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*Corresponding author: Godwin Imo Ibe, Department of Banking and Finance, University of Nigeria, Nigeria E-mail: godwin.ibe@unn.edu.ng

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DEVELOPMENT ECONOMICS | RESEARCH ARTICLE

Financial inclusion and its impact on economic growth: Empirical evidence from sub-Saharan Africa

Chuka Ifediora¹, Kenechukwu Onochie Offor², Eze Festus Eze³, Samuel Manyo Takon⁴, Anthony Eboselume Ageme³, Godwin Imo Ibe^{3*} and Josaphat U. J. Onwumere³

Abstract: This study examines the impact of financial inclusion on economic growth using panel data of 22 sub-Sahara African (SSA) countries during the period spanning from 2012 to 2018. The study employs the system Generalized Method of Moments (GMM). Using a composite index of financial inclusion as well as individual financial inclusion indicators, we discovered that the availability dimension of financial inclusion, penetration dimension of financial inclusion and composite financial inclusion (all indicators put together) significantly and positively impact economic growth while the usage dimension of financial inclusion improves economic growth but not significantly. Also, bank branches and ATMs have positive and significant impact on economic growth, deposit accounts and outstanding loans promote economic growth but not significantly while outstanding deposits adversely affects economic growth. In addition, findings for mobile money indicators from 2012 to 2018 revealed that mobile money agents weaken economic growth while mobile money accounts and mobile money transactions foster

ABOUT THE AUTHOR

Specifically, Kenechukwu Onochie Offor initiated the idea of this paper during the course of his Postgraduate Studies in the Department of Banking and Finance, Faculty of Business Administration, University of Nigeria. The other authors Chuka Ifediora, Eze Festus Eze, Samuel Manyo Takon, Anthony Eboselume Ageme and Godwin Imo Ibe, keyed into the topic because of our interest in development finance. Prof. Josaphat U. J. Onwumere is Kenechukwu's supervisor and played a major role in seeing to the completion of the paper. Our collective interest was to empirically review the impact of financial inclusion on economic growth in sub Saharan Africa given the enormous contribution of finance at contributing to economic growth and development. Based on our findings, financial inclusion, penetration and availability dimension, improves economic growth while the usage dimension does not influence economic growth meaningfully. Therefore, this paper is apt at these times where most sub-Saharan African countries are in dire needs of alternative sources of finance to grow their economies.

PUBLIC INTEREST STATEMENT

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Financial inclusiveness plays important role in the economy as it facilitates positive wealth creation and sustainable economic growth. In the United Nations' (UN) Sustainable Development Goals (SDGs), financial inclusion features prominently as a target objective in eight (8) out of the 17 SDGs. For example, to achieve health and well-being for all (SDG 3) amidst the novel coronavirus pandemic, financial inclusion through digital financial services can help minimize community-based transmission in Africa. Digital finance does this through providing secure, low-cost and contactless financial instruments across ecosystems. Therefore, this study examined how different dimensions of financial inclusion affects economic growth in sub-Saharan Africa. Undeniably, the study has revealed that the general financial inclusion, penetration and availability dimension, improves economic growth while the usage dimension does not influence economic growth meaningfully. The study provided some important policy suggestion that seek to improve financial inclusion especially usage of financial services in the sub-region.





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economic growth but not significantly. This implies that financial education policies which help Africans better understand the potential benefits of the usage of banking services should be pursued.

Subjects: Africa - Regional Development; Economics and Development; Financial Services Industry

Keywords: Financial inclusion; economic growth; principal component analysis; GMM; sub-Saharan Africa

1. Introduction

Financial inclusion has increasingly become a crucial topic among researchers, stakeholders and policymakers especially in developing nations. However, 65% of adults in the poorest developing nations still lack access to a transaction account and only 20% save through a formal financial institution (Pazarbasioglu et al., 2020). According to the Global Findex report in 2017, only 33% of the adult population own a bank account at a formal financial institution in sub-Saharan Africa (SSA), which is less than any other region in the world (Demirguc-Kunt et al., 2018). Primarily, financial inclusion begins with adults owning a transaction account which can be used to save money, send and receive payments (Demirgüç-Kunt et al., 2017). For low-income individuals and households, owning formal bank accounts involve inconveniences and high transaction costs (Beck & Demirgüç-Kunt, 2008; Karlan et al., 2016; Soumaré et al., 2016) but the availability of mobile telephony has helped to reduce the constraints, especially, in rural areas (Andrianaivo & Kpodar, 2011; Pazarbasioglu et al., 2020).

Moreover, the widespread availability of smartphones and internet usage has enormously transformed the way we live, work, and communicate. In addition to the traditional financial services already offered to customers by banks, mobile financial services are transformational in developing countries—with the goal of attracting the underserved and financially excluded into the formal financial system (Andrianaivo & Kpodar, 2011; Chinoda et al., 2019; Kim et al., 2017). The possibility of accessing banking services through mobile devices has significantly enhanced financial inclusion by closing up existing financial infrastructural gap (Chatterjee, 2020; Chatterjee & Anand, 2017). For instance, M-Pesa, the most widely adopted mobile phone-based financial service in the world (Jack & Suri, 2014), shows that leveraging mobile technology, well-designed financial products and revenue models, low-cost transactional platform, and a conducive regulatory environment are the necessary ingredients for developing countries to attract the unbanked population into the formal financial net (Mas & Radcliffe, 2011). Currently, in more than 20 fragile states that offer mobile money services, on average, for every commercial bank branch, there are close to 47 mobile money agents, leading to the proliferation of a new class of payment services and a novel way to access financial services (Espinosa-Vega et al., 2020).

Interestingly, inclusive finance facilitates positive wealth creation and sustainable economic growth (Dahiya & Kumar, 2020; Inoue & Hamori, 2016; Kim et al., 2017; Sethi & Acharya, 2018; Sharma, 2016; Lenka & Sharma, 2017 and others). For the United Nations' (UN) Sustainable Development Goals (SDGs), financial inclusion features prominently as a target objective in eight (8) out of the 17 SDGs (Abor et al., 2018). For example, to achieve health and well-being for all (SDG 3) amidst the novel coronavirus pandemic, financial inclusion through digital financial services can help to minimize community-based transmission in Africa. Digital finance does this through providing secure, low-cost and contactless financial instruments across ecosystems as this will lessen the physical exchange of cash and limit traditional branch-based banking. The significance of financial inclusion in promoting economic growth is theoretically and empirically recognized. The provision of adequate and affordable financial services such as savings, credits and payment to the underserved could increase business opportunities, expand investments and significantly contribute to economic growth (Afolabi, 2020;

Demirguc-Kunt & Klapper, 2012). Financial inclusiveness can also help smoothen consumption, safeguard savings and insure against the financial risks of unbanked and underbanked adults (Corrado & Corrado, 2017; Sahay et al., 2015; Sotomayor et al., 2018; Yah & Chamberlain, 2018). Therefore, financial inclusiveness promotes general economic growth, reduces income inequality gap, and ensures poverty reduction (Adedokun & Ağa, 2021; Honohan, 2004).

This study contributes to literature by including mobile money indicators in constructing a composite financial inclusion index for 22 SSA countries from 2012 to 2018. To the best of our knowledge, this is the first empirical study to include mobile money as an indicator of financial inclusion and capture its impact on economic growth in SSA—in the advent of digital financial services. Abdulmumin et al. (2019) and Nguyen (2020) added mobile money variables to build a financial inclusion index but focused on measuring the degree of financial inclusion. Mobile money reflects a positive outcome in financial services' expansion for developing countries (Demirguc-Kunt & Klapper, 2012). Secondly, this study will contribute to literature by bundling (supply side and demand side dimensions) and unbundling the financial inclusion indicators in order to avail us the advantage of further policy implications. The bundled indicators will show us the dimensions that have contributed more to economic growth in SSA while the unbundled indicators will help channel specific policies to each of the individual indicators of financial inclusion.

The rest of the study is organised as follows. Section 2 presents the literature review. Section 3 describes the methodology. Section 4 reports and discusses the empirical results. Section 5 provides the conclusion and policy implications.

2. Literature review

2.1. Concept of financial inclusion

According to Lenka (2021), the financial sector can be broadly discussed within two folds financial development (financial depth and liquidity) and financial inclusion (financial access). Financial development is the realisation of financial innovation and institutional developments to reduce information asymmetry, advance market inclusiveness, promote competiveness and ease transaction cost in a financial system (Hartmann et al., 2007; Ibrahim & Alagidede, 2017). It defines the development of financial institutions and markets, and foreign capital flows that work together to reduce information, transaction and enforcement costs. However, the maxim of financial inclusion is connecting unbanked and underbanked people to affordable, transparent and reliable financial services which have far-reaching economic benefits (Sarma, 2015; Siddik et al., 2019). Although financial development and financial inclusion are broadly two inseparable concepts (financial inclusion is a basic determinant of financial development), it is imperative to know that a country may be financially developed with several people still remaining outside the formal financial system (Lenka, 2021; Sarma, 2008). Both promote economic growth with differing magnitudes (Chauvet & Jacolin, 2015; Li & Wong, 2018).

Literature presented several definitions of financial inclusion (Aduda & Kalunda, 2012; Akileng et al., 2018; Andrianaivo & Kpodar, 2011; Demirgüç-Kunt et al., 2017) with no clear consensus (Chinoda et al., 2019; Nguyen, 2020). However, generally, financial inclusion is concerned with the accessibility, availability, and affordability of financial services to all economic participants with a particular focus on the poor, underserved, and small enterprises (Sarma & Pais, 2011; Tita & Aziakpono). Financial inclusion counts on the delivery of formal financial services that are adequate, timely, affordable and sustainable to the disadvantaged group in the society (Andrianaivo & Kpodar, 2011; Joshi et al., 2014; Koker & Jentzsch, 2013; Sarma, 2008). In most studies, the financial services are cited as credit, savings, payment, and insurance (Clamara & Tuesta, 2014; Ghosh & Ghosh, 2014), but, in a broader sense, it includes the quality of service, access to facilities,

and digital technology (Ozili, 2018). On the other hand, the contrast of financial inclusion is financial exclusion—referring to accessibility concerns for diverse categories of financial services: banking, credits, saving, and insurance (Sinclair, 2001). Financial inclusion/exclusion is as a result of numerous factors such as absence of literacy and awareness, unfavourable demographic and geographical conditions, self-exclusion, income per capita, internet access, inflation, and bank concentration (Thathsarani et al., 2021; Asuming et al., 2018; Ajide, 2017; Karlan et al., 2016; Oyelami et al., 2017; Evans & Adeoye, 2016; Soumaré et al., 2016; ZSotomayor et al., 2018; Pazarbasioglu et al., 2020). Furthermore, financial exclusion arises principally with social exclusion and poverty (Barboni et al., 2017). Consequently, financial access is a problem for disadvantaged and susceptible groups that have not enough social amenities and education (Bernheim et al., 2015). In many countries, financial inclusion is critical in determining economic development. Therefore, it has turned out to be the focus of development finance, attracting the interest of policymakers and scholars, globally.

2.2. Measuring financial inclusion

Not surprisingly, as there is no consensus on the definition of financial inclusion, so it is in the measurement of financial inclusion. Earlier scholars have discussed diverse financial inclusion measurements with numerous proxies. One of the major efforts in measuring financial access was done by Beck et al. (2007). The researchers developed new measures of three types of bank access—loans, deposits, and payments—reflecting access and use of financial services. Honohan (2008) similarly measured financial inclusion using the fraction of households that have access to accounts in the formal financial sector. Other studies used a set of specific indicators—savings, credit and payment as financial inclusion measures (Demirguc-Kunt & Klapper, 2012; Demirguc-Kunt et al., 2018; Demirgüç-Kunt et al., 2015). The indicators were developed through interviews in a survey of more than 150, 000 persons between the ages of 15 and above in 148 countries. Nevertheless, financial inclusion cannot be accurately measured using individual indicators due to its multidimensional nature (Clamara & Tuesta, 2014). Individual indicators being used alone can only provide partial evidence about the financial system's inclusiveness and the level of coverage within an economy (Nguyen, 2020; Sarma, 2016).

However, many studies have tried to construct a suitable measurement for financial inclusiveness (Gupte et al., 2012; Sarma, 2008). Sarma (2008) documented three constituents of banking-availability, penetration, and usage dimensions—in constructing the financial inclusion index. While Gupte et al. (2012) used the average of four dimensions—usage, outreach, cost of transactions and ease of transactions. The index formation followed the method employed by the United Nations Development Program (UNDP) in constructing the human development index (HDI). The limitation in the methodology for these studies is that it assigned equal weights or weights are assigned arbitrarily to the selected constituents (Amidžic et al., 2014; Singh & Stakic, 2020). It means that the weights are assigned based on the academic intuition or experience of the author and the assumption is that all constituents or indicators have the same impact on financial inclusiveness. Due to this limitation, to determine the appropriate weights, Amidžic et al. (2014) and Clamara and Tuesta (2014) proposed a factor analysis and principal component analysis (PCA) approach, respectively, for constructing the financial inclusion index. This approach is less arbitrary in assigning weights but relies on available data for the various dimensions and indicators. Amidžic et al. (2014)'s approach normalized the variables; each dimension identified with weighted geometric mean. One downside of this approach is that the factor analysis does not totally use all the data provided. However, Clamara and Tuesta (2014) applied the two-stage PCA. The first stage estimates the three sub-indicators—access, usage and barriers while the second stage estimates weights of the dimensions and the general index for financial inclusion.

Regardless, in forming an index of financial inclusion, most studies have used either the PCA approach (Ahamed & Mallick, 2019; Anarfo et al., 2019; Clamara & Tuesta, 2014; Elsherif, 2019;

Lenka & Bairwa, 2016; Nguyen, 2020; Park & Mercado, 2018) or Sarma (2008) method (Anwar & Amiruddin, 2017; Dahiya & Kumar, 2020; Goel & Sharma, 2017; Huang & Zhang, 2019; Park & Mercado, 2015; Sethi & Sethy, 2019). However, each of these methods has merits and demerits which has allowed for non-consensus among researchers (Mialou & Amidžic, 2017; Park & Mercado, 2015). The construction of financial inclusion index is not only dissimilar in approach, it also varies in the choice of indicators among studies (Nguyen, 2020).

2.3. Theoretical framework: financial inclusion and economic growth linkages

Literature is replete with studies explaining the role of the financial sector in economic growth configurations, with each study offering insights into the subject matter. The foundation to understanding the relationship between the financial sector and economic growth could be seen from the works of Schumpeter (1912), Shaw (1973), and Mckinnon (1973). The underlying theory is that the financial sector is one of the vital fundamentals in explaining economic growth patterns. In the distribution of available scarce resources in an economy, the financial sector plays an important part in providing affordable financial services, thereby fostering economic growth (Chen et al., 2021; Graff, 2003). Furthermore, explaining time and cross-country differences in economic growth led to two major growth models—exogenous and endogenous growth models. The exogenous growth model highlights the place of labour productivity (Domar, 1946) and exogenous technological progress (Solow, 1956) as major factors in explaining growth differentials in the world. The exogenous growth model has been criticised based on none recognition of the efficiency factors such as macroeconomic conditions, suitable regulatory environment, and institutions that transform savings to investment (Chirwa & Odhiambo, 2018).

On the other hand, the endogenous growth model places interest on innovative capital, intellectual capital and human capital in explaining economic growth differences across countries and over time (Chirwa & Odhiambo, 2018; Inoue & Hamori, 2019). This new economic growth theory assumes that technological progress occurs through innovation; in the form of new products, processes and markets, many of which are determined by economic activities. Technological progress adds to both observable and non-observable productions. Several studies have recognised the role of financial services in terms of saving money, sending and receiving payments (Andersen & Tarp, 2003; Ibrahim & Alagidede, 2018; Sharma, 2016) and financial technology such as mobile money (Srouji, 2020) in the endogeneous economic growth framework. Moreover, two major channels underpin the theoretical relationship between financial inclusion and economic growth. Firstly, the provision of affordable and low cost financial services to the poor and underserved will encourage more economic activities resulting in increased national output as well as improved wellbeing (A.V. Banerjee, 2003; Adedokun & Ağa, 2021; Agnello et al., 2012; Nanda & Kaur, 2016; Sahay et al., 2015). Secondly, the unbanked having possible access to deposits and insurance services will encourage the vulnerable to save in the bank and non-bank financial institutions, aiding the flow of funds to the financial markets. This guarantees efficient fund allocation into long-term investments leading to more productive output, increased employment levels, income redistribution and poverty reduction in an economy (Claessens & Perotti, 2007; Ramkumar, 2017; Yoko, 2010).

2.4. Empirical literature

Empirically, literature is rich in explaining the link between financial inclusion and economic growth. Several studies have reported a positive relationship (Chatterjee, 2020; Inoue & Hamori, 2016, 2019; Kim et al., 2017; Makina & Walle, 2019; Nizam et al., 2020; Sethi & Acharya, 2018; Siddik et al., 2019; Singh & Stakic, 2020; Thomas et al., 2017). Specifically, Inoue and Hamori (2016) analyzed the effect of financial access on economic growth in 37 sub-Saharan African countries for the period 2004– 2012. The study employed the panel dynamic GMM estimator and the results showed that there is a positive relationship between the number of commercial bank branches and real GDP per capita. Furthermore, financial deepening had a positive and significant effect on economic growth in subSaharan Africa. Also, Thomas et al. (2017) investigated the relationship between financial accessibility and economic growth in eight South Asian countries from 2007 to 2015. Employing the GMM estimators, the results showed that an increase in financial accessibility led to an increase in income. Furthermore, an increase in financial access indicators had a greater impact on economic growth in low-income countries than in middle-income countries. In the same vein, Kim et al. (2017) investigated the relationship between financial inclusion and economic growth in 55 Organization of Islamic Cooperation (OIC) countries and employed dynamic panel estimation, panel vector autoregressive (VAR) methodology, impulse-response functions (IRFs) and panel Granger causality tests. Results of dynamic panel estimations proved that financial inclusion has a positive effect on economic growth in 11 countries during the period 2007 to 2016 and employed a pooled regression model, vector error correction model and Granger causality tests. The findings revealed that there was a long-run relationship between financial inclusion and economic growth.

Furthermore, Sethi and Acharya (2018) examined the impact of financial inclusion on economic growth for 31 developed and developing countries from 2004 to 2010 and employed the following panel data models: country-fixed effect, random effect and time fixed effect regressions, panel cointegration and panel causality tests. The results revealed a positive and long-run relationship between financial inclusion and economic growth across the selected countries while there was a bidirectional causality between financial inclusion and economic growth. The study confirmed that financial inclusion influences economic growth and suggested that appropriate policies focused on promoting financial inclusion shall result in higher economic growth in the long run. Inoue and Hamori (2019) examined the role of financial inclusion in the economic growth of developing countries by employing differenced GMM on a panel of 168 countries between 2004 and 2014. The paper analyzed whether financial inclusion through improved access to formal financial services has contributed to economic growth and found a positive relationship between the number of commercial bank branches and real per capita GDP. Moreover, financial deepening had a positive and significant effect on economic growth in the selected countries. Likewise, Makina and Walle (2019) evaluated the effect of financial inclusion on economic growth in 42 African countries for the period 2004 to 2014, employing the system GMM dynamic panel data estimator. Measuring financial inclusion using the number of commercial bank branches per 100,000 adults, the results revealed that financial inclusion has a positive and statistically significant effect on economic growth in Africa. Van and Linh (2019) examined the impact of financial inclusion on economic development in 23 Asian countries over the period 2010 to 2015. The results proved that there was a relationship between large numbers of bank branches, ATMs, domestic credit in the private sector and an increase in economic development. Similarly, Siddik et al. (2019) evaluated if financial permeation influence economic growth in 24 Asian countries from 2004 to 2016. Using Granger causality and fixed effect regression techniques, the study revealed that financial permeation have significant positive impact on the economy of Asian countries. Also, based on the Granger causality test, there is bidirectional causality between economic growth and financial permeation in Asian economies.

More so, Chatterjee (2020) examined the roles of financial inclusion and ICT in economic growth. The study used fixed-effect model on a data from 41 countries between 2004 and 2015, the findings highlighted the role of financial inclusion, powered by a better ICT penetration, in engendering the growth of the countries in a dynamic panel data model. The results suggested that financial inclusion individually and once coupled with internet and mobile telephony can improve economic growth per capita. However, in the case of developing countries, the role of ICT indicators in enhancing financial inclusion and economic growth is not significant. Singh and Stakic (2020) examined the nexus between financial inclusion index and economic growth in all eight South Asian Association for Regional Cooperation (SAARC) countries for the period 2004 to 2017. The study employed the Pedroni panel co-integration test and the Fully Modified Ordinary Least Square (FMOLS) and the

Dynamic Ordinary Least Square (DOLS) methods. The Pedroni panel co-integration test confirms the existence of a long-run relationship between financial inclusion and economic growth in the SAARC countries. The coefficients of FMOLS and DOLS showed that the financial inclusion index and selected control variables together support economic growth. Furthermore, the Granger causality test confirmed bi-directional causality between financial inclusion and economic growth. For 33 developing countries, Ain et al. (2020) investigated the relationship between financial inclusion and economic arowth employing GMM from 2004 to 2016. The study reported that financial inclusion impacts economic growth positively. Similarly, Huang et al. (2021) examined financial inclusion-economic development nexus, comparing the old and new EU (27) countries between 1995 and 2015. The study used FMOLS and panel autoregressive distributed lag (ARDL) models and found that financial inclusion is important for economic growth. However, it is more significant for the low-income and new EU countries than for high-income and old EU countries. Also, Dahiya and Kumar (2020) considered the link between economic growth and financial inclusion in emerging Indian economy from 2005 to 2017. The study estimated the relationship using Bayesian autoregression and found that only the usage dimension of financial inclusion has a link with economic growth. Nizam et al. (2020) investigated the effect of financial inclusiveness on economic growth in 63 developed and developing countries for the years of 2014 and 2017. The study used new construction of the financial inclusion index and a cross-sectional threshold regression technique. They discovered a non-monotonic positive relation between financial inclusiveness and economic growth which is more pronounced at a higher level of financial inclusion index.

In summary, research has been devoted to measuring the level of financial inclusion (Abdulmumin et al., 2019; Lenka & Barik, 2018; Nguyen, 2020) while considerable research have focused on the micro-level and macro-level determinants of financial inclusion (Evans & Adeoye, 2016; Soumaré et al., 2016; Oyelami et al., 2017; Sotomayor et al., 2018; Chinoda et al., 2019). Furthermore, previous empirical literature revealed that financial inclusiveness promotes economic prosperity (Inoue & Hamori, 2016; Chatterjee, 2020; Nizam et al., 2020 and several others). However, with the proliferation of mobile phones and internet access, none of the previous empirical studies examined the impact of financial inclusion on economic growth with respect to the introduction of digital financial services in SSA economies. Also, bundling and unbundling financial inclusion indicators will contribute to literature. Therefore, to fill these gaps, we include mobile money in constructing the index of financial inclusion in SSA countries.

3. Methodology

3.1. Data and variable sources

To examine the impact of financial inclusion on economic growth, this study sampled 22 SSA countries. The countries are; Botswana, Cameroon, Chad, Eswatini, Ghana, Guinea, Kenya, Lesotho, Madagascar, Malawi, Mauritania, Mauritius, Mozambique, Namibia, Republic of Congo, Rwanda, Seychelles, South Africa, Tanzania, Uganda, Zambia and Zimbabwe. The data is collected from the Financial Access Survey (FAS) of the International Monetary Fund (IMF) and the World Development Indicators (WDI) of the World Bank. The countries are selected due to the availability of consistent representative data. Interestingly, we choose 2012 as the starting year due to mobile money introduction in that year and it reflects a positive outcome in financial services expansion for developing countries (Demirguc-Kunt & Klapper, 2012; Nguyen, 2020). The dependent variable for this study is the GDP per capita (GDPPC) as a measure of economic growth (see, Inoue & Hamori, 2016; Kim et al., 2017). The value of the GDPPC is expressed in US dollars and in natural logarithm. The data is sourced from the World Development Indicators (WDI) of the World Bank.

Meanwhile, proxies for financial inclusion are both bundled and unbundled measures. The bundled measures are the three dimensions (availability, penetration and usage) of financial inclusion and the aeneral financial inclusion index (Nguyen, 2020). First, availability dimension index (ADI) is measured with the natural logarithms of the number bank branches, number of ATMs and the number of mobile money agents. According to Sarma (2016), transaction points are necessary and should be easily available to users in an inclusive financial system. The second bundled measure of financial inclusion is the penetration dimension index (PDI) which is measured with the natural logarithms of deposit accounts and mobile money accounts. An all-inclusive financial system requires numerous users, implying that it needs to penetrate deeply (Nguyen, 2020). The third bundled measure of financial inclusion is the usage dimension index (UDI) which is measured with the natural logarithms of outstanding deposits with commercial banks as a percentage of GDP, outstanding loans with commercial banks as a percentage of GDP and mobile money transactions with commercial banks as a percentage of GDP. A more comprehensive financial system guarantees that financial services are wholly utilized (Nguyen, 2020; Sarma, 2016). Finally, the general financial inclusion index (GFII) is constructed from the three dimensions of financial inclusion. In developing countries, significant changes in the financial system is due to wide penetration of mobile phone application to exploit financial services (Donovan, 2012), thus justifying our inclusion of mobile money variables to the traditional measures of financial inclusion. The bundling is achieved by using principal component analysis (PCA) method. PCA is a multidimensional approach which involves the transformation of a number of correlated set of variables into a smaller number of uncorrelated variables. This process reduces a set of observed variables into principal components which retain information from the original set of variables as much as possible (Aluko & Ajayi, 2018). Following Lenka and Barik (2018), and Le et al. (2019), this study constructed financial inclusion index for each of the three selected dimensions of financial inclusion and also a general single index. The unbundled measures of financial inclusion include the eight individual measures of financial inclusion (FI)—bank branches (FI1), automated teller machines (ATMs) (FI2), mobile money agents (FI3), deposit accounts (FI4), mobile money accounts (FI5), outstanding deposits (FI6), outstanding loans (FI7) and mobile money transactions (FI8).

Numerous macroeconomic variables are used to control for other factors that could affect economic growth. Therefore, for the model, we include three control variables in their natural logarithms by following Kim et al. (2017) and Nizam et al. (2020). They are inflation rate, population growth rate and trade openness. According to the results from these researchers, the control variables should have either positive or negative influence on economic growth. Inflation is expected to have a negative influence on GDP per capita while population growth rate and trade openness could be positive or negative depending on the quality of the population and trade. A population with high rate of dependence will likely discourage income growth than a population of skilled workers. Also, an economy that is mostly involved in primary products in their trade will likely not see their income grow compared to an economy that trades in secondary commodities. See, Table 1 for the summary description of data sources.

3.2. Estimation strategy

The empirical strategy for this study follows the works of Inoue and Hamori (2019) and Makina and Walle (2019) which empirically estimated the relationship between financial inclusion and economic growth. Therefore, this study considers the following dynamic model:

$$Y_{it} = \delta Y_{it-1} + \theta' X_{it} + f_t + v_i + u_{it}$$
⁽¹⁾

where Y_{it} is GDP per capita (GDPPC) for country *i* at period *t*; X_{it} is a vector of our variables of interest—either the composite financial inclusion index, the index of each of the dimensions (availability, penetration and usage) or the different variables measuring financial inclusion, and

| Table 1. Description of | f variables | | |
|------------------------------------|--------------|---|---------|
| Variable Name | Dimension | Description | Sources |
| Bank branches (FI1) | Availability | Number of commercial bank branches per 100,000 adults | FAS |
| ATMs (FI2) | Availability | Number of Automated Teller Machines (ATMs) per 100,000 adults | FAS |
| Mobile money agents (FI3) | Availability | Number of registered mobile money agent outlets per 100,000 adults | FAS |
| Deposit accounts (FI4) | Penetration | Number of deposit accounts with commercial banks per 1,000 adults | FAS |
| Mobile money accounts (FI5) | Penetration | Number of registered mobile money accounts per 1,000 adults | FAS |
| Outstanding deposits (FI6) | Usage | Outstanding deposits with commercial banks (% of GDP) | FAS |
| Outstanding loans (FI7) | Usage | Outstanding loans from commercial banks (% of GDP) | FAS |
| Mobile money transactions (FI8) | Usage | Total volume of mobile money transactions (% of GDP) | FAS |
| Inflation rate (INF) | | Annual percentage change in the average consumer price index | WDI |
| Population growth rate (PoGr) | | The rate at which the total population increases over time | WDI |
| Trade openness (Trop) | | Trade openness measured by Export + Import as a percentage of GDP | WDI |

control variables—inflation rate, population growth rate and trade openness; f_t is the time-invariant factor; v_i is the country-specific effects, u_{it} is the error term.

However, due to the inclusion of the dependent variable as a regressor, we employed the dynamic panel system generalized method of moments (SGMM). The SGMM procedure combines the first differences' equations and another set of levels equations for the estimation of the model. Arellano and Bover (1995) recommended the use of forward orthogonal deviations for the elimination of fixed effects and endogeneity rather than the use of first differencing. Basically, in order to reduce the issues of fixed effect, the Helmet transformation is used for the regressors (Arellano & Bover, 1995; Love & Zicchino, 2006). Furthermore, in line with conventional works on GMM application, the Arellano and Bond autocorrelation test [AB-AR(2)] of the model should not be rejected in the absence of autocorrelation in the residuals. In the same vein, the alternative hypotheses of the Sargan and Hansen over-identification restrictions (OIR) tests should be rejected because their null hypotheses are that the instruments are not correlated with the error terms and then valid. Also, to limit

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Dependent Variable = InGDPPC

| resid | | |
|---------------|--------|-------|
| InTRADE_ | 2.83 | 0.096 |
| InPOPgr_resid | 3.14 | 0.079 |
| InINF_resid | 25.58 | 0.000 |
| InGFII_resid | 4.41 | 0.038 |
| InUDI_resid | 6.14 | 0.015 |
| InPDI_resid | 13.90 | 0000 |
| InADI_resid | 2.83 | 260.0 |
| InFI8_resid | 6.58 | 0.012 |
| InFI7_resid | 22.81 | 0.000 |
| InFI6_resid | 8.81 | 7000 |
| InFI5_resid | 6.94 | 600.0 |
| InFI4_resid | 125.1 | 0.000 |
| InFI3_resid | 5.90 | 0.017 |
| InFI2_resid | 155.5 | 0.000 |
| FI1_resid | 150.8 | 0000 |
| VR | F-Stat | Prob |

.

Note: VR = Variable Residual, FI1_resid = residual of bank branches, FI2_resid = residual of ATMs, FI3_resid = residual of mobile money agents, FI4_resid = residual of deposit accounts, FI5_resid = residual of mobile money agents, FI4_resid = residual of deposit accounts, FI5_resid = residual of outstanding deposits, FI7_resid = residual of outstanding loans, FI8_resid = residual of mobile money transactions, ADI_resid = residual of availability dimension index, PDI_resid = residual of penetration dimension index, UDI_resid = residual of usage dimension index, GFII_resid = residual of general financial inclusion index

instrument proliferation, the rule of thumb requires that for each specification, the number of instruments should be lower than the number of cross sections. Nevertheless, the SGMM has two variants—one step and two steps SGMM estimators. According to Roodman (), the two-step option of the SGMM compared to the one-step option is more asymptotically efficient due to the use of optimal weighting matrix in its estimation procedure. Consequently, we adopted the two-step SGMM estimator in this study.

Justifying the adoption of SGMM, alternative methods that we may have considered are the random effects (RE) and the fixed effects (FE) models. The inference from the random effects (RE) and fixed effects (FE) models in Eq. (1) may be biased and inconsistent due to the inclusion of the dependent variable's lag(s; Arellano & Bond, 1991). Also, the possible simultaneity between financial inclusion and economic growth (Ajide, 2017; Chinoda et al., 2019; Evans & Adeoye, 2016; Inoue & Hamori, 2016; Kim et al., 2017) is another reason for the choice of SGMM. Moreover, Table 2 is the Durbin-Wu-Hausman (DWH) test of endogeneity showing that all the variables for this study are endogenous given that the probability of their F-statistic is significant at 10% level. Another justification for the use of SGMM in this study is its suitability in a micro panel [when (T < N)] and when the data is unbalanced. The GMM estimation procedure produces estimates that control for heterogeneity among cross sections, consistent in autocorrelation and heteroskedasticity, and it controls for endogeneity in the panel model. The SGMM is also free from some of the weakness of the differenced GMM—the later has small sample bias (Asongu & Nwachukwu, 2016a; Goczek & Witkowski, 2015; Love & Zicchino, 2006).

Finally, for the robustness check, we employ a bias-corrected least square dummy variable (BC-LSDV) estimator. The estimator was proposed by Kiviet (1995) to correct biasness using LSDV estimator in a dynamic panel. The method was extended by Judson and Owen (1999), Bun and Kiviet (2003), and Bruno (2005a) for balanced panels. However, Bruno (2005b) extended the procedure for unbalanced panel data. The method is demonstrated to perform better compared to instrumental variable regression and the GMM approaches in efficiency performance (Bruno, 2005b; Bun & Kiviet, 2003; Judson & Owen, 1999; Kiviet, 1995) especially in finite sample (Meschi & Vivarelli, 2009). The study set the fixed effect for an estimate of O(1/NT). The bias-correction procedure follows the initialization from Binici et al. (2012) in satisfying the bias-correction method. To justify the first round of consistent estimates, it follows Blundell and Bond (1998) estimator. For evaluating statistical significance of the coefficients of the BC-LSDV, 200 iterations for the bootstrapped standard errors is carried out.

4. Empirical results and discussions

Table 3 presents the PCA for the dimensions of financial inclusion as well as the general financial inclusion index. The criterion developed by Kaiser (1974) and Jolliffe (2002) to maintain the common factors is used in retaining the eigenvalues. The criterion for the common factor is that an eigenvalue less than one should not be retained. Therefore, the penetration dimension (PDI), availability dimension (ADI) and the usage dimension (UDI) show an eigenvalue (cumulative proportion) of 1.921, 1.260, and 2.106 (64.0%, 63.0%, and 70.2%) respectively. In a similar take, the general financial inclusion (GFII), which explains more than 81.1% of the information in the eight financial inclusion indicators, is with an eigenvalue of 4.144 and 2.345 for first and second principal component, respectively.

In Table 4, we present the descriptive statistics and correlation matrix of the log transformed variables. The highest mean value was observed with the log of gross domestic product per capita (*InGDPPC*) at 3.25. It was followed by the log of deposit accounts (*InFI4*) and the least mean value was recorded by the log indexes of penetration dimension (*InPDI*) and usage dimension (*InUDI*). Also, it is of importance to note that the highest variability in the variables was recorded by the

| Table 3. Pri | incipal Compor | nent Analysis (I | PCA) for | composite 1 | financial ind | clusion | | | | | | |
|--|--|--|---|---|----------------------------------|-----------------------------------|---------------------------------|-------------------------------------|---------------|------------------------------------|-----------------------------------|--------------------------------|
| Principal Comp | oonent | | | | Component Mc | atrix (Loadings) | | | | Proportion | Cumulative Proportion | Eigen Value |
| | | | | | | | | | | | | |
| | | InF11 | lnFI2 | lnFI3 | InFI4 | InFI5 | lnFI6 | lnFI7 | lnF18 | | | |
| First PC(PDI) | 0.675 | | 0.680 | -0.287 | ı | 1 | | | ı | 0.640 | 0.640 | 1.921 |
| Second PC | 0.224 | | 0.182 | 0.957 | I | I | 1 | 1 | 1 | 0.306 | 0,946 | 0.918 |
| First PC(ADI) | I | | I | I | 0.707 | 0.707 | ı | 1 | I | 0.630 | 0:630 | 1.260 |
| Second PC | 1 | | I | I | 0.707 | -0.707 | 1 | 1 | 1 | 0.370 | 1.000 | 0.740 |
| First PC(UDI) | 1 | | I | I | ı | 1 | 0.643 | 0.650 | -0.405 | 0.702 | 0.702 | 2.106 |
| Second PC | 1 | | I | I | ı | 1 | 0.310 | 0.263 | 0.914 | 0.261 | 0.963 | 0.783 |
| First PC(GFII) | 0.411 | | 0.424 | -0.256 | 0.368 | -0.107 | 0.416 | 0.427 | -0.289 | 0.518 | 0.518 | 4.144 |
| Second PC | 0.200 | | 0.232 | 0.495 | 0.352 | 0.575 | 0.037 | -0.016 | 0.457 | 0.293 | 0.811 | 2.345 |
| Third PC | -0.26 | 8 | -0.315 | 0.086 | -0.286 | 0.034 | 0.582 | 0.536 | 0.334 | 0.083 | 0.894 | 0.660 |
| Note: PC = Prir InFI6 = log of UDI = usage d | rcipal Component, outstanding depo limension index, ln | , InFI1 = log of ban osits, InFI7 = log c oGFII = general finc | ik branches, of outstand ancial inclu | , InFI2 = log of ling loans, InF sion index | f ATMs, lnFI3 = I8 = log of m | = log of mobile obile money tu | money agents ransactions, Pl | , InFI4 = log of DI = penetratic | deposit accou | nts, lnFI5 = log index, ADI = α | of mobile mor vailability dime | iey accounts, ension index, |

| e: PC = Principal Component, lnFI1 = log of $_{ m i}$ | bank branches | s, InFI2 = log | g of ATMs, InF. | [3 = log of I | mobile mo | oney agents | s, InFI4 = log of de | osit accounts | , InFI5 = log |) of mobile mor | ey account |
|---|-------------------|----------------|-----------------|---------------|------------|--------------|----------------------|---------------|---------------|-------------------|-------------|
| $6 = \log of outstanding deposits, lnFI7 = l_1$ | og of outstand | ding loans, | InFI8 = log o | f mobile m | noney trar | nsactions, P | DI = penetration | limension ind | ex, ADI = c | ıvailability dime | ension inde |
| = usage dimension index, lnGFII = general | l financial inclu | usion index | | | | | | | | | |
| | | | | | | | | | | | |

| Table 4. D | Descriptive | statistics | and correl | ation mat | rix | | | | | | | | | | | |
|-------------|-------------|--------------|-------------|-----------|-------|-------|-------|-------|-------|-------|-------|-------|--------|-------|---------|-------------|
| | InGDPPC | InFI1 | InF12 | In F13 | InF14 | InFIS | lnF16 | InFI7 | InF18 | InADI | IDPDI | InuDI | InGFII | InINF | InPOPgr | InTRADE |
| Mean | 3.25 | 0.72 | 66.0 | 2.12 | 2.54 | 2.47 | 1.47 | 1.33 | 0.27 | 0.01 | -0.06 | -0.06 | -0.04 | 0.69 | 0.27 | 1.88 |
| Std.Dev | 0.44 | 0.38 | 0.53 | 0.62 | 0.49 | 0.68 | 0.33 | 0.34 | 1.14 | 1.36 | 1.12 | 1.33 | 2 | 0.35 | 0.32 | 0.18 |
| Minmum | 2.5 | -0.18 | -0.4 | 0.23 | 1.44 | 0.22 | 0.78 | 0.52 | 2.32 | -2.76 | -3.97 | -0.95 | -2.78 | -0.65 | -1.26 | 1.5 |
| Maximum | 4.21 | 1.74 | 1.92 | 3.33 | 3.36 | 3.28 | 2.36 | 2.35 | 2.25 | 3.26 | 1.79 | 6.57 | 4.87 | 1.44 | 0.57 | 2.34 |
| Observation | 154 | 150 | 150 | 123 | 148 | 130 | 149 | 149 | 128 | 123 | 130 | 127 | 121 | 141 | 154 | 153 |
| | | Correlation | matrix | | | | | - | | | | | | | | |
| InGDPPC | - | | | | | | | | | - | + | | | - | - | |
| InFI1 | 0.81 | 1 | | | | | | | | | | | | | | |
| InF12 | 0.82 | 0.85 | 1 | | | | | | | | | | | | | |
| InF13 | -0.38 | -0.27 | -0.24 | 1 | | | | | | | | | | | | |
| InF14 | 0.71 | 0.81 | 0.87 | -0.01 | 1 | | | | | | | | | | | |
| InFI5 | -0.1 | -0.09 | 0.1 | 0.66 | 0.25 | 1 | | | | | | | | | | |
| InF16 | 0.48 | 0.65 | 0.59 | -0.36 | 0.51 | -0.18 | 1 | | | | | | | | | |
| InF17 | 0.56 | 0.63 | 0.63 | -0.47 | 0.53 | -0.24 | 0.89 | 1 | | | | | | | | |
| InF18 | -0.48 | -0.36 | -0.35 | 0.82 | -0.1 | 0.71 | -0.35 | -0.41 | 1 | | | | | | | |
| InADI | 0.86 | 4 6.0 | 76.0 | -0.47 | 0.8 | -0.14 | 0.67 | 0.71 | -0.52 | 1 | | | | | | |
| | | | | | | | | | | | | | | | | (Continued) |

* cogent - economics & finance

| I able4. (| (continued) | | | | | | | | | | | | | | | |
|------------|-------------------|--------------|---------------|---------------------------------|-------------------|--------------|---------------|---------------|-------------|----------|----------|----------|----------|----------|----------|------------------|
| | InGDPPC | In FI1 | InF12 | InF13 | InF14 | InFIS | InFI6 | lnF17 | InF18 | IDAnl | IDUI | IdUn | nGFII | InINF In | POPgr | InTRADE |
| InPDI | 0.39 | 97.0 | 0.63 | 0.4 | 0.8 | 0.78 | 0.22 | 0.2 | 0.37 | 0.43 | 1 | | | | | |
| InUDI | 0.35 | 0.47 | 0.37 | -0.41 | 0.26 | -0.3 | 0.91 | 0.87 | -0.33 | 0.49 | -0.02 | _ | | | | |
| InGFII | 0.79 | 0.87 | 0.86 | -0.55 | 0.74 | -0.27 | 0.84 | 0.87 | -0.59 | 0.95 | 0.31 | 0.7 | | | | |
| InINF | -0.3 | -0.07 | -0.03 | 0.13 | 0.07 | 0.05 | -0.13 | -0.2 | 0.16 | -0.08 | 0.08 | -0.19 | -0.12 | | | |
| InPOPgr | -0.54 | -0.49 | -0.52 | 0.26 | -0.51 | 0.04 | -0.43 | -0.32 | 0.37 | -0.54 | -0.3 | -0.26 | -0.53 (| 0.16 1 | | |
| InTRADE | 0.38 | 0.47 | 0.14 | 0.15 | 0.2 | -0.27 | 0.41 | 0.27 | -0.48 | 0.51 | -0.04 | 0.23 | - 87.0 | -0.02 -(| 0.39 1 | |
| Note: LnGD | $PPC = \log of g$ | Jross domest | ic product pe | r capita, InFI1 donocito laG | $1 = \log of bar$ | nk branches, | InFI2 = log o | f ATMs, InFI3 | = log of mo | bile mon | ey agen' | s, InFI4 | = log of | deposit | accounts | , InFI5 = log of |

mobile money accounts, InFI6 = log of outstanding deposits, InFI7 = log of outstanding loans, InFI8 = log of mobile money transactions, InADI = log of availability dimension index, InPDI = log of population are availability dimension index, InFIN = log of population growth, InTRADE = log of transactions, InPOPgr = log of population growth, InTRADE = log of transactions, InPOPgr = log of population growth, InTRADE = log of trade openness, and Std. Dev. = standard deviation.

| Table 5. Fishe | er ADF panel un <u>it roo</u> | t test | | | | |
|----------------|-------------------------------|----------------|---------------|------------------------------------|-----------------------|----------------------|
| Variable | Inverse chi- square | Inverse normal | Inverse logit | Modified Inverse chi- square | Decision | Order of integration |
| InGDPPC | 99.470*** | -5.406*** | -5.324*** | 5.913*** | Reject H _o | I(0) |
| lnFI1 | 203.237*** | -3.542*** | -8.985*** | 16.974*** | Reject H ₀ | I(0) |
| InFI2 | 161.647*** | -4.162*** | -7.329*** | 12.541*** | Reject H ₀ | I(0) |
| InFI3 | 288.907*** | -7.279*** | -15.656*** | 26.107*** | Reject H ₀ | I(0) |
| InFI4 | 134.307*** | -0.012 | -3.295*** | 9.626*** | Reject H ₀ | I(0) |
| InFI5 | 403.641*** | -9.569*** | -21.285*** | 38.337*** | Reject H ₀ | I(0) |
| InFI6 | 170.733*** | -2.932*** | -7.616*** | 13.509*** | Reject H ₀ | I(0) |
| lnFI7 | 87.058*** | -0.898 | -1.887** | 4.590*** | Reject H _o | I(0) |
| InFI8 | 274.540*** | -6.594*** | -14.241*** | 24.575*** | Reject H ₀ | I(0) |
| InADI | 130.436*** | -0.392 | -3.264*** | 9.214*** | Reject H ₀ | I(0) |
| InPDI | 151.532*** | -2.085** | -5.475*** | 11.463*** | Reject H ₀ | I(0) |
| InUDI | 82.315*** | -4.2628*** | -4.139*** | 4.398*** | Reject H _o | I(0) |
| InGFII | 227.979*** | -5.898*** | -11.674*** | 19.612*** | Reject H ₀ | I(0) |
| InINF | 91.713*** | -3.8679*** | -4.346*** | 5.424*** | Reject H ₀ | I(0) |
| InPOPgr | 332.097 *** | -10.182*** | -18.444*** | 30.711*** | Reject H ₀ | I(0) |
| InTRADE | 110.759*** | -2.569*** | -3.885*** | 7.1166*** | Reject H ₀ | I(0) |

Note: LnGDPPC = log of gross domestic product per capita, lnFI1 = log of bank branches, lnFI2 = log of ATMs, lnFI3 = log of mobile money agents, lnFI4 = log of deposit accounts, lnFI5 = log of mobile money accounts, lnFI6 = log of outstanding deposits, lnFI7 = log of outstanding loans, lnFI8 = log of mobile money transactions, lnADI = log of availability dimension index, lnPDI = log of penetration dimension index, lnUDI = log of usage dimension index, lnGFII = general financial inclusion index, lnINF = log of inflation rate, lnPOPgr = log of population growth, lnTRADE = log of trade openness. ***, **, and * represents 1%, 5% and 10% significance level respectively.

general financial inclusion index (*InGFII*) at a value of 2.00 followed by the availability dimension index (*InADI*) at a value of 1.36. However, the variable with the least variation is the log index of penetration dimension (*InPDI*) at a value of 0.17.

The correlation matrix in Table 4 shows a mixed relationship between the regressors and the regressand. There is a positive relationship between GDPPC and every other variable except log of mobile money agents (InFI3), log of mobile money accounts (InFI5), log of mobile money transactions (InFI8), log of inflation rate (InINF) and log of population growth (InPOPgr) where there is a negative correlation. Also, to take care of multicollinearity, the regressors are checked for high-level correlation. Prodan (2013) and Asumadu-Sarkodie and Owusu (2017) proposed that regressors with correlation higher than 90% should not be included together in the same model. Consequently, the correlation matrix in Table 4 establishes that the variables with the correlation greater than 0.90 are only between InADI and InFI1, InADI and InFI2, InUDI and InFI6, and InGFII and InADI. Therefore, these variables will not be specified in the same model.

4.1. Unit root test

To guarantee suitability and avoid spurious regression in a dynamic panel estimation, the stationary properties are imperative (Gujarati & Porter, 2010). Hence, as a prerequisite for our estimation method, the panel Fisher ADF test is adopted as a result of its robustness in an unbalanced panel. Evidence from Table 5 reveals that all our variables even at 1% significance level are stationary in levels under the condition of short and unbalanced panel.

| lable b. Gross | domestic product | per capita and 1 | inancial inclusion | Dimonsion | | acion | Conoral Finan | cial Tachician |
|--------------------------------|--------------------------------|----------------------|--------------------------------|-----------------------|--------------------------------|----------------------|-------------------------|----------------------|
| | Αναιιασιπις | | renerranon | | n aguso | | | |
| | SGMM _{twostep} | LSDV _{BC} | SGMM _{twostep} | LSDV _{BC} | SGMM _{twostep} | LSDV _{BC} | $SGMM_{twostep}$ | LSDV _{BC} |
| Constant | 1.743** (0.616) | 1 | 1.048 (0.841) | I | 0.657 (0.626) | ı | 1.600** (0.751) | |
| InGDPPC(-1) | 0.639*** (0.219) | 4.703*** (0.0002) | 0.771*** (0.163) | 4.316*** (0.0002) | 0.848*** (0.143) | 4.486*** (0.0002) | 0.672*** (0.144) | 4.967*** (0.0002) |
| InADI | 0.057* (0.032) | 0.079* (0.046) | 1 | 1 | 1 | , | 1 | |
| InPDI | | 1 | 0. 022* (0.012) | 0.052*** (0.015) | | | 1 | |
| InUDI | | 1 | | 1 | 0.004 (0.030) | 0.012 (0.016) | 1 | |
| InGFII | 1 | 1 | 1 | I | I | 1 | 0.036* (0.021) | 0.023 (0.021) |
| lnINF | -0.128*** (0.035) | 0.061** (0.025) | -0.099** (040) | -0.034 (0.023) | -0.110** (0.052) | -0.054** (0.024) | -0.144*** (0.046) | -0.144*** (0.066) |
| InPOPgr | -0.147 (0.121) | 0.442** (0.176) | -0.164 (0.206) | 0.172 (0.128) | -0.033 (0.168) | 0.189 (0.132) | -0.221 (0.213) | 0. 485 (0.132) |
| InTRADE | -0.236 (0.121) | 0.637*** (0.131) | -0.103 (0.206) | 0.578*** (0.128) | -0.033 (0.168) | 0.563*** (0.127) | -0.148 (0.136) | 0.709*** (0.170) |
| Observations | 100 | 100 | 104 | 104 | 102 | 102 | 98 | 98 |
| Countries | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 |
| Instruments | 20 | 24 | 19 | 24 | 19 | 24 | 19 | 19 |
| F/Wald test: p value | 62.80 *** | 484,916*** | 76.10 *** | 528,959*** | 57.11*** | 502,787*** | 38.50*** | 472,940*** |
| AR(1) | 0.248 | 0.001 | 0.053 | 0.001 | 0.053 | 0.003 | 0.160 | 0.001 |
| AR(2) | 0.116 | 0.101 | 0.084 | 0.091 | 0.073 | 0.050 | 0.130 | 0.102 |
| Hansen/Sargan test: p value | 0.397 | 0.000 | 0.222 | 0.000 | 0.137 | 0.000 | 0.433 | 485 |
| Note. Standard erro | ors are in paraenthesis | s. Windmeijer (2005) | finite sample standar | d errors of the estin | nates for GMM. ***, ** c | ind * at 1%, 5% and | 10% level of significar | nce respectively |

4.2. Basic results

Table 6 presents the robust two-step GMM and biased-corrected least square dummy variable (LSDV) regression results of Eq. (1). The specifications are different by allowing the measurement of each dimensions of financial inclusion as well as the general financial inclusion index to be examined on its impact on the gross domestic product (GDP) per capita. For comparison and taking cognizance of robustness, the Windmeijer standard errors system GMM estimator and the bias-corrected LSDV are estimated. However, before further analysis of the estimated result, various specification and diagnostic tests are considered for efficiency and consistency of our estimates. First, serial correlation test of Arellano and Bond (1991) revealed no second-order correlation in the results with the AR(2) being non-significant. Therefore, in line with Baltagi et al. (2009), we can reject the absence of second-order correlation in the GMM and LSDV estimators. Second, the Hansen test, recommended as more appropriate for the system GMM (Kripfganz, 2017) is statistically insignificant while the Sargan test for the biased-corrected LSDV shows significance. So, the test implies that the instrument set is appropriate for the system GMM models but it is not for biased-corrected LSDV. The pre-condition (rule of thumb) for the Hansen/Sargan over identification restriction (OIR) test is that the instrument set should be less than the number of groups. Thirdly, the Fisher test shows that the coefficients of the results are jointly significant. Therefore, the specification and diagnostic tests reveal the reliability of the GMM estimates compared to that of the LSDV, which means that it is more valid to draw inference from the system GMM estimates.

The two sets of estimators ($SGMM_{twostep}$ and $LSDV_{BC}$) with different measures of financial inclusion index are not different—at least in terms of our variables of interest, both in direction and significance. On the other hand, the system GMM and the bias-corrected LSDV report conflicting results especially in the control variables for their coefficient estimates. For example, if the emphasis is on dealing with simultaneity and endogeneity issues, by considering inflation rate, population growth and trade openness as endogenous variables—inflation, population growth and trade openness are negatively related with economic growth rate in SSA. When we consider inflation, population growth and trade openness as exogenous, the relationship between inflation and economic growth are negative while that of population growth, trade openness and economic growth appears to be positive. However, our results demonstrate that the inference relies noticeably on the choice of the estimator.

The system GMM regression results, as our preferred set of estimates, totally confirm the postulated signs of the estimates according to theory and empirics. In testing the conditional convergence hypothesis from standard literature on economic growth, the initial GDP per capita coefficient variable [(GDPPC (-1)] should be negative in all models. However, the results show positive coefficients revealing that there is no conditional convergence for the study sample. It means that lower income per capita countries do not grow faster compared to higher income per capita countries in SSA. To examine the relationship between financial inclusion and economic growth, the index of the dimensions and the general financial inclusion index are considered. First, Table 6 shows that the availability dimension index (InADI) of financial inclusion exacts a positive (0.057) and statistically significant impact on economic growth at 10% level in SSA countries. The result implies that an increase of 1% in the availability dimension will increase economic growth by 0.057% in the SSA. The more the financial sector provides transaction points, the more economic agents respond by increasing economic activities. Secondly, penetration dimension index (InPDI) of financial inclusion also has positive (0.022) and significant influence on economic growth at 10% level. It signifies that the penetration dimension of financial inclusion increases economic growth by 0.022% at every 1% increase in the sub region. As more people are admitted into the formal financial system, the more economic activities in the SSA. Thirdly, the usage dimension showed a positive and non-statistically significant effect on economic growth. It means that the usage dimension did not influence economic arowth meaningfully. Fourthly, the general financial inclusion index (InGFII) reveals a positive (0.036) and statistically significant impact on economic growth at 10% level. Thus, a 1% increase in general

financial inclusion increases economic growth by 0.036% in SSA countries. The findings from this study support the endogenous growth model where provision of financial services encourage economic growth (Andersen & Tarp, 2003; Ibrahim & Alagidede, 2018; Sharma, 2016). Empirically, for the general financial inclusion index, this result supports the findings of Thomas et al. (2017) in eight South Asian countries, Kim et al. (2017) in 55 Organization of Islamic Cooperation (OIC) countries, Sethi and Acharya (2018) for 31 developed and developing countries, Siddik et al. (2019) in 24 Asian countries, Chatteriee (2020) in 41 countries, Huang et al. (2021) in 27 EU countries, Singh and Stakic (2020) for eight SAARC countries and Nizam et al. (2020) in 63 developed and developing countries. Financial inclusion constitutes an additional fold of the financial sector, and so, it is expected to contribute to economic growth through the essential functions that financial activity undertakes. However, the findings for the different dimensions is not consistent with Dahiya and Kumar (2020) who found that only the usage dimension influences GDP per capita. The difference in the two results may stem from the geographical scope with different policy frameworks for achieving financial inclusion, the choice of variable used in the estimation or the estimation strategy. Consequently, in explaining the non-significance of the usage dimension, evidence from literature document that Africa witnessed some of the highest growth rates in bank account and mobile money account ownership, but low financial usage and account inactivity has kept dormancy rates persistently high (Henandez, 2020). People open bank and mobile money accounts without making use of the available services and the use of those services are vital for the realization of inclusive economic growth. It could buttress the finding of Nizam et al. (2020) that financial inclusion influences economic growth positively, however, at a threshold. Therefore, it is possible that the usage dimension in SSA has not reached the threshold to meaningfully influence economic growth.

For the control variables in the GMM estimates, inflation and trade openness have a negative and significant impact on economic growth while the estimated coefficient of population growth rate—though not significant—shows that increase in economic growth is not due to population growth. However, the coefficient for inflation and population growth is consistent with theory while trade openness is inconsistent. The result for inflation rate supports the empirical findings of Nizam et al. (2020) for selected developing and developed countries. Our findings for population growth is similar to R. Banerjee (2012) and Yao, Kinugasa, and Hamori (2013) for Australia and China respectively, while it negates the findings of Nizam et al. (2020) for selected developing and developed countries, Tumwebaze and Ijjo (2015) for Eastern and Southern Africa and Sethy and Sahoo (2015) for India. Therefore, we could say that the economic growth impact of population growth varies with specific conditions. Finally, the result of trade openness is in line with Nizam et al. (2020) for selected developing and developed countries. It shows that trade openness benefits are not instinctive; however, policies that foster encouraging business environment and macroeconomic stability must be in place in the SSA.

In the last step, individual financial inclusion indicators are used to evaluate their respective importance in the financial inclusion–growth relationship and to avail us the advantage of further policy implications. Table 7 presents the results from the system GMM analysis. However, to ascertain the validity of the system GMM, the diagnostic information is examined. First, the second-order autocorrelation (AR(2)) for Arellano and Bond test with the null hypothesis of no autocorrelation is not rejected for all estimations. Second, Hansen over-identification restrictions test shows that the instruments are valid. Moreover, the concerns for instrument proliferation is ensured through the rule of thumb requirement (the instruments should be less than the number of groups/countries) for each specification. Finally, to assess the estimated coefficients' joint validity, the Fisher test is significant for the specifications.

After ascertaining the validity of the GMM estimate, the following findings can be established from Table 7: First, within the availability dimension of financial inclusion, the number of bank branches

| lable /. Gross | lomestic product | : per capita and i ailability Dimens | ndividual measul i ion | res of financial inc Penetration | lusion Dimension | | Jsage Dimension | |
|---|---|--|---|---|---|--|--|--|
| | InFI1 | InF12 | lnFI3 | lnFI4 | InFIS | lnFI6 | lnFI7 | InF18 |
| Constant | 1.021* (0.534) | 0.891* (0.485) | 0.568 (0.352) | 1.387** (0.544) | 1.526* (0.860) | 2.196*** (0.670) | 1.268** (0.588) | 0.806** (0.384) |
| InGDPPC(-1) | 0.729*** (0.144) | 0.783*** (0.101) | 0.928*** (0.093) | 0.611*** (0.116) | 0.647*** (0.214) | 0.699*** (0.173) | 0.725*** (0.151) | 0. 857*** (0.076) |
| lnFI | 0. 203** (0.080) | 0.082*** (0.023) | -0.029 (0.026) | 0.061 (0.065) | 0.007 (0.860) | -0.254 (0.245) | 0.017 (0.078) | 0.001 (0.012) |
| lnINF | -0.135* (0.072) | -0. 139** (0.053) | -0. 156** (0.060) | -0.141** (0.065) | -0.160* (0.077) | -0.123* (0.061) | -0.159** (0.061) | -0.150 ** (0.058) |
| InPOPgr | -0.081 (0.107) | -0. 119 (0.089) | -0.088 (0.040) | -0.250 (0.153) | 0.233* (0.118) | -0.395* (0.228) | 0.156 (0.128) | -0.111 (0.080) |
| InTRADE | -0. 087 (0.106) | -0.077 (0.153) | -0.077 (0.153) | -0.064 (0.109) | 0.123 (0.109) | -0.347* (0.200) | 0.131 (0.180) | -0.113 (0.50) |
| Observations | 116 | 116 | 100 | 115 | 104 | 115 | 115 | 103 |
| Countries | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 |
| Instruments | 17 | 19 | 19 | 19 | 20 | 19 | 19 | 19 |
| F test: p value | 71.95*** | 45.12*** | 137.23*** | 26.40*** | 47.16*** | 57.11*** | 24.92*** | 180.17 *** |
| AR(1) | 0.038 | 0.022 | 0.056 | 0.030 | 0.043 | 0.095 | 0.047 | 0.018 |
| AR(2) | 0.115 | 0.114 | 0.104 | 0.102 | 0.181 | 0.108 | 0.135 | 0.075 |
| Hansen test: p value | 0.126 | 0.193 | 0.282 | 0.181 | 0.376 | 0.233 | 0.248 | 0.319 |
| Note InFI1 = log of deposits, InFI7 = log Level of significance | aank branches, InFI2 3 of outstanding loan 3 at respectively. | = log of ATMs, lnFI3 = is, lnFI8 = log of mob | = log of mobile mone) ile money transactio | / agents, InFI4 = log of ns. Windmeijer (2005) | deposit accounts, lı finite sample stand | nFI5 = log of mobile mo ard errors are in parae | oney accounts, lnFI6 = nthesis. ***, ** and * a | log of outstanding t 1%, 5% and 10% |

(InFI1) and ATMs (InFI2) per 100,000 adults, as individual indicators, have positive and statistically significant impact on economic growth at 95% confidence interval. A percentage increase in bank branches and the number of ATMs per 100,000 adults will increase economic growth of the sub-Saharan African countries by 0.20% and 0.082% respectively. These results could be explained due to the expanding access to banking services through the extension of financial infrastructure- bank branches and ATMs- to the population and improved financial intermediation structures in the SSA, thus corroborating Van and Linh (2019), Inoue and Hamori (2016), and Thomas et al. (2017) who showed that commercial bank branches and ATMs per 100,000 adults had a positive and significant influence on economic growth for their study samples. The last of the availability dimension—the number of mobile money agents' outlets (InFI3)—has a negative and not significant impact on economic growth. This contradicts the endogenous growth theory that presented a model of increasing returns in which there was a stable positive equilibrium growth rate resulting from endogenous technological progress (Srouji, 2020). The finding indicates that the demographic and behavioural pattern of Africans mainly in the rural areas suggest a lack of trust in digital financial platforms, high financial illiteracy in handling financial technology and the regular use of informal financial channels for savings and borrowing.

Secondly, the two individual indicators of penetration dimension—number of deposit accounts with commercial banks per 1,000 adults (*InFI4*) and number of registered mobile money accounts per 1,000 adults (*InFI5*)—have positive and non-significant impact on economic growth. This shows that increased number of deposit and mobile money accounts will increase economic growth with rather not meaningful impact. Possibly, the results of policies in many African economies—like the development and operationalization of national financial inclusion strategies—have facilitated banking penetration and this finding is in consonance with Kim et al. (2017) who showed that deposit accounts with commercial banks per 1,000 adults had a positive impact on economic growth and Thomas et al. (2017) who showed that deposit accounts with commercial banks per 1,000 adults had a positive and not significant impact on economic growth. However, the reason for the insignificant outcome may not be far from the fact that financially excluded people who have a cash preference may open formal bank accounts and still use informal financial services for "sensitive" transactions. This may be due to fear of increased transparency (formal identification, collection, and recording of personal financial information), and enabled government surveillance (Koker & Jentzsch, 2013).

Thirdly, for the usage dimension, outstanding deposits with commercial banks as a percentage of GDP (InFI6) has a negative and not significant impact on economic growth. It means that increase in deposit decreases economic growth, although it is not meaningful. This is in line with Chatterjee (2020) who opined that outstanding deposits negatively affects financial stability and economic growth especially during financial crises. Our findings contradict Sharma (2016) who documented a positive and significant association between GDP and outstanding deposits in India and Inoue and Hamori (2016) who found that outstanding deposits contributed positively and significantly to economic growth in 37 SSA countries. The possible explanation is that a greater proportion of deposits towards the sub region's GDP may mostly come from the high-income groups in the economies. Furthermore, outstanding loans from commercial banks as a percentage of GDP (InFI7) and total volume of mobile money transactions percentage of GDP (InFI8) have positive and not significant impact on economic growth in the SSA. It means that increased outstanding loans and mobile money transactions encourages economic growth but it is not meaningful. Our results on the positive impact of outstanding loans on economic growth are in tandem with Sharma (2016) and Inoue and Hamori (2016). Schumpeterian model of growth recognized that loanable funds have a multiplicative effect on economic activity. The explanation of the insignificant impact of outstanding loans on economic growth signifies that in SSA, bank credit is not utilized by micro, small and medium scale (MSME) businesses. The perception of high default risk and the influence of wideranging collateral demands by banks make MSME reluctant to take loans from banks. For mobile

money, although it has helped reduce transaction costs in informal markets, strengthened risksharing networks, and improved households' ability to respond to shocks (Jack & Suri, 2014), people still feel anxiety about using mobile phones and internet to access formal banking services (Chatterjee, 2020). This could be due to fear of identity theft and cybercrime, disclosure of personal data to third parties and privacy concerns (Koker & Jentzsch, 2013). These fears expose them to financial shocks, poor financial planning and low utilization of financial products and services (Abor et al., 2018) and then, it affects economic growth.

5. Conclusion and policy implications

Empirical studies have revealed that financial inclusion is fundamental to the economic growth of every country and a powerful accelerator of economic progress. Recent literature has often considered SSA countries as the epicenter of mobile money, expressing that mobile device will become the payment vehicle of first resort as mobile and digital financial services transform the African financial system. Financial access imbalance and the limited usage of the formal banking sector in Africa are some of the drawbacks that lead to limited socio-economic development and a slowdown in economic growth. Therefore, this study examined the impact of financial inclusion on economic growth in a sample of 22 SSA countries, employing the two-step system GMM estimator suitable for dynamic panel model estimation. The study controlled for inflation, population growth and trade openness. For more informed policy implication, the index for the dimensions and the general financial inclusion index were examined, likewise, the individual financial inclusion measures. For further insight, the biased-corrected LSDV was used as an alternative technique. Thus, the results that stemmed from this study are as follows:

Firstly, among the dimensions of financial inclusion, the availability and penetration dimensions showed positive and significant impact on economic growth while the usage of banking services encourages economic growth but it is not meaningful. The implication is that provision of financial infrastructure improves the economy in SSA countries but the utilization of those financial infrastructure has not been meaningful to influence economic growth. Secondly, the general financial inclusion index increases GDP per capita in sub-Saharan African countries. The implication is that the dimensions of financial inclusion are complementary, and therefore, will encourage economic growth when treated as a single index of financial inclusion. Thirdly, for the individual indicators of financial inclusion, our empirical evidence showed that bank branches and ATMs have positive and significant impact on economic growth, deposit accounts and outstanding loans promote economic growth but not significantly while outstanding deposits adversely affects economic growth. Also, the findings for mobile money indicators revealed that mobile money agents weaken economic growth while mobile money accounts and mobile money transactions foster economic growth but not meaningfully in SSA countries. This implies that digital financial services is still not being used very well as to encourage more productivity in SSA countries.

Finally, the outcomes of this study is important from the view point of developing countries and SSA in particular which have allowed a number of policy suggestions. First, the present research advocates for governments of the SSA countries to address not only the usage dimension but also the availability and penetration dimension by taking initiatives that encourage banking habits of the underserved and rural dwellers. These initiatives could be through financial education programmes that will equip the underserved with information on how to better manage their finances, seize opportunities to utilize more financial services and then increase economic growth in the SSA countries. Secondly, some of the integral weaknesses of the SSA countries' financial system such as misallocation of financial resources due to information asymmetry should be resolved to allow more of the underserved gain access to financial services. This will allow more MSMEs to have access to loans without having to face outrageous collateral requirements and default risks. Thirdly, improving financial trust and addressing the problem of informality in the SSA financial system could have a spill-over effect on

the usage of formal financial services. To build financial trust, it is essential to strengthen the regulatory and supervisory frameworks for consumer protection in order to safeguard new entrants to the banking system or mobile money from predatory practices in the provision of financial services. Fourthly, policies should be geared towards a more competitive landscape and close up inclusion gaps by promoting more entrants of financial technology (fintech) and a deliberate effort to sensitize the people on its benefits. It is imperative that policymakers take into consideration the design of fit-for-purpose and cost-efficient solutions in fintech to deliver citizen-centric finance as more countries seek policies that consider African specificities. Fifth, policies should be geared towards preventing digital divide that stems from access to technology inequality across and within SSA countries. The reduction of high transaction costs by investing in the prerequisites for developing digital financial services such as mobile broadband infrastructure (especially in remote areas), expansion of digital identification including biometric data, and building agent networks that meet individual's local need to cash in and cash out will be necessary.

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Author details

Chuka Ifediora¹ Kenechukwu Onochie Offor² Eze Festus Eze³ Samuel Manyo Takon⁴ Anthony Eboselume Ageme³ Godwin Imo Ibe³

E-mail: godwin.ibe@unn.edu.ng

Josaphat U. J. Onwumere³

- ¹ Department of Marketing, University of Nigeria, Calabar, Nigeria.
- ² Department of Banking and Finance, University of Nigeria, Calabar, Nigeria.
- ³ Department of Economics, University of Nigeria, Calabar, Nigeria.
- ⁴ Department of Banking and Finance, University of Calabar, Calabar, Nigeria.

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