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Exploring the Channels of Financial Inclusion's Impact on Poverty Reduction in Sub-Saharan Africa

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Abstract: There is no doubt that Sub-Saharan Africa (SSA) is home to many financially excluded persons, and the sub-region accounts for a high proportion of the world's poor. Despite the co-existence of low level of financial inclusion (FI) and high poverty level in SSA, little attention has been given to empirical linkage between these two phenomena. This research attempts to unravel the channels through which FI (measured by the composite financial inclusion index developed using the Principal Component Analysis) impact poverty reduction in a sample of 25 SSA countries. The system-Generalized Method of Moments (i.e., system-GMM) estimator was employed to analyze data for the 2004-2022 period. The empirical outcomes portray that the FI-poverty reduction relation is non-linear, and it identify income growth, consumption expenditure, agricultural output, and unemployment as the channels through which FI influences poverty reduction in the SSA region. The findings further reveal that an FI value beyond thresholds of 1.44 and 5.25 increases income growth and reduces unemployment, thereby reducing poverty. Additionally, an FI value below thresholds of 2.87 and 1.40 positively impacts consumption expenditure and agricultural output, leading to poverty reduction. The study recommends that the monetary authorities in SSA adopt policies which increase the access to financial services and promote financial literacy to enhance financial inclusion and reduce poverty.

Keywords: financial inclusion; poverty reduction; Principal Component Analysis; system-GMM.

JEL classification: E52; C12; O10.

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1. INTRODUCTION

Over the years, financial inclusion (FI) and poverty reduction have remained topical issues commonly discussed in economics literature (Abu *et al.*, 2022; Aracil *et al.*, 2022; Felix *et al.*, 2022; Jiang and Liu, 2022; Sakanko *et al.*, 2024). Interestingly, the nexus between these economic phenomena has generated heated debate on whether improvements in FI reduce poverty. The finance-growth hypothesis earlier advanced by Shaw (1973), suggests that poor access to finance is a significant driver of income disparity (inequality) and sluggish growth, which in turn results to poverty. A strand of empirical researches appears to support this claim that greater FI lessens poverty (Bakari *et al.*, 2019; Sakanko *et al.*, 2020; Andrian *et al.*, 2021; Dogan *et al.*, 2022; Nasution *et al.*, 2023).

In a bid to attain high economic growth rates and sustainable development, various countries adopt different policies (or strategies) during different stages of their development. Although meaningful progress has been made in lowering poverty and raising affluence in other regions particularly developed economies, a significant population in SSA economies are still very poor (Omar and Inaba, 2020), partly due to incoherent economic and financial policies including weak institutional frameworks. The Development Initiatives (2023) disclosed that the SSA region hosts 42.6% of world's population living in extreme poverty, with South Asia accounting for 13.7% in 2022. A major factor blamed for the slow reduction in poverty in developing nations (SSA inclusive) is excessive income disparity, which poses a serious threat to improvements in economic conditions (Schmied and Marr, 2016; Omar and Inaba, 2020; World Bank, 2022b).

To end extreme poverty and boost the shared prosperity of each nation's bottom (40%) population by 2030, the World Bank has set targets for reducing income inequality (Omar and Inaba, 2020). As a result, FI has risen to the top of global reform agenda, owing to its potential in breaking generational cycle of poverty (Sakanko *et al.*, 2018). In addition, given that global financial systems are not completely inclusive, there is a growing clamour for FI, due to its perceived potential in promoting inclusive and sustainable development (Nsiah *et al.*, 2021; Shihadeh, 2021; Ozili, 2022; Adams and Atmanti, 2023). Interestingly, the SSA region's FI level increased sharply from 23% in 2011 to 55% in 2021, thus, further stressing the importance of the discussion on the role it (FI) plays in enhancing livelihoods of citizens of these nations (World Bank, 2022b).

Nevertheless, an emerging issue of interest amongst scholars and policymakers, centers on the channel via which the impacts of FI are transmitted to poverty reduction. Besides, empirical research on this subject remains scanty, with inconclusive and mixed findings. A number of researches have explored antithetic proxies to quantify poverty reduction in nexus with FI while including per capita income, households' consumption expenditure, (un)employment, and agricultural output, among others. For instance, Abimbola *et al.* (2018) found that improvements in FI (captured by the number of deposits and customers with bank accounts) lower poverty via a rise in per capita income. Similar outcomes have been documented by Susiyanti (2019) for ASEAN member-countries, and Omar and Inaba (2020) for 116 developing nations. A more recent research by Nasution *et al.* (2023) portrayed that FI reduces poverty via increased households' investment, consumption, education, and income. Overall, the exploration of the channels via which FI transmits its effect to poverty reduction remains inconclusive and needs further examination. Besides, no study (to our knowledge) has explored the subject, focusing primarily on the SSA region.

Therefore, this research is timely and concentrates on SSA for the following reasons. First, despite the various strategies and/or interventions to reduce poverty, 35.1% of SSA's population still lives on less than $2.15 per day (World Bank, 2022a), while FI in the region (measured by account ownership) stands at 55% in 2021 up from 43% in 2017 (World Bank, 2022b). Second, the dimensions of FI vary significantly in terms of depth in SSA countries compared to other regions of the world. Coupled with these are the differences in economic structure from one region (or country) to another. Thus, it is insufficient to draw inference(s) on the channels via which FI transmits poverty reduction in the region based on the outcomes of research covering other regions or country-specific studies.

This research extends the literature by identifying the channels through which FI transmits to poverty reduction in SSA. Also, unlike prior researches which assumed linearity in their empirical analysis, the present research explores whether (or not) the identified channels transmit non-linear effects from FI to poverty reduction. This is motivated by the conflicting findings on FI-poverty reduction link via the identified channels. For instance, Park and Mercado (2021) and Omar and Inaba (2020) established a positive relation between FI and income, while Boukhatem (2016), Kim (2011), and Schmied and Marr (2016) found evidences suggesting a negative relation. Also, Chakrabarty and Mukherjee (2022) and Cavoli and Gopalan (2023) attributed improvements in consumption to greater FI, but Li *et al.* (2022) suggested a diminishing influence of FI. Yet Liu and Yao (2024) confirmed an asymmetric link between FI and consumption.

Moreover, mixed results have been observed for FI and agricultural output nexus. For example, Atakli and Agbenyo (2020) and Farooq *et al.* (2023) disclosed a negative relation, while Hu *et al.* (2021) and Xu and Wang (2023) documented a positive effect of FI on agricultural output. Furthermore, varying impacts of FI on unemployment have been reported. Whereas Okoro *et al.* (2020) and Amakor and Eneh (2021) reported an increasing influence of FI on unemployment, Wu *et al.* (2023) and Wibowo *et al.* (2023) recorded contrasting results.

Besides, FI may have the least influence on poverty reduction until a certain threshold (or turning point) is reached, beyond which its influence becomes more pronounced. Thus, identifying the turning point and determining the channel(s) from FI to poverty reduction provides useful information to policymakers on the strategies to deploy to improve FI so as to reduce poverty in SSA region. Following the introduction, section 2 presents literature review and conceptual framework. The 3rd section addresses the methodology, and section 4 discusses the results. Section 5 concludes the study.

2. LITERATURE REVIEW

2.1 Conceptual review

FI implies the availability, accessibility, and affordability of financial services to the underprivileged segment of the society, and it emphasizes access to financial services and products including loans, savings, insurance, credit, financial advice, transfers and payment, etc., which can lift the poor out of poverty (Demirgüç-Kunt *et al.*, 2018; Tran and Le, 2021). According to Van Doeveren (2018), FI refers to free access to, and use of, appropriate financial services for all people and businesses at affordable cost and participation in society of disadvantaged groups based on equal rights and duties. Furthermore, FI implies access to

financial services like savings, credit, loans, equity, and insurance, which can help them build wealth (Mckinsey & Company, 2023).

On the other hand, Poverty is defined as the lack of essential resources needed for survival (Felix *et al.*, 2022). It refers to a condition where individuals/households cannot afford the basic necessities of life including food, clean water, shelter, and clothing (Sakanko, 2023). It is a situation where individuals/households have significantly less income or resources than the average in their community or country (Abosedra *et al.*, 2016; Aracil *et al.*, 2022). According to Dogan *et al.* (2022), poverty is the lack of access to education, healthcare, social services, and political participation. Poverty also involves being excluded from full participation in society, facing discrimination, and having limited opportunities to improve one's circumstances (Abimbola *et al.*, 2018; Adams and Atmanti, 2023).

2.2 Theoretical review

To comprehensively explain the FI and poverty relationship, this study builds on McKinnon (1973); King and Levine (1993) finance-growth theory. This theory posits that financial development, including access to financial services, leads to economic growth, which in turn reduces poverty. It emphasises that FI ensures individuals and businesses have access to affordable financial services, enhancing income-generating opportunities, smoothing consumption, and promoting investment in education, health, and businesses, ultimately helping to lift people out of poverty (Schmied and Marr, 2016; Sakanko, 2023). Additionally, the transmission from FI to poverty reduction is portrayed through two channels: the direct channel (King and Levine, 1993; Rajan and Zingales, 1998) and the indirect channel (Schumpeter, 1934; McKinnon, 1973; Shaw, 1973). The former asserts that functioning financial systems create an enabling environment for increased access to financial services, mobilizing savings, boosting investments, and promoting efficient resource allocation. These, in turn, foster economic growth, leading to poverty reduction. In fact, when households or individuals have access to formal financial services such as bank accounts, credit, and insurance, they gain more opportunities to increase their income (Demirgüç-Kunt *et al.*, 2015), whether by starting or expanding businesses, accessing credit for investment or education, or saving for future needs. As income grows, individuals and households acquire more resources to meet their basic needs, resulting in improvements in overall well-being and poverty reduction (Omar and Inaba, 2020).

Proponents of the indirect nexus between FI and poverty reduction argue that improved FI first induces economic growth, which subsequently leads to job creation and increased government spending on public services like health, education, and social protection. These improvements enhance the welfare of the poor and contribute to a decline in poverty levels (Perotti, 1993; King, 2014; Abosedra *et al.*, 2016; Li, 2018; Anga *et al.*, 2021).

2.3 Empirical review

Scholars have attempted to explore the empirical nexus between FI and income, unemployment, agriculture and consumption. A review of the studies are presented in the sub-sections.

2.3.1 Financial inclusion and income

Some efforts have gone into exploring FI and income nexus. For example, in a study of five lower middle-income economies, Nasution *et al.* (2023) adopted the ARDL panel estimation procedure and disclosed that FI significantly reduces poverty. Kanga *et al.* (2022) analyzed the diffusion of financial technology, FI and income per capita in 137 countries using the dynamic heterogeneity panel techniques. They disclosed that Fintech and FI exhibit greater positive and significant influence on per capita income.

Also, in a study of 106 developing nations, Omar and Inaba (2020) used the Fixed Effects (FE) estimator on data over the 2004-2016 period, and portrayed that FI impacts poverty mainly through per capita income. Moreover, Park and Mercado (2021) investigated FI's impact on poverty and income inequality in 151 countries, and observed that greater FI considerably lower poverty rates. Others including Demirgüç-Kunt *et al.* (2018) found that greater FI is associated with higher levels of income growth, suggesting a link between FI and poverty reduction through economic growth.

In Africa, Mohammed Jabir *et al.* (2017) explored FI and poverty reduction relation among low-income households in a panel of 35 SSA economies. They obtained that FI significantly reduced poverty in the sub-region. But Evans and Alenoghena (2017) used a Bayesian VAR method and reported that FI is insignificant in raising income in 15 African economies. Elsewhere, Evans and Lawanson (2017)) established a bidirectional nexus between FI and economic output, including reporting that FI enhances economic growth which tends to lessen poverty.

In Nigeria, Sakanko *et al.* (2020) employed the ARDL estimation technique to investigate FI's role on inclusive growth (poverty, inequality, households' expenditure, and unemployment) from 2007 to 2018, and revealed that higher FI boosts households' income. Employing the OLS estimator, Ogbeide and Igbinigie (2019) found a strong and increasing influence of FI on per capita income in Nigeria during the 2002-2015 period, suggesting poverty reduction impact of FI. Also, Abimbola *et al.* (2018) found that FI (captured by the number of deposits and customers with bank accounts) lowers poverty via a rise in per capita income.

2.3.2 Financial inclusion and consumption

Researchers have also looked at the empirical relation between FI and consumption. For example, Cavoli and Gopalan (2023) investigated FI and consumption smooth relation in emerging economies during the 1995-2017 period. Using the heterogeneous ARDL panel, they found FI to smoothen households' consumption. Also, Yang and Zhang (2022) documented that higher financial technology considerably increased households' consumption and reduced consumption inequality in China.

Similarly, Chakrabarty and Mukherjee (2022) adopted the standard FE estimator to analyze FI and consumption nexus in India, and observed that households' consumption expenditure increased significantly with improvements in FI. Furthermore, Luo and Li (2022) employed a FE estimator to analyze digital FI's impact on households' consumption over the 2015-2017 period in China. They portrayed that improvements in digital FI considerably lessened consumption inequality. In the same vein, Lai *et al.* (2020) discovered that digital FI enhanced individuals' consumption smoothening over the 2010-2016 period in China.

In Africa, Mwangi and Atieno (2018) explored the FI and households' welfare nexus in Kenya using a dynamic panel regression to analyze data for the 2009-2016 period. They reported that households' welfare increased with greater FI. In Nigeria, Sakanko *et al.* (2020) employed the ARDL method and submitted that FI (measured by consumers' deposit and credit to the private sector) promoted households' consumption during the long-term.

2.3.3 Financial inclusion and agricultural output

Empirical research on FI and agriculture abounds. For example, Xu and Wang (2023) adopted heterogeneity panel technique to analyze digital FI and agriculture output in Chinese 33 cities and provinces, and observed a strong positive influence of digital FI on agricultural productivity.

Also, using ARDL and DOLS estimators, Farooq *et al.* (2023) portrayed that FI (proxied by broad money) significantly boosts agricultural growth, whereas FI (measured by domestic credit) has a significant adverse influence on agricultural growth. In addition, employing a dynamic panel FE estimator, Zhai *et al.* (2023) explored the effect of digital FI on agricultural productivity in China, and showed that electronic-FI boosts agricultural output. Similarly, Hu *et al.* (2021) adopted the dynamic panel estimation method, and found that FI promotes agricultural growth in China's provinces.

In Africa's context, Atakli and Agbenyo (2020) explored FI, gender, and agricultural output relations in Ghana using the OLS technique. They discovered a strong positive influence of FI on agricultural output. Also, Mhlanga *et al.* (2020) investigated the FI and poverty relation amongst Zimbabwean smallholder farmers using simple regression method. The results suggest that improving smallholder farmers' access to FI is an important channel for lowering poverty. Agbenyo *et al.* (2019) used the FMOLS estimator to explore the long-term FI and agricultural output nexus in Ghana. The results portrayed that FI (proxied by domestic credit to the private sector) adversely impact agricultural growth, while FI (proxied by lending interest rate) has a significant and increasing influence on agricultural growth.

Besides, Abu and Haruna (2017) found agricultural commercialization to increase with FI in Ghana using the endogenous switching regression (ESR) and Heckman treatment effect (HTE) technique. In Nigeria, Umaru and Eshiozemh (2022) confirmed a strong positive influence of FI on agricultural output using both NARDL and Stepwise Least Squares (STEPLS) estimators. A Similar finding was established by Fowowe (2020) in Nigeria's case.

2.3.4 Financial inclusion and unemployment

Some studies focused on the FI and unemployment relation. For instance, using two stage least squares (2SLS) and GMM estimators, Wu *et al.* (2023) showed that unemployment declines with increases in FI for seven (7) Asian countries. Also, Wibowo *et al.* (2023) used both FE and RE estimators to assess FI's influence on economic growth and unemployment in Indonesia, Malaysia, Thailand, Philippines, and Cambodia. The results point to a strong negative influence of FI on unemployment. Similarly, using the GMM estimator, Mehry *et al.* (2021) disclosed that FI lowers unemployment in 43 emerging economies. Also, Erra and Venkatachalapathy (2018) employed the system-GMM estimation, and confirmed that FI significantly reduces unemployment and poverty in India.

Moreover, concentrating on non-oil-producing Middle East and North Africa (MENA) group (including Egypt, Jordan, Lebanon, Morocco, and Tunisia), Alshyab *et al.* (2021) used the RE estimator and observed that unemployment decreases with greater FI. In India, Tp (2014) employed the OLS technique, and documented that FI has a strong dampening influence on unemployment via empowerment and poverty reduction. In the context of Africa, Okoro *et al.* (2020) adopted FE and RE estimators, and established that FI exerts a strong and negative influence on unemployment in SSA countries.

2.4 Literature gap

Despite the volume of research exploring FI-poverty reduction relation, some gaps remain, particularly in the SSA context. While numerous studies have investigated FI's impact on income, consumption, agricultural output, and unemployment across various regions, critical gaps persist in understanding the specific channels through which FI influences poverty reduction in SSA.

First, much of the research focused on broader cross-country analyses that encompass diverse economies with varying financial structures and development stages (Park and Mercado, 2021; Kanga *et al.*, 2022; Nasution *et al.*, 2023). Although insightful, the studies may not have adequately captured the unique socioeconomic and institutional dynamics of SSA, where financial infrastructure, literacy, and access to formal financial services remain relatively underdeveloped.

Second, whereas scholars have explored the direct impact of FI on poverty and income growth (Mohammed Jabir *et al.*, 2017; Demirgüç-Kunt *et al.*, 2018), limited attention has been given to understanding the distinct channels via which FI operates to alleviate poverty in SSA. For instance, while Omar and Inaba (2020) highlighted FI's role in enhancing per capita income in developing nations, the pathways through which FI contributes to poverty reduction (including consumption smoothing, job creation, and agricultural productivity) remain under-explored in the SSA context.

Third, studies on SSA region have produced mixed findings regarding FI's effectiveness. For example, Mohammed Jabir *et al.* (2017) found a significant poverty-reducing impact of FI in 35 SSA economies, whereas Evans and Alenoghena (2017) reported that FI had an insignificant influence on raising income across 15 African countries. This inconsistency underscores the need for further investigation into the mechanisms via which FI influences poverty reduction in SSA.

Furthermore, while studies like Sakanko *et al.* (2020) and Ogbeide and Igbinigie (2019) explored FI's impact on inclusive growth, they focused on single-country or deemed it unnecessary to unravel the direct and indirect channels of FI's impact on poverty reduction. Additionally, existing research predominantly emphasizes income-related aspects, overlooking other critical dimensions such as consumption patterns, agricultural productivity, and employment generation.

Moreover, research concentrating on FI-poverty reduction in the SSA region is almost non-existent, and related studies used indicators (including money supply, bank branches, number of borrowers, savings, number of depositors, credit to private sector, number of Automatic Teller Machines, domestic credit-GDP ratio, etc.,) considered bias as a measure of FI.

2.5 Conceptual framework

Given the theoretical foundation and empirical literature, we develop a framework on how poverty reduction is linked to FI via channels like income, consumption, agricultural output, and unemployment (Figure no. 1). This research proposes that FI acts as a catalyst for poverty reduction by boosting income growth, promoting consumption stability, reducing unemployment, and enhancing agricultural output. The discussion on these is done in the subsequent sub-sections.

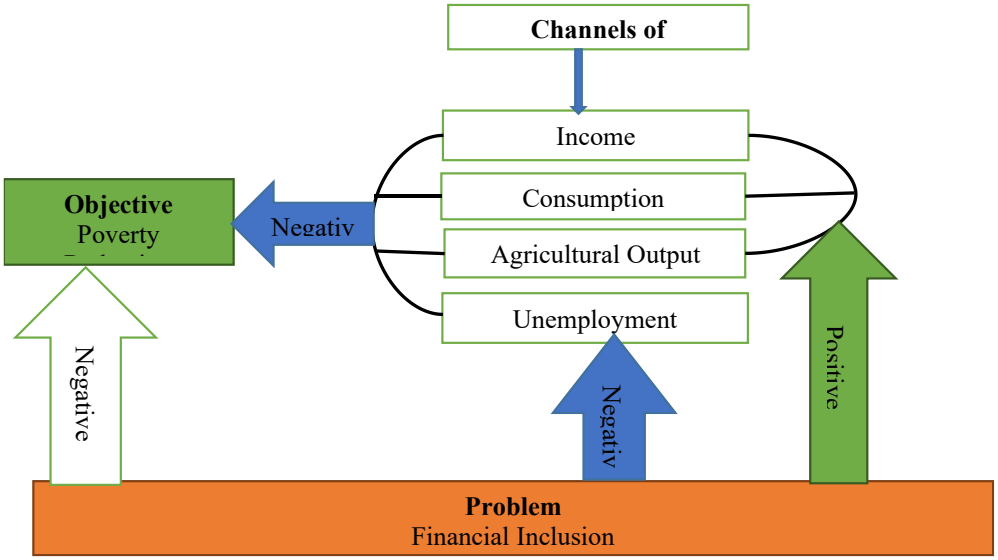

Figure no. 1 – Financial inclusion and poverty reduction conceptual framework
Source: authors' own representation

2.5.1 Financial inclusion and income

The literature argues that if individuals (or households) have increased access to formal financial services (like bank accounts, credit, and insurance, etc.,) they have greater opportunities to increase their incomes. Rising income can be brought about via starting a new business or expanding an existing one, accessing credit for investment or education, or saving for future needs. As income grows, it can contribute to poverty reduction through providing households with more resources to meet their basic needs, resulting to improvements in their overall wellbeing.

The hypothesis testable is:

H*$_{01}$: Financial inclusion does not transmit a significant effect from income to poverty reduction.*

2.5.2 Financial inclusion and consumption

FI can also impact households' consumption. As individuals witnessed increased access to formal financial services, they can save and invest their resources (or money) efficiently, thus, allowing them to smooth consumption over time. This results to improved financial stability and resilience to economic shocks, hence, a reduction in the likelihood of falling into poverty. Additionally, greater access to credit enables people to make valuable investments including purchasing durable goods or investing in education, which further enhances their consumption capabilities and contributing to poverty reduction.

The hypothesis testable is:

***H_{02}**: Financial inclusion does not transmit a significant effect from consumption to poverty reduction.*

2.5.3 Financial inclusion and agricultural output

Greater FI can raise agricultural output. Fowowe (2020) suggested that access to formal financial services can provide farmers with credit, insurance, and other financial tools to invest in their agricultural activities. These result in improved farming techniques, more efficient use of resources and increased productivity. As agricultural output expands, so do farmers' incomes, leading to poverty reduction within rural communities where agriculture is primarily the source of livelihood (Baba *et al.*, 2023).

The hypothesis testable is:

***H_{03}**: Financial inclusion does not transmit a significant impact from agricultural output to poverty reduction.*

2.5.4 Financial inclusion and unemployment

The literature portrays that improved access to financial services increases the easy with which individuals can start their own businesses or engage in entrepreneurship activities, leading to creation of employment opportunities (Tp, 2014). When people are employed and have a regular income, poverty rates tends to decline because individuals can meet basic needs and improve their living conditions (Erra and Venkatachalapathy, 2018).

The hypothesis testable is:

***H_{04}**: Financial inclusion does not transmit a significant impact from unemployment to poverty reduction.*

3. METHODOLOGY

To explore the channel that transmit FI's influence on poverty reduction in SSA, this study concentrates on (and tests) four channels (i.e., income per capita, households' consumption expenditure, agricultural output, and unemployment rate). In essence, this research explores FI's impact on each channel to ascertain how individually they contribute

to poverty reduction. The significance of each channel will disclose whether (or not) it serves as an avenue in the FI-poverty reduction nexus in SSA region. For each of the channels, the dynamic model employed is:

$$W_{it} = \beta_i W_{it-1} + \gamma_i' FI_{it} + \delta_i FI_{it}^2 + \theta_i X_{it} + \mu_i + \varepsilon_{it} \quad (1)$$

where the cross-sectional unit and time i and t, respectively. W is the dependent variable and channel (proxied by each of income growth, consumption expenditure, agricultural output, and unemployment rate) to be investigated, while FI and FI^2 are the financial inclusion and its squared term variables, respectively. X is the vector of control variables (i.e., trade, interest rate, inflation, money supply, exchange rate, and population), while W_{it-1} is the lagged dependent variable. μ_i represents country-specific individual effect, and it denotes unobserved heterogeneity among the countries. ε is the error term. The same control variables are used to account for each dependent variable's behaviour due to their potential influence on the identified channels.

For example, studies of Freund and Bolaky (2008) and Kim (2011) established that increasing trade positively impacted per capita income. Similarly, income per capita growth is influenced by interest rate (Husain *et al.*, 2020), money supply and inflation (Razia and Omarya, 2022), and exchange rate (Guillaumont Jeanneney and Hua, 2001). However, Hajamini (2015) disclosed that population growth has an asymmetric influence on per capita income.

Furthermore, Muthayya *et al.* (2014) documented that more trade raises consumption expenditure, while Gong (2018) obtained the opposite. Moreover, households' consumption decreases with interest rate (Kapoor and Ravi, 2009; Jappelli and Scognamiglio, 2018) and inflation (Ihugba *et al.*, 2021), but it increases with money supply (Ihugba *et al.*, 2021). Other core drivers of consumption are real and nominal exchange rates (Mumtaz and Ali, 2020; Derindag *et al.*, 2022) and population growth (Schneider *et al.*, 2011).

Additionally, agricultural output is impacted negatively by trade openness (Hart *et al.*, 2015), while population growth boost agricultural output (Schneider *et al.*, 2011). Other significant determinants of agricultural output include money supply, interest rate, inflation rate, and exchange rate (Kadir and Tunggal, 2015).

Moreover, unemployment reduces with greater trade (Felbermayr *et al.*, 2011; Marzan *et al.*, 2020) and inflation (Shighweda, 2020), but it increases with interest rate (Doğrul and Soytas, 2010) and money supply (Shighweda, 2020). Lastly, unemployment declines with exchange rate (Bakhshi and Ebrahimi, 2016), while Maijama'a *et al.* (2019) reported that exchange rate and population growth contribute to unemployment.

Besides, the inclusion of the squared term of FI in the model is to ascertain whether (or not) the channels under consideration (i.e., income per capita, households' consumption expenditure, agricultural output, and unemployment rate) exhibit non-linear (asymmetric) influence from FI to poverty reduction. This is due to the conflicting findings on the link between FI and these transmission channels. For instance, certain studies including Park and Mercado (2021) and Omar and Inaba (2020) found an increasing influence of FI on income, but others like Kim (2011), Boukhatem (2016) and Schmied and Marr (2016) disclosed a negative relation between them. In addition, researchers like Chakrabarty and Mukherjee (2022) and Cavoli and Gopalan (2023) linked improved consumption to FI, but Li *et al.* (2022) obtained a dampening influence of FI on consumption. Yet Liu and Yao (2024) reported a

non-linear nexus between FI and consumption. Also, Atakli and Agbenyo (2020) and Farooq *et al.* (2023) discovered a negative connection between FI and agricultural output, while Hu *et al.* (2021) and Xu and Wang (2023) disclosed a positive influence. In addition, Okoro *et al.* (2020) and Amakor and Eneh (2021) reported that FI promoted unemployment, whereas Wu *et al.* (2023) and Wibowo *et al.* (2023) recorded contrasting results.

Given the mixed and/or conflicting empirical outcomes, it is possible that FI will have the least/highest impact until a certain threshold/turning point is reached, beyond which its effects become more/less pronounced. The squared term of FI is included in the model to determine whether the channels under consideration transmit non-linear effects from FI to poverty reduction. Thus, for any channel to be adjudged as transmitting a non-linear influence, the coefficients γ_i and δ_i must bear opposite signs and significance. Suppose the former (γ_i) is positive and the latter (δ_i) is negative, the relation is said to be concave (or inverted U-shaped). But if γ_i is negative and δ_i is positive and are both significant, then, the relation is convex (or U-shaped). The threshold (turning point) is computed from Equation (1) via partial derivative regarding FI, expressed in Equation (2) as:

$$\frac{\partial W_{it}}{\partial FI_{it}} = \frac{\gamma_i}{-2\delta_i} = \text{concave} \quad \text{or} \quad \frac{\partial W_{it}}{\partial FI_{it}} = \frac{-\gamma_i}{2\delta_i} = \text{convex} \tag{1}$$

A concave relation denotes a function that curves downward (i.e., decreasing). For a convex relationship, the function curves upward (i.e., increasing). The coefficient of the squared term/variable (FI^2) is calculated by differentiating the estimation with respect to FI in Equation (1), expressed as:

$$\frac{\partial W_{it}}{\partial FI_{it}} = \gamma_i + 2\delta_i FI_{it} \tag{3}$$

3.1 Data

This research uses yearly data that span 2004-2022 for 25 SSA economies (including Angola, Benin, Botswana, Burkina Faso, Cameroon, Cote D'Ivoire, D.R. Congo, Ethiopia, Gabon, Ghana, Guinea, Guinea-Bissau, Liberia, Madagascar, Malawi, Mali, Niger, Nigeria, Senegal, Sierra Leone, Tanzania, Togo, Uganda, Zambia, and Zimbabwe). The data were gathered from the World Bank (2023) Development Indicators. Income growth is measured by GDP per capita growth (in %), consumption by households' consumption expenditure (% of GDP), agricultural output by agricultural value added (% of GDP), unemployment rate by total unemployment as a % of total labour force, trade as a % of GDP, interest rate by lending interest rate (in %), money supply by broad money supply (% of GDP), inflation by consumer prices annual changes (in %), exchange rate by official exchange rate of the local currency per US$, and population by annual population growth (in %). The measurement procedure of FI is provided in the next sub-section.

3.2 Financial inclusion index

The literature portrays several approaches involved in the measurement of FI. The indicators include credit to private sector, number of Automatic Teller Machines (ATM), bank

branches, money supply, depositors, borrowers, savings, domestic credit-GDP ratio, etc. However, the indicators were criticized of bias (Nguyen, 2021; Cavoli and Gopalan, 2023), leading to the development (or construction) of a composite Financial inclusion index (FII) with global acceptance. The index adopts a multi-dimensional measurement of the level and dimensions of FI that is comprehensive and robust (Nguyen, 2021; Sakanko *et al.*, 2024). Two techniques used to develop the composite FII are parametric and non-parametric. Interestingly, the non-parametric method is criticized due to the subjective weight of importance it assigns to indicators exogenously based on the researcher's intuition, resulting in the preference for its parametric counterpart, i.e., principal component analysis (PCA).

We follow Nguyen (2021) and Sakanko *et al.* (2024) two-stage PCA method to develop the index. The first stage involves estimating sub-indices of three dimensions of financial inclusion (i.e., access, availability, usage dimensions) based on series of macroeconomic indicators of the dimensions. The second stage includes using the PCA approach to construct the overall index (i.e., composite FII) via the sub-indices generated during the first stage.

3.3 Estimation technique

To achieve the goal of this research, the system-Generalized Method of Moment (i.e., system-GMM) estimator is employed to analyze data for the 2004-2022 period. The justification for adopting the system-GMM lies in the dimension of the dataset, where the number of cross-section is greater than the time-series (Roodman, 2009; Hassan and Meyer, 2021). The system-GMM model combines level equation, first-difference, and the lagged level of the regressor(s). The validity of the estimator is based on the assumption of constant country-specific effect and the level of the regressors over time including the possibility of an absence of correlation between both (Uddin *et al.*, 2017; Abdul Karim *et al.*, 2022).

The appearance of lagged dependent variable (W_{it-1}) in Equation (1) suggests the possibility of endogeneity in the (FI) model as established in the literature (Erra and Venkatachalapathy, 2018; Mehry *et al.*, 2021; Wu *et al.*, 2023). Thus, using static panel data techniques like Pooled OLS, FE and RE methods to estimate FI-poverty reduction relation will be inappropriate. To address this problem, this research adopts the GMM estimator (Arellano and Bond, 1991; Blundell and Bond, 1998) that supports differencing of Equation (1) given as:

$$\Delta W_{it} = \beta_i \Delta W_{it-1} + \gamma_i{}' \Delta FI_{it} + \delta_i \Delta FI_{it}^2 + \theta_i \Delta X_{it} + \Delta \varepsilon_{it} \quad (4)$$

Taken the first-differencing in Equation (1), the expected linear correlation between W_{it-1} (lagged dependent variable) and the country-level specific effect (μ_i), is removed. However, the endogeneity problem that arises due to the linear association between W_{it-1} and the new error term (ε_{it}) still persists ($W_{it-1} * \varepsilon_{it} \neq 0$). To this end, Arellano and Bond (1991) opined the problem can be resolved via using lagged value of exogenous variable(s) as an instrument. Thus, the GMM estimator is advantageous due to its ability to address problems relating to country-specific effect and simultaneity bias. Notwithstanding, Blundell and Bond (1998) added that the inclusion of lagged dependent and independent variables may result to faulty inferences because of weak instrument(s). Moving forward, Arellano and Bover (1995) and Blundell and Bond (1998) collectively advanced the system-GMM method to address this limitation.

To validate and/or ascertain the robustness of the results generated based on the system-GMM, two tests are conducted. They include the Sargan's test for over-identifying restriction which is performed to validate the instrument(s) used, and the Arellano and Bond (1991) autoregressive test of first-order autocorrelation (i.e., AR(1)) and second-order autocorrelation (i.e., AR(2)) to see if (or not) the error terms in the differenced regression exhibit auto (serial) correlation. Whereas it's not uncommon that the error terms in the first-differenced estimation have AR(1), the presence of AR(2) renders the results invalid and/or inconsistent. If the probability of the Sargan's statistic is greater than 0.05, then, we do not accept the null hypothesis, thus, implying that over-identifying restrictions are not valid. In addition, if the probability of the AR(2) test statistic exceeds 0.05, the null hypothesis of the presence of second-order autocorrelation is not accepted.

4. EMPIRICAL RESULTS AND DISCUSSION

4.1 Descriptive statistics

The summary of descriptive statistics of the variables (Table no. 1) portrays the mean/average financial inclusion(FI) for the studied period (i.e., 2004-2022) as 4.680. The average income (INC), consumption (CON), agricultural output (AGR), and unemployment (UNE) are 6.003, 66.176, 24.098, and 1.819, respectively, for the same period. Furthermore, the mean of population (POP) is 3.115, trade (TRD) is 57.885, interest rate (INT)is 14.760, log of exchange rate (LnEXR) is 5.870, money supply (MOS) is 25.175, and inflation rate (INF) is 9.761.

The highest (maximum) and lowest (minimum) values for FI are 4.830 and -2.993, respectively. The highest and lowest values for the remaining variables are: 21.852% and 0.320% for INC, 119.413% and 12.449% for CON, 66.033% and 1.739% for AGR, 19.939% and -22.383% for UNE, 11.244 and 0.524 for POP, 143.982 and 2.886 for TRD, 131.813 and 3.105 for INT, 22.629 and -0.106 for LnEXR, 53.548 and 4.530 for MOS, and 557.202 and -3.233 for INF. The standard deviations for the variables including INC (5.537), CON (21.407), AGR (13.372), UNE (3.887), TRD (24.271), INT (13.353), LnEXR (3.302), MOS (10.049), and INF (29.237), except those of FI (1.160) and POP (1.662) which portray that the data points are dispersed around their average values.

Table no. 1 – Summary statistics

	Mean	Std. Dev.	Min.	Max.	Obs.	N	T
FI	4.680	1.160	−2.993	4.830	475	25	19
INC	6.003	5.537	0.320	21.852	475	25	19
CON	66.176	21.407	12.449	119.413	475	25	19
AGR	24.098	13.372	1.739	66.033	475	25	19
UNE	1.819	3.887	−22.383	19.939	475	25	19
POP	3.115	1.662	0.524	11.244	475	25	19
TRD	57.885	24.271	2.886	143.981	475	25	19
INT	14.760	13.353	3.105	131.813	475	25	19
InEXR	5.870	3.302	−0.106	22.629	475	25	19
MOS	25.175	10.049	4.530	53.548	475	25	19
INF	9.761	29.237	−3.233	557.202	475	25	19

Note: FI = Financial inclusion, INC = Per capita income, CON = Household consumption expenditure, AGR = Agricultural output, UNE = Unemployment rate, POP = Population growth rate, TRD = Trade, INT = Interest rate, EXR = Exchange rate, MOS = Money supply, INF = Inflation, Ln = Logarithm.

4.2 Results of system-GMM estimation

The use of time series data for estimation purpose can lead to problems such as serial-correlation and heteroscedasticity. The presence of these problems can invalidate or make unreliable any estimates generated. To ascertain the reliability of the estimated results, diagnostic tests were conducted. The results of diagnostic tests are reported in Table no. 2.

The results were generated using the system-GMM estimator for four models of income (INC), consumption (CON), agricultural output (AGR), and unemployment (UNE) as dependent variables (and measure of poverty) given in columns II, III, IV and V, respectively. The coefficient of the lagged dependent variable (W_{t-1}) is statistically significant at 5% in all models, suggesting the persistence of the dependent (endogenous) variable in the sample. The diagnostic tests' results portray that the probability of AR(2) test statistic in all models exceeds 5%, indicating absence of the second-order serial correlation. The Sargan's test result is significant at 5% in all the models, and it portrays that the system-GMM model is not over-identified. The Wald test result implies that the explanatory are jointly significant at 5% level.

The income model estimates (Column II) show that the coefficient of FI is negative and the squared variable (FI^2) is positive, and both are statistically significant at 5% level. These results imply a convex relation betweenFI and income growth, indicating that the non-linear influence of FI on poverty reduction is transmitted via income growth. The coefficient of FI is -0.467[or $-1.537 + 2(0.535)$] (computed from Equation (3)), while the turning point for FI and income growth relation is -1.44[$= \frac{-1.537}{2(0.535)} = \frac{-1.537}{1.07}$] (computed from Equation (2)).

Table no. 2 – Results of system-GMM estimation

Dependent Variable	INC	CON	AGR	UNE
(I)	(II)	(III)	(IV)	(V)
W_{t-1}	0.098^{**}	0.790^{***}	0.832^{***}	0.816^{***}
FI	-1.537^{**}	1.778^{**}	0.765^{**}	0.546^{***}
FI^2	0.535^{**}	-0.310^{**}	-0.274^{**}	-0.052^{*}
TRD	0.105^{***}	0.040^{*}	0.006	0.001
INT	-0.006	-0.058^{*}	-0.011	0.015^{***}
MOS	-0.235^{***}	0.014	0.045^{*}	0.016^{*}
INF	-0.028^{***}	0.005	-0.003	0.003^{*}
InEXR	0.022	-0.081	-0.192^{*}	0.075^{***}
POP	0.710	1.390	1.334^{***}	0.038
Threshold of FI	1.436%	2.868%	1.396%	5.25%
AR(1)	0.003	0.004	0.003	0.028
AR(2)	0.278	0.392	0.868	0.280
Sargan Test	301.702^{***}	265.826^{***}	284.171^{***}	259.677^{***}
Wald Test	92.50^{***}	759.75^{***}	8107.10^{***}	7465.28^{***}

Note. *, ** and *** represents statistical significance at 1%, 5% and 10%, respectively. FI = Financial inclusion, INC = Per capita income, CON = Households' consumption expenditure, AGR = Agricultural output, UNE = Unemployment rate, POP = Population growth rate, TRD = Trade, INT = Interest rate, EXR = Exchange rate, MOS = Money supply, INF = Inflation, Ln = Logarithm.

A unit increase in FI results in 0.467% decline in income growth (and poverty elevation) in SSA. The positive coefficient on FI^2 portrays convexity (i.e., an upward relation). That is, whereas the financial inclusion and income growth relation is negative, the (adverse) impact

begins to reduce once financial inclusion reaches 1.44. This is the threshold beyond which financial inclusion starts to impact income growth positively. It signifies that income growth begins to transmit a negative influence from financial inclusion to poverty reduction on the far side of the threshold of financial inclusion. The supportive role of FI can be attributed to increased households' knowledge of financial services and products, regulatory environment, and consumer protection beyond this threshold. Thus, they can increase their savings, invest in income-generating activities, and make informed investment decisions, leading to increased income and welfare, and as a result poverty reduction. This finding substantiates the outcomes of related studies (Evans and Alenoghena, 2017; Evans and Lawanson, 2017; Ogbeide and Igbinigie, 2019; Sakanko *et al.*, 2020; Kanga *et al.*, 2022).

The coefficient of trade (TRD) is positive and statistically significant at 1% level. A percentage increase in TRD raises income by 0.105%. This portrays the significant role of trade in income growth. Rising trade increases the access of households who engage in production activities to markets for goods and services, leading to higher sales and profits including their income. In addition, trade can promote competition and push down goods/services prices. Falling prices in turn raise households' buying power, resulting in the consumption of more goods/services and declines in poverty. This outcome affirms the findings of Freund and Bolaky (2008) and Kim (2011).

Moreover, a percentage increase in money supply (MOS) and inflation (INF) is found to impact income negatively by 0.235% and 0.028%, respectively, at 1% level. The diminishing influence of MOS and INF implies that more money supply and inflationary pressure erode households' buying power, create macroeconomic uncertainty, and foster complex interest rates via tight monetary policy. These leave undesirable impacts on households' income and earnings of businesses, with their tendency to elevate poverty. The result conforms to the work Razia and Omarya (2022) that rising inflation and money supply hurt income.

The results of the consumption model (Column III) portray that households' consumption constitutes a channel for transmitting financial inclusion non-linear impact to poverty reduction, given the opposite signs and statistical significance of FI and FI^2. The coefficient of FI is 1.158[or $1.778 - 2(0.310)$], while the turning point for financial inclusion and consumption relation is -2.87[or $\frac{1.778}{-2(0.310)} = \frac{1.778}{-0.62}$]. These findings entail a concave (or downward) relation between them.

The coefficient of FI signifies a positive relation between consumption and financial inclusion at 5% level. A unit increase in FI results in 1.158% improvement in households' consumption (and poverty reduction) in SSA region. The negative coefficient on FI^2 shows a downward relation, and the threshold between financial inclusion and consumption is 2.87. Thus, the relationship turns negative once financial inclusion FI reaches 2.87, and it is the threshold/turning point beyond which consumption starts to launch a positive influence from FI to poverty reduction. The finding suggests that households' consumption contributes to poverty reduction before financial inclusion reaches 2.87. The negative influence of FI beyond this point may be due to excessive borrowing (for consumption purposes) and associated debts which reduces households' ability to finance future consumption. Besides, rising interest rates occasioned by inflationary pressures in the SSA region reduces not only accessibility but also affordability of financial services. Moreover, rising risks of financial fraud which accompany growing FI may discourage households from accessing financial services in an attempt to avoid losing their assets to fraudsters. These can reduce savings, investment and consumption,

and as a result increase the poverty level. The outcome lays credence to the research of Li *et al.* (2022) suggesting a dampening influence of FI on consumption, but it contradicts the findings of others on its supportive role on consumption (Mwangi and Atieno, 2018; Sakanko *et al.*, 2020; Chakrabarty and Mukherjee, 2022; Cavoli and Gopalan, 2023).

The coefficient of TRD is significant at 10% level, demonstrating that a percentage gain in trade raises households' consumption by 0.040%. This suggests that trade can boost consumption in SSA via expansion in job opportunities and income generation for individuals involved in export-oriented activities including increased households' access to a wide range of goods/services. The increased consumption will lead to improved welfare and poverty reduction. The result is consistent with outcomes of Muthayya *et al.* (2014).

More so, interest rate (INT) is shown to hurt households' consumption and the relation is significant at 10% level. A percentage increase in INT dampens households' consumption by a 0.058%. This portrays that higher interest rates can reduce consumption in SSA due to increased borrowing costs which in turn hinder investment growth. The implications of these are reduced production capacity and employment opportunities including declining consumer spending, which all result in elevating poverty. This discovery conforms to empirical findings of Kapoor and Ravi (2009) and Jappelli and Scognamiglio (2018).

Furthermore, the results of agriculture output (AGR) model (Column IV) disclose that both FI and FI^2 are significant at 5% level, respectively. The FI coefficient bears a positive sign and FI^2 a negative sign, thus, portraying a non-linear relation between agricultural output and financial inclusion. The coefficient of FI is 0.217[or$0.765 - 2(0.274)$], while the turning point for financial inclusion and agricultural output relation is -1.40[or$\frac{0.765}{-2(0.274)} = \frac{0.765}{0.548}$].

A unit increase in FI leads to 0.217% improvement in agricultural output (and poverty reduction) in SSA region. The negative coefficient on FI^2 shows a downward link, and the threshold between financial inclusion and agricultural output is 1.40. Thus, financial inclusion and agricultural output relation rises into negative after financial inclusion reaches 1.40. Beyond this point, agricultural output transmits a positive impact from financial inclusion to poverty reduction. The negative influence of financial inclusion after this threshold could pass off from possible diversion of funds meant for agricultural development to non-agricultural purposes or higher interest rates.

For example, loans or credit provided through financial inclusion programmes designed to boost agricultural productivity may be diverted to consumption or non-agricultural businesses. Also, despite financial inclusion programme goals to provide affordable credit, mounting interest rates present obstacles to smallholder farmers in via increased borrowing costs. These may produce a declining influence on agricultural output, leading to falling incomes and elevating poverty level. In addition, if agricultural production is export-biased rather than boosting domestic consumption, it will create scarcity and raise domestic prices as was the case recently in Nigeria. This is accompanied by lower households' buying power and consumption, resulting to increased poverty. This result is in line with the findings of previous studies like Agbenyo *et al.* (2019), but it contrasts the positive effect obtained by others (Atakli and Agbenyo, 2020; Hu *et al.*, 2021; Umaru and Eshiozemh, 2022; Farooq *et al.*, 2023; Xu and Wang, 2023; Zhai *et al.*, 2023).

The coefficients of MOS and population (POP) are positive and significant at the 10% level and 1% level, respectively. Specifically, 0.045% and 1.334% increase in agricultural output are associated with a percentage increase in money supply and population growth,

respectively. Raising money supply may contribute to reduced interest rates and improvements in investment in agricultural infrastructure (like irrigation systems, storage facilities, better seeds, and mechanization, etc.,) for farmers. These in turn enhance agricultural productivity and output. In addition, a growing population induces governments to prioritise agricultural expansion via policies aimed at improving access to credit, inputs, market infrastructure, and extension services for farmers to stimulate agricultural production. These contribute to boosting consumption and reducing poverty. This finding validates the studies of Kadir and Tunggal (2015) and Schneider *et al.* (2011) that money supply and population are increasing determinants of agricultural output.

Also, the coefficient of exchange rate (LnEXR) is negative and significant at 10% level. A percentage depreciation in the exchange rate dampens agricultural output by 0.192%. Given that most SSA countries have limited domestic production capacity and rely heavily on agricultural imported inputs (such as machinery and fertilizers), depreciation makes these inputs very costly, thus, slowing down agricultural productivity. These contribute to higher agricultural produce prices, falling consumption, and poverty elevation. The result conforms to the finding of Kadir and Tunggal (2015).

The results of unemployment (UNE) model (Column V) reveal that the FI and FI^2 are statistically significant at 1% level and 10% level, respectively. In addition, both bear opposite signs, implying a non-linear between FI and unemployment. The coefficient of FIis 0.442[or $0.546 - 2(0.052)$]. The turning point for FIand unemployment relation is -5.25[or $= \frac{0.546}{-2(0.052)}$ $= \frac{0.546}{-0.104}$]. The positive coefficient of FI suggests an upward relation between financial inclusion and unemployment. A unit increase in FI results in 0.442% rise in unemployment (and poverty elevation) in SSA countries. However, FI and unemployment relation becomes negative once the financial inclusion reaches 5.25. This is the threshold beyond which unemployment (begins to decline and) transmits a negative impact from financial inclusion to poverty reduction. This finding portrays that if greater financial inclusion increases households' access to financial services, they can invest and engage in income generating activities with ease leading to declines in unemployment and poverty reduction. The outcome is consistent with previous research (Erra and Venkatachalapathy, 2018; Okoro *et al.*, 2020; Alshyab *et al.*, 2021; Mehry *et al.*, 2021; Wibowo *et al.*, 2023).

In addition, interest rate (INT), money supply(MOS), inflation(INF), and exchange rate (LnEXR) coefficients are positive and significant at 5% level, respectively. A percentage increase in these variables increases unemployment by 0.015%, 0.016%, 0.003%, and 0.075%, respectively. The results affirm outcomes of prior researches (Doğrul and Soytas, 2010; Maijama'a *et al.*, 2019; Shighweda, 2020). The studies disclosed that interest rate, money supply, and exchange rate significantly increased unemployment, while Shighweda (2020) reported that higher inflation reduced unemployment.

5. CONCLUSION

This research explores the channels through which financial inclusion (proxied by the financial inclusion index constructed based on the principal component analysis) transmits its influence to poverty reduction in SSA countries during the 2004-2022 period using the system-GMM estimation technique. The empirical outcomes portray that financial inclusion transmits non-linear influence to poverty reduction in SSA nations via income growth,

households' consumption, agricultural output, and unemployment. Moreover, the findings disclose that an FI value beyond thresholds of 1.44 and 5.25 would boost income growth and reduce unemployment, thereby reducing poverty. In addition, an FI value below thresholds of 2.87 and 1.40 positively impacts consumption expenditure and agricultural output, leading to poverty reduction.

Policy implications emanating from this research outcome include the need for SSA's governments and policy makers to prioritise raising individuals' access to financial services and promoting financial literacy through increased awareness on the importance of mobile banking services, insurance products, remittance services, savings, managing credit or debt, and investing wisely to reduce the otherwise impacts on the identified channels. These will enhance individuals' capacity to earn income and/or increase their chances of employment opportunities. Besides, greater access to financial products like credit (or loan) raises people's capacity to consume goods and services, leading to improved welfare. In addition, increased access to financial services makes it easier for individuals engaged in agricultural production or business to raise their output. Sustained expansion in output can bring down prices of agricultural produce, resulting in higher purchasing power and consumption for households. Coupled with these are the increased sales and profits that accrue to operators in the agricultural sector. All of these can contribute to poverty reduction.

As a limitation, the current study focuses on the transmission channels of financial inclusion to poverty reduction in SSA countries. Therefore, future research should explore the role of digital financial inclusion on poverty reduction in addition to exploring regional variation across SSA, especially in light of the growing adoption of FinTech solutions and digital banking services.

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