the system for training employees needs to continuously adapt to changes in digital technology, the need to put in place appropriate consumer protection strategies and policies, and the requirement that governments protect consumers globally and establish regulations to ensure that financial markets operate in the best interests of all. Moreover, in order to encourage consumers to make good financial decisions and

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exercise their rights, financial literacy initiatives must educate consumers about these financial services.

It is true that African countries have followed a number of financial reforms in recent years, but the results remain below expectations.
In this regard, few studies have examined how financial innovation affects FI in Africa. This study has provided a clear perspective on the beneficial effects of financial innovation on FI in Africa. Therefore, government officials in these countries should invest more in building innovative financial infrastructure to advance the process of FI.

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