Digital Inclusion and Financial Sector Growth in Selected African Countries

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Abstract
Many countries, including African nations, are now embracing to modern technology and digitalisation of their economies through internet resources. This study seeks to determine whether digital inclusion contributes to the growth of financial system in African countries by examining both money and capital market variables. The study obtains data from World Bank Development Indicators and the international Monetary Fund database for 8 African countries accross the four regional blocks from 2000 to 2022. The FMOLS technique is employed to perform multiple regressions of financial sector variables on digital inclusion variables. Findings indicate that the proportion of internet users has positive and significant effect on commercial bank branch expansion in the money market and market capitalisation in the capital market. Mobile cellular subscriptions are also found to have apositive and significant effect on commercial bank branch expansion and stock traded. Additionally, the deposit interest rate has positive and significant effect on credit to private sector in the money market and market capitalisation in the capital market, while it is insignificant effect on commercial bank branch expansion and stock traded in the stock exchange. The study recommends that digital infrastructure should be upgraded in African countries to meet global requirements in order to maximise financial sector's potential benefits from worldwide digitalisation and technological transformation.

Keywords: Digital Inclusion, Money Market, Capital Market, Financial Sector, Digital Infrastructure

Introduction
Many countries of the world including African nations, increasingly embracing open to modern technology and digitalisation of their economies through internet resources. The internet and technology, with thei multiple applications and uses, are creating more opportunities in almost all human endeavours such as economic, political, cultural, social and so on (Dominguez, 2023). Online connectivity enables the right and the ability to access basic human services such as health care, economic and personal development opportunities, skills development, and education for all (ITU, 2022).

Traditional financial services hitherto being practised in the financial sector were characterised by poor monitoring of the regulatory system and the money market characterized by banks with low capital base and operational inefficiency. The capital market, on the other hand, was characterized by poor infrastructure, high cost of transaction, low capitalization, long delays in settlements, and poor investment attitude of buy-and-hold. Also, the insurance firms were poorly capitalized and found it difficult to manage risks, and thus had negligible impact on activities in the capital market. The financial system as a whole was unable to attract substantial foreign investment and adequate capital needed to facilitate economic growth and development. Other potential hindrances to digital inclusion in the financial sector of African economies include but not limited to wide existence of low-level of formal financial services, low per capita income, financial illiteracy, underdeveloped technology, weak infrastructure and so on (Emefiele, 2022). The increasing use of computers and the internet in the 1990s and early 2000s has given rise to physical access to technology globally. This has affected the way businesses are being conducted in all sectors, including the financial sector of economies globally.

In this digital age, African countries are taking advantage of internet resources to grow and sustain their economies. The rapid global use of internet (digitalization) in all works of life (work, education and social life) engenders economic development in Africa (Ighodaro, 2021). Mobile money services, internet banking, and other financial services are now being practiced in the financial sector of the regional economies to grow the sector. Households, businesses and government institutions are now making use of internet facilities for efficient day-to-day activities. (Ighodaro, 2021). However, the growth of digital inclusion is still considered low in Africa when compared with what obtainable in the developed economies. This is due to dearth of enabling infrastructures and low level of digital education among the citizens. Digital inclusion is defined as "equitable, meaningful, and safe access to use, lead, and design of digital technologies, services, and associated opportunities for everyone, everywhere" (ITU, 2022). In other literature, digital inclusion is defined as the policies and programmes that provide access to the internet regardless of race, gender, income or ability. These definitions have brought out some elements namely: i) affordable, robust broadband internet service, ii) internet-enabled devices that meet the needs of the user, iii) access to digital literacy training, iv) quality technical support and v) applications and online content designed to enable and encourage self-sufficiency, participation and collaboration. Digital inclusion is also a form of social inclusion in this digital age. It broadly refers to the concept of ensuring all individuals and communities in society have equal opportunity and ability to access and effectively use digital technologies. Digital technologies in this wise, include software and hardware for different information and communication technologies (ICTs), the internet, relevant content, and services as well as the skills and knowledge required for effectively using these concepts (Nguyen, 2022).

The right word to describe these digital activities in the financial sector is 'fintech'. Fintech is a combination of finance and technology. It describes the use of technology to deliver financial services and products in banking, insurance, investment and other services that relate to finance (IMF,2022). Thus, the internet combined with the widespread use of mobile phones and computers is revolutionizing the financial sector in both developed and developing economies. Various applications under this fintech include virtual bank account opening, linking smartphones with bank account for transaction monitoring, use of ATM by bank

account holders, cash withdrawal, deposit or make payment to a third party (IMF, 2022). This promotes increased efficiency in the financial sector through improving speed of payments, reduction in costs of transfer and receiving payments. Transparency in the financial sector is also guaranteed using digital technology which has tendency to reducing corruption appreciably in financial transactions and thus ensuring the growth of the financial system (Ferrata, 2019; Ojediran & Emiola, 2024).

Digitalization of the Nigerian commercial bank has brought about new models in businesses, that is, new ideas with regards to development and improvement in various areas, from mobile banking to financial transactions and internet banking. This has continued to grow and supplant the conventional banking services to the customers through innovative technologies to meet the developing complex necessities and challenges of globalization. The Nigerian banking and financial sector have experienced radical changes and improvement over the last few years and is in a consistent state of development (Abbasi and Weigand, 2017). Globally, stock markets have also expanded, and emerging markets have observed massive market booms over the years. Emerging markets in Africa, especially Sub-Saharan Africa experienced benefit of markets boom. New markets were created in Swaziland, Malawi, Ghana, Zambia and Uganda in recent years. By 1989, only five stock markets existed in sub-Saharan Africa with three in North Africa and two in the south western Africa. Currently, there exists over 29 stock markets in the African continent. Economically, stock market development encourages financial liberalization programs in sub-Saharan African (SSA) states. Various studies equally attributed the growth of the sector to digitalization and technological development in the industry (Emiola, 2023). Individuals subscribe to shares and stocks, firms borrow from this market to fund investments, all based on the ability to monitor the activities in the market on daily basis. This is enabled through the internet and their phones and other forms of digital transmission of the market activities as well as digital tracking of values of their investments.

Trends of major infrastructures needed for efficient digital financial inclusion in electricity, mobile phone and internet usage had been on the increase since year 2000 in African countries. Although, when these infrastructures are compared with other regions of the world, African countries are still far from what is required to achieve economic growth and development (Ighodaro, 2021). There has been a gap in extant literature regarding the nexus between individual sectors of African economies, economic growth and development. Most of the past research works had been on aggregate real sectors' effect on Africa's economic growth. It is becoming clearer in the past two decades that all activities to transit to higher economic growth and development is dependent on the growth and sustainability of the financial sector in the developed and developing countries. A healthy and sound financial sector impacts positively on all other sectors of the economy. This includes increased access to financial transactions, diversification, industrialization and information dissemination among the citizens. (Iganiga, 2019). Since empirical studies are limited on the nexus between digital inclusion and financial growth in African countries, this research examines the effect of digital inclusion on financial sector variables such as commercial bank branch expansion, credit to private sector and bank deposit interest rate in the money market and market capitalization and stock traded in the capital market in eight (8) selected African countries.

Literature Review

Chinoda and Kapingura (2023) explored the following variables as index of digital financial inclusion: z-score, Herfindahl–Hirschman Index (HHI), and non-performing loans to examine the impact of digital financial inclusion and bank competition on bank stability in Sub-Saharan Africa for the period 2014 to 2020 using the two-step Generalised Method of Moments (GMM). Their findings revealed that digital financial inclusion has a significant and positive relationship with bank stability (z-score) and a negative relationship with non-performing loans. The study also found a significant negative effect of bank competition (HHI) on bank stability for the period under review. Recommendations of the authors included education in digital financial literacy for all, policy strategies and bank competition to make the banks to be insolvent. Banna (2020) used principal component analysis, a two-step dynamic system generalised method of moment analysis, ordinary least square, and panel-corrected standard error approaches to investigate the nexus between digital financial inclusion and bank stability in ASEAN countries. The empirical study finds that digital financial inclusion accelerates ASEAN banking stability, which not only reduces bank default risk but also increases financial mobility in the region, using an unbalanced panel data of 213 banks from 4 ASEAN nations. The findings also imply that by implementing digital financial inclusion, ASEAN banks will be able to maintain banking sector stability by decreasing liquidity crises and non-performing loans in the post-COVID-19 future.

The impact of digital financial services on financial inclusion in Africa had also been researched on. Data from the Global Findex database was used to examine the extent to which digital financial services have increased access to financial products, particularly among women and rural populations. Findings indicate that digital financial services have had a positive impact on financial inclusion across Africa, particularly for women and rural populations. Countries with higher penetration of digital financial services experienced greater improvements in financial inclusion metrics. It was however observed that the benefits of digital financial services were unevenly distributed, with the elderly and less educated, who are still facing significant barriers to access (Demirgtic-Kunt, Klapper and Singer, 2020).

In related research, that focused on Nigeria, Ogujiuba and Emeka (2020) analysed the role of fintech in promoting financial inclusion. Econometric models were utilized to assess the impact of fintech innovations on financial access, particularly, for undeserved communities. Findings revealed that fintech innovations in Nigeria have significantly enhanced financial inclusion by providing alternative financial services to the undeserved population (unbanked and underbanked populations), through mobile platforms and digital wallets. It is however worthy to note that the research emphasized the fact that, despite the recorded positive impact of fintech innovations, regulatory hurdles, cybersecurity concerns and digital literacy gaps are barriers to further enhance fintech driven financial inclusion. The relationship between digital inclusion and financial sector development in Rwanda was researched upon by Nkurunziza and Bizimana, (2023). A mixed method approach was utilized by combining quantitative analysis of financial access data with qualitative data from interviews of stakeholders. Findings indicate that Rwanda's digital inclusion initiatives have led to substantial growth in the financial sector. It was emphasized that, the government's proactive policies on promoting mobile banking and digital payment systems were crucial in driving growth in Rwanda's financial sector. However, this research emphasized the need for better digital infrastructure and more comprehensive

financial education to Rwandans in thus sustaining long-term financial inclusion among the general populace.

A comparative study on Ghana and South Africa on the economic impact of mobile banking services on financial inclusion and economic growth had been conducted. A difference -in -difference methodology was utilized. Findings showed clearly that mobile banking had a positive impact on economic development in both Ghana and South Africa. In Ghana for instance, mobile banking led to increased savings rates and investments in small businesses, thus positively impacting economic growth of the country. On the other hand, mobile banking services reduced transaction costs and improved access to financial services for low-income households. The study identified the importance of addressing the issue of disparities in access and usage of mobile banking services between urban and rural areas (Aker and Mbiti, 2023). Taiwo & Agwu, (2017) investigated the role of e-banking on the operational efficiency of commercial banks in Nigeria. Utilizing primary data obtained by administering questionnaire to the staff of four selected banks (Ecobank, UBA, GTB and First bank), Pearson Correlation Coefficient was adopted to analyze the data. Results indicated that banks' operational efficiency in Nigeria since the adoption of electronic banking has improved compared to the era of traditional banking. This improvement was noticed in the strength of banks, bank branch expansion, revenue and capital bases, as well as customers' loyalty. It was concluded that introduction of new channels into the e-banking operations drastically increased bank performances, since the more the active customers are with their electronic transactions, the more profitable it is for banks.

Okonkwo, Obinozie & Echekoba (2017) conducted an investigative analysis on the impact of information communication technology and financial innovation on performance of Nigerian commercial banks. The study was based on eleven selected deposit money banks in Nigeria. The study adopted secondary source of data extracted from banks' annual reports and CBN Factbooks from 2001 to 2013. Ordinary Least Square estimation was adopted in data analysis. The results showed that banking innovations did not really improve performance of Nigerian commercial banks. Also, e-banking service shows a positive impact on bank's performance, but not significant. This finding indicates that investment in e-banking services did not necessarily increase commercial banks profitability proportionately while ATM's usability is negative and not significant. This finding indicated that use of ATM did not necessarily influence commercial banks performance in Nigeria. This might result to liability on the part of host banks. Asidok & Michael, (2018) investigated the impact of ATM transactions on bank profitability in Nigeria. Selected banks data were obtained from electronic payment system and Nigeria's Central Bank Statistical Bulletin. Panel unit root and SURE model estimation technique were employed to conduct quantitative analysis for four selected old and new generation banks. The positive and statistically significant relationship found existing between ATM of old and new generation banks in Nigeria indicate that ATM is a major factor that contributes to old and new banks performance in Nigeria. The significant relationship between POS of old and new generation bank in Nigeria point out that POS is a major factor that adds to old and new banks profitability in Nigeria. The positive and significant relationship between mobile banking of old and new generation banks and bank performance in Nigeria indicate that mobile banking is a major factor that contributes to old and new banks performance in Nigeria

Shena et al (2021) used data of the World Bank and the International Monetary Fund to calculate the index of digital financial inclusion and measure the level of digital financial inclusion in 105 countries. Result showed that digital financial inclusion has a significant and positive effect on economic growth in the selected countries under study. Such positive effects are also felt in neighboring nations. Considering the role of institutions and governance on the digital financial inclusion and economic growth nexus in Sub-Saharan Africa (SSA) from 2014 to 2020, Chinoda and Kapingura (2024) employed generalized method of moment (GMM) technique for analysis. The empirical results showed significant and positive effect of institutional quality and governance on the digital financial inclusion-economic growth nexus in SSA. It was also found out that the effect of trade and population growth on economic growth was significantly positive. Gundogdu & Taskin (2017) investigated the relationship between financial innovation and performance of Turkish banking system. The study covered the period of 2006 and 2015 utilizing secondary data. Ordinary Least Square inferential statistics was used to analyze relationship between financial innovation and performance of Turkish banking system. It was found out that only credit card usage had a significant impact on return on asset (ROA), return on equity (ROE) and net interest margin (NIM). The positive impact on ROA and ROE imply that credit card usage increases profitability and thus performance of banking system. However, positive impact on NIM shows that banks charge their customers for their credit card usage, which is probably due to excessive utilization of credit cards by customers. The results also propose that online banking and ATM usage did not have substantial bearing on performance and concluded that managers of banks should deploy strategies to improve the usage of these delivery channels to reduce their costs and therefore increase performance. Ahmad ET AL. (2021) researched into the digital financial inclusion and economic growth nexus in China. The researchers result showed positive impact of digital financial inclusion on economic growth in China. Focusing on the internet as a foundational technology, Sharp (2022) summarized recent developments in digital inclusion theory as it relates to developing countries. The framework of core components of digital inclusion which included access/ use, quality of access, affordability, and digital skills among the users were outlined. Recommendation to policy makers identified the improvement of policies needed to accelerate digital inclusion in the financial sector of the economy.

It is clear from the reviewed studies that there is a dearth in the literature that specifically focuses on the relationship between digital financial inclusion, bank competition and bank stability in Sub-Saharan Africa. The concept of digital financial inclusion has become the catchphrase in the field of financial economics research, but its link with bank competition and bank stability is one novel contribution of this paper. Considering the debate that submits that global digital financial inclusion is an essential avenue and a game changer in ascertaining progress towards the accomplishment of the United Nations Sustainable Development Goals (SDGs), particularly in developing countries, this paper focuses on digital financial inclusion, bank competition and bank stability in Sub-Saharan Africa where a considerable number of adults remain unbanked. Specifically, the analysis of the combined impact of digital financial inclusion and bank competition on bank stability is rare to the best of our knowledge.

Methodology

The panel co-integration regression method of model specification is adopted in this study. This method allows a set of pooled time series data to be modelled simultaneously. Traditionally it involves a substantial degree of sacrifice in terms of the permissible heterogeneity of the individual time series. In order to ensure broad applicability of any panel co-integration test, it will be important to allow for as much heterogeneity as possible among the individual members of the panel, Pedroni (1999). In its most general form, the panel cointegration model is specified as:

$Y_{it} = \alpha_i + \delta_i t + \gamma_t + \beta_i X_{it} + \mu_{it}$ ……. (1)

Where;

Y_{it} = observable time series panel of dependent variable

X_{it} = observable time series panel of independent variables

i = panel component = 1, 2……..N

t = time series component = 1, 2……..T

The variables Y_{it} and X_{it} are assumed to be integrated of order one, denoted I(1), for each member i of the panel, and under the null of no co-integration the residual will also be I(1), in which case we refer to (1) as the spurious regression. The parameters α_i and δ_i of the model in (1) above allow for the possibility of member specific fixed effects and deterministic trends respectively while γ_t will allow the possibility of common effects that are shared across individual members of the panel in any given period. In general, the slope, coefficient β_i will be permitted to vary by individual, though the study will also consider the special case in which it takes on a common value for all members. In keeping with many panel data models, we will assume that the underlying error process can be decomposed into common disturbances that are shared among all members of the panel and independent idiosyncratic disturbances that are specific to each member i. Specifically, let $Z_{it} = (Y_{it}, X_{it})$ such that the process is generated as:

$Z_{it} = Z_{it-1} + \varphi_{it}$ …….. (2)

And $\varphi_{it} = (\varphi_{it}^{y}, \varphi_{it}^{x})$ is conditional on any common effects.

The main objective of this study is to determine the extent of digital inclusion's effectiveness in driving financial sector growth in African countries. To achieve this, we fit an empirical model following the Pedroni (1999) above to model financial sector growth as a function of digital inclusion. The model is adopted and modified to be in line with the objective of this study. The relationship between digital inclusion and financial sector growth is therefore modelled and fitted as:

$Y_{it} = \alpha_i + \beta X_{it} + \mu_{it}$ ……..……..……. (3)

$X_{it} = X_{it-1} + \varphi_{it}$ ……..……..…...…….... (4)

Where:

Y_{it} (CBB, CPS, MC and ST) = X_{it} (β_1RGDP, β_2PIU, β_3MCS, β_4DEPRAT, β_5TO) ….. (5)

Equation (5) is a panel member co-integrating vector of the dependent and the independent variables, with cointegrating vector β.

Y_{it} = dimensional vector of regressand which is integrated of order one

X_{it} = dimensional vector of regressors, which are not co-integrated with each other.

α_i = the intercept which allows the co-integrating relationship to include member specific fixed effects.

$\varphi_{it} = (\mu_{it}, \lambda_{it})$ is the vector error process which is stationary with asymptotic covariance matrix.

In the study, our dependent variable is financial sector growth comprising commercial bank branch expansion (CCB) and credit to private sector (CPS) representing the monetary sector, and stock market capitalization and stock traded ratio at the stock market representing the capital market. We measure stock market capitalization by the size and the liquidity level of stock market. The size is measured by the market capitalization ratio, which equals the value of listed shares divided by the gross domestic product (MC). The second indicator used is the stock traded ratio, which equals the total value of shares traded on the stock exchange as a ratio of gross domestic product (ST). The independent variable is digital inclusion (proxied by proportion of internet users as a ratio of gross domestic product (PIU) and mobile cellular subscription also as a ratio of gross domestic product (MCS)). It is believed that in addition to digitalization variables (PIU and MCS) having effects on financial sector development variables (CCB and CPS), other variables could have great impact on financial sector development. The omission of these variables could bias the relationship between digital inclusion and financial sector development. In view of this, we included three control variables, including Real GDP, deposit interest rate (DEPRAT) and trade openness ratio (TO) to avoid simultaneous bias in our regressions (Gujarati, 1995). Real GDP is the growth of the economy, interest rate is central to financial sector operations while trade openness is to reflect the openness of the economy to worldwide globalisation. The data for all the variables and for all the countries were obtained from World Bank data base, World Bank Development Indicators (2024).

Data and Data Sources

The study is carried out on eight African countries for the period 2005–2022. These countries are Morocco, South Africa, Nigeria, Kenya, Ghana, Mauritius, Egypt and Zambia. The choice of these countries was determined primarily by the digital life of the people of different countries of Africa. The 5th annual digital quality of life (DQL) index constructed by Surshark International ranks countries of the world in terms of best digital quality of life. The best countries within rank two to three in the index in each region of North, West, East and South Africa are considered appropriate for this study. However, this is subject to our variable data availability.

Estimation Technique and Procedures

To investigate our study objective, we used the Fully Modified Ordinary Least Squares (FMOLS). The FMOLS method was originally developed by and traced to Phillips and Hansen (1990) for the estimation of a single cointegrating relationship that has a combination of I (1). We chose this technique especially for its advantage over the simple OLS and other common estimation techniques. For instance, the FMOLS tends to perform better than the OLS in terms of consistency, especially in the presence of large sample bias. Furthermore, the estimates of the OLS may suffer problems of heteroscedasticity and serial correlation due to the possibility of omitted dynamics captured in the residual influencing the model performance and likely affecting the true state of the standard errors. However, the FMOLS can solve this problem and provide accurate results by adding leads and lags that account for this likely problem of endogeneity and serial correlation. Rukhsana and Shahbaz (2008) state that the FMOLS is

important for achieving asymptotic efficiency due to its ability to modify the ordinary least squares to account for the effects of serial correlation in the regressors that result from the existence of cointegrating relationships.

Data Analysis and Results

Panel Unit Root Test

Table 1 above shows the result of panel unit root test of stationarity. The test was conducted without intercept and trend by using Levin, Lin and Chu (LLC) and Im, Pesaran and Shin (IPS) panel unit root test options. The choice of the LLC and IPS is to allow for comparison of results. The estimated results show that for both LLC and IPS, all the variables are not stationary at levels because the probability values for the estimates are greater than 5 per cent. This implies that the null hypothesis that the variables contain unit root cannot be rejected. At first difference however, the estimated probability for the estimates are less than 5 per cent, implying that the variables are stationary. Hence, all the variables are integrated of order one (I (1)). The presence of unit root in the variables implies that the variables may be co-integrated. Hence, a test of co-integration was conducted to confirm whether or not a long-run relationship exist among the variables of the study.

Table 1: Panel Unit Root Test

Variable	LLC At level	LLC 1st Diff	IPS At level	IPS 1st Diff	Remark
CCB	3.554 (1.000)	-26.35* (0.000)	2.129 (1.000)	-2.337* (0.000)	I(1)
CPS	8.215 (1.000)	-35.72* (0.000)	9.948 (1.000)	-25.16* (0.000)	I(1)
MC	0.814 (0.575)	-24.52* (0.000)	-1.127 (0.586)	-21.34* (0.000)	I(1)
ST	8.159 (1.000)	-16.68* (0.000)	10.01 (1.000)	-27.62* (0.000)	I(1)
PIU	0.4812 (1.693)	-14.04* (0.000)	0.4463 (0.6721)	-17.67* (0.000)	I(1)
MCS	0.4731 (0.6892)	-16.41* (0.000)	0.2310 (0.5931)	-19.24* (0.000)	I(1)
RGDP	-1.083 (0.0885)	-41.65* (0.000)	10.62 (1.000)	-3.033* (0.032)	I(1)
DEPRAT	2.413 (1.000)	-13.31* (0.000)	1.913 (1.000)	-15.31* (0.000)	I(1)
TO	2.051 (1.000)	-14.07* (0.000)	3.891 (1.000)	-18.22* (0.000)	I(1)

Panel Cointegration result

The Pedroni (2004) panel cointegration techniques reports a combination of various test statistics in two categories, namely the group statistics and the panel test statistics. Following the outcomes of the group and panel statistics, conclusions about cointegration status are drawn based on seven (7) individual test statistics: the rho statistics, the panel v-statistics, the PP-

statistics, the ADF-statistics, the group PP-statistics, the group ADF-statistics, and the group rho statistics. The outcomes of the test are reported in Table 2.

Table 2: Panel Co-integration: H_0 = No co-integration

Pedroni Residual Cointegration	Statistic	Prob	Weighted Statistic	Prob
Panel v-Statistic	5.405	0.000	1.265	0.103
Panel rho-Statistic	-4.224	0.000	-3.265	0.0005
Panel PP-Statistic	-4.915	0.000	-5.445	0.000
Panel ADF-Statistic	-10.50	0.000	-7.007	0.000
Group rho-Statistic	-1.093	0.137		
Group PP-Statistic	-4.354	0.000		
Group ADF-Statistic	-7.591	0.000		

Table 2 shows the result of panel co-integration. The test was conducted both for "within and between dimensions". The result shows that all the panel statistics and group statistic, except panel v-weighted and group rho, are significant as revealed by their probability values. In other words, in a list of eleven statistics, nine statistics reject the null hypothesis of no cointegration at 5% levels of significance. On this basis, it is logical to conclude that the variables of the study are co-integrated. Hence, the variables have a long-run equilibrium relationship. In other words, they move together over the long run in a balancing manner.

Results of Panel Fully Modified Ordinary Least Square (PFMOLS)

Having established that the variables are stationary and exhibit long-run cointegration in the previous subsections, the study proceeds to estimate the long-run impact of digital inclusion on financial sector growth in African countries using the Panel Fully Modified Ordinary Least Squares (PFMOLS) estimator. The choice of the PFMOLS over Ordinary Least Squares (OLS) estimator is based on the fact that it has the dual advantage of correcting for both serial correlation and potential endogeneity problems that may arise when the OLS estimator are used. We estimate four models, one each for the variables of dependent variable – commercial bank branches, credit to private sector (both in the money sector), and market capitalization and stock traded in the stock exchange (both in the capital market).

Table 3 shows the estimated results for fully modified ordinary least square (FMOLS). In the commercial bank branch equation, the long run FMOLS result shows that the coefficient of our main variables of interest, proportion of internet users and mobile cellular subscriptions are positive and significant at 5% level of significance. This means that a high level of each of proportion of internet users and mobile cellular subscriptions is associated to high level of commercial bank branch expansion

in African countries. This result is in line with a priori expectation. Also, these results are in conformity with the results of some studies that support the positive links between digitalization and financial sector growth (e.g. Jack and Suri, 2023; Ogujiuba and Emeka, 2022). Real GDP growth is also found to be positive and significant, the growth of the economy impacts positively on bank branch expansion. Deposit interest rate has an expected negative sign, but it is not significant, so also, trade openness is not found to be significant in the model.

Table 3: Results on Fully Modified Ordinary Least Square

Regressand	RGDP	PIU	MCS	DEPRAT	TO
CBB	0.087* (2.132)	2.620* (4.808)	0.522* (4.629)	-0.001 (-1.304)	0.522 (1.412)
CPS	1.268* (4.481)	-1.165 (-1.123)	0.243 (1.231)	4.793* (3.412)	0.352 (0.925)
MC	0.0167 (0.3266)	2.001* (2.269)	1.346 (1.103)	0.197* (4.627)	2.237 (0.734)
ST	-1.268* (-4.123)	1.823 (1.112)	-0.034* (-3.041)	4.314 (1.426)	0.331* (2.891)

*indicates significant at 5%. T-calculated in parenthesis. Author's computation 2024

For the other money market variables, the long run FMOLS result shows that the coefficient of the variables of interest, proportion of internet users and mobile cellular subscriptions in the credit to private sector model are not significant at 5%. This suggests that changes in each of proportion of internet users and mobile cellular subscriptions has no effect on credit to private sector in African countries. Although this result contrasts the a priori expectation, mobile cellular subscriptions' result is in conformity with the results of some earlier studies supporting non-significance of economic digitalization's effect on financial sector growth (e.g. Okwonkwo, Obinozie and Echekoba, 2017). Real GDP growth is however found to be positive and significant. This implies that the growth of the economy impacts positively on credit to private sector. Deposit interest rate is also significant but it is positive, contrary to the expected negative sign. Trade openness is again not significant. In the case of capital market model, the market capitalization's long run FMOLS result shows that the coefficient of one of the main variables of interest, proportion of internet users is positive and significant at 5% level of significance. This means that a higher number of proportions of internet users is associated with an expansion in stock market capitalization in African countries. This result is in line with a priori expectation. Mobile cellular subscriptions is rather not significant in the model. Deposit interest rate is significant but it is positive contrary to expectation. Increase in deposit interest rate in the money market is found to have a positive effect on market capitalization in the capital market as against a negative sign. Real GDP growth and trade openness are not significant. In the last model, the second capital market equation, the result shows that the coefficient of mobile cellular subscriptions, a digital inclusion variable is significant at 5%, however its sign is unexpectedly negative. This translates to the fact that, a higher level of mobile cellular subscriptions, is associated with a reduction in the level of stock traded in the stock market in African countries. This is an unexpected result. Real GDP growth is found to

be significant but with a negative impact on stock traded. Trade openness is found to be significant and positive indicating increasing trade openness to other countries of the world is leading to increased stock traded in the capital market. This is really in line with expectation. Deposit interest rate is not significant as expected.

Conclusion and Recommendations

This study investigates the effects of digital inclusion on financial sector development in African countries. It samples 8 African countries based on 2023 Surfshark's International annual digital quality life index. Financial sector development is captured with commercial bank branch expansion, credit to private sector (both in the money market) and market capitalisation and stock traded in the stock exchange (for the capital market). Digital inclusion variables are proportion of internet users and mobile cellular subscription. Panel Fully Modified OLS technique of analysis is employed to find the effects of digital inclusion on financial sector. The results show that the proportion of internet users has positive and significant effect on commercial bank branches expansion in the money market and on market capitalisation in the capital market. Mobile cellular subscription is also found to be positively and significantly affecting commercial bank branches and stock traded in the stock exchange. Deposit interest rate has positive and significant effect on credit to private sector in the money market and on market capitalisation in the capital market, while it is insignificant in its effect on commercial bank branch expansion and stock traded in the stock exchange.

The study, therefore, recommends that in line with the significance of digitalization in both the money and capital markets in African countries, digital infrastructure should be upgraded in these countries to meet global requirements. This will maximize financial sector potential benefits from worldwide digitalisation and technological transformation. In addition, ICT consultation and professional advice to participants in the financial sector, particularly banks and stock exchange should be made available at a minimal cost. This will go a long way in improving digital service delivery to customers in both the money and the capital markets.

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