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## Article

# Does digitisation determine financial development? Empirical evidence from Africa

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## Does digitisation determine financial development? Empirical evidence from Africa

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### ABSTRACT

Africa is investing and recalibrating its digital infrastructure in the financial and other sectors to support economic growth and development. It is in light of this, the study seeks to examine from an empirical perspective whether digitisation has a significant role in financial development in African countries. Specifically, the study employed macroeconomic data on Africa from World Development Indicators (WDI) from the period of 2000-2021. The data covers all the 54 African countries. Bayesian Panel Vector Auto-Regression (BPVAR) was adopted to estimate the parameters involved in the study objective. The results indicate that digitisation helps to increase financial inclusion, reduce transaction costs, and promote the development of new financial products and services, all promoting financial development and exploiting its allied opportunities. The findings also suggest that other factors such as infrastructure, financial inclusion, economic development, institutional quality, and government support are important for the development of the financial sector and should be addressed in conjunction with digital innovation. Policymakers in Africa should take note of these findings and work to create an enabling environment that supports financial sector development. Efforts to improve institutional quality, governance, and infrastructure can help to create a more conducive environment for financial development. Overall, the study suggests that digitisation has the potential to improve financial sector development in Africa, and can play a key role in mitigating financial risk, improving financial sector efficiency and harnessing the opportunities that abound in the financial sector.

### IMPACT STATEMENT

There are currently encouraging efforts in place by African leaders to digitise almost every sphere of the African economy as a result, Africa is witnessing rapid development in the digital front especially in the financial sector. It is in the light of the aforementioned, the study examined from an empirical perspective whether digitisation has a significant role in financial development in African countries. The results indicate that digitisation helps to increase financial inclusion, reduce transaction costs, and promote the development of new financial products and services, all promoting financial development and exploiting its allied opportunities. The findings also suggest that other factors such as infrastructure, financial inclusion, economic development, institutional quality, and government support are important for the development of the financial sector and should be addressed in conjunction with digital innovation. The study is advocating for policymakers in Africa to take note of these findings and work to create an enabling environment that supports financial sector development. Efforts to improve institutional quality, governance, and infrastructure can help to create a more conducive environment for financial development. Overall, the study suggests that digitisation has the potential to improve financial sector development in Africa, and can play a key role in mitigating financial risk, improving financial sector efficiency and harnessing the opportunities that abound in the financial sector.

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## Introduction

The financial sector is an essential mechanism for facilitating transactions, mobilising savings, allocating capital, and managing risk (Rani et al., 2023). Financial development is a critical factor in promoting growth and development, especially in developing regions such as Sub-Saharan Africa (SSA), through the facilitation of savings allocation towards productive investments (Ibrahim, 2017). Nevertheless, the efficient allocation of resources through effective intermediation, which is enabled by digital infrastructure, is not enough for mere savings mobilisation (Otchere et al., 2017). Financial development promotes the exchange of commodities and services, enables the production of investment information, oversees corporate governance, and facilitates trading and risk management, according to Evans et al. (2019).

To revive their economies, SSA nations implemented structural adjustment programmes in response to the economic crises of the 1970s and 1980s (Graham, 1996). Financial liberalisation, which signified a transition to more efficient and transparent financial systems, arose as an essential element of these initiatives. Numerous development economists assert that the liberalisation of financial systems encourages domestic investments and savings, thereby improving the efficacy of capital allocation (Graham, 1996). As a result, initiatives to foster economic expansion and progress in the area incorporated financial sector reforms as a fundamental component (Otchere et al., 2017). There is an increasing focus on utilising digital infrastructure to propel the development of the financial sector as economies in Sub-Saharan Africa (SSA) progress (Alagidede et al., 2020). The financial sector's integration of Information and Communication Technology (ICT), which encompasses digital currency exploration and mobile money transactions, is indicative of a more extensive digitalisation trend in Sub-Saharan Africa (IMF, 2022).

African nations have initiated digitisation and financial reforms in response to these developments to bolster their competitiveness and foster economic expansion (Alagidede et al., 2020). Despite a growing body of scholarly work that examines the relationship between digitisation and financial development, there is still a lack of comprehension regarding the impact of digital infrastructure on the dynamics of the financial sector in Sub-Saharan Africa (Ejemeyovwi et al., 2021). The objective of this research is to fill this void by investigating the determinants of financialisation, specifically digitisation, and offering policy suggestions that leverage the capabilities of digital technologies to promote the financialisation of African economies.

The findings of this research have substantial implications for policy and practice concerning the digitalisation and development of the financial sector. First, through an analysis of the determinants promoting financialisation, such as the impact of digitisation, this research enhances our understanding of how digital infrastructure affects the dynamics of the financial sector in Sub-Saharan Africa. The inclusion of this empirical evidence will not only contribute to the advancement of academic discourse but also provide development agencies, financial institutions, and policymakers with invaluable insights on how to utilise digital technologies to foster sustainable economic expansion. Furthermore, financial institutions that operate in SSA can benefit from the practical implications of this study's findings. Through the process of identifying the factors that influence financialisation and how they relate to digitisation, financial institutions can enhance the precision of their approaches to exploit the potential benefits that digital technologies offer. Potential strategic initiatives to address this issue encompass augmenting financial inclusion programmes, investing in digital infrastructure, and expanding digital banking services to underserved populations. Moreover, regulatory frameworks designed to promote digital financial services while mitigating potential risks associated with technological advancements may be informed by the findings of this research.

The findings of this study have the potential to provide policymakers with valuable insights as they develop evidence-based interventions aimed at fostering financial sector development and capitalising on the revolutionary capabilities of digitalisation. Through comprehending the determinants that propel financialisation, policymakers can enact focused measures that tackle obstacles to the widespread adoption of digital technologies, fortify the capabilities of institutions, and augment the level of financial literacy within the populace. Furthermore, the knowledge gained from this research can provide valuable input for macroeconomic strategies that seek to cultivate inclusive growth, increase competitiveness, and foster economic stability throughout Sub-Saharan Africa.

## Empirical review

While it is clear that financial development exhibits a significant positive nexus with economic growth the question of what determines financial development remains unanswered. Economists, practitioners and empirical studies have still a subpar understanding of the aforementioned key issue. The positive nexus between financial development and economic growth links has aroused the interest of researchers to unearth what determines financial development. Literature connecting digital infrastructure and financial sector development in Africa is fascinating whereas there are studies that have investigated the role of digitisation in promoting financial development, the majority of the studies are based on firm-level data for instance, Taiminen and Karjaluoto (2015) conducted research to highlight on the goals of digital marketing and the elements that influence its acceptance and use by small and medium-sized enterprises (SMEs). The sample includes 16 managers from SMEs who took part in semi-structured thematic interviews and 421 survey respondents from Central Finland. The poll found that small and medium-sized enterprises are not making the most of digital technologies. It is also unclear from the data whether SMEs are recognising the game-changing impact that digitalisation has had on communication.

Molinillo and Japutra (2018) performed a literature analysis to assess the determinants that affect the deployment of digital information and technology inside organisations, with a special emphasis on small and medium-sized enterprises (SMEs). The results show that businesses of all sizes may benefit from using digital information and technology in marketing-related activities. Three primary theories (the diffusion of innovation theory, the technology-organisation-environment framework, and the institutional theory) have been employed to get a deeper understanding of the adoption process. These two concepts, when combined, may simplify the adoption process for everyone involved. Payne et al. (2018) performed research to construct a conceptual model that describes the major determinants influencing Lebanese bank customers' adoption of mobile banking. The hypotheses were evaluated using structural equation modelling and route analysis based on survey data. The study captured 320 participants. The results demonstrate that consumers' views about adopting mobile banking are mostly influenced by their level of digital literacy, resistance to change, perceptions of risk, usability, and usefulness. By contrast, awareness and compatibility had no discernible impact on adoption.

Despite using micro-level data, some studies used country-level or macroeconomic data for instance, Yussif et al. (2019) examined the implications of digitisation for financial development in emerging economies. The authors analysed secondary data across 30 emerging economies from 2004 to 2017 extracted from the World Bank's World Development Indicators (WDI) database as well as the International Telecommunications Union. Adopting the Generalised Method of Moments (GMM) estimations for the analysis, the authors concluded that digitisation remains a key determinant of financial development. The study prescribed a policy push among emerging economies to broaden their investment in technology development for the financialisation of their economies. According to Voghouei et al. (2011), the financial system is supported by aspects including good institutions, open financial and trade markets, legal tradition, and political economy. Political and economic factors might be the ones that have the greatest influence on financial development because they can affect it directly as well as indirectly through other determinants (Voghouei et al., 2011). Variations in a country's political economy may well account for differences in its financial development.

The results of Law and Habibullah, (2009) dynamic panel data analysis show that real per capita income and institutional quality are statistically significant predictors of banking sector development and capital market development. However, trade openness plays a bigger role in fostering the growth of the capital market. The empirical findings of financial liberalisation revealed that while stock market liberalisation is powerful in bringing about stock market development, domestic financial sector reforms are likely to boost banking sector development. According to Ayadi et al. (2013), a full bundle of strong legal institutions, excellent democratic administration, and competent financial reform implementation can have a significantly positive impact on FD. Furthermore, while the capital account is open, inflation has a less negative impact on banking development. Growing public debt slows credit expansion, proving that public debt 'crowds out' private lending. Also, capital inflows predominantly have an income

effect, increasing national savings and credit availability via raising income and consequently financial development (Ayadi et al., 2013).

Takyi and Obeng (2013) discovered a distinctive cointegrating link between financial development, inflation, trade openness, reserve requirement, per capita income, and government borrowing using quarterly data from 1988 to 2010. The regression analysis findings indicate that per capita income and trade openness are crucial factors in Ghana's financial development. People's attitudes regarding the financial market alter as society develops in the form of greater trust, control, and other attributes, and they do more financial transactions. Consequently, improved financial development results. Dutta and Mukherjee (2012) discovered that culture strongly affects the degree of financial growth using the quantile estimation technique for a sample of 90 nations. Cherif and Dreger (2016) findings implied that institutional factors matter in both financial categories, even after controlling for traditional macroeconomic variables and fixed effects. Corruption appears to have the greatest impact on the banking industry. The effects of corruption and law and order seem to matter for the stock market. Openness to foreign commerce is crucial for all facets of financial development, even though per capita income and inflation do not appear to be key factors according to Cherif and Dreger (2016). Ibrahim and Sare (2018) demonstrate that, even though human capital has a significant impact on financial development, trade openness has a greater impact on private credit than on domestic credit. Financial development is closely tied to the interacting concepts of openness and human capital. The marginal effects analysis shows that trade openness (human capital) has a bigger impact on private (domestic) credit than human capital. The study substantially supports the idea that trade openness and human capital development are both important factors in the financial success of Africa.

Khalfaoui (2015) indicates that the degree of economic and human development, as well as the banking and financial sectors, are the key predictors of financial development. The study further intimated that only in industrialised nations do the factors connected to economic stability and the institutional and legal framework have a considerable impact on financial development. Gu et al. (2021) demonstrate the significance of income, human capital, technical innovation, and research and development (R&D) spending as long-term factors influencing financial development. The study further discovered that in the E7 countries, human capital strengthens the link between technological innovation and financial success. Asratie (2021) revealed that economic development, trade openness, and the political freedom index all have a favourable short- and long-term impact on financial development. Interest rates and reserve requirements, however, have a negative impact. The study further shows that the real exchange rate has little impact in the short term and a negative impact over the long term. The credit-to-private sector model, on the other hand, is influenced favourably by inflation, political freedom, economic growth, and trade openness. However, foreign debt, the need for reserves, and lending interest rates have a negative impact (Asratie, 2021).

Zafar et al. (2022) show that information and communications technology (ICT) investment needs policymakers' attention because they have empirically established long-run inverse consequences of the aforementioned in terms of financial development. Control of corruption, government effectiveness, political stability, and free speech and accountability are the main World Governance Indicators (WGIs) that significantly affect financial development, according to the empirical findings of Eldomiaty et al. (2020). According to IMF (2022), Sub-Saharan Africa (SSA) is witnessing rapid development in the digital front especially in the financial sector and given the above empirical studies, it is evident what determines financial development depends on or varies from country to country. This may be related to specific national policies, geo-politics and regional economic policies. We find it necessary to investigate whether investment in the digital front determines financial development in Africa.

## Hypothesis development

### *The effect of digitisation and financial sector development*

The financial services delivery sector has undergone a significant transformation due to digitisation, which has been propelled by developments in information and communication technologies (ICT). This transformation has resulted in enhanced efficiency, accessibility, and inclusivity within the financial



system (Ibrahim, 2017; Ibrahim et al., 2022). Financial institutions have the potential to access previously unreachable segments of the population, expedite operations, and decrease transaction expenses through the utilisation of digital platforms and electronic channels (Mishra et al., 2020). Furthermore, the process of digitisation has enabled the advent of novel financial products and services, including peer-to-peer lending, mobile banking, and digital payments. These advancements have not only empowered businesses and individuals but have also democratised access to financial services (Ibrahim et al., 2022). Nevertheless, the extent to which digitisation influences the progress of the financial sector is dependent on a multitude of elements, such as digital literacy, infrastructure, cybersecurity, and regulatory frameworks (Molinillo & Japutra, 2018). Digitisation, although capable of significantly augmenting economic growth and fostering financial inclusion, presents obstacles to data privacy, cybersecurity risks, and regulatory adherence (Khalfaoui, 2015). As a result, policymakers, regulators, and practitioners must comprehend the interplay between digitisation and the development of the financial sector to exploit the advantages of digital innovation while minimising potential vulnerabilities and risks. Based on this, they hypothesized that:

H1: Improved digitisation has a positive significant effect on Financial Sector Development in SSA

## Methodology

### *Population and sample*

The population of the study encompassed all eligible participants or study entities that were considered in the study. Thus, the study area is Africa, where 54 countries in the sub-region constituted the population. A census study was undertaken; thus all 54 countries were included in the study. The countries included are, Algeria, Angola, Benin, Burkina Faso, Burundi, Botswana, Cameroon, Central African Republic, Chad, Cote d'Ivoire, Congo Republic, Comoros, Cape Verde, Democratic Republic of Congo (DRC), Djibouti, Egypt, Equatorial Guinea, Eritrea, Eswatini, Ethiopia, Gabon, Ghana, the Gambia and Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Libya, Madagascar, Malawi, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, South Sudan, Sudan, Tanzania, Togo, Tunisia, Uganda, Zambia and Zimbabwe. The secondary data for these countries was extracted over 21 years, thus from 2000 to 2021 from the World Bank.

### *Variable description*

The World Bank's World Development Indicators (WDI) were mined for information on the 54 nations in Africa. Specifically, the following variables were elicited to achieve the study objectives:

**Financial Sector Development:** the financial development index of each country was used to measure financial sector development. The index constituted six measurements; they are financial depth, financial access, financial stability, financial size, financial efficiency and financial activity.

**Digitisation:** Three proxy variables were used to measure the adoption of digitisation in the countries under study. Therefore, the variables of information and communication technology (ICT), national innovation, and the relationship between digitalisation and innovation. The prevalence of ICT was evaluated by tallying the number of mobile phone users and internet browsers. Innovation on the other hand was measured by the number of Scientific and technical journal articles in each country.

The study also included controlled variables based on the extant literature of Ejemeyovwi et al. (2021) and other studies. Therefore, controlled variables such as institutional quality (IQ) and real gross domestic product growth (GDPGR) among others were used for the study.

**Institutional Quality:** The quality of governance in each country in Africa was taken into account for the research. Therefore, we utilised the World Bank's data to create a governance index.

**Financial Inclusion:** We employed the two-stage PCA method, and as a result, we first assessed the three sub-indices of usage, barriers, and access that, following the literature, constitute financial inclusion. Using the dimensions as explanatory variables, we estimate the dimension weights and the overall financial inclusion index in the second stage.

### Variables and A-prior signs

Table 1 indicates the Variable description, data sources and a priori signs of the variables used in the study.

### Data analysis

To determine the link and interdependence between macroeconomic and financial variables as used in this study, the VAR model is pertinent. However, this model is time-invariant; as such, highly restrictive in accounting for the dynamics of time-series economic data (Pacífico, 2018). Therefore, the effect of digitization on financial development in Africa was achieved with the Bayesian Panel Vector Auto-Regressive (BPVAR). This method has been used by Rahman et al. (2023), Berdiev and Saunoris (2016) and Ejemeyovwi et al. (2021) which turned out to produce very efficient and unbiased results. Prior and post-estimation tests were conducted to ensure the reliability and validity of the estimated models. The preliminary tests such as descriptive statistics (such as mean, standard deviation, skewness and kurtosis) and graphical representation of the data preceded the main data analysis. This was aimed at getting the overall picture and trend of the data set. Also, some important pre-test analysis of the panel data is the stationarity test of the variable to ensure the model is devoid of spurious regression and to assist in identifying a suitable methodology for the study. Post-estimation tests included correlation, multicollinearity, and heteroscedasticity among others. The panel regression model used in the analysis included all dependent, independent and controlled variables. This study employed SPSS v26 and Eviews version 10 as analytical software for this study. While the study employed SPSS v26 to perform the dimensional reduction method, the selection of Eviews version 10 was based on its strong functionalities in time-series analysis and econometric modelling, which make it highly suitable for investigating the dynamics of the financial sector. Similar software was used in previous studies (e.g. Ejemeyovwi et al., 2021).

Consider the functional form of the model in equation (1):

$$FD = f(S, X, Z) \quad (1)$$

Where the independent variables are represented by S, X, and Z. S represents Information and communication technology (ICT), X is innovation, and Z is the control variables.

In panel form, the implicit functional form is represented as:

$$FD_{i,t} = f(ICT_{i,t}, INN_{i,t}, GDPGR_{i,t}, IQ_{i,t}, INF_{i,t}, GS_{i,t}, FI_{i,t}, ED_{i,t}, POP_{i,t}, UEM_{i,t}) \quad (2)$$

Where the subscripts 'i' and 't' represent country 'i' at time 't'. See Table 1 below for variable descriptions and measurements. The explicit model for the study is specified as presented in equation (3).

$$FD_{i,t} = \beta_0 + \beta_1 ICT_{i,t} + \beta_2 INN_{i,t} + \beta_3 IQ_{i,t} + \beta_4 GDPGR_{i,t} + \beta_5 INF_{i,t} + \beta_6 GS_{i,t} + \beta_7 FI_{i,t} + \beta_8 ED_{i,t} + \beta_9 POP_{i,t} + \beta_{10} UEM_{i,t} + \varepsilon_{i,t} \quad (3)$$

To compute for Financial Development (FD), the study employed SPSS v26 to perform the dimensional reduction method. Thus, the widely used principal component analysis (PCA) technique as used by Ejemeyovwi et al. (2021) was employed in this study. This method enabled the study to reduce and transform the six constructs (that is; financial depth, financial access, financial activity, financial efficiency, financial size, and financial stability) that measure FD into a smaller data set or variables while still keeping the relevant information of the data.

The purpose of this study is to gauge the effect of one variable (digitization) on the other (financial development). This necessitated the use of the Bayesian Panel Vector Auto-Regressive (BPVAR) method. The BPVAR is not entirely different from the conventional VAR model, especially regarding the



**Table 1.** Variable description, data sources and a priori signs.

Variables	Description	Measurement	Data Source	A priori Sign
Dependent				
Financial Sector Development (FD)	1. Financial Depth 2. Financial Access 3. Financial Activity 4. Financial efficiency 5. Financial size 6. Financial stability	1. The ratio of private sector credit to GDP 2. Depositors with commercial bank 3. Issuance of private domestic loans from financial institutions 4. The ratio of bank credit to bank deposit 5. Bank assets on central bank assets 6. Z-score of banks	World Bank Financial Development Database Trading Economics, 2022	
Independent Variables				
Digitisation	1. ICT 2. Innovation (INN)	1. Subscribers of mobile phone 2. Internet users 3. The number of scientific and technical journals 4. ICT-Innovation interaction	1. World Bank, 2021a 2. World Bank, 2021a 3. World Bank, 2021b 4. World Bank, 2021b	+  + +
Controls	1. Institutional Quality (IQ) 2. GDPGR 3. Financial Inclusion (FI) 4. Inflation (INF) 5. Government Support (GS) 6. Economic Development 7. Unemployment Rate 8. Population rate	1. Effectiveness of government 2. Gross Domestic Product growth rate Index of usage, barriers and access Annual Consumer Price Index (CPI) The ratio of government expenditures to the total output of the economy Using the human development index The number of unemployed individuals by the total labour force and then multiplied by 100 to express it as a percentage. The percentage change in the population over a specified period. This is expressed as the annual percentage change in population size.	3. World Bank, WGI Database, 2022b 4. World Bank, 2021a World Bank Financial Development Database WDI WDI WDI WDI	+/- + + - + - +

interdependency and endogeneity of the variables; except that BPVAR incorporated the cross-sectional nature of the data to ensure that shocks from one country do not transmit to other countries (Thi Thuy & Nguyen Trong, 2021). Time variations in the coefficients and the variance of the shocks and accounting for cross-sectional dynamic heterogeneities are all easily incorporated into the BPVAR, making it a useful tool for capturing both static and dynamic interdependencies (Ejemeyovwi et al., 2021; Thi Thuy & Nguyen Trong, 2021).

VARs are statistical models with a great deal of leeway because of their many free parameters. By considering the model parameters to be independent random variables and assigning them prior probability, the BVAR eliminates the issue of over-parameterisation. Using the Bayesian theorem in conjunction with conventional VAR models, the BPVAR approach can circumvent the shortcomings of the unconstrained VAR (UVAR) technique, the gold standard for estimating the dynamics of economic issues. The UVAR has been criticised for being excessively open-ended and lacking limitations in its presentation of the autoregressive components of the model. In his (2018) paper, Pacifico highlighted the results of their generalised UVAR models. (1) The problem of overfitting, caused by the lack of prior beliefs and leading to unreliable coefficients, is nearly always present in models with an unconstrained structure. This problem is generated by the fact that there are no prior beliefs. (2) The analysis often provides a straightforward account of the facts it examines. In a nutshell, these findings may not be accurate, hence the implementation of the BPVAR model in this study.

Given that the coefficients beyond the dependent ones are given smaller relative variances since fluctuations or deviations in VAR models are compensated for by their lags. Additionally, a fixed variance-

covariance matrix for the error term is assumed. The model takes the form;

$$Y_{i,t} = X_{i,t} + B_{i,t}(M)Y_{i,t-1} + \varepsilon_{i,t} \quad (4)$$

$$\text{Where } Y_{i,t} = \begin{bmatrix} FD_{it} \\ ICT_{it} \\ INN_{it} \\ GDPGR_{it} \\ IQ_{it} \\ INF_{it} \\ GS_{it} \\ FI_{it} \\ ED_{it} \\ POP_{i,t} \\ UEM_{i,t} \end{bmatrix} \quad X_{i,t} = \begin{bmatrix} B_{FD} \\ B_{ICT} \\ B_{INN} \\ B_{GDPGR} \\ B_{IQ} \\ B_{INF} \\ B_{GS} \\ B_{FI} \\ B_{ED} \\ B_{pop} \\ B_{UEM} \end{bmatrix} \quad \varepsilon_{i,t} = \begin{bmatrix} \mathcal{E}_{FD} \\ \mathcal{E}_{ICT} \\ \mathcal{E}_{INN} \\ \mathcal{E}_{GDPGR} \\ \mathcal{E}_{IQ} \\ \mathcal{E}_{INF} \\ \mathcal{E}_{GS} \\ \mathcal{E}_{FI} \\ \mathcal{E}_{ED} \\ \mathcal{E}_{POP} \\ \mathcal{E}_{UEM} \end{bmatrix}$$

$Y_{i,t}$  Represents the dependable variable for time  $t=1$  and the 54 countries considered for each country as indicated in equation 4.  $X_{i,t}$  is a (10 by 1) vector of the individual country's intercept parameters for time  $t$ .  $B_i(M)$  is a (10 by 10) matrix of the lag polynomials with  $M$  identifying as the lag operator.  $\mathcal{E}$  residual is a (10 by 1) vector of error terms with  $i$  variation for each country, connoting a normal distribution of the data set.

$$\begin{aligned} Y_{i,t} = & \beta_{yi} + \sum_{j=1}^n a_{1\ FDj} FD_{i-j} + \sum_{j=1}^n a_{1\ ICTj} ICT_{i-j} + \sum_{j=1}^n a_{1\ INNj} INN_{i-j} + \sum_{j=1}^n a_{1\ GDPGRj} GDPGR_{i-j} \\ & + \sum_{j=1}^n a_{1\ IQj} IQ_{i-j} + \sum_{j=1}^n a_{1\ INFj} INF_{i-j} + \sum_{j=1}^n a_{1\ GSj} GS_{i-j} + \sum_{j=1}^n a_{1\ FIj} FI_{i-j} + \sum_{j=1}^n a_{1\ EDj} ED_{i-j} \\ & + \sum_{j=1}^n a_{1\ popj} POP_{i-j} + \sum_{j=1}^n a_{1\ uemj} UEM_{i-j} + \varepsilon_t \end{aligned} \quad (6)$$

Equation 6 represents the PVAR for individual countries for financial development (FD) and other variables as defined previously.

### Robustness test

To enhance the reliability of the results, the study employs the Generalised Method of Moments (GMM) as a test for robustness. Generalised Moving Averages (GMMs) are a robust econometric method that mitigates potential endogeneity issues through the use of instrumental variables, which enhance the estimation efficacy of parameters (Ayadi et al., 2013). Within the framework of this study, where unobserved variables may concurrently influence and determine financial sector development and digitalisation, GMM proves to be an advantageous instrument for reducing biases and bolstering the dependability of the findings.

$$\begin{aligned} FD_{i,t} = & \beta_0 + \beta_1 FD_{i,t-1} + \beta_2 ICT_{it} + \beta_3 INN_{i,t} + \beta_4 IQ_{i,t} + \beta_5 GDPGR_{i,t} + \beta_6 INF_{i,t} + \beta_7 GS_{i,t} + \beta_8 FI_{i,t} + \beta_9 ED_{i,t} \\ & + \beta_{10} POP_{i,t} + \beta_{11} UEM_{i,t} + \varepsilon_{i,t} \end{aligned} \quad (7)$$

Through the utilisation of GMM, the study can effectively address potential endogeneity concerns such as omitted variables or simultaneity issues, which might introduce bias into the estimated coefficients and compromise the validity of the results if not accounted for. Utilising the fundamental economic theory, GMM permits the researcher to specify a set of moment conditions that are used to generate instrumental variables that reflect the exogenous variation in the independent variables of interest (Berdiev & Saunoris, 2016). The inclusion of these instrumental variables in the estimation process permits more accurate and objective parameter estimates. Furthermore, in the realm of emergent markets, where data constraints, institutional intricacies, and structural difficulties may present further methodological obstacles, GMM presents several benefits. Through the implementation of more effective estimation methods and the resolution of endogeneity issues, GMM effectively improves the dependability and accuracy of the outcomes, thus fortifying the study's conclusions (Alagidede et al., 2020). The

model for the GMM estimation is specified above, adapted from existing literature (e.g. Asratie, 2021; Berdiev & Saunoris, 2016).

## Results

### Descriptive statistics

Descriptive statistics were chosen because they enable data to be summarized based on frequency and percentage. Using frequency and percentage distributions, descriptive statistics have been shown to give researchers confidence and insight into the nature of their raw data (Creswell, 2017). Creswell (2017) argues that researchers can also utilise other types of descriptive statistics such as histograms, box plots, frequency polygons, bar charts, pie charts, and scatter diagrams to elaborate on the ideas behind their studies. The researchers in this study, however, as shown in Table 2 made use of measures of central tendency (mean, coefficient of variation, and standard deviation) to classify the variables.

The mean score of 2.143 for financial sector development as shown in Table 2 suggests that, on average, the financial sector in the Africa sub-region may be moderately developed. However, the standard deviation of 1.939 indicates that there is considerable variation in the level of financial sector development across these regions. This could be due to differences in economic, political, and social factors that influence financial sector development. In contrast, the mean score of 3.717 for innovation and 3.290 for ICT suggests that, on average, Africa may have a relatively high level of innovation and ICT adoption. This could be due to the increasing use of technology and digital tools in the region, as well as the growing emphasis on innovation and entrepreneurship as drivers of economic growth. These descriptive results are consistent with previous research that has highlighted the importance of innovation and technology in driving financial sector development in Sub-Saharan Africa (Asratie, 2021; Tchamyou & Asongu, 2017). They also support the view that investment in digital infrastructure and innovation can help promote economic growth and development in the region (Asongu & Nwachukwu, 2019; Mukhtarov & Aliyev, 2021).

The mean score of 3.368 for economic development suggests that, on average, the level of economic development in the study may be moderate. The standard deviation of 1.483 indicates that there is a fair amount of variability in economic development across the sample. These results are consistent with findings from previous studies that suggest economic development is influenced by a range of factors, including institutional quality and government support (Cherif & Dreger, 2016; Eldomiaty et al., 2020). The mean score of 3.539 for institutional quality suggests that, on average, the institutions in Africa may be relatively strong. Strong institutions are important for promoting economic development because they can help reduce corruption, promote the rule of law, and provide a stable environment for investment (Ibrahim, 2017). The mean score of 2.210 for government support suggests that, on average, the level of government support in Africa may be relatively low. This result may be cause for concern, as

**Table 2.** Descriptive statistics.

Variables	Mean	Std. Dev	CV	Observation
FD	2.143	1.939	0.905	1188
ICT	3.290	1.025	0.3115	1188
INN	3.717	2.824	0.7597	1188
FI	15.738	13.533	0.859	1188
ED	3.368	1.483	0.440	1188
IQ	3.539	1.499	0.424	1188
GS	2.210	0.408	0.185	1188
IFS	4.303	2.460	0.572	1188
GDPGR	15.731	5.403	0.343	1188
INF	9.500	3.500	0.368	1188
UEM	0.062	0.013	0.209	1188
POP	0.089	0.027	0.303	1188

Source: Authors' Computation (2023): Notes: NB; where 'FD is the Financial Sector Development, ICT is the information communication technology, INN is the innovation, FI is the financial inclusion, ED is the economic development, IQ is the institutional quality, GS is the government support, IFS is the infrastructure, GDPGR is the Gross Domestic Product growth rate, INF is the inflation rate, UEM is the unemployment rate, and POP is the population rate 'The sample size was all the 54 Africa with 1188 observations in the time intervals of 2000 to 2021.

government support can play an important role in promoting economic development by providing infrastructure, education, and other public goods (Ziberi et al., 2021).

The mean score of 4.303 for infrastructure suggests that, on average, the level of infrastructure in Africa may be moderate. However, the standard deviation of 2.460 indicates that there is considerable variation in the quality of infrastructure across the region. This finding is consistent with previous research, which has highlighted the challenges faced by sub-Saharan African countries in developing their infrastructure, such as inadequate funding, weak institutional capacity, and lack of private-sector involvement (Asongu & Nwachukwu, 2019). The mean score of 15.731 for GDP growth rate suggests that, on average, sub-Saharan African countries have experienced moderate economic growth in recent years. However, this growth rate may not be sufficient to achieve financial development, given the region's high levels of poverty and inequality (IMF, 2022). Additionally, the mean score of 9.500 for inflation suggests that the region experiences moderate to high levels of price increases, which could have negative impacts on financial development and social welfare as noted by Ibrahim et al. (2022). Also, the mean unemployment rate of 0.062 represents the proportion of the labour force that is unemployed or the average level of unemployment across the selected countries. This statistics result is an essential indicator of the state of the labour market and the efficacy of the economy. In general, a reduced unemployment rate indicates an enhanced labour market characterised by increased employment and economic activity (Alagidede et al., 2020). On the contrary, the mean population growth rate of 0.089 signifies the average annual percentage variation in population magnitude throughout the period under observation. The rate of population growth is a significant demographic metric that has an impact on a multitude of socio-economic aspects, such as the availability of labour, patterns of consumption, and the need for infrastructure (Ibrahim et al., 2022).

### **Correlation analysis**

The correlation analysis as shown in Table 3, reveals interrelationships between variables that are essential for comprehending the development of the financial sector in African nations. The relationship between Financial Sector Development (FD) and several significant determinants is moderately positive. Significantly, there exists a weak positive correlation between FD and Information Communication Technology (ICT), which suggests that digitalisation plays a role in the progression of financial systems. The finding is consistent with previous research (Asongu & Nwachukwu, 2019; Ayadi et al., 2013) that highlights the critical role that ICT plays in promoting innovation and financial inclusion, thus contributing to the overall development of the sector. Additionally, the correlation analysis underscores the mutually beneficial association between innovation (INN) and the advancement of the financial sector. Berdiev and Saunoris (2016) found that innovation-driven initiatives might make a substantial contribution towards improving financial inclusion, efficiency, and access to financial services, as indicated by the strong positive correlation. This finding is consistent with previous studies' conclusions that underscore the critical importance of innovation in fostering economic expansion and advancing the evolution of the financial sector (Boateng, 2018). Consequently, to fuel economic advancement and financial sector development, policymakers ought to give precedence to cultivating an atmosphere that is favourable for innovation.

An additional significant factor that exhibits a positive correlation with economic development (ED), institutional quality (IQ), and government support (GS) is financial inclusion (FI). This highlights the significance of inclusive financial systems in advancing more comprehensive economic goals, including the reduction of poverty, equality in income, and sustainable development (Demirgüç-Kunt et al., 2018).

Previous research has demonstrated that there is a positive correlation between economic development and financial inclusion (Hermes et al., 2018; Beck et al., 2017). This supports the notion that by improving the accessibility and affordability of financial services, significant socioeconomic advantages can be achieved. Furthermore, the correlation analysis as shown in Table 3 reveals relationships between institutional quality (IQ) and economic development (ED).

According to Boateng (2018), the observed positive correlation among these variables indicates that the efficacy of institutions might have a significant impact on the promotion of sustainable economic growth and financial stability. This finding is consistent with prior research that underscores the

**Table 3.** Correlation results.

S/N	Variables	1	2	3	4	5	6	7	8	9	10	11	12
1	FD	1											
2	ICT	0.0944	1										
3	INN	0.1589	0.0304	1									
4	FI	0.0999*	0.5099*	0.0389*	1								
5	ED	0.1248*	0.3920*	0.4904*	0.2509*	1							
6	IQ	0.0929	0.0209*	0.0893***	0.0449	0.0049	1						
7	GS	0.0309	0.0849*	0.0639	0.0379*	0.0829	0.5099*	1					
8	IFS	0.004**	0.026*	0.0409**	0.0242	0.0493*	0.3920*	0.1442*	1				
9	GDPGR	0.0904	0.093***	0.0994***	0.0324	0.0989	0.3089*	0.1360*	0.4332*	1			
10	INF	−0.0842*	0.004	0.2094*	0.2409*	0.0999*	0.0994	0.1809*	0.3999*	0.0922	1		
11	UEM	−0.094*	0.046	0.0409*	0.0094	0.0308	0.3449*	−0.0398	0.1989*	0.0240	0.2999*	1	
12	POP	0.0928	0.049*	0.0994*	0.9949*	0.0298	0.3499*	0.0099	0.3422*	0.0198*	0.1792*	0.0399	1

Source: Authors' Computation (2023); NB; where 'FD is the Financial Sector Development, ICT is the information communication technology, INN is the innovation, FI is the financial inclusion, ED is the economic development, IQ is the institutional quality, GS is the government support, IFS is the infrastructure, GDPGR is the Gross Domestic Product growth rate, INF is the inflation rate, UEM is the unemployment rate, and POP is the population rate '.

**Table 4.** Cross-sectional dependence tests.

Test	Statistic	p-Value
Pesaran CD test	2.1967	0.0038
Pesaran scaled LM test	2.6302	0.0192
Breusch-Pagan LM test	20.4829	0.0054

Source: Authors' Computation (2023).

significance of regulatory frameworks, sound governance, and adherence to the rule of law in promoting financial sector resilience and economic development (Cherif & Dreger, 2016; Dutta & Mukherjee, 2012). On this basis, policymakers ought to give precedence to institutional reforms that are designed to fortify regulatory frameworks and governance structures, with the ultimate goal of cultivating a conducive atmosphere that promotes financial sector development and economic expansion.

Furthermore, the significant observations of inverse relationships between financial sector development and the inflation rate (INF) and unemployment rate (UEM) give rise to relevant inquiries regarding the influence of the macroeconomic environment on the dynamics of the financial system. Prior research (Levine, 2018; Beck et al., 2016) has investigated the correlation between financial sector development and macroeconomic stability. Thus, to appraise the drivers and repercussions of financial sector development comprehensively, it is vital to comprehend the macroeconomic environment. By acknowledging the interconnectedness of financial and macroeconomic factors, policymakers can implement more comprehensive approaches that seek to foster sustainable economic expansion and stability. Furthermore, the results emphasise the necessity for harmonised policy initiatives that tackle not only reforms in the financial sector but also more extensive macroeconomic issues. Policies aimed at reducing unemployment and controlling inflation, for instance, may have substantial effects on the performance of the financial markets, and conversely. For resilient and inclusive economic development, therefore, a multi-dimensional approach that integrates macroeconomic policies and financial sector reforms is essential.

### Cross-sectional dependence tests

Tests for cross-sectional dependency in Table 4 show that the existence of cross-sectional reliance in the data is confirmed and the null hypothesis is rejected, as shown in the table. Consistent with previous empirical investigations (Levine, 2018), we address this problem using the Bayesian Panel Vector Auto-Regressive (BPVAR) technique. Given that the number of explanatory variables in our model exceeds the number of cross-sectional units, the study uses country-fixed effects to estimate the model.

### Stationarity test

To enhance the accuracy and reliability of BVAR models, the data series under consideration must exhibit stationarity. A stationary data series is one where the mean and variance remain constant over time, and the covariance between two extreme periods is independent of the time at which it is

**Table 5.** Panel unit root test.

Variables	LLC Level	IPS	ADF	PP	LLC First difference	IPS	ADF	PP
FD	0.465	8.319	46.104	68.435	−81.187***	−10.199***	781.311***	891.192***
ICT	−0.5472	−1.821	75.190	78.171	−21.217***	−23.183***	231.141***	664.119***
INN	−3.821***	−8.714***	94.972***	161.61***	−19.319***	−24.181***	745.161***	1510.11***
FI	−6.491***	−4.243***	45.215***	140.112***	−20.130***	−23.812***	389.164***	1219.917***
ED	−8.738***	−3.7651***	23.815***	32.472***	13.894***	13.892***	283.291***	2138.929***
IQ	1.483	10.835	54.198	76.576	−89.387***	−20.132***	681.381***	789.392***
GS	−1.837	−3.936	59.846	88.473	−29.419***	−33.875***	131.491***	558.889***
IFS	−7.5673***	−7.378***	84.572***	287.687***	−29.349***	−34.291***	775.861***	2510.893***
UEM	−8.5648**	−3.8352**	48.9201***	137.2617***	−23.2718**	45.6179***	378.0917**	1187.1982***
POP	−6.5637***	−8.4824**	56.5491***	88.7142***	−33.6179*	−12.1867**	541.8918**	1271.8854***
GDPGR	−6.745***	−4.378***	39.485***	210.312***	−10.230***	−33.882***	287.164***	1319.817***
INF	−9.746***	−3.845***	35.485***	42.472***	23.184***	23.772***	283.291***	2938.649***

Source: Authors' Computation (2023): NB; where 'FD is the Financial Sector Development, ICT is the information communication technology, INN is the innovation, FI is the financial inclusion, ED is the economic development, IQ is the institutional quality, GS is the government support, IFS is the infrastructure, GDPGR is the Gross Domestic Product growth rate, INF is the inflation rate' Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

computed but instead depends on the lag between them. The Augmented Dickey-Fuller (ADF) (Dickey & Fuller, 1979), Phillips and Perron (1988), and Kwiatkowski et al. (1992) tests are commonly used to determine the integrated level of each series. Notably, the panel unit root test results as shown in Table 5 indicate that the stationarity property of the dataset is free from issues and can be used for BVAR analysis as all the variables are stationary at I (1) (order 1) or first difference.

### **Digitisation and other financial sector development determinants in African countries**

From Table 6 the coefficient of Information Communication Technology (ICT), which is both positive and statistically significant, highlights the profound capacity of digital technologies to enhance the accessibility and efficacy of financial services in the region. This is consistent with an increasing body of scholarly work that highlights the critical significance of information and communication technology (ICT) implementation in improving financial inclusion, optimising payment systems, and extending banking services to populations that were previously underserved. For example, scholarly research conducted by Eldomiaty et al. (2020) and Emmanuel and Abuya (2019) has underscored the transformative effects of technological advancements, including digital payment platforms and mobile banking, on the economic empowerment of marginalised communities in Africa and the expansion of financial access in the region. The significance of the Innovation (INN) coefficient, as observed, is consistent with previous studies that underscore the critical role of innovative practices in propelling advancements in the financial sector (Opoku et al., 2019). Blockchain technology and fintech solutions have all played a pivotal role in facilitating advances in efficiency, bolstering capabilities in risk management, and advancing market liquidity. This discovery emphasises the vital importance of cultivating an environment that promotes innovation in financial institutions and regulatory structures to accommodate changing market dynamics and fulfil the evolving demands of businesses and consumers. Additional insights have been provided by Gu et al. (2021) and Ibrahim (2017) regarding how novel financial products and services can foster market expansion and enhance financial intermediation in a variety of socioeconomic settings.

Furthermore, as seen in Table 6, the significant positive coefficient linked to Financial Inclusion (FI) emphasises the criticality of expanding the availability of formal financial services as a driver for promoting inclusive development and growth. This finding aligns with prior research that emphasises the favourable association between financial inclusion and initiatives to alleviate poverty, foster entrepreneurship, and strengthen the economy (Ibrahim, 2017; Ibrahim et al., 2022). Policy interventions that are designed to foster financial literacy, augment banking infrastructure, and utilise technology to extend services to remote and marginalised communities are pivotal in improving the outcomes of financial inclusion. The positive effects of financial inclusion initiatives on inclusive economic growth and income inequality reduction have been empirically supported by studies conducted by Khalfaoui (2015) and Molinillo and Japutra (2018). Moreover, the substantial coefficient associated with Economic Development (ED) highlights the mutually beneficial association between the expansion of the financial sector and macroeconomic growth. Favourable business environments, stable macroeconomic policies,



**Table 6A.** Digitisation and other financial sector development determinants in African countries.

Variable	Model (1) FD	Model (2) ICT	Model (3) INN	Model (4) FI	Model (5) ED
ICT	0.0256*** (0.0061)	0.0418** (0.0178)	0.0163*** (0.0019)	0.0446** (0.0227)	0.0221*** (0.0049)
INN	0.0201*** (0.0065)	0.0360** (0.0182)	0.0548** (0.0225)	0.0354** (0.0177)	0.0671*** (0.0199)
FI	0.0344 *** (0.0112)	0.0954*** (0.0295)	0.0121*** (0.0035)	0.0541*** (0.0039)	0.0758* (0.0426)
ED	0.236*** (0.0611)	0.0367** (0.0125)	0.0177*** (0.006)	0.0201*** (0.0071)	0.0299*** (0.0084)
IQ	0.0121*** (0.0035)	0.0105* (0.0055)	0.0177*** (0.006)	0.0201*** (0.0071)	0.0299*** (0.0084)
GS	0.0177*** (0.0064)	0.0212*** (0.0073)	0.0256*** (0.0063)	0.0151** (0.0077)	−0.0254*** (0.0067)
IFS	0.0383** (0.0152)	0.0214** (0.0091)	0.0256*** (0.0061)	0.0171 (0.0120)	0.0257*** (0.0069)
GDPGR	0.0477** (0.0187)	0.0439** (0.0161)	0.0344 (0.1110)	0.0344 (0.1110)	0.0344 (0.1112)
INF	−0.0609** (0.0289)	0.0411** (0.0251)	0.0446 (0.2110)	−0.0162 (0.0198)	−0.0254*** (0.0067)
POP	0.0167*** (0.0101)	−0.0391*** (0.0109)	0.0457** (0.0182)	0.0383** (0.0146)	−0.0208** (0.0089)
UEM	−0.196*** (0.0632)	−0.0162*** (0.0061)	0.0334*** (0.0023)	0.0684** (0.0415)	0.0224*** (0.0081)

Source: Authors' Computation (2023): NB; where 'FD is the Financial Sector Development, ICT is the information communication technology, INN is the innovation, FI is the financial inclusion, ED is the economic development, IQ is the institutional quality, GS is the government support, IFS is the infrastructure, GDPGR is the Gross Domestic Product growth rate, INF is the inflation rate, POP is the population rate, UEM is the unemployment rate' \*\*\*, \*\*, significant at 1% and 5% levels. Values in parentheses are standard errors.

**Table 6B.** Digitisation and other financial sector development determinants in African countries.

Variable	Model (6) IQ	Model (7) GS	Model (8) IFS	Model (9) GDPGR	Model (10) INF	Model (11) POP	Model (12)
ICT	0.0334*** (0.0069)	0.0120*** (0.0032)	0.0167** (0.0082)	0.0256*** (0.0061)	0.0257*** (0.0069)	0.0295*** (0.0079)	0.0256*** (0.0063)
INN	0.0413*** (0.0028)	0.0296*** (0.00621)	0.0477*** (0.0132)	0.0201*** (0.0065)	0.0249*** (0.0073)	0.0301*** (0.0082)	0.0201*** (0.0064)
FI	0.0121*** (0.0034)	0.0103** (0.0044)	0.0609** (0.0289)	0.0344 (0.0112)	0.0171 (0.0120)	0.0443 (0.0328)	0.0344 (0.1110)
ED	0.0177*** (0.0063)	0.0145** (0.0055)	0.0477** (0.0187)	0.236*** (0.0611)	0.249*** (0.0627)	0.340*** (0.0676)	0.236*** (0.0601)
IQ	0.0177*** (0.0063)	0.0145** (0.0055)	0.0383** (0.0152)	0.0121*** (0.0035)	0.0541*** (0.0039)	0.0758* (0.0426)	0.121*** (0.0034)
GS	−0.0184** (0.0085)	0.239*** (0.0719)	0.0248** (0.0124)	0.0177*** (0.0064)	0.0201*** (0.0071)	0.0299*** (0.0084)	0.0177*** (0.0063)
IFS	−0.0295*** (0.0079)	0.0231** (0.0098)	0.0274** (0.012)	0.0383** (0.0152)	0.0532*** (0.0117)	−0.0260** (0.0103)	0.0383** (0.0146)
GDPGR	0.0526*** (0.0162)	0.0335* (0.0188)	0.0502** (0.0211)	0.0477** (0.0187)	0.0235* (0.0138)	0.0327* (0.0177)	0.0477*** (0.0184)
INF	0.0206*** (0.0064)	0.267*** (0.062)	0.0186*** (0.0063)	−0.0609 (0.0289)	0.0358** (0.0180)	−0.0468* (0.0244)	−0.0609** (0.0284)
POP	0.0161*** (0.0047)	0.0373** (0.0186)	0.0131*** (0.0034)	0.0167 (0.0101)	0.0520** (0.0254)	0.0802* (0.0416)	0.0167** (0.0078)
UEM	−0.0116 (0.0113)	−0.0162*** (0.0060)	0.0587*** (0.0128)	0.0158*** (0.0048)	0.0335* (0.0188)	0.0150 (0.0428)	0.0158*** (0.0047)

and robust institutions are all components of robust economic fundamentals that foster financial intermediation, investment, and capital formation. This discovery aligns with established theoretical frameworks, including the finance-growth nexus, which asserts that efficient resource allocation, savings mobilisation, and productive investment facilitation are all critical functions of sound financial systems that stimulate economic growth. Mukhtarov and Aliyev (2021) and Odhiambo, (2020) have conducted empirical investigations that substantiate the existence of a positive correlation between financial sector development and economic development in various international settings.

### Robustness test

The application of the Generalised Method of Moments (GMM) estimation provides a robustness check for the analysis, shedding light on the correlation between digitisation and a range of determinants of

financial sector development in African nations. When addressing potential endogeneity concerns that arise as a result of simultaneously determining variables in the financial system, GMM is especially useful. By including lagged values of financial sector development (FD) as an explanatory variable, the model accounts for the continued influence of previous progress on subsequent developments. The aforementioned persistence highlights the concept that historical advancements form the basis for continuous enhancements in the financial domain. From Table 7, the coefficient for lagged FD, which is both positive and statistically significant, serves to reinforce the significance of ongoing efforts to facilitate consistent progress in the financial sector to stimulate economic expansion and stability. Consistent with prior research by Thi Thuy and Nguyen Trong (2021) and Voghouei et al. (2011), which emphasise the long-term effects of financial sector reforms on economic development, these results support this notion.

In a similar vein, the coefficient for Information Communication Technology (ICT) as shown in Table 7, is both positive and statistically significant, signifies that financial sector development in African nations remains significantly influenced by investments in digital infrastructure. The correlation between ICT and development in the financial sector highlights the profound influence that technological advancements have on areas such as risk management, service provision, and financial inclusion. Through the utilisation of digital technologies, financial institutions can augment the efficiency, accessibility, and inclusivity of the financial system. This, in turn, can make a significant contribution to the advancement of the economy as a whole and to the reduction of poverty. These results are consistent with prior research conducted by Yussif et al. (2019) and Zafar et al. (2022), which underscore the significance of digitalisation in facilitating the modernisation of the financial sector and broadening the availability of financial services.

Furthermore, in Table 7, the coefficients associated with other determinants, including Economic Development (ED), Innovation (INN), and Financial Inclusion (FI), which are all positive and statistically significant, underscore the complex and varied characteristics of the factors that support the evolution

**Table 7.** GMM Estimation for Digitisation and other financial sector development determinants in African countries.

Dependent variable = Financial Sector Development	
Variables	Coefficient
$FD_{i,t-1}$	0.0295*** (0.0079)
ICT	0.0301*** (0.0082)
INN	0.0443*** (0.0328)
FI	0.340*** (0.0676)
ED	0.0758** (0.0426)
IQ	0.0299*** (0.0084)
GS	0.0260** (0.0103)
IFS	0.0327*** (0.0177)
GDPGR	0.0468*** (0.0244)
INF	−0.0802*** (0.0416)
POP	0.239*** (0.0719)
UEM	−0.0212*** (0.0073)
Hansen J-Statistic	0.435
Sargan Test	0.219
AR (1)	0.054
AR (2)	0.059

Source: Authors' Computation (2023); NB; where 'FD is the Financial Sector Development, ICT is the information communication technology, INN is the innovation, FI is the financial inclusion, ED is the economic development, IQ is the institutional quality, GS is the government support, IFS is the infrastructure, GDPGR is the Gross Domestic Product growth rate, INF is the inflation rate, POP is the population rate, UEM is the unemployment rate' \*\*\*, \*\*, significant at 1% and 5% levels.

of the financial sector. The determinants in question comprise a variety of elements, such as regulatory frameworks, product innovation, and overall economic development. Each of these components plays a role in improving the efficacy of resource allocation, risk management, and financial intermediation. The correlations that exist between these factors and the development of the financial sector emphasise the significance of cultivating favourable regulatory settings, encouraging the introduction of novel financial products, and fostering comprehensive economic expansion to bolster strong financial sector development. The results of this study align with previous investigations conducted by Zafar et al. (2022) as well as Ziberi et al. (2021), which underscore the interrelatedness of multiple elements that influence the dynamics of the financial sector. On the other hand, the negative coefficient associated with the inflation rate (INF) indicates that expansions in inflationary expectations could potentially hinder the progress of the financial sector. This finding emphasises the significance of maintaining price stability as a macroeconomic policy goal, given that elevated inflation volatility has the potential to erode financial stability and long-term development prospects. Monetary policy frameworks that are efficient in their pursuit to contain inflationary pressures are critical in preserving an economic environment that is stable and conducive to the growth and stability of the financial sector. The results of this study are consistent with established theoretical frameworks, including the finance-inflation nexus, which Yussif et al. (2019) and Tchamyu and Asongu (2017) discuss. This nexus emphasises the adverse effects that inflation volatility has on both long-term development prospects and financial stability.

## Conclusion

This study contributes to the existing literature on the determinants of financial sector development by providing a comprehensive analysis of the factors that contribute to the development of the financial sector. The study highlights the importance of digitisation, financial inclusion, economic development, institutional quality, government support, and infrastructure in promoting the growth and development of the financial sector. The study's findings are consistent with previous research, which emphasizes the implications of digitisation for financial development. The study also highlights the importance of economic development in driving the demand for financial services and the development of the financial sector. Institutional quality is another critical determinant of financial sector development. The study emphasizes that strong legal and regulatory institutions are essential for creating a stable and predictable environment for financial transactions to take place, reducing information asymmetry and lowering transaction costs, which are crucial for the development of a robust financial sector. In sum, given the study's main objective which is to examine whether digitisation determines financial development in African countries, the studies identified digitisation as a key determinant of financial development in Africa. The results indicate that digitalisation can help to increase financial inclusion, reduce transaction costs, and promote the development of new financial products and services, all of which can contribute to improving financial sector development. The findings also suggest that other factors, such as financial inclusion, economic development, institutional quality, government support, and infrastructure, are important for the development of the financial sector and should be addressed in conjunction with digital adoption. Policymakers in Africa should take note of these findings and work to create an enabling environment that supports digitisation-financial sector development. Efforts to improve institutional quality, governance, and infrastructure can help to create a more conducive environment for financial development. Overall, the studies suggest that digitalisation has the potential to complement financial sector development in Africa and other regions, and can create an outburst of opportunities in the financial sector in terms of integrating financial systems, reducing financial risk and enhancing investment finance.

## Recommendation

### *Theoretical implication*

The theoretical implications of the empirical results concerning the significant coefficients linked to Information Communication Technology (ICT), Innovation (INN), Financial Inclusion (FI), and Economic Development (ED) are of utmost importance in comprehending the financial sector development in

African nations. The transformative impact of digital technologies on financial systems and the promotion of inclusive growth is highlighted by the positive and statistically significant coefficient associated with ICT. This is consistent with technological determinism that asserts progress in information and communication technologies is the primary catalyst for societal and economic transformations (Taiminen & Karjaluo, 2015). Moreover, it aligns with the notion of the digital divide, which underscores the criticality of narrowing technological access disparities to advance fair and balanced development (Raza et al., 2014). Through the utilisation of information and communication technology (ICT), financial institutions can improve operational effectiveness, diminish transaction expenses, and extend services to marginalised communities, thus promoting increased financial inclusion and economic empowerment (Taiminen & Karjaluo, 2015).

Additionally, the noted importance of the INN coefficient emphasises the pivotal function that innovation plays in driving the progress of the financial sector. This is consistent with theories concerning the diffusion and adoption of innovations, which posit that competitive advantages and productivity gains can result from the adoption of novel practices and technologies (Rahman et al., 2023). Moreover, it aligns with Schumpeter's creative destruction theory, a concept that underscores the significance of innovation in upsetting established economic frameworks and propelling sustained economic expansion (Rani et al., 2023). Financial institutions can enhance their risk management practices, facilitate financial inclusion, and stimulate economic growth by cultivating an environment that encourages innovation and adopting disruptive technologies like fintech and blockchain.

### **Practical implication**

The practical implications of the coefficients that were observed within the framework of Economic Development (ED), Information Communication Technology (ICT), Innovation (INN), and Financial Inclusion (FI) provide policymakers, financial institutions, and other stakeholders with valuable insights into how to promote the development of the financial sector in African nations. First, the positive coefficient linked to ICT implies that allocating resources towards digital infrastructure development and encouraging the utilisation of digital financial services could result in substantial advantages in terms of enhancing financial accessibility and streamlining financial transactions. Prioritising initiatives that promote digital literacy, facilitate greater financial inclusion, and enhance the accessibility of financial services for underserved populations are all viable approaches for policymakers to pursue. Such initiatives may also include providing incentives for the development of digital payment systems.

Furthermore, the INN coefficient's observed significance underscores the criticality of cultivating an innovative culture in the financial industry to propel progress in service provision, product assortment, and operational effectiveness. By connecting the potential of technologies like artificial intelligence, blockchain, and machine learning, financial institutions can create inventive resolutions that cater to the distinct requirements and inclinations of customers, enhance risk management methodologies, and optimise operational procedures. Financial institutions can distinguish themselves in a highly competitive market, draw in fresh clientele, and generate value for stakeholders through the adoption of innovative practices. Furthermore, it is crucial to emphasise the significance of implementing focused policies and initiatives that facilitate enhanced access to formal financial services for underserved and marginalised populations, as indicated by the substantial coefficient associated with Financial Inclusion (FI). Policymakers may wish to direct their attention towards measures such as augmenting the scope of banking infrastructure, endorsing initiatives that foster financial literacy, and facilitating the provision of accessible and affordable financial products and services to small businesses and low-income individuals. Through the prioritisation of financial inclusion, policymakers and financial institutions can facilitate the economic realisation of latent communities, mitigate income inequality, and make substantial contributions to the social and economic progress of African nations as a whole.

### **Author Contributions**

UA: Wrote the introduction of the paper and also conducted the analysis and interpretation of the data. ALS: Performed a literature search and reviewed all the literature in the study. MSSS: Conducted or worked on the

methodology section of the paper. MMY: Critically revised the paper for intellectual content and worked on the final approval version for submission. All the aforementioned authors collectively agreed to be accountable for all aspects of the work.

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## Data availability statement

The study used publicly available data from WDI and Trading Economics which is available on their respective websites. However, the authors are ready to make the data and any materials associated with the paper available to anyone upon reasonable request.

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