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The Impact of FinTech Adoption on Traditional Financial Inclusion in Sub-Saharan Africa

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Abstract: This study investigates the impact of FinTech adoption on traditional financial inclusion in 22 countries in sub-Saharan Africa (SSA). The study utilizes the World Bank's World Development Indicators data and the International Monetary Fund's Financial Access Survey data. This study employed Principal Component Analysis (PCA) to construct the dimensions of traditional financial inclusion and the overall financial inclusion index. Applying the Generalized Method of Moments estimation technique to annual data spanning from 2004 to 2022, the findings show that FinTech has a negative and statistically significant effect on the geographic and usage dimensions. However, it has a positive and statistically significant impact on the demographic dimension and the overall traditional financial inclusion index. These findings indicate that FinTech does not have a detrimental impact on traditional financial inclusion, which is contrary to the findings of other studies. Therefore, in order to enhance the degree of financial inclusion in SSA, it is important for traditional financial inclusion to effectively utilize FinTech.

Keywords: FinTech; traditional financial inclusion; Principal Component Analysis; Generalized Method of Moments

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1. Introduction

The global Sustainable Development Goals (SDGs) and the African Union's Agenda 2063 both seek to enhance the welfare of people. Financial inclusion is seen as a key indicator in achieving this objective. Klapper et al. (2016) suggest that expanding financial inclusion in countries can help achieve nine out of the seventeen SDGs and potentially contribute to two additional SDGs that researchers have not yet empirically tested. Policymakers have also perceived financial inclusion as a means to enhance the quality of life for individuals, alleviate poverty, and promote economic development (IMF 2015). The emphasis on financial inclusion originated from many international calls, including the Alliance for Financial Inclusion Initiative (AFI) in 2009, the G20 Summit in 2010 (Polloni-Silva et al. 2021), and several prominent international organizations, such as the International Monetary Fund (IMF), African Development Bank (AfDB), Asian Development Bank (ADB), Organization for Economic Co-operation and Development (OECD), and United Nations (UN), had been providing funding for research on financial inclusion. The objective was to include a significant portion of the population that had been excluded from formal financial institutions. The World Bank Group initiated the first worldwide assessment of the need for financial services in 2011, combining diverse measures of financial inclusion. Since then, they have been regularly supplying data every three years. Consequently, there has been an increase in empirical research examining the global growth of financial inclusion.

Traditional banking institutions have played a significant role in bringing most of the population into the formal financial system. Initially, the banking system was the only means of bringing people to formal financial institutions. However, in sub-Saharan Africa (SSA), there is still a lack of sufficient bank branches, with most of the branches located in cities while neglecting the rural population. Over the past two decades, banks have

attempted to encourage the population to utilize banking services by installing ATMs and issuing debit cards, allowing customers to access their deposits through these machines.

Although significant efforts have been made to bring the majority of the population into the formal financial system, there is still a significant number of people who remain excluded from it. The World Findex 2021 report reveals that a staggering 1.4 billion adults globally do not have access to banking services. Within the SSA region, only 55 percent of the adult population has formal financial accounts, of which mobile money accounts make up 33 percent.

FinTech has emerged as a major force behind the global transformation of the financial services sector in recent years (Ndung'u 2022), and it is significantly influencing the structure of the financial sector in SSA. Emerging technologies are currently being created and utilized in SSA, which has the capacity to significantly alter the competitive environment in the financial sector by improving access to financial services through the use of the rapid growth of digital technologies, mobile phones, and information and communication technology (ICT) (Appiah-Otoo and Song 2021; Song and Appiah-Otoo 2022; Sy et al. 2019). FinTech, which refers to the alternative financial service providers that utilize technology, such as mobile phones and digital platforms, to deliver innovative and easily accessible financial goods and services to a broader consumer base, has changed the financial landscape in SSA (Djoufouet and Pondie 2022; Yeyouomo et al. 2023). These providers are making financial services more accessible and advocating for financial inclusion, thereby facilitating the connection between traditional banks and individuals who are excluded in SSA. This facilitation can positively or negatively affect some aspects of traditional financial inclusion and enhance efficiency by expanding access to many components of the financial services value chain. Thus, certain studies have revealed a negative correlation between FinTech adoption and traditional financial inclusion, while also highlighting concerns over new vulnerabilities (Tok and Heng 2022; Tashin et al. 2018); however, none of the researchers has explored the specific aspects of traditional financial inclusion that are negatively or positively impacted by the adoption of FinTech, nor have they provided reasons for these effects.

This research contributes to the existing literature by examining the impact of FinTech adoption on traditional financial inclusion. It incorporates all three dimensions identified by Mandira Sarma (2012) and the dimensions outlined by the International Monetary Fund (IMF). The study reveals the specific dimensions in which FinTech adoption has a positive or negative effect. These findings can assist traditional financial inclusion efforts in identifying areas for improvement through the adoption of FinTech. The study initially creates an index for the three dimensions before creating the overall index for traditional financial inclusion. The dimensions for this research are geographical outreach, demographic outreach, and usage dimension.

In the past few decades, there have been suggestions of various theoretical models by researchers and scholars to forecast and elucidate the adoption and utilization of technology. Notably, these include the Technology Acceptance Model (TAM) proposed by Davis in 1989 and the Unified Theory of Acceptance and Use of Technology (UTAUT) put forth by Venkatesh, Morris, Davis, and Davis in 2003.

The adequacy of current models utilized in this field has not been thoroughly investigated. Furthermore, these theories of technology acceptance were originally designed to be used in workplace or organizational settings. It is probable that additional modifications would be necessary to apply to these frameworks in order to predict consumers' intentions and actual usage of FinTech. The UTAUT framework (2003) has recently undergone revision to enhance its ability to forecast technology usage in the consumer setting. This has led to the development of the expanded UTAUT2 (Venkatesh et al. 2012).

Therefore, this research integrates the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) with the Prospect theory. The UTAUT evaluates the antecedents while the Prospect theory concentrates on human technology usage's cognitive and behavioral

aspects. This study examines the impact of the adoption of FinTech on traditional financial inclusion in SSA and investigates whether the adoption has a positive or negative effect.

This study provides governments with insights into how they may utilize FinTech to enhance the availability of financial services in SSA. This involves examining the potential advantages of FinTech solutions in advancing financial inclusion, determining specific ways in which FinTech might improve access to financial services, and evaluating the overall effect of FinTech on increasing financial inclusion. The research article enhances the existing knowledge of utilizing technology and solves the financial exclusion problem in sub-Saharan Africa.

This study initially used pooled ordinary least square (OLS) to find the relationship between FinTech and traditional financial inclusion. However, due to the numerous unobserved factors that may exhibit correlation with our chosen variables, we further employed systems Generalized Method of Moments (GMM), which is a robust model that effectively tackles a range of econometric problems like endogeneity, autocorrelation, heteroscedasticity, and other related problems.

This study distinguishes itself from previous studies by examining the impact of FinTech on traditional financial inclusion. It does so by considering various dimensions of traditional financial inclusion and by also estimating the effect of the overall traditional financial inclusion index. This sets it apart from numerous studies already done. In addition, this study utilizes dynamic panel data approaches through the application of the systems GMM estimator.

This paper is divided into five sections. The work is introduced in Section 1. Section 2 involves the comprehensive assessment of the existing literature and discussion of the hypothesis. Section 3 provides an explanation of the data sources, including the measures of the variables; it also outlines the empirical technique by presenting an empirical model. Section 4 provides the findings and discussions, while Section 5 offers the conclusion and recommendations.

2. Literature Review

2.1. Financial Inclusion

Financial inclusion encompasses various efforts aimed at guaranteeing that individuals and businesses can obtain cost-effective and appropriate financial products and services. This encompasses the provision of savings accounts, credit facilities, insurance coverage, and payment services, along with other financial instruments that facilitate individuals in effectively managing their finances and enhancing their economic welfare. Researchers widely agree that financial inclusion is vital to the economy, as an adequate financial system enables savings, access to credit, investment prospects, financial stability, risk diversification, improved well-being, and decreased income inequality and poverty (Chibba 2014; Chinoda and Kapingura 2023; Hussaini and Chibuzo 2018; Inoue 2018; Lyons et al. 2020; Mallick and Zhang 2019; Sarpong and Nketiah-Amponsah 2022).

The World Bank has also emphasized the importance of an inclusive financial system in promoting efficient resource allocation and equipping individuals with the necessary tools to address challenges related to stability, equitable resource distribution, improved welfare, poverty reduction, and sustainable development (World Bank Group 2013). An inclusive financial system promotes economic stability and advancement by guaranteeing that a diverse array of individuals and businesses may obtain financial services at a reasonable cost. It aids individuals in surmounting financial obstacles and enhancing their quality of life, while also fostering a fairer distribution of resources. Promoting financial inclusion can also bolster a nation's endeavors to alleviate poverty and strive towards attaining long-term sustainable development objectives. This, in turn, fosters a varied financial ecosystem that creates more employment prospects and enhances the overall national economy (Jia et al. 2021).

Governments worldwide consider the integration of individuals into the financial system to be a crucial economic policy in their efforts to attain the objective of financial

inclusion. Bhandari (2018) argues that governments are actively striving for financial inclusion in order to integrate all adult populations into the financial system. The primary goal is to expand the advantages of financial inclusion to different sectors of society, with a specific focus on the poor who will profit from enhanced chances to save and borrow (Adjasi et al. 2023; Ozili 2018). Global initiatives by international communities and governments are also being made to promote financial inclusion worldwide, with a specific focus on regions like Asia and Africa which have low levels of financial inclusion and high poverty rates.

Historically, traditional financial inclusion banks have dominated the financial systems of many SSA nations, often functioning as major channels by which the population and businesses obtain financial services. However, the limitations of traditional banking in reaching majorities of the population that are underserved and advancing financial inclusion in rural areas where majorities of the population are poor have been a major concern for governments and policymakers. Traditional banks have found it difficult to serve the unbanked and underbanked masses in SSA, which has left 45 percent of the adult population without access to financial services due to obstacles such as exorbitant charges, inadequate physical infrastructure, documentation, and strict procedures in account opening, among many other reasons (Demirgüç-Kunt et al. 2020; Kass-Hanna et al. 2022; Klapper 2021).

Due to the significant level of financial exclusion in SSA, there has been an increase in the emergence of alternative financial service providers, such as FinTech businesses which aim to bridge the gap and offer financial services to individuals who have been excluded from the traditional banking sector. It has successfully facilitated financial inclusion for a significant portion of the unbanked population by leveraging mobile money, mobile banking, peer-to-peer lending platforms, and several other FinTech platforms (Chinoda and Mashamba 2021; Demir et al. 2022; Ozili 2023; Djoufouet and Pondie 2022).

2.2. FinTech Adoption and Financial Inclusion

FinTech mostly emerges in SSA through the widespread use of mobile money. Mobile money refers to a digital payment system that allows users to securely store, transfer, and receive funds using a mobile device, such as a smartphone (Jack and Suri 2011). Mobile money services are commonly provided by mobile network operators, financial institutions, or specialized mobile money providers. Mobile money has emerged as a crucial FinTech instrument for promoting financial inclusion, empowering individuals economically, reducing poverty, fostering economic growth, and facilitating digital payments (Gosavi 2018; Okello Candiya Bongomin et al. 2018; Suri and Jack 2016). It provides a convenient and easily available means for individuals to manage their finances using their mobile phones. According to the GSMA Report (2023) as at the end of 2022, the global mobile service subscription count exceeded 5.4 billion individuals, with 4.4 billion of them also utilizing the mobile internet. The disparity in mobile internet usage has significantly decreased over the past five years, with the average gap reduced from 50 percent in 2017 to 41 percent in 2022. However, the gap still exists and requires immediate action from all parties involved. The rise in mobile phone and internet usage has created a foundation for the growth of FinTech worldwide, hence improving financial inclusion.

The growing popularity of FinTech in sub-Saharan Africa (SSA) has experienced a significant rise, mostly driven by the necessity to improve financial inclusion, encompassing both traditional and digital aspects, in this region. Multiple studies have found that FinTech is essential for enabling and advancing financial inclusion, as well as mitigating income inequality and reducing poverty (Appiah-Otoo and Song 2021; Ashenafi and Dong 2022; Chinoda and Mashamba 2021; Demir et al. 2022; Ghosh 2016; Kanga et al. 2022). FinTech enables the provision of financial services to individuals regardless of their geographical locations, catering to people from all levels of society. According to the Consultative Group to Assist the Poor (CGAP), digital finance can offer secure, convenient, and cost-efficient financial services to those with low incomes in developing countries.

The relationship between FinTech and financial inclusion may vary depending on the dimensions of financial inclusion, specifically geographical, demographic, and usage dimensions, as well as the specific type of financial service being considered, especially such as payments, savings, credit, or insurance; therefore, this study will assess the impact of FinTech on the various dimensions of traditional financial inclusion (banks). Previous studies have examined the relationship between FinTech and financial inclusion, inequality, poverty, and economic growth (Appiah-Otoo and Song 2021; Chinoda and Mashamba 2021; Demir et al. 2022; Senyo et al. 2021; Song and Appiah-Otoo 2022; Zhang et al. 2018), and Najib et al. (2021) found a positive relationship between P2P lending adoption through FinTech and the sustainability of small food businesses in Indonesia.

Hypothesis 1 (H1). *FinTech adoption has a negative effect on the geographical dimension of traditional financial inclusion.*

Traditional financial inclusion has been the foundation of financial services in SSA. Consumers are more likely to embrace new technology if they see it as user-friendly and simple to use, facilitating a swift adoption process.

Although FinTech has had a positive influence on overall traditional financial inclusion, Tok and Heng (2022) have discovered that advanced FinTech services such as mobile cellular subscriptions and fixed-line subscriptions have a detrimental impact on banking branches. Tashin et al. (2018) also concluded that FinTech acts as a substitute for bank branches and other services, competing with them and consequently reducing their presence.

Hypothesis 2 (H2). *FinTech adoption has a positive effect on the demographic dimension of traditional financial inclusion.*

The acceptance and easy use of FinTech has increased the level of financial inclusion in SSA. The demographic dimension of traditional financial inclusion entails the number of ATMs and bank branches per 100,000 adults. According to Chinoda and Mashamba (2021), FinTech has a positive impact on both ATMs and bank branches. This shows that FinTech adoption increases the amount of the population with access to banking.

Hypothesis 3 (H3). *FinTech adoption has a negative effect on the usage dimension of traditional financial inclusion.*

FinTech firms provide high-yield savings accounts, convenient fund accessibility, and other deposit products that entice users away from traditional banks, resulting in a decline in deposits held by traditional banks.

FinTech lending platforms also facilitate direct connections between borrowers and lenders, eliminating the need for traditional banks as intermediaries. This can result in a decline in the demand for conventional bank loans, hence leading to a reduction in the amount of loans that traditional banks hold.

Hypothesis 4 (H4). *FinTech adoption has a positive effect on overall traditional financial inclusion.*

FinTech can positively impact overall traditional financial inclusion because it enables banks to easily reach populations with limited access to banking services or without bank accounts through the use of digital platforms. Also, banks can broaden their customer base and provide financial services to greater numbers of people while simplifying banking procedures, automating operations, and decreasing operational expenses. Banks may save costs, increase profitability, and improve risk management and regulatory compliance by incorporating FinTech solutions into their operations. Various researchers have found that FinTech adoption has a positive effect on financial inclusion; for example, Ashenafi and Dong (2022) used pooled ordinary OLS and two-stage least square (2sls) estimation methods and found that FinTech has a positive and significant effect on financial

inclusion, and Kanga et al. (2022) used 3SLS and error correction model and also found that FinTech diffusion has a positive and significant effect on financial inclusion. There are many other researchers who have found a significant positive effect on financial inclusion, such as Chinoda and Mashamba (2021); Demir et al. (2022); Gosavi (2018); Mbiti and Weil (2011); and Djoufouet and Pondie (2022).

Nevertheless, it is important to acknowledge that previous researchers did not examine the impact of FinTech on the various dimensions of traditional financial inclusion. Therefore, this study aims to investigate the effects of FinTech on the various dimensions of traditional financial inclusion and the overall traditional financial inclusion index.

Given the information from the literature and the hypotheses developed earlier, we have created the initial model in Figure 1 to illustrate the effects of FinTech adoption on financial inclusion. We examine the impact of FinTech adoption on all dimensions of traditional financial inclusion, including its overall effect on traditional financial inclusion.

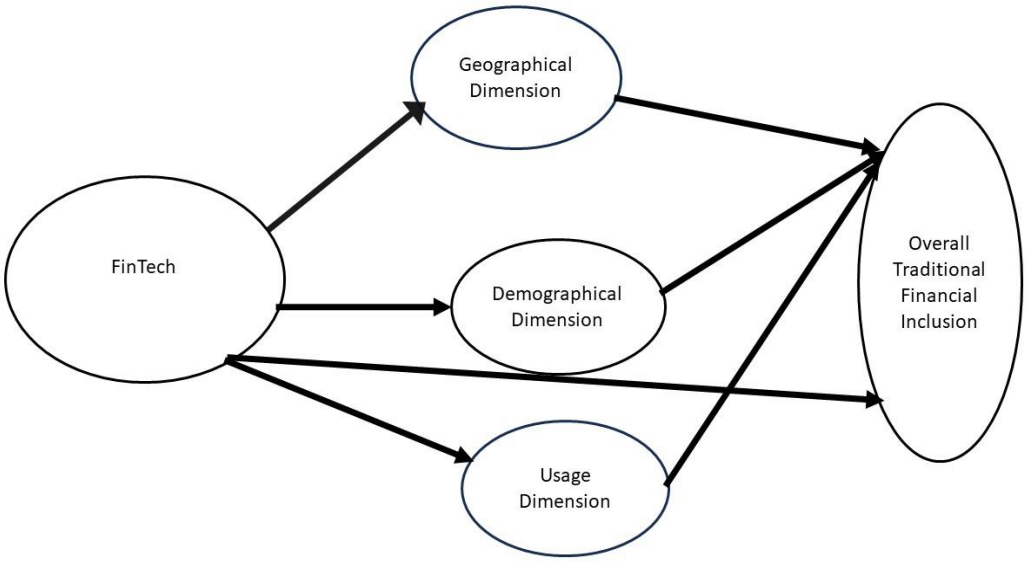

Figure 1. Impact of FinTech adoption on traditional financial inclusion.

3. Data and Methodology

The study utilized data from the World Bank's World Development Indicators (WDI) database and the International Monetary Fund's (IMF's) Financial Access Survey (FAS) data. This study encompasses 22 nations in the SSA region and it spans a duration of 18 years, from 2004 to 2021. The reason for choosing this timeframe is that the IMF's FAS data became available in 2004.

The use of different data to assess both FinTech and financial inclusion indicators explains the disparity in findings across studies examining the influence of FinTech adoption on financial inclusion. Several studies have employed a single indicator for both FinTech and FI, while others have utilized one indicator for FinTech and have used two or three indicators to measure financial inclusion (Chinoda and Mashamba 2021; Demir et al. 2022). Additionally, other studies incorporated more than three variables in measuring financial inclusion in their studies (Mohammed et al. 2017; Sarpong and Nketiah-Amponsah 2022; Djoufouet and Pondie 2022). This study utilizes two variables as proxies for FinTech: fixed broadband subscriptions and mobile cellular subscribers, in accordance with Emara (2022). These variables are utilized to construct an index that represents the level of FinTech. The fixed broadband subscriptions refer to the number of subscriptions for high-speed access to the public Internet, namely a TCP/IP connection, with downstream rates equal to or more than 256 kbit/s. This encompasses several types of broadband subscriptions, such as cable modem, DSL, fiber-to-the-home/building, other fixed (wired) broadband, satellite broadband, and terrestrial fixed wireless broadband. It does not include subscriptions that can connect to data networks, such as the Internet used through mobile-cellular networks.

The inclusion of fixed WiMAX and other fixed wireless technologies is necessary. It encompasses both residential subscriptions and subscriptions for organizations. Mobile cellular subscriptions are subscriptions to a public mobile telephone service that allow access to the PSTN (Public Switched Telephone Network) utilizing cellular technology. The indicator comprises two components: the count of postpaid subscriptions and the count of active prepaid accounts, which are defined as accounts that have been utilized over the past three months. The indication encompasses all mobile cellular subscriptions that provide voice communications. It does not include subscriptions made using data cards or USB modems, subscriptions to public mobile data services, private trunked mobile radio, telepoint, radio paging, and telemetry services.

For financial inclusion, this study covers five dimensions—density of commercial bank branches per 1,000 square kilometers (geographical dimension), the density of ATMs per 100,000 adults, the density of commercial bank branches per 100,000 adults (demographic dimension), the proportion of outstanding deposits with commercial banks as a percentage of GDP, and the proportion of outstanding loans from commercial banks as a percentage of GDP (usage dimension)—in line with other researchers who have used various indicators when measuring financial inclusion (Adedokun and Ağa 2021; Tok and Heng 2022; Kim et al. 2017; Mandira Sarma 2012; Djoufouet and Pondie 2022). The study constructed an index by incorporating all the variables and also generated an index for each dimension.

Following the model proposed by Cámara and Tuesta (2014), this study used Principal Component Analysis for building the financial inclusion index. There are several reasons to use PCA for this study. First, since the selected variables for this study are highly correlated, we should transform the selected variables into an uncorrelated set of new variables by using PCA. The newly transformed variables are linear combinations of the original data in PCA (Nguyen 2020). Second, PCA is also used to statistically capture theoretically unobservable variables of interest called latent variables via covariance between observed variables. Third, PCA allows the researcher not to assign importance (weight) subjectively to underlying indicators, as the importance (weight) of the indicator's covariance is computed endogenously. Finally, PCA allows for the building of the overall index that is used in forming a linear function alongside other variables to measure the dynamic relationship between them. Therefore, Equations (1)–(5) show the indexes created through the use of PCA. Equation (1) represents the index for FinTech, Equation (2) represents the index for the geographic dimension, Equation (3) represents the index for the demographic dimension, Equation (4) represents the index for the usage dimension, and Equation (5) represents the index for overall traditional financial inclusion.

$$\text{FinTech}_{it} = \alpha_0 + \alpha_1 \text{FBBS}_{it} + \alpha_2 \text{MCS}_{it} + \varepsilon_{it} \quad (1)$$

$$\text{GEO}_{it} = \alpha_0 + \alpha_1 \text{ATMKM}_{it} + \alpha_2 \text{BBKM}_{it} + \varepsilon_{it} \quad (2)$$

$$\text{DEM}_{it} = \alpha_0 + \alpha_1 \text{ATMP}_{it} + \alpha_2 \text{BBP}_{it} + \varepsilon_{it} \quad (3)$$

$$\text{USAGE}_{it} = \alpha_0 + \alpha_1 \text{ODCB}_{it} + \alpha_2 \text{OLCB}_{it} + \varepsilon_{it} \quad (4)$$

$$\text{FII}_{\text{IT}} = \alpha_0 + \alpha_1 \text{GEO}_{it} + \alpha_2 \text{DEM}_{it} + \alpha_3 \text{USAGE}_{it} + \varepsilon_{it} \quad (5)$$

The equations above present the various indexes created. Equation (1) presents FinTech, where FBBS represent fixed broadband subscriptions and MCS is mobile cellular subscriptions. Equation (2) presents the geographical dimension, where ATMKM represent the number of ATMs in square kilometers and BBKM is the number of bank branches in square kilometers. Equation (3) presents the demographic dimension, where ATMP represents the number of ATMs per 100,000 adults and BBP is the number of bank branches per 100,000 adults. Equation (4) presents the usage dimension, where ODCB represents the proportion of outstanding deposits, with commercial banks as a percentage of GDP, and OLCB is the proportion of outstanding loans from commercial banks as a percentage of GDP. Finally, Equation (5) represents the financial inclusion index, which is a combination

of all the dimensions. FII is financial inclusion index; GEO is geographical dimension; and DEM is demographic dimension and usage dimension.

The data from the World Bank include variables such as fixed broadband subscriptions, mobile cellular subscriptions, trade, primary school enrollment, domestic investment (gross capital formation), and population growth. On the other hand, the IMF data entail all the variables of financial inclusion.

- Models and Economic Strategy

The paper uses panel data techniques (pooled OLS and GMM) in 22 SSA countries for the period 2004–2021.

To model the impact of FinTech on traditional financial inclusion, the estimating equation can be stated as follows:

$$FII_{it} = \beta_0 + \beta_1 FinT_{it} + \beta_2 Trade_{it} + \beta_3 Pop_{it} + \beta_4 Edu_{it} + \beta_5 Exp_{it} + \varphi_{it} + \omega_{it} + \varepsilon_{it} \quad (6)$$

From Equation (6), the dependent variable is the financial inclusion index (FII), which serves as a proxy for financial inclusion in country i at time t. The independent variable of interest is $FinT_{it}$, which represents FinTech in country i at time t. There are four other independent variables, $Trade_{it}$, Pop_{it}, Edu_{it}, and Exp_{it}. These variables represent trade openness, which is measured as the total value of imports and exports as a share of GDP; annual population growth, which takes into account all individuals residing in a particular country regardless of their legal status or citizenship; education (school enrollment), the proportion of individuals, regardless of age, who are enrolled in educational institutions; and gross capita formation, which includes expenditures on the expansion of the economy's fixed assets, as well as the net variations in inventory levels in country i at time t, respectively. φ_{it} represents country dummies to control for country-specific effects that may influence the dependent variable. ω_{it} represents time dummies to account for time-specific effects.

We initially estimate Equation (6) using the pooled OLS method. However, the presence of numerous unobserved factors that may be associated with our measurement of FinTech and possibly affect financial inclusion means that the estimation of FinTech may yield biased results. Also, it does not account for time-invariant unobserved factors that could potentially influence both the independent and dependent variables. Due to the limitations of the pooled OLS estimates, this study only used pooled OLS to check for the correlation between the variables of interest and the dependent variable. Therefore, this study employs a dynamic panel data model to address several problems, such as heteroskedasticity, endogeneity, autocorrelation, and other related issues that may affect a model. This study uses the systems Generalized Method of Moments (GMM) estimator to examine the dynamic relationship between FinTech and financial inclusion. Therefore, Equation (6) is transformed as follows:

$$FII_{it} = \beta_0 + \beta_1 FII_{t-1} + \beta_2 FinT_{it} + \beta_3 Trade_{it} + \beta_4 Pop_{it} + \beta_5 Edu_{it} + \beta_6 Exp_{it} + \varepsilon_{it} \quad (7)$$

This study utilizes systems GMM estimation as stated in Equation (7), based on the methods established by Arellano and Bover (1995) and expanded upon by Blundell and Bond (1998). The systems GMM estimator effectively resolves the problem of endogeneity by producing estimates that are both consistent and efficient. Also, it is well-suited for panel studies with a larger sample size (N) compared to the number of time periods (T), providing a distinct advantage for our study, which has a sample size of 22 and time period of 19. Blundell and Bond (1998) also discovered that the utilization of systems GMM reduces bias and enhances the accuracy of the estimates. Additionally, systems GMM employs a model that includes lagged dependent variables to analyze the dynamic characteristics of both the dependent and independent variables, while also considering endogeneity.

4. Results and Discussion

4.1. Findings

This study uses both pooled OLS and GMM estimation techniques to investigate the impact of FinTech on traditional financial inclusion. The study presents the results in this section. Table 1 presents the summary statistics, while Table 2 displays pooled OLS estimates of Equation (6) in four different models. Column 1 presents estimates of our primary equation without the inclusion of country dummies and year dummies. Column 2 displays results for only country dummies, excluding year dummies. Column 3 shows results with only year dummies, excluding country dummies. The last column provides estimates by including both country and year dummies. Robust standard errors are employed to mitigate the influence of heteroskedasticity on the outcomes. We also further present the findings for each dimension of traditional financial inclusion.

Table 1. Summary statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
Mobile cellular sub	395	67.837	43.804	1.279	185.559
Fixed broadband sub	364	1.754	4.692	0	38.772
ATMs sqkm	375	19.219	46.918	0	228.571
ATMs per adults	375	17.688	20.7	0	91.773
Bank branch km	394	10.441	24.034	0.015	111.823
Bank branch per adults	394	8.317	10.543	0.356	54.448
Outstanding deposit	389	32.812	32.697	2.544	191.769
Outstanding loans	389	22.548	19.111	0.789	134.241
Financial inclusion index	371	0	1	−0.856	3.559
FinTech	364	0	1	−0.374	7.889
Geographical dimension	374	0	1	−0.446	4.107
Demographic dimension	374	0	1	−0.855	3.574
Usage dimension	389	0	1	−1.139	5.844
Trade	392	80.805	38.812	27.236	235.82
Population growth	396	2.188	1.11	−2.629	4.78
Education	332	104.76	18.863	51.199	148.346
Government spending	381	24.239	9.01	1.525	56.467

The summary statistics show all the variables utilized in this study. In the process of establishing the FinTech index, we utilized two factors: mobile cellular subscriptions and fixed broadband subscriptions. Additionally, we used two financial inclusion variables to construct each dimension of the financial inclusion. Finally, we combined these three dimensions to form the financial inclusion index.

Table 2 presents the relationship between FinTech and the geographical dimension of traditional financial inclusion. Without the inclusion of country dummies and year dummies, column 1 displays the estimates of our primary equation, which demonstrate a positive and significant correlation. Column 2 displays results for only country dummies, excluding year dummies, and the relationship is positive and significant between FinTech and traditional financial inclusion. Column 3 shows results with only year dummies, excluding country dummies, and it shows a positive and significant relationship. The 4th column provides estimates by including both country and year dummies, and it shows that FinTech has a negative and also insignificant relationship with the geographical dimension of traditional financial inclusion.

Table 2. Results of pooled OLS estimation (dependent variable is geographical dimension of traditional financial inclusion).

	(1)	(2)	(3)	(4)
VARIABLES	**Pooled OLS**	**Pooled OLS**	**Pooled OLS**	**Pooled OLS**
FinTech	0.315 ***	0.0521 *	0.532 ***	−0.0378
	(0.0675)	(0.0271)	(0.0795)	(0.0330)
Trade	0.00590 ***	0.00269 **	0.00386 ***	0.00300 ***
	(0.00139)	(0.00111)	(0.00135)	(0.000943)
Population growth	−0.308 ***	0.0311	−0.176 **	0.0131
	(0.0770)	(0.0297)	(0.0718)	(0.0248)
Education	−0.00253	−0.00179	−0.00203	−0.00290 **
	(0.00221)	(0.00121)	(0.00234)	(0.00129)
Government spending	0.00799 *	0.00231	0.00374	0.00281
	(0.00417)	(0.00224)	(0.00434)	(0.00227)
Country dummies		YES	NO	YES
Year dummies		NO	YES	YES
Constant	0.285	−0.587 ***	1.256 **	−0.913 ***
	(0.409)	(0.168)	(0.597)	(0.231)
Observations	280	280	280	280
R-squared	0.551	0.980	0.609	0.985

Note: Robust standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Author computation using Stata 18.

Table 3 presents the pooled OLS estimate of the relationship between FinTech and the demographic dimension of traditional financial inclusion. All columns show a positive and significant relationship, although, in the 4th column, the coefficient becomes smaller compared to the other columns.

Table 3. Results of pooled OLS estimation (dependent variable is demographic dimension of traditional financial inclusion).

	(1)	(2)	(3)	(4)
VARIABLES	**Pooled OLS**	**Pooled OLS**	**Pooled OLS**	**Pooled OLS**
FinTech	0.453 ***	0.363 ***	0.530 ***	0.233 ***
	(0.0549)	(0.0381)	(0.0703)	(0.0555)
Trade	0.00321 ***	−0.00254 *	0.00244 *	−0.000453
	(0.00120)	(0.00144)	(0.00137)	(0.00163)
Population growth	−0.263 ***	0.174 ***	−0.220 ***	0.179 ***
	(0.0527)	(0.0585)	(0.0536)	(0.0626)
Education	0.00632 **	0.0150 ***	0.00674 **	0.0194 ***
	(0.00245)	(0.00458)	(0.00263)	(0.00463)
Government spending	0.00440	−0.000668	0.00305	0.00285
	(0.00483)	(0.00348)	(0.00490)	(0.00357)
Country dummies		YES	NO	YES
Year dummies		NO	YES	YES
Constant	−0.447	−2.017 ***	−0.139	−3.000 ***
	(0.338)	(0.584)	(0.376)	(0.657)
Observations	280	280	280	280
R-squared	0.649	0.936	0.662	0.946

Note: Robust standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Author computation using Stata 18.

Table 4 presents the usage dimension of traditional financial inclusion; columns 1 and 3 show a positive and significant relationship, while column 2 is positive although not significant, and finally column 4 shows a negative and significant relationship between FinTech and traditional financial inclusion.

Table 4. Results of pooled OLS estimation (dependent variable is usage dimension of traditional financial inclusion).

	(1)	(2)	(3)	(4)
VARIABLES	**Usage**	**Usage**	**Usage**	**Usage**
FinTech	0.207 **	0.0620	0.360 ***	−0.126 **
	(0.0805)	(0.0430)	(0.101)	(0.0531)
Trade	−0.00463 ***	8.18e−05	−0.00629 ***	0.00221
	(0.00158)	(0.00249)	(0.00161)	(0.00212)
Population growth	−0.497 ***	0.0725	−0.430 ***	0.0630
	(0.0887)	(0.0571)	(0.0956)	(0.0532)
Education	−0.00407	0.00876	−0.00414	0.0106
	(0.00324)	(0.00616)	(0.00368)	(0.00805)
Government spending	−0.00380	−0.0158 ***	−0.00883	−0.0131 ***
	(0.00726)	(0.00565)	(0.00717)	(0.00468)
Country dummies		YES	NO	YES
Time dummies		NO	YES	YES
Constant	2.064 ***	−0.538	2.237 ***	−1.481 *
	(0.504)	(0.631)	(0.573)	(0.884)
Observations	293	293	293	293
R-squared	0.376	0.888	0.414	0.904

Note: Robust standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Author computation using Stata 18.

In Table 5, all columns shows that FinTech has a positive and significant correlation with traditional financial inclusion, although the coefficient in the 4th column becomes smaller compared to the other columns. Despite potential endogeneity and other issues that might affect the results of the pooled OLS estimation, the estimate demonstrates a significant and positive correlation in all the columns. Nevertheless, we also examine the relationship between FinTech and the three dimensions of traditional financial inclusion.

Table 5. Results of pooled OLS estimation (dependent variable is traditional financial inclusion).

	(1)	(2)	(3)	(4)
VARIABLES	**Pooled OLS**	**Pooled OLS**	**Pooled OLS**	**Pooled OLS**
FinTech	0.451 ***	0.362 ***	0.529 ***	0.232 ***
	(0.0547)	(0.0379)	(0.0701)	(0.0553)
Trade	0.00320 ***	−0.00253 *	0.00243 *	−0.000452
	(0.00120)	(0.00144)	(0.00136)	(0.00163)
Population growth	−0.262 ***	0.173 ***	−0.220 ***	0.179 ***
	(0.0526)	(0.0583)	(0.0534)	(0.0624)
Education	0.00631 **	0.0149 ***	0.00672 **	0.0193 ***
	(0.00245)	(0.00456)	(0.00262)	(0.00462)
Government spending	0.00439	−0.000666	0.00304	0.00284
	(0.00482)	(0.00347)	(0.00489)	(0.00356)

Table 5. *Cont.*

	(1)	(2)	(3)	(4)
VARIABLES	**Pooled OLS**	**Pooled OLS**	**Pooled OLS**	**Pooled OLS**
Country dummies		YES	NO	YES
Year dummies		NO	YES	YES
Constant	−0.449 (0.337)	−2.015 *** (0.582)	−0.142 (0.375)	−2.995 *** (0.655)
Observations	280	280	280	280
R-squared	0.649	0.936	0.662	0.946

Note: Robust standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Author computation using Stata 18.

Table 6 presents findings obtained from the systems GMM estimation. The table entails the three dimensions of traditional financial inclusion and the overall traditional financial inclusion index. In the table, column 1 shows the impact of FinTech adoption on the geographical dimension of financial inclusion. Column 1 shows that FinTech has a negative effect on the geographical dimension of traditional financial inclusion, which entails the number of bank branches and ATMs per square kilometer. It shows that a percentage increase in FinTech adoption reduces bank branches and ATMs by 0.045 percent.

Table 6. Results from systems GMM estimation.

	(1)	(2)	(3)	(4)
VARIABLES	**GEO**	**DEM**	**Usage**	**FII**
FinTech	−0.0449 *** (0.00164)	0.0429 *** (0.00617)	−0.0788 ** (0.0361)	0.0473 *** (0.00642)
Trade	0.000831 *** (0.000100)	0.00185 *** (0.000427)	0.00200 *** (0.000709)	0.00247 *** (0.000446)
Population growth	0.0455 *** (0.000758)	0.0225 ** (0.00964)	0.0590 ** (0.0232)	0.0301 *** (0.00136)
Education	0.000451 ** (0.000184)	0.000302 (0.00144)	0.00629 *** (0.00102)	0.00145 (0.00156)
Government spending	0.000490 ** (0.000219)	−0.00253 ** (0.00115)	−0.00355 *** (0.00124)	−0.00257 ** (0.00106)
GEO (−1)	0.900 *** (0.00259)			
DEM (−1)		0.797 *** (0.0256)		
Usage (−1)			0.0326 (0.0644)	
FII (−1)				0.770 *** (0.0258)
Constant	−0.209 *** (0.0174)	−0.160 (0.147)	−0.833 *** (0.146)	−0.344 ** (0.151)
Observations	232	232	248	232
Number of id	22	22	22	22

Note: Robust standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Author computation using Stata 18. FII = Financial inclusion index, GEO = geographical dimension, DEM = demographic dimension and usage dimension.

Column 2 presents the demographic dimensions of traditional financial inclusion; it shows that FinTech has a positive and significant effect on the demographic dimension of traditional financial inclusion, which entails the number of ATMs and bank branches

per 100,000 adults. It shows that a one-percent increase in FinTech adoption increases the demographic dimension of traditional financial inclusion by 0.043 percent.

Column 3 shows the usage dimension of traditional financial inclusion, and the result shows that FinTech has a negative significant effect on the usage dimension of traditional financial inclusion, which entails outstanding deposits and outstanding loans. It shows that an increase in FinTech adoption by 5 percent reduces the outstanding loan and deposit of traditional financial inclusion by 0.079 percent.

Column 4 presents the overall traditional financial inclusion, and it shows that FinTech has a positive and significant effect on overall traditional financial inclusion. It shows that a one-percent increase in FinTech adoption increases the overall traditional financial inclusion by 0.047 percent.

For the control variables, both trade and population growth exhibit a positive and statistically significant impact across all the columns. Education has a positive effect in all the columns, because education promotes financial inclusion by providing individuals with crucial financial literacy skills, including the comprehension of fundamental financial principles, proficient financial management, budget creation, savings accumulation, and informed decision-making in financial matters. Government spending has a positive and statistically significant impact in the geographical dimension, but a negative and statistically significant impact in all other dimensions.

- Robustness Checks

To test the robustness of our results, we used internet usage to replace FinTech as the variable of interest and employed a quantile regression model to present our analysis. The result of the quantile regression shows that internet usage has a positive and significant effect in all the quantiles. This finding confirms the findings of Tchamyou et al. (2019), who found that ICT contributes greatly to the access of financial products.

4.2. Discussion: FinTech Adoption Impact on Traditional Financial Inclusion

Although technology has experienced remarkable growth and widespread use, the pace at which traditional financial inclusion institutions in SSA use technology remains extremely low. Hence, the present study investigated the impact of FinTech adoption on traditional financial inclusion in SSA. The theoretical model is distinct in its utilization of UTAUT2 to examine the impact of FinTech adoption on traditional financial inclusion in Sub-Saharan Africa. The researchers initially employed pooled OLS to investigate the correlation between the dependent and the independent variables before using GMM as the primary model to present the analysis.

To enhance the accuracy of the correlation analysis, we incorporated year and country dummies into all pooled OLS regression models. In terms of the geographical dimension in Table 2, we started by just the ordinary regression without including both the country and year dummies in column 1. In column 2, we included country dummies only, and in column 3 we included year dummies only, while in column 4 we included both country and year dummies. We observed a positive and statistically significant correlation between FinTech and the geographical dimension of traditional financial inclusion in all columns, except for the fourth column, where we accurately capture the correlation between the variables by including both country and year dummies. The results indicate a negative correlation between FinTech and the geographical dimension of traditional financial inclusion. Following the use of pooled OLS to examine the correlation, we employed GMM to obtain the actual findings, as GMM addresses many issues that the model may experience. The result from the GMM in Table 6, column 3, indicates that FinTech has a significant negative effect on the geographical dimension, which includes the number of ATMs and bank branches per square kilometer. Thanks to the advent of FinTech, banks have shifted their focus away from expanding physical branches and building ATMs. Instead, they have prioritized enhancing their technological capabilities, enabling customers to conveniently carry out various banking transactions, such as checking balances, transferring funds, and paying bills. These functions can now be easily performed online or through mobile appli-

cations. This shift has not only made financial services more accessible but also reduced the cost of traditional financial inclusion. This finding is in line with Tok and Heng (2022) and Tashin et al. (2018).

For the demographic dimension of traditional financial inclusion using the pooled OLS, as presented in Table 3, all columns, including those taking country and year dummies, shows a significant and positive correlation between FinTech and the demographic traditional financial inclusion. We went further to employ the GMM in Table 6, and the findings from the GMM show that FinTech adoption has a positive significant effect on the demographic dimension of traditional financial inclusion. The demographic dimension of traditional financial inclusion entails the number of ATMs and bank branches per 100,000 adults. FinTech adoption has significantly enhanced the utilization of traditional financial inclusion by enabling a majority of the adult population to obtain access to financial services. Although FinTech adoption has experienced growth, a significant portion of the population in SSA continues to depend on physical cash for specific transactions. The increase in financial inclusion has led to a rise in the number of people accessing bank branches and ATMs. This is because not all individuals and businesses in SSA can conduct transactions online. A significant portion of the population also visits physical branches and ATMs for services such as opening accounts, depositing checks, depositing cash, and resolving other matters that cannot be resolved online. Thus, despite the increasing number of FinTech platforms providing easy digital services, users may still need face-to-face support for complex financial matters or problem resolution. Under such circumstances, consumers have the option to physically go to bank branches to receive individualized assistance. FinTech adoption has increased the amount of people accessing traditional financial inclusion. This is in line with the findings of Ashenafi and Dong (2022) and Demirgüç-Kunt and Singer (2017).

When examining the relationship between the adoption of FinTech and traditional financial inclusion's usage dimension, we utilized pooled OLS regression analysis as presented in Table 4, column 1, without the inclusion of country and year dummies. The results showed a significant and positive correlation. In column 2, when we introduced country dummies, the correlation remained positive but was no longer statistically significant. However, when we included year dummies, the correlation remained positive and became statistically significant. Finally, when we incorporated both country and year dummies into the analysis, the correlation between FinTech adoption and usage dimension became negative and statistically significant. We went further to present our analysis using GMM in Table 6. The GMM results shows that FinTech adoption has a significant negative effect on the usage dimension of financial inclusion, which entails outstanding deposits and outstanding loans. FinTech offers certain services that compete with those provided by banks, while also enhancing banks' operational efficiency through the provision of digital banking services that simplify consumers' financial management and online payment processes. This can result in a reduction in the amount of deposits held by banks, since customers may instead opt to retain their funds in FinTech accounts for more convenient accessibility. FinTech platforms also enable alternative financing options, such as peer-to-peer lending and crowdfunding, enabling borrowers to acquire funding through channels other than traditional banking. This can reduce the dependence on bank loans and decrease the quantity of loans held by banks, as well as reducing outstanding deposits from the banks. This is in line with the findings of Ozili (2023).

Finally, we used PCA to create the overall traditional financial inclusion index by putting together all dimensions of traditional financial inclusion. In Table 5, the pooled OLS shows that FinTech adoption has a positive significant correlation with the overall traditional financial inclusion in all the columns. In Table 6, column 4, the results from the GMM show that FinTech adoption has a significant positive effect on overall traditional financial inclusion. The overall traditional financial inclusion can increase because FinTech adoption enables banks to easily reach populations that have limited access to banking services or do not have bank accounts, through the use of digital platforms. Also, banks can

broaden their customer base and provide financial services to a greater number of people while simplifying banking procedures, automating operations, and decreasing operational expenses. Banks may save costs, increase profitability, and improve risk management and regulatory compliance by incorporating FinTech solutions into their operations. While there is a prevailing perception that FinTech has the potential to disrupt the financial sector (Disrupt Africa 2023; Goswami et al. 2022), it is important to note that if banks effectively embrace FinTech adoption, they can attract a larger customer base and therefore increase their profits. This finding is in line with the findings of Ashenafi and Dong (2022); Chinoda and Mashamba (2021); Demir et al. (2022); Gosavi (2018); Iddrisu et al. (2022); Mbiti and Weil (2011); and Djoufouet and Pondie (2022).

For the control variables, both trade and population growth exhibit a positive and statistically significant impact across all the columns. Trade has the ability to stimulate economic growth and generate higher revenue, especially for individuals and businesses involved in the exporting sectors that benefit from global trade. This, in turn, leads to increased incomes. When a country experiences higher incomes, there is a greater demand for financial services, which promotes the growth of financial inclusion. This finding supports those of Demir et al. (2022). Trade can facilitate financial inclusion by attracting foreign investment and creating job opportunities, thus enabling more individuals to use financial services and products and ultimately enhancing the level of financial inclusion. This finding is similar to those of Kanga et al. 2022. Population growth has a positive and significant impact as it leads to an increased demand for financial services, such as savings accounts, loans, payment systems, and other necessities. Consequently, traditional banks are compelled to expand their range of services and expand their coverage in order to accommodate the growing population, resulting in a rise in financial inclusion. Population growth can also result in the expansion of the customer base for banks. This can incentivize banks to broaden their activities through the establishment of more branches and the implementation of ATMs, and also develop new financial products that are easily accessible and user-friendly. Education has a favorable and significant impact on the geographical dimension and usage dimension. However, its impact on demographic and overall traditional financial inclusion is positive but not statistically significant. Education promotes financial inclusion by providing individuals with crucial financial literacy skills, including the comprehension of fundamental financial principles, proficient financial management, budget creation, savings accumulation, and informed decision-making in financial matters. In addition, education enables users to utilize technology for convenient access to financial services. Therefore, individuals with higher levels of education tend to demonstrate more proficiency in understanding financial systems, effectively using a range of financial products and services, and making well-informed financial decisions, such as evaluating interest rates, identifying fraudulent activities, and managing risks. Similar results have been found by Ozili (2018) and Djoufouet and Pondie (2022). Government spending has a positive and statistically significant impact in the geographical dimension, but a negative and statistically significant impact in all other dimensions. The substantial nature of government spending can diminish the amount of financial inclusion by crowding out the private banking sector and monopolizing resources. This dominance might hinder the successful operation of private financial institutions and their ability to provide comprehensive financial services. Consequently, individuals may have few alternatives other than the ones provided by governments, which can negatively reduce the overall traditional financial inclusion in SSA.

In Table 7, we conducted robustness checks using internet usage to examine the potential impact of internet on traditional financial inclusion. This is because the adoption of FinTech is primarily dependent on internet access, as many financial institutions rely on internet-based platforms and products such as mobile banking, mobile apps, and online transactions for domestic and international remittance. We utilized the quantile regression model to analyze the data and provide the findings for the 10th, 25th, 50th, 75th, and 90th quantiles. Across all quantiles, the data consistently demonstrate that internet usage

has a strong and statistically significant impact on traditional financial inclusion in all the quantiles.

Table 7. Results from quantile regression model.

	(0.1)	(0.25)	(0.5)	(0.75)	(0.9)
VARIABLES	**FII**	**FII**	**FII**	**FII**	**FII**
Internet usage	0.0195 ***	0.0205 ***	0.0216 ***	0.0224 ***	0.0230 ***
	(0.00457)	(0.00291)	(0.00175)	(0.00198)	(0.00264)
Trade	−0.00122	−0.00148	−0.00175	−0.00195	−0.00208
	(0.00465)	(0.00296)	(0.00177)	(0.00201)	(0.00268)
Population growth	0.126	0.132	0.139 *	0.144	0.147
	(0.213)	(0.135)	(0.0810)	(0.0921)	(0.123)
Education	0.0178 **	0.0144 ***	0.0110 ***	0.00839 **	0.00661
	(0.00776)	(0.00495)	(0.00297)	(0.00336)	(0.00447)
Government spending	0.0136	0.0138 *	0.0139 ***	0.0141 ***	0.0142 **
	(0.0115)	(0.00730)	(0.00437)	(0.00497)	(0.00662)
Observations	298	298	298	298	298

Note: Standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ (Source: Author computation).

Table 8 presents the hypotheses of our research. Our findings confirm all of our hypotheses. Our research indicates that the adoption of FinTech has a substantial negative impact on both the geographical and usage dimensions of traditional financial inclusion. However, it has a significant positive effect on both the demographic and overall traditional financial inclusion.

Table 8. Hypothesis Testing Results from Table 6.

Hypotheses	Coefficients and *p*-Values	Decision
FinTech Adoption on Geographical Dimension (Table 6, column 1)	−0.0449 ***	Supported
FinTech Adoption on the Demographic Dimension (Table 6, column 2)	0.0429 ***	Supported
FinTech adoption on the Usage Dimension (Table 6, column 3)	−0.0788 **	Supported
FinTech Adoption on the overall traditional financial inclusion (Table 6, column 4)	0.0473 ***	Supported

Note: Standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$ (Source: Author computation).

5. Conclusions and Recommendations

Existing theories and research indicate that financial inclusion has a positive effect on economic growth, while also reducing income inequality and poverty. However, there is a lack of empirical studies that have specifically demonstrated the influence of FinTech on financial inclusion in SSA. This empirical study has investigated the influence of FinTech adoption on traditional financial inclusion, considering the different dimensions of traditional financial inclusion across a panel of 22 countries. The study has utilized data from the World Bank's world development indicators and the IMF's FAS data from 2004 to 2022. We employ PCA to construct an index for FinTech, dimensions of traditional financial inclusion, and the overall traditional financial inclusion index. Additionally, we utilize pooled regression to examine the relationship between our dependent and independent variables. To analyze our findings, we employ systems GMM, which shows that FinTech has a positive and significant effect on overall traditional financial inclusion. Furthermore, we employ a quantile regression model as a robust method to validate our findings, and it also shows that FinTech has a positive and significant effect on the overall traditional financial inclusion index in SSA.

Our findings lead to four distinct conclusions. Firstly, FinTech has a negative effect on the geographical dimension, as it leads to a decrease in the establishment of physical bank branches and the construction of ATMs. Furthermore, it has a favorable and substantial impact on the demographic dimension, leading to an increase in the number of individuals utilizing branches and ATMs. Additionally, it negatively impacts the usage dimension by decreasing the amount of outstanding deposits and loans. Lastly, it positively influences the overall traditional financial inclusion. For the geographical dimension, the findings imply that a significant portion of the population now favors digital and online banking because of its convenience and efficiency. Consequently, banks must improve their technology and adjust to technological advancements rather than depending solely on physical branches and ATMs for the demographic dimension. Additionally, they have raised awareness about the operations of financial services, resulting in a greater number of individuals utilizing traditional bank branches and ATMs for specific transactions and depositing funds. For the usage dimension, through peer-to-peer lending platforms, crowd-funding sites, and digital payment providers, FinTech platforms facilitate direct connections between borrowers and lenders and offer alternative financial services. As a result, some consumers choose to save their money on FinTech platforms rather than into the banks. By allowing people and companies to access funds, save, or conduct transactions outside of traditional banking channels, FinTech solutions have reduced the amount of outstanding deposits and loans. Finally, FinTech positively affects the overall traditional financial inclusion because FinTech platforms lower infrastructure costs, as banks are more likely to upgrade their technologies rather than constructing new branches or ATMs. They also make online banking transactions easier and more affordable, which encourages the majority of people to use the traditional financial inclusion platforms.

Our research results provide important policy implications. First, FinTech regulatory bodies should create supportive environments for FinTech innovation that will increase financial inclusion, especially by serving the underserved and the unserved population, and also create a regulatory sandbox where FinTech companies can test their products and services in a controlled environment, and can foster innovation while ensuring consumer protection and compliance. It should also be designed to accommodate new business models and address the specific needs of all the populations. Therefore, SSA countries can expand, make better use of accessible financing, and create a favorable environment for FinTech operations, which increases the use of the traditional financial inclusion system. Finally, the central banks of SSA countries should encourage most organizations and businesses to be innovative enough to engage in digital payment systems, as we are witnessing a revolution of mobile money which has changed the method of financial system operation in Kenya and other countries; FinTech has been a driving force for inclusive finance. This will help most people to appreciate the services of FinTech in enhancing traditional financial inclusion. This study did not capture the population that used both FinTech adoption variables and also did not include digital financial inclusion.

Future research on this subject should be contingent upon the availability of data. It should aim to quantify the impact of FinTech on both traditional financial inclusion and digital financial inclusion in SSA. Also, a comparative study between Africa and Asia can be conducted.

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