


STATE-DEPENDENCY IN THE NEXUS BETWEEN DIGITAL FINANCIAL INCLUSION AND ECONOMIC GROWTH IN SUB-SAHARAN AFRICA

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ARTICLE INFO	ABSTRACT
<p>Article history: Received: March, 13th 2024 Accepted: May, 13th 2024</p>	<p>Objective: The objective of this study is to investigate state-dependency in the nexus between digital financial inclusion and economic growth in sub-Saharan Africa, with the aim of examining the impact of adopting digital financial technology to reduce financial exclusion and contribute to economic growth.</p>
<p>Keywords: Financial Inclusion Index; Digital Financial Inclusion; Economic Growth; State Dependency; Quantile Regression.</p> <div data-bbox="172 969 480 1211" style="text-align: center;">  </div>	<p>Theoretical Framework: The paper extends the work of Sarma (2008) and Khera et al. (2021), by creating a new financial inclusion index that captures both traditional and digital financial inclusion.</p> <p>Method: The methodology adopted for this research comprises the principal component analysis (PCA) to identify signals in financial inclusion indicators, thereafter financial inclusion indexes for digital and traditional financial services were constructed. The panel quantile regression methodology was employed to analyse the impact of shocks and determine state dependency in the nexus, respectively. Data collection was carried out through secondary sources.</p> <p>Results and Discussion: The result confirms a positive relationship between digital financial inclusion and economic growth with the greatest impact in countries with lower real GDP, confirming state dependency.</p> <p>Research Implications: The findings suggest that policymakers should focus on promoting digital financial inclusion, particularly in countries with low to intermediate levels of income.</p> <p>Originality/Value: This study contributes to the literature by broadening the definition of digital financial inclusion beyond what is currently found in the literature to include vital financial inclusion dimensions such as access to financial services. The relevance and value of this research are further evidenced by the consideration of state-dependency in the relationship between financial inclusion and growth.</p> <p>Doi: https://doi.org/10.26668/businessreview/2024.v9i6.4675</p>

DEPENDÊNCIA DO ESTADO NO NEXO ENTRE INCLUSÃO FINANCEIRA DIGITAL E CRESCIMENTO ECONÔMICO NA ÁFRICA SUBSAARIANA

RESUMO

Objetivo: O objetivo deste estudo é investigar a dependência do Estado no nexo entre a inclusão financeira digital e o crescimento econômico na África Subsaariana, com o intuito de examinar o impacto da adoção da tecnologia financeira digital para reduzir a exclusão financeira e contribuir para o crescimento econômico.

Estrutura teórica: O artigo amplia o trabalho de Sarma (2008) e Khera et al. (2021), criando um novo índice de inclusão financeira que capta tanto a inclusão financeira tradicional quanto a digital.

Método: A metodologia adotada para esta pesquisa compreende a análise de componentes principais (PCA) para identificar sinais nos indicadores de inclusão financeira; em seguida, foram construídos índices de inclusão financeira para serviços financeiros digitais e tradicionais. A metodologia de regressão de quantis de painel foi

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empregada para analisar o impacto dos choques e determinar a dependência do estado nonexo, respectivamente. A coleta de dados foi realizada por meio de fontes secundárias.

Resultados e Discussão: O resultado confirma uma relação positiva entre a inclusão financeira digital e o crescimento econômico, com o maior impacto em países com PIB real mais baixo, confirmando a dependência do Estado.

Implicações para a Pesquisa: Os resultados sugerem que os formuladores de políticas devem se concentrar na promoção da inclusão financeira digital, principalmente em países com níveis de renda baixos e intermediários.

Originalidade/Valor: Este estudo contribui para a literatura ao ampliar a definição de inclusão financeira digital para além do que é encontrado atualmente na literatura, incluindo dimensões vitais de inclusão financeira, como o acesso a serviços financeiros. A relevância e o valor desta pesquisa são evidenciados ainda mais pela consideração da dependência do Estado na relação entre inclusão financeira e crescimento.

Palavras-chave: Índice de Inclusão Financeira, Inclusão Financeira Digital, Crescimento Econômico, Dependência do Estado, Regressão de Quantis.

DEPENDENCIA DEL ESTADO EN EL NEXO ENTRE INCLUSIÓN FINANCIERA DIGITAL Y CRECIMIENTO ECONÓMICO EN ÁFRICA SUBSAHARIANA

RESUMEN

Objetivo: El objetivo de este estudio es investigar la dependencia del Estado en el nexo entre la inclusión financiera digital y el crecimiento económico en el África subsahariana, con el fin de examinar el impacto de la adopción de la tecnología financiera digital para reducir la exclusión financiera y contribuir al crecimiento económico.

Marco Teórico: El documento amplía el trabajo de Sarma (2008) y Khera et al. (2021), mediante la creación de un nuevo índice de inclusión financiera que capta tanto la inclusión financiera tradicional como la digital.

Método: La metodología adoptada para esta investigación comprende el análisis de componentes principales (ACP) para identificar señales en los indicadores de inclusión financiera, posteriormente se construyeron índices de inclusión financiera para servicios financieros digitales y tradicionales. Se empleó la metodología de regresión cuantílica de panel para analizar el impacto de las perturbaciones y determinar la dependencia estatal en el nexo, respectivamente. La recogida de datos se llevó a cabo a través de fuentes secundarias.

Resultados y Discusión: El resultado confirma una relación positiva entre la inclusión financiera digital y el crecimiento económico, con mayor impacto en los países con menor PIB real, lo que confirma la dependencia estatal.

Implicaciones de la Investigación: Los resultados sugieren que los responsables políticos deberían centrarse en la promoción de la inclusión financiera digital, especialmente en países con niveles de renta bajos e intermedios.

Originalidad/Valor: Este estudio contribuye a la literatura ampliando la definición de inclusión financiera digital más allá de lo que se encuentra actualmente en la literatura para incluir dimensiones vitales de inclusión financiera como el acceso a los servicios financieros. La pertinencia y el valor de esta investigación se ponen aún más de manifiesto por la consideración de la dependencia del Estado en la relación entre inclusión financiera y crecimiento.

Palabras clave: Índice de Inclusión Financiera, Inclusión Financiera Digital, Crecimiento Económico, Dependencia del Estado, Regresión Cuantil.

1 INTRODUCTION

The study is an attempt to analyse digital financial inclusion and economic growth in sub-Saharan Africa. It aims to review the age-long debate about the role of finance in the economic development process with a particular focus on events between the period 2011 to 2022. The analysis would entail adopting digital financial technology to reduce financial exclusion, contribute to economic growth and reduce inequality and poverty. The examination of the debate on the finance-growth nexus shall include the analyses of the impact of country-

specific factors, such as financial intermediation and digital financial services, on the financial system's ability to promote economic growth. The country-specific factors considered in the study are state-dependent effects – such as financial inclusion, digital financial service channels, and economic growth.

State dependent effects in the nexus between economic growth and financial inclusion conceptually describes the idea that the relationship between economic growth and financial inclusion can vary depending on the level of economic growth and development in a country or in a group of countries. Contingent on the level of economic development, the impact of financial inclusion can be non-linear. Small improvement in financial inclusion can lead to substantially larger economic growth in low-income countries, while the impact may be less significant in more developed economies. State dependent effects has been established as an important factor to consider when assessing the relationship between fiscal policy and economic growth (Fazzari et al., 2015).

Financial exclusion, the inability of individuals and households to access financial services (Wentzel et al., 2016) is a major barrier to sustainable economic growth and poverty reduction in emerging and developing economies, especially in Africa. Without access to financial services, people cannot manage risk, save for the future, invest in income-generating activities, or cope with unexpected expenses. This contributes to poor living standards, wealth inequality, and socioeconomic underdevelopment. There has been significant recognition of the importance of financial inclusion to promote economic growth, reduce poverty, and enhance social inclusion. However, there remain a large financial exclusion gap.

Digital financial inclusion could be a real-life solution to the livelihood of vulnerable people in developing and emerging economies. The World Bank estimated the global financial exclusion rate at about 30 per cent (World Bank, 2018); about 1.7 billion adults are excluded from the formal financial intermediation system. In sub-Saharan Africa, the exclusion rate is highest among poor people and rural households, the same demography that accounts for more than 70 per cent of global poverty (World Bank, 2018). The above is an indication that financial exclusion hinders the livelihood and economic progress of families (Omar & Inaba, 2020). The United Nation's 2030 agenda for sustainable development identified seventeen sustainable development goals targeted at making a difference in the livelihood of the most vulnerable (United Nations, 2015). Among the seventeen goals of the agenda, financial inclusion featured prominently as a target in eight. The McKinsey Global Institute recommended a panacea in digital financial instruments, noting that it could add US\$3.7 trillion to the emerging and

developing countries' Gross Domestic Product (GDP) in ten years with considerable benefits to the livelihood of billions of people (McKinsey Global Institute, 2016).

The rapid pace of financial technology (fintech) development and rising adoption of digital technology in finance has contributed to financial inclusion (Khera et al., 2021). Developments in information and communication technology (ICT) is resulting to a greater access and usage of financial services. Literature is awash with studies on the impact of financial development on economic growth (Beck et al., 2007). While many of these studies showed a positive relationship between financial inclusion and growth, they focused primarily on traditional financial inclusion facilitated by financial institutions like banks. Many efforts have recently been dedicated to unravelling the relationship between traditional financial inclusion and economic growth (Sahay et al., 2015) and between traditional financial inclusion and poverty alleviation (World Bank, 2008).

Efforts to foster greater inclusiveness in finance received a crucial boost from advancements in digital technology. This is not the first time that new technology is introduced into the provision of financial services (Feyen et al., 2021). However, the latest intensity and speed of technological innovation is unmatched. They severely impact transaction costs, information exchange and scope of service delivery. Thus, fintech has repositioned the ability of financial institutions to serve the unbanked and under-banked populations. Understanding the nature of novel digital financial services, their role in digital financial inclusion, and the causal relations between them and the larger economy is a critical challenge. Since earlier studies have not considered state dependency in the nexus between digital financial inclusion and growth, this study attempts to fill the gap.

The objective of the paper is to examining digital financial inclusion and economic growth in sub-Saharan African economies by answering the following research questions: i) Does digital financial inclusion impact positively on economic growth in sub-Saharan Africa? ii) Are there state-dependent effects of digital financial inclusion on economic growth in sub-Saharan Africa?

This paper aims to fill the gap in the existing literature by unveiling the impact of digital financial inclusion on growth and identify state dependent effects that may exist in the relationship. The key contribution of this paper will be the establishment of state-contingent effects of digital financial inclusion on economic growth in sub-Saharan Africa int the post-Global Financial Crisis (GFC) era. The paper intends to draw inferences from stylised facts and estimated econometric

models to test the study's hypotheses and provide answers that will broaden the general understanding of the behaviour and role of digital financial instruments in the economy.

Following this brief background, related theoretical and empirical literatures are discussed. An exploration of stylized facts follows the section on literature review. In addition, the methodology adopted in the paper are discussed and econometric inferences are drawn to answer the research questions with conclusions and policy recommendations.

2 LITERATURE REVIEW

2.1 THEORETICAL LITERATURE

The finance-growth nexus of Bagehot (1873) and Schumpeter (1911) form the theoretical foundation for this study. Other tangentially related theories include the Financial Intermediation Theory (Goldsmith, 1969) and Financial Innovation Theory (Silber, 1983). The financialisation "the increasing role of financial motives, financial markets, financial actors and financial institutions in the operations of the domestic and international economies" (Epstein, 2005) of the world economy was conceived as an antidote to the economic crisis of the 1970s. The financial products became more numerous and complex, defying understanding even among professionals.

Not all scholars believe in the efficacy of finance in influencing growth. In the Smithian or classical belief, the role of finance in promoting economic growth is null. This viewpoint is represented by Lucas Jr (1988), when he dismissed the importance of finance in promoting growth and described it as overstressed. This viewpoint was first echoed by Robinson (1952) and re-echoed by Miller (1988) that wherever there is enterprise, finance follows. Thus, the growth-led finance hypothesis was birthed. Robinson also called for total disregard of the connection. He noted that "financial markets contribute to economic growth is a proposition too obvious for a serious discussion" (Miller, 1988). While there are handfuls of studies supporting the view that the role of finance is overstressed, a good number of other studies comfortably support the flip side of the argument. They found support for the Schumpeterian school of thought.

The Schumpeterian school not only gives prominence to finance in promoting economic expansion, but it also sees it as central to its sustenance. Thus, Gurley and Shaw (1955), Goldsmith agreed with Bagehot and Schumpeter that finance is critical to economic growth. If finance is vital

in promoting economic growth, the need to acquire information, enforce contracts and make transactions create the need for a financial market. Although the Schumpeterian school believes that the financial system impacts economic growth, the channels of influence are many and different. A helpful framework that will guide the examination of the connection between digital financial inclusion and economic growth and the discussion of other financial factors is the AK-based model of (Pagano, 1993). Pagano assumed an AK model given by

$$Y_t = AK_t \quad (1)$$

where:

$Y_t = N_t y_t$ is the aggregate output,
 y_t is output generated by a given firm i ,
 N_t is the number of firms in the economy,
 A is the efficiency parameter, and
 K_t is the aggregate capital stock.

He argued that this model is a reduced form of two underlying frameworks, where individual firm-level productivity responds to the aggregate capital stock. On the one hand, each competitive firm produces with the neoclassical production function and, on the other hand, the productivity in each firm benefits from the spillover in the economy. This productivity spillover prevents the economy-wide productivity from being subject to diminishing returns to scale, which could have held the growth process to stagnation. The argument, therefore, is that there are channels through which financial factors can help experience unbounded growth. Assuming the capital accumulation process of the form

$$I_t = K_{(t+1)} + (1 + \delta)K_t \quad (2)$$

and saving function given by

$$\varphi S_t = I_i \quad (3)$$

where:

φ and δ are the fraction of saving not lost to financial intermediation and eventually transmitted to investment.

Analytically, he found three channels through which financial factors got transmitted to output growth. One is through the banking efficiency channel, which works through ϕ , the allocational efficiency working through A and the saving ratio working through $s=S/Y$. This framework will serve as a theoretical foundation to this work.

While this theoretical foundation points to the channels through which financial factors affect economic growth, financial intermediation attributes such as digital finance and inclusion that are of primary interest in this study are hardly directly linked in empirical studies to economic growth. Instead, the connection between finance or financial development and economic growth is studied widely, and there are many published papers on this theme. Levine (1991) provided a concise review of the earlier papers on the connection between these two macroeconomic concepts. This is suggestive that the nexus between finance and economic growth has a contentious outlook among scholars, leading to divergent views in the literature.

Along the line of Pagano's framework, which posited that the channels may include, but not limited to the banking efficiency channel, the allocational efficiency channel, and the saving ratio channel. Furthermore, the effects of the financial system on economic growth can be enhancing or stifling. Cournède et al (2015) categorised these effects and noted that more financial development promotes economic growth by reducing the need for financing projects from own funds; by allocating capital to more productive uses; by monitoring investments more professionally; by providing and boosting innovation; and by generating productivity gains within the sector. On the other hand, the negative effects of financial development on economic growth can stem from the misallocation of capital by funding projects with too low profitability, magnifying the distortionary costs of inefficiencies in financial intermediation and heightening of the risks of regulatory capture. Most theoretical models emphasise the allocative role of the financial systems (Wu & Huang, 2022); their ability to allow firms to diversify portfolios, enhance liquidity and reduce risks (Levine, 1991); their effects of financial development on the efficiency of financial intermediation (Arestis et al., 2001); fostering specialisation in entrepreneurship and the adoption of new technologies (Greenwood & Jovanovic, 1990); and financial markets' ability to effect changes in incentives for corporate control (Demirgüç-Kunt & Levine, 1996).

2.2 EMPIRICAL LITERATURE

The literature on the impact of financial development on economic growth is rich (Beck et al., 2007). While many of these studies showed a positive relationship between financial inclusion and growth, they are primarily focused on traditional financial inclusion (Sahay et al., 2015). This has created a huge gap as digital finance rapidly becomes crucial. Few papers have recently examined digital financial inclusion and its relationship with growth using relevant indicators, like access and usage of mobile money accounts and automated teller machines (ATM), as proxies for digital financial inclusion (Loukoianova et al., 2018). However, the indicators represent only a narrow aspect of digital finance at a time and do not capture a comprehensive picture (Khera et al., 2021).

Regarding financial inclusion and economic growth, the literature suggests a strong positive correlation between the two. Studies have found that when more people have access to financial services, such as savings accounts and credit, it leads to increased economic activity and higher rates of entrepreneurship and job creation (World Bank, 2018). Some of the most famous studies in the area adopted randomized controlled trials to measure the impact of financial inclusion on economic growth and poverty reduction. For instance, a randomized controlled trial conducted in Kenya showed that households with access to mobile banking experienced increased savings and investments, resulting in higher economic growth and a reduction in poverty levels.

Saab (2017) examined the impact of financial inclusion on growth in the MENA and BRICS regions through transmission channel identification. The study used a VAR regression to quantify the relationship between financial inclusion in terms of financial activities, financial literacy, and growth and to study its impact on the economic growth in the MENA region. It found that financial inclusion is important for growth in growth in the region. Furthermore, the study found that increasing financial literacy and promoting financial activities such as mobile banking and e-payments can have a significant positive impact on economic growth and development in the MENA and BRICS regions.

Erlando et al. (2020) studied the relationship between financial inclusion and economic growth in Eastern Indonesia. It empirically analyses the contribution of financial inclusion to economic growth, poverty alleviation and income inequality using the Toda-Yamamoto VAR bivariate causality model and the dynamic Panel Vector Autoregression (PVAR). Their study found a significant relationship level between financial inclusion, economic growth,

poverty, and income distribution in Eastern Indonesia. Socio-economic development was found to react positively to the level of financial inclusion, with a negative impact on poverty. Meanwhile, financial inclusion positively affects inequality, leading to a widening income gap.

As opposed to traditional financial inclusion, the literature on the relationship between economic growth and digital financial inclusion is not as rich. Chinoda & Mashamba (2021) studied the nexus between digital financial inclusion and growth in sub-Saharan Africa, isolating the role of institutions and governance. Their study utilized the generalised method of moments methodology with variables such as DFI index, growth of GDP per capita, as well as measures of institutions and governance. The paper found a positive digital financial inclusion-economic growth nexus with a significant positive effect of institutional quality and governance.

Similarly, Khera et al. (2021) developed a new digital financial inclusion index to examine its impact on growth. The authors used a cross-sectional instrument variable procedure and result suggest that digital financial inclusion is positively associated with per capita GDP growth. Ugwuanyi et al. (2022) studied the impact of financial inclusion on economic growth based on a disaggregation between traditional and digital financial inclusion. The study used the panel feasible generalised least squares and panel system generalised method of moment techniques and the panel vector autoregression. The study found that while digital financial inclusion positively and significantly affects economic growth, traditional financial inclusion plays an even greater role in promoting economic growth. However, in low-income countries, only digital financial inclusion significantly affects economic growth, indicating a possible nuance in the relationship.

Limited research efforts focus on digital financial inclusion and growth (Thaddeus et al., 2020). Recent studies in the area (Kim et al., 2018) mostly concluded that digital financial inclusion is positive for economic growth (Rekha et al., 2021). However, their incomprehensive and diverse definition of digital finance is a great course for concern. In addition, no study has considered state-dependent factors in the relationship between digital financial inclusion and economic growth in sub-Saharan Africa.

3 METHODOLOGY AND RESEARCH DESIGN

3.1 THEORETICAL FRAMEWORK

The neoclassical growth model explains the long-run economic growth. It was developed by Solow (1964); Romer (1986) and it has been extended by many other economists since then. The neoclassical growth model is based on the following assumptions:

1. production is a function of capital and labour;
2. capital and labour are substitutable for each other;
3. capital and labour are fully employed;
4. technological progress is exogenous and labour-augmenting.

Given these assumptions, the neoclassical growth model predicts that the economy will grow at a steady rate in the long run. The steady-state growth rate is determined by the rate of technological progress and the rate of population growth.

A panel data regression is a type of regression analysis that uses data from multiple time periods and multiple cross-sectional units. Panel data regressions can be used to estimate the effects of explanatory variables on a dependent variable, while controlling for individual and time-specific effects. In the context of the neoclassical growth model, a panel data regression could be used to estimate the effects of capital, labour, technological progress, and other factors on economic growth in a panel of countries over time.

$$\text{If } Y = AK^\alpha L^{1-\alpha} \quad (4)$$

$$Y_{it} = \alpha + \beta X_{it} + U_{it} \quad (5)$$

where:

the variables Y and X have both i and t subscripts for $i = 1, 2, \dots, N$ sections and $t = 1, 2, \dots, T$ time periods.

3.2 MODEL SPECIFICATION

The study intends to employ two empirical techniques to evaluate the impact of digital financial inclusion on economic growth in the region and to examine the possibility of state-

dependent effects in the relationship. First, Principal Component Analysis (PCA) is used to identify the signals for the constructed indexes, while the panel quantile regression will be adopted to answer the two research questions. Quantile regression is a type of regression analysis that estimates the conditional quantiles of a response variable, rather than the conditional mean. This means that quantile regression can be used to estimate the effects of the independent variables on different parts of the distribution of the response variable, not just the mean.

VAR models are commonly used for forecasting systems of interrelated time series and for analysing the dynamic impact of random disturbances on the system of variables. The reduced form VAR approach sidesteps the need for structural modelling by treating every endogenous variable in the system as a function of p -lagged values of all the endogenous variables in the system (Lütkepohl, 2006).

The functional form of the model to be estimated is specified as follows:

$$GDP = f(CAP, LAB, HCD, DFI, TFI) \quad (6)$$

where:

GDP is real gross domestic product,

CAP is physical capital stock proxied by gross fixed capita formation,

LAB is tota labour employed proxied by employment level,

HCD is human capital development proxied by secondary school education,

DFI is digital financial inclusion and

TFI is traditional financial inclusion.

The quantile regression model specification, with estimated equation quantile tau = 0.5, means that the model is estimating the conditional quantile of the LGDPPC variable at the 50th percentile (i.e., the median). The independent variables in the model are the C, DFI, and INF variables.

The quantile regression model can be written as follows:

$$GDP = C + \beta_1 CAP + \beta_2 LAB + \beta_3 HCD + \beta_4 DFI + \beta_5 TFI + \mu \quad (7)$$

where:

μ is the error term.

The quantile regression model estimates the parameters of this equation using a quantile regression estimation method. The quantile regression model specification can be further extended to include additional independent variables, interaction terms, and other non-linear terms.

3.3 DATA SOURCES AND DESCRIPTION

The study adopted a cross-section of six (5) major sub-Saharan African countries representing 62.6 per cent of the total GDP of the region estimated at US\$1.71 trillion (World Bank, 2018). Data are drawn from the Financial Access Survey (FAS) of IMF, United Nation International Telecommunication Union (ITU) database and the World Development Indicator (WDI) database of the World Bank. Table 1 shows the economic and financial access indicators used in the study and their sources. A total of twenty-four (24) variables were used including twelve (12) traditional financial inclusion indicators and ten (10) digital financial inclusion indicators grouped into the three dimensions of financial services availability, access, and usage. The variables selection and dimensions classification in the study are guided by extant literature and data availability.

A decline in GDP signals an economic downturn, while a high growth rate of GDP signals economic buoyancy. GDP is used to identify regime changes in the macroeconomy of sample countries.

Table 1

Description of data and sources

S/N	Variable	Code	Dimension	Measurement	Source
Digital Financial Inclusion Indicators					
1	No. of ATMs	fcaa_dav	Availability	per 100,000 adults	IMF
2	No. of ATMs	fcak_dav	Availability	per 1,000 km ²	IMF
3	No. of registered mobile money agent outlets	fcmark_dav	Availability	per 1,000 km ²	IMF
4	No. of registered mobile money agent outlets	fcmark_dav	Availability	per 100,000 adults	IMF
5	No. of registered mobile money accounts	fcmark_dac	Access	per 1,000 adults	IMF
6	No. of debit cards	fccdca_dac	Access	per 1,000 adults	IMF
7	Individuals using the Internet	intern_dac	Access	% of Total	ITU
8	Mobile-cellular subscriptions	mobil_dac	Access	per 100 inhabitants	ITU
9	No. of mobile money transactions	fcmta_dus	Usage	per 1,000 adults	IMF
10	Value of mobile money transactions	fcmtvg_dus	Usage	% of GDP	IMF
Traditional Financial Inclusion Indicators					
11	No. of commercial bank branches	fbodck_tav	Availability	per 1,000 km ²	IMF
12	No. of commercial bank branches	fbodca_tav	Availability	per 100,000 adults	IMF
13	No. of insurance corporations	fciofia_tav	Availability	per 100,000 adults	IMF

14	No. of other deposit takers branches	fcbodda_tav	Availability	per 100,000 adults	IMF
15	No. of borrowers from all microfinance institutions	fcramfa_tac	Access	per 1,000 adults	IMF
16	No. of borrowers from commercial banks	ferodca_tac	Access	per 1,000 adults	IMF
17	No. of depositors with commercial banks	fcdodca_tac	Access	per 1,000 adults	IMF
18	Outstanding deposits with commercial banks	fclodcg_tus	Usage	% of GDP	IMF
19	Outstanding Deposits with Other deposit takers	fcloddg_tus	Usage	% of GDP	IMF
20	Outstanding loans from all microfinance institutions	fcsamfg_tus	Usage	% of GDP	WB
21	Outstanding loans from commercial banks	fcsodcg_tus	Usage	% of GDP	WB
22	Outstanding loans from other deposit takers	fcsoddg_tus	Usage	% of GDP	IMF
Macroeconomic Indicators					
23	Inflation Rate	inf	-	Annual (%)	WB
24	GDP Per Capita	gdppc	-	US\$	WB

4 RESULTS AND DISCUSSIONS

4.1 PRELIMINARY ANALYSES

4.1.1 Composite Index of Financial Inclusion

This study adopted the approach of Sarma (2008), Park and Mercado (2018), and Khera et al. (2021) in constructing a three-dimensional composite index of financial inclusion (IFI). The dimensions include financial services availability, access, and usage. In addition, the study made a distinction between the traditional financial inclusion index (TFI) and digital financial inclusion index (DFI) by constructing separate indices which were combined to create the IFI.

The principal component analysis (PCA) method, the most popular factor analysis methodology for data extraction, was used to identify the signals and confirm the robustness of combining the variables into indices. PCA synthesizes variables to construct the principal components, the most important factors in the variables. The indices are weighted average of the selected indicators with the weights determined parametrically. The weights are determined by the importance of each indicator in measuring financial inclusion. The index was normalized for each country, which makes it comparable across countries. This index is useful in tracking changes in financial inclusion over time and across countries.

The first step in PCA is to ensure that some correlation exists among the variables. Factoring is only possible if several variables are correlated. Otherwise, factoring will be meaningless.

In terms of interpretation, a higher DFI, TFI and IFI indicate a more inclusive financial system and vice versa. The composite index of financial inclusion is a useful tool for policymakers and researchers who are interested in monitoring and analyzing financial inclusion. This forms the basis for further model estimations in this study.

The graphical illustration of financial inclusion indexes across countries in Figure 1 indicates that different countries' development stages tend to influence financial inclusion. It also indicates rapid acceleration in financial inclusion as a whole and digital financial inclusion in particular. For example, South Africa is shown to have the highest level of financial inclusion among the sampled countries, mostly driven by brick and mortar financial services as shown in the high levels of traditional financial inclusion. In the same vein, financial inclusion in Kenya, though mostly driven by traditional financial inclusion has benefited from the strong growth in the digital financial inclusion space. On the other hand, the financial inclusion in Nigeria, Rwanda and Ghana has been driven mostly from acceleration in digital financial inclusion.

Figure 1

Financial Inclusion Index and Real GDP in Nigeria

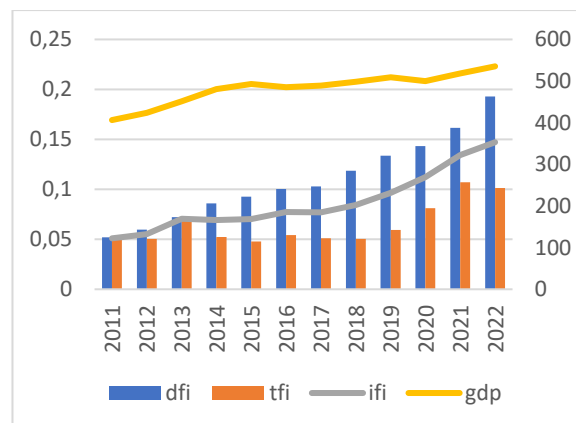


Figure 2

Financial Inclusion Index and Real GDP in Kenya

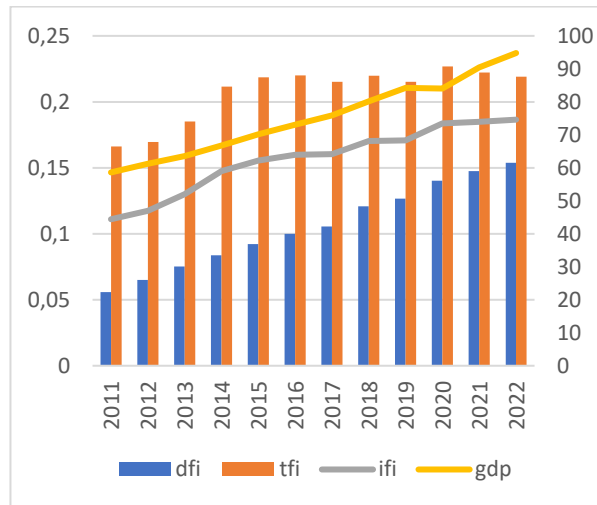


Figure 3

Financial Inclusion Index and Real GDP in South Africa

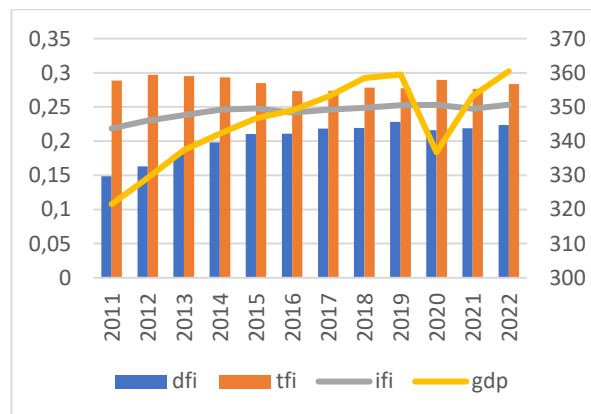


Figure 4

Financial Inclusion Index and Real GDP in Ghana

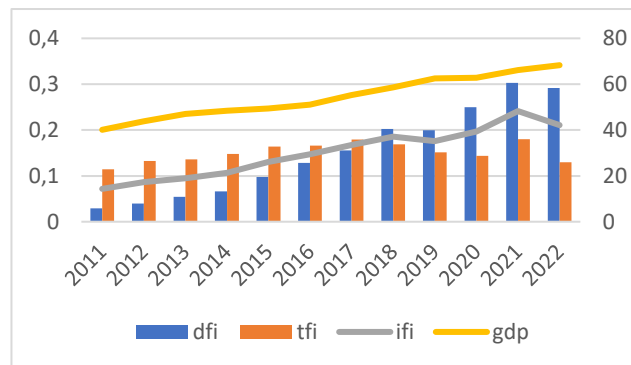
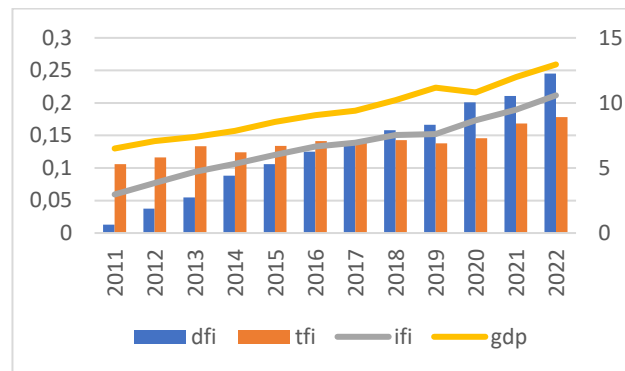


Figure 5*Financial Inclusion Index and Real GDP in Rwanda*

In terms of reaction of growth to financial inclusion, graphical illustration indicates that real GDP is more influenced by financial inclusion indices in Kenya, Ghana and Rwanda as depicted in Figure 1. However, the strength of this impact is lower for South Africa and Nigeria. This indicates that there may be different reactions of growth to different measures of financial inclusion across countries and overtime. Further in-depth analysis is required to confirm these observations.

4.2 DESCRIPTIVE STATISTICS

Table 2 shows the descriptive statistics of all variables. It shows that on average, TFI still remain higher in the sampled countries, indicating the still emerging adoption of DFI. In addition, on average, sampled countries seem to experience wide divergence in macroeconomic performance among countries as indicated by the large standard deviation in GDP, CAP, LAB and HCD. In terms of volatility of financial inclusion indexes, the standard deviation shows that levels of traditional financial services exhibit higher volatility compared with digital financial services.

Table 2*Descriptive statistics*

	N	Mean	SD	Min	Max
<i>Ifi</i>	60	0.15	0.06	0.25	0.05
<i>Dfi</i>	60	0.14	0.07	0.30	0.01
<i>Tfi</i>	60	0.17	0.08	0.30	0.05
<i>Gdp</i>	60	193.46	188.97	535.34	6.50
<i>Cap</i>	60	32.10	27.07	80.20	1.26
<i>Lab</i>	60	57.40	10.47	72.36	39.72
<i>Hcd</i>	60	6.10	6.50	25.77	0.43

Overall, based on the descriptive analysis, it is apparent that macroeconomic indicators are generally more volatile. To answer the question of whether financial inclusion is responsible for this behaviour will require further investigation. Therefore, additional analysis of the series is conducted to further strengthen our understanding of the behaviour of the variables.

4.3 EMPIRICAL RESULTS AND DISCUSSIONS

This section presents the empirical result of the Panel Quantile Regression. It includes the model estimates with the traditional financial inclusion and digital financial inclusion indexes. CAP, LAB, HCD, DFI and TFI forms the set of regressors adopted in the study to explain variations in the dependent variable, GDP. Level variables were differenced while other variables are first-order derivations of level indicators, which ensures that they are stationary, see Table 3.

The results of the panel quantile regression model with the median as the target quantile are presented in Table 4 based on the signs, magnitudes, and statistical significance of the estimated coefficients. The results of the quantile regression model show that the coefficient on the DFI variable is not statistically significant, while the coefficient on TFI is positive and statistically significant. This suggests that the TFI has positive and statistically significant effect on the median of the GDP distribution. CAP and HCD are also significant determinant of GDP with significant positive effects.

The adjusted R-squared statistics is moderate at 34.55 per cent, suggesting that the model does not explain all the variation in GDP. However, this is not necessarily a problem, as quantile regression models are not intended to explain a large proportion of the variation in the response variable. Instead, quantile regression models are intended to provide information about the effects of the independent variables on different parts of the distribution of the response variable.

In sum, the results of the quantile regression model suggest that TFI is statistically significant, DFI exhibit weak statistical significance. However, to have a deeper understanding of the relation, it is important to undertake further analysis to determine the existence or otherwise of significance at different levels of growth, otherwise refers to as state dependency.

Table 3

Panel Quantile Regression Estimation Results for Economic growth Method: Panel Quantile Regression (Median) Dependent Variable: Economic growth - D(GDP) Sample: 2011-2022

Variabes	Coefficients P. value
C	0.8333 0.8103
D(CAP)	1.7114 0.0000
LAB	-0.0732 0.1594
D(HCD)	8.5529 0.0000
DFI	-2.2316 0.7662
TFI	24.5152 0.0080
ADJ R ²	0.3455 0.0000

Table 4

Panel Quantile Regression – Quantile Process

Method: Panel Quantile Regression (Median)
Dependent Variable: Economic growth - D(GDP)
Sample: 2011-2022

Variables	Quantiles								
	10 th	20 th	30 th	40 th	50 th	60 th	70 th	80 th	90 th
C	-3.5413 0.3251	-0.9196 0.7490	-0.3462 0.9096	-0.4448 0.9214	0.8287 0.8333	0.6206 0.8566	2.5700 0.3928	3.7052 0.3085	15.4918 0.1623
D(CAP)	1.7056 0.0001	1.1524 0.0000	1.1519 0.0000	1.4105 0.0888	1.7114 0.0000	1.6473 0.0000	1.2884 0.3300	1.5447 0.0014	0.3326 0.5897
LAB	-0.0434 0.3750	-0.0497 0.2253	-0.0466 0.2805	-0.0531 0.4717	-0.0732 0.1594	-0.0738 0.1230	-0.0992 0.0303	-0.0902 0.0595	-0.1919 0.0645
D(HCD)	1.0902 0.5675	4.1732 0.0034	3.9533 0.0141	6.2327 0.2647	8.5529 0.0000	9.3217 0.0000	10.6379 0.0000	10.3486 0.0000	14.1170 0.0028
DFI	13.2099 0.0481	1.4397 0.7864	-2.2630 0.7244	-3.7414 0.5705	-2.2316 0.7662	-0.3314 0.9618	-0.8451 0.9037	-4.9191 0.4755	-7.1099 0.4515
TFI	19.2480 0.0246	21.7578 0.0014	23.0583 0.0013	27.5500 0.0013	24.5152 0.0080	25.7506 0.0039	25.6817 0.0011	24.8070 0.0067	4.7174 0.8123

The quantile process estimates show the coefficients and p.values for ten quantiles of the GDP variable (0.1 to 0.9). The coefficients can be interpreted as the effect of a one-unit increase in the independent variable on the corresponding quantile of the GDP. For the TFI, the coefficients

are positive and statistically significant for nearly all the ten quantiles. This suggests that TFI has positive and statistically significant effect on the GDP at almost all quantiles.

For DFI, the coefficient is positive and statistically significant for only the 0.1 quantile, but not for the remaining quantiles. This suggests that the DFI variable has a positive and statistically significant effect on the GDP only at the lowest quantile. The coefficients for CAP and HCD are positive and statistically insignificant for almost all quantiles. This suggests that CAP, HCD and TFI exert the most statistically significant effect on the GDP at any quantile.

Overall, the findings indicate that digital financial inclusion significantly impacts GDP per capita only at the lowest level of adoption in the selected sub-Saharan African countries, especially. While traditional financial services remained the most important for financial inclusion and economic growth. Countries at lower income bracket can reap more benefits from digital financial inclusion. Thus, financial inclusion policy can assist economic growth over the long term. This finding confirms state dependency in the relationship between DFI and GDP and is consistent with the preliminary analysis.

5 CONCLUSION AND POLICY RECOMMENDATIONS

The study is an attempt to analyse digital financial inclusion and economic growth in sub-Saharan Africa. It aims to review the age-long debate about the role of finance in the economic development process with a particular focus on events between the period 2011 to 2022, to broaden understanding of the variables of interest and to draw inferences that are useful for policy purposes. The analysis entails adopting digital financial technology to reduce financial exclusion and contribute to economic growth. The paper extends the work of Sarma (2008) and Khera et al. (2021), by creating a new financial inclusion index, capturing traditional and digital financial inclusion. Recent studies adopted a narrow definition of digital financial inclusion and excluded vital financial inclusion dimensions such as access to financial services. Moreover, no study has considered state-dependency in the relationship between financial inclusion and growth. In this study, a principal component analysis is used to identify signals in financial inclusion indicators, thereafter financial inclusion indexes for digital and traditional financial services are constructed. The quantile regression methodology was employed to analyse the impact of shocks and determine state dependency in the nexus, respectively. The result confirms a positive relationship between digital financial inclusion and economic growth with the greatest impact in countries with lower income, confirming state dependency. The

findings suggest that policymakers should focus on promoting digital financial inclusion, particularly in countries with low to intermediate levels of income.

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