Journal of Cleaner Production 520 (2025) 146135

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro

Examining microfinance and financial inclusion nexus in poverty alleviation and sustainable development in Sub-Saharan Africa

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ARTICLE INFO

Keywords:
SDG 1
Financial inclusion
Microfinance
Sustainability
Unemployment
Digital financial services

ABSTRACT

This study explores the critical role of microfinance and financial inclusion in addressing poverty and promoting sustainable development in 10 Sub-Saharan African countries from 2000 to 2023. It addresses two key objectives: first, to investigate how microfinance influences poverty reduction and sustainable development through the moderating role of financial inclusion, and second, to determine the threshold levels at which financial inclusion variables, such as ATMs and mobile banking, significantly affect poverty alleviation and economic growth. The findings reveal that ATM penetration significantly reduces poverty and enhances GDP growth. Mobile banking also reduces poverty and contributes to economic growth. Threshold analysis shows that ATM access must exceed 36.65 units per 100,000 adults, while mobile penetration must reach 19.13 units to achieve significant impacts. The study emphasises the need for collaborative, sustainable strategies that align with the Sustainable Development Goals to maximise the impact of microfinance on poverty reduction and economic resilience. It recommends investing in digital infrastructure, such as ATMs and mobile banking, to improve accessibility. Policymakers should focus on partnerships, financial literacy programs, and tackling macroeconomic challenges like inflation and unemployment to ensure long-term stability.

1. Introduction

Poverty remains one of Africa's most pervasive and pressing challenges, undermining human development and economic growth. Sub-Saharan Africa (SSA) consistently records the highest global extreme poverty rates. As of 2019, approximately 35.1 % of the population in SSA lived on less than $2.15 per day, significantly higher than South Asia's 8.5 % poverty rate (You et al., 2020). While global extreme poverty declined to 8.4 % during the same period, SSA's progress has been markedly slower. In addition to poverty, income inequality is stark, with 12 of the 20 most unequal countries globally located in Africa (Galal, 2023). The rural population in SSA is particularly disadvantaged, with nearly 50 % living in extreme poverty compared to only 10 % in urban areas. These challenges are compounded by widespread malnutrition, further exacerbating the continent's socioeconomic vulnerabilities (Chen and Ravallion, 2013; Galal, 2023; Vyas-Doorgapersad, 2024).

Amid these persistent challenges, microfinance has emerged as a prominent intervention for poverty alleviation and financial inclusion. Microfinance gained international recognition in the 1970s through pioneers like Bangladesh's Grameen Bank and its founder, Muhammad Yunus, who envisioned it as an anti-poverty instrument targeting those excluded from traditional banking systems (Adams and Raymond, 2008; Bayulgen, 2008; Karim, 2021). Over the decades, the microfinance sector has expanded significantly, aiming to address the financial needs of low-income individuals and communities in rural and urban areas. Unlike traditional banking, microfinance institutions (MFIs) focus on serving clients at the base of the economic pyramid, offering tailored financial products such as microcredit, micro-savings, micro-insurance, and other services. These initiatives empower individuals and communities by facilitating self-employment, managing risk, smoothing consumption, and fostering investment in diverse income-generating activities (Bertoldi et al., 2021; Gupta and Kanungo, 2022).

Microfinance has evolved through three distinct generational shifts. In its early stages, group-based approaches such as Village Savings and Loan Associations (VSLAs) were widely employed to deliver microcredit. These models were instrumental in reaching underserved populations by pooling resources and mitigating the risk of individual defaults (Ksoll et al., 2016; Mwansakilwa et al., 2017). Over time, the sector transitioned to a second generation, characterised by the

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https://doi.org/10.1016/j.jclepro.2025.146135
Received 4 December 2024; Received in revised form 17 June 2025; Accepted 4 July 2025
Available online 7 July 2025

emergence of non-bank MFIs, including non-governmental organisations (NGOs) and credit unions, which offered a broader range of financial products and services. The current third generation marks a digital transformation, with MFIs adopting financial technologies to enhance outreach and efficiency. Many specialised MFIs have also transitioned into commercial banks, blending social missions with profitability to sustain their operations (Mia et al., 2019).

Despite its growing prominence, microfinance remains a subject of considerable debate. Theoretical frameworks explaining its impact on poverty are still evolving. Early theories, such as the "financial systems" approach, posited that access to credit and savings alleviates liquidity constraints, enabling people experiencing poverty to improve their well-being (Madialo, 2022). These theories argued that financial inclusion could empower individuals to invest in productive activities, ultimately alleviating poverty. However, critics have highlighted several challenges, including the high interest rates some MFIs charge, the risk of over-indebtedness, and the uneven distribution of benefits. Moreover, questions persist about whether microfinance effectively promotes sustainable development or inadvertently reinforces existing socioeconomic inequalities (Ouma, 2022).

Modern frameworks, such as the "capital provider" approach, have expanded the understanding of microfinance by emphasising its role in fostering micro-entrepreneurship and managing risk (Zapalska et al., 2017). These frameworks highlight how microfinance empowers marginalised groups, enhances local economies, and promotes socioeconomic resilience. However, they also acknowledge the potential unintended consequences of microfinance on broader development goals, including the risk of dependency or the diversion of resources from other critical areas of development. As a result, there is a critical gap in aligning microfinance initiatives with broader global development priorities, including the United Nations' 2030 Sustainable Development Goals (SDGs). Addressing these gaps is imperative to ensure that microfinance alleviates poverty and contributes meaningfully to sustainable development and inclusive growth.

In Africa, the role of microfinance is particularly significant, given the continent's unique socioeconomic dynamics. Most of the population relies on informal sectors for their livelihoods, where access to formal financial services remains limited. Microfinance has the potential to bridge this gap by providing low-income households with the tools to manage risks, stabilise incomes, and invest in long-term growth opportunities (Kelikume, 2021; Spring 2009; Verhoef, 2001). By addressing these needs, microfinance can play a crucial role in empowering communities to break the cycle of poverty and achieve sustainable development.

Our study focuses on two specific research objectives. First, it examines the effects of microfinance on poverty alleviation and sustainable development, emphasising the moderating role of financial inclusion. This analysis employs the Driscoll-Kraay Fixed Effects and Panel Fixed Effects Regression Models. Second, it aims to determine the threshold level at which the interaction between microfinance and financial inclusion influences sustainable economic development, utilising the Dynamic Panel Threshold (DPT) regression model. As a result, our study contributes to literature by examining the role of microfinance in alleviating poverty in Africa through the lens of financial inclusion from the experiences of ten SSA countries. This study addresses critical gaps in the literature by exploring the mechanisms through which microfinance facilitates poverty alleviation and identifying the challenges that hinder its effectiveness. By doing so, our study provides actionable insights for policymakers, practitioners, and stakeholders seeking to optimise microfinance as a tool for poverty reduction and inclusive growth.

Ultimately, this study aims to align microfinance initiatives with broader development objectives, including financial inclusion, gender empowerment, and economic resilience. By shedding light on the Challenges and successes of microfinance in SSA, the study seeks to inform the design of more effective interventions that can accelerate progress toward achieving the SDGs. In doing so, it highlights the transformative potential of microfinance as a vehicle for sustainable human development and inclusive economic prosperity in Africa. The remainder of this study is structured as follows: Section 2 presents the literature review, Section 3 outlines the materials and methods, Section 4 covers data analysis and interpretation of results, and Section 5 focuses on the conclusion, policy recommendations and suggestions for further studies.

2. Literature review

2.1. Poverty alleviation and sustainable development

Sustainable Development Goal 1, which anchors on "Ending Poverty", is the foundational pillar of the 17 objectives outlined in the 2030 Agenda for Sustainable Development. This goal embodies a historic global commitment to eradicating poverty. It emphasises ensuring access to basic social protections, reducing vulnerability to economic shocks, and eliminating extreme poverty by reducing it to less than 3 % of the global population by 2030 (Ajaj et al., 2024; Kaltenborn, 2017; Leal Filho et al., 2021). Achieving this ambitious target requires tackling the multifaceted nature of poverty, which extends beyond income to include access to healthcare, education, nutrition, financial inclusion, secure ownership rights, and resilience to disasters (Kutty et al., 2020).

The depth and scope of SDG 1 are ambitious, recognising the interconnected relationships between poverty and other factors, including inequality, food security, infrastructure accessibility, and environmental sustainability. These elements underscore the need for inclusive policies that reduce social and economic equity barriers while fostering sustainable development (Kaltenborn, 2017; Leal Filho et al., 2019; Lim et al., 2018). Raub and Martin-Rios (2019) highlight the significance of understanding the systemic inequalities perpetuating poverty, such as limited employment opportunities, susceptibility to discrimination, and weak institutional frameworks.

Monitoring progress toward SDG 1 presents a challenge due to the inherent subjectivity in defining poverty thresholds. While financial measurements remain a critical indicator, they fail to capture the full spectrum of poverty, particularly in regions where systemic challenges exacerbate vulnerability. Purvis et al. (2019) advocate for complementary indicators that measure human development, vulnerability, and individual rights to provide a holistic picture of poverty.

In SSA and parts of Asia, where poverty remains pervasive, efforts to reduce poverty have yielded mixed results. Leal Filho et al. (2019) noted that national poverty reduction strategies must account for local contexts, particularly in developing countries where climate change, agricultural dependency, and weak infrastructure compound poverty. Geraldo and de Souza Pinto (2021) emphasise that climate challenges in these regions exacerbate vulnerabilities, further slowing progress. For example, agriculture, an essential livelihood for millions, is susceptible to climate variability, requiring coordinated interventions to safeguard food security and income stability.

As illustrated in Fig. 1, extreme poverty disproportionately affects African countries. Nations like Nigeria (30.86 %), Niger (41.35 %), Liberia (44.43 %), Mozambique (63.68 %), and South Sudan (76.5 %) represent some of the highest rates of extreme poverty globally (Hassel, 2022). These figures highlight the persistent challenges of eradicating poverty in regions with underdeveloped social safety nets and limited economic opportunities. In stark contrast, countries such as Canada (0.25 %), China (0.09 %), and France (0.02 %) have virtually eradicated extreme poverty, demonstrating the transformative potential of effective social and economic policies. The disparities observed in Fig. 1 emphasise the urgent need for integrated policymaking to tackle poverty's intricate determinants.

Alkhammash et al. (2019) advocate for a multi-sectoral approach that synchronises agriculture, education, healthcare, financial inclusion, and disaster response efforts to build resilience and improve livelihoods.

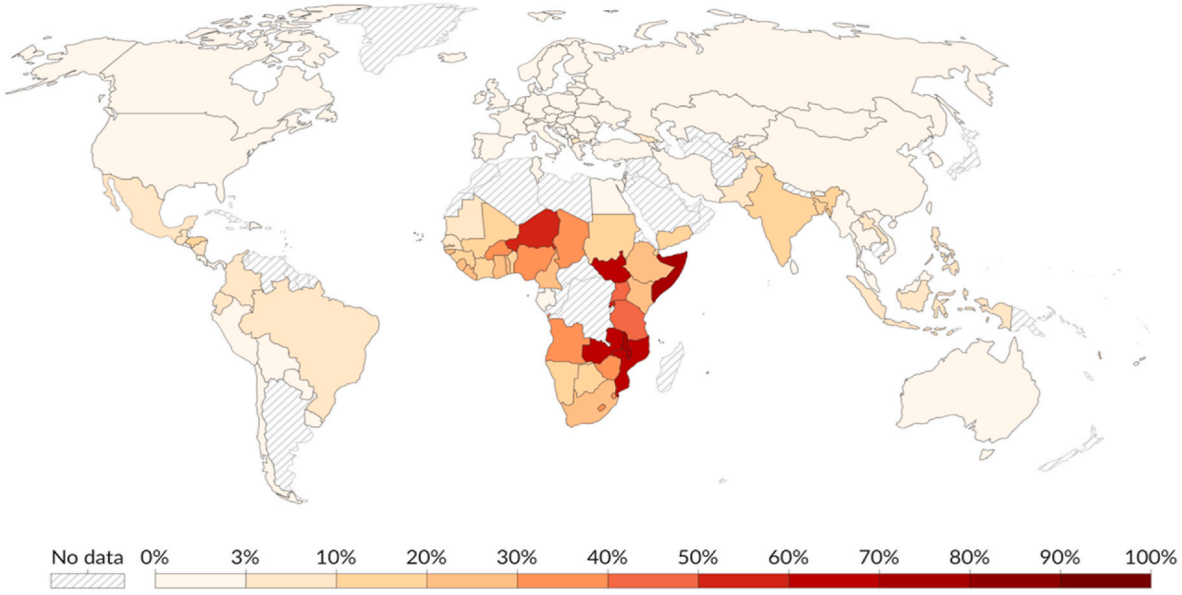

Fig. 1. Global population living in extreme poverty.

For example, social safety programs targeting the most vulnerable groups and sustained investments in infrastructure, education, and job creation are essential for fostering long-term poverty reduction. Despite the challenges, progress is achievable with a commitment to integrated and inclusive development policies. Poverty alleviation strategies must prioritise the most vulnerable populations, ensuring equitable access to resources and opportunities. Furthermore, aligning microfinance and financial inclusion efforts with the SDG 1 agenda can accelerate progress by empowering low-income individuals to escape poverty traps.

2.2. Challenges and successes of microfinance in SSA

Microfinance has emerged as a transformative tool for poverty alleviation and economic empowerment in SSA (Babalola et al., 2023). By providing financial services to low-income individuals and small businesses, microfinance has contributed to increased financial inclusion and socioeconomic development. Despite its potential, the sector faces significant challenges that limit its ability to achieve full impact, even as it records notable successes.

2.2.1. Challenges of microfinance in SSA

One of the foremost challenges MFIs encounter in SSA is infrastructural deficits, which drive up operational costs and limit outreach. Many rural areas lack reliable electricity, transportation networks, and communication systems, making setting up and maintaining microfinance operations expensive (Madialo, 2022; Parikh, 2006). These deficiencies hinder the expansion of agent banking and the adoption of digital financial platforms, which are crucial for scaling financial inclusion. Another pressing issue is the limited availability of credit information systems. The lack of well-developed credit bureaus prevents MFIs from accurately assessing the creditworthiness of clients, increasing the risk of loan defaults. Institutions face difficulty managing credit risks and maintaining portfolio quality without reliable data.

Capacity gaps in human capital and institutional capabilities further compound these issues. Many MFIs face skill shortages in essential areas such as client engagement, credit analysis, and financial management (Ouma, 2022). These deficits impair the ability to deliver quality services, monitor portfolios effectively, and foster client trust. The microfinance sector in SSA also struggles with narrow product offerings due to resource constraints. Many MFIs focus almost exclusively on credit products, leaving significant demand for savings, insurance, and other financial services unmet. This inability to diversify product lines limits the sector's ability to cater to the varied needs of low-income populations (Nguyen, 2020).

2.2.2. Successes of microfinance in SSA

Despite the challenges of MFIs highlighted in section 2.2.1, microfinance has made significant strides in advancing financial inclusion across SSA. The sector has reached millions of unbanked individuals, enabling them to access credit, build savings, and invest in income-generating activities (Sengupta et al., 2024). Women have benefited from microfinance programs, gaining greater economic independence and improved livelihoods (Neogi et al., 2017; Sudan, 2007; Tariq and Sangmi, 2020; Vachya, 2015). Microfinance has also supported the growth of small and micro-enterprises, fostering job creation and community development (Babajide, 2012; Ojong and Simba, 2019; Vargas, 2000). Microfinance institutions have contributed to local economic growth and resilience by providing entrepreneurs with capital (Iyengar et al., 2021; Ngoasong and Kimbu, 2016; Soumaré et al., 2020).

Technological innovations have further boosted the sector's outreach where digital inclusive finance enhances access to affordable financial resources by reducing financing barriers and expanding fund availability (Niu et al., 2025). Mobile money platforms and digital banking solutions have enabled MFIs to serve remote and underserved areas more efficiently. For instance, countries like Kenya and Uganda have successfully integrated mobile financial services with microfinance operations, significantly reducing transaction costs and improving accessibility. Efforts to strengthen governance and institutional capacity yield positive outcomes in some regions. Sector-wide consolidation exercises, such as Nigeria's 2009 microfinance reforms, have improved regulatory compliance and enhanced the financial stability of MFIs (Gupta and Kanungo, 2022). Moreover, partnerships with NGOs, government agencies, and international development organisations have enabled MFIs to leverage resources and scale their impact (Sievers and Vandenberg, 2007).

2.3. Theoretical review

Our study anchored on the financial intermediation theory propounded by (Gurley and Shaw, 1956). The theory provides a foundational explanation for how financial institutions, particularly MFIs, facilitate financial inclusion by bridging the gap between surplus and

deficit economic agents. The theory posits that intermediaries exist to reduce transaction costs, mitigate risks, and address information asymmetries between lenders and borrowers (Gurley, 1960; Scholtens and Van Wensveen, 2003). In SSA, financial exclusion remains a significant barrier to economic participation, especially among low-income individuals, women, and rural populations. Traditional financial institutions often view these groups as high-risk due to a lack of collateral, credit history, and formal employment. This is where MFIs, acting as financial intermediaries, play a transformative role by designing products tailored to the needs of the excluded and vulnerable (Stiglitz and Weiss, 1981).

Microfinance institutions promote financial inclusion by offering accessible credit, savings, and other financial services that empower disadvantaged populations to participate in economic activities (Egharevba et al., 2016; Lal, 2021). Through group lending, social collateral, and flexible repayment systems, MFIs reduce the barriers to entry into formal finance and support entrepreneurship, particularly among women (Armendáriz and Morduch, 2010). In doing so, they enhance clients' capacity to generate income, accumulate assets, and improve household welfare, which are key financial inclusion indicators. The relevance of this theory to the study lies in its alignment with our study's objective. As intermediaries, MFIs provide financial services, stimulate inclusive growth, and reduce poverty.

2.4. Empirical review

2.4.1. Empirical insights on the impact of microfinance across diverse countries

Empirical studies have explored the diverse impacts of microfinance on various facets of economic development, particularly in low and middle-income countries. For instance, Abebe and Kegne (2023) investigated the effects of microfinance on sustainable development in Nigeria. Using a descriptive survey approach, they collected data from 200 MFI clients across five states. The study found that microcredit improved entrepreneurial skills, livelihood diversification, and poverty reduction. Abebe and Kegne (2023) recommended strengthening programs that link microfinance to micro and small businesses.

Similarly, Hambolu (2021) evaluated the impact of microcredit on women's empowerment in Nigeria. A sample of 180 women from three financial institutions in South-West Nigeria was selected using a multistage sampling process. Structured interviews revealed that microcredit significantly increased women's income levels, socioeconomic engagement, and decision-making power, ultimately reducing gender disparities. Kehinde and Ogundeji (2022) focused on the productivity of smallholder female farmers in South-Western Nigeria. Analysing survey data from 220 farmers, their regression analysis showed that microloans increased agricultural output by 31 %, alongside income levels and crop diversity improvements. Expanding microfinance outreach to rural women was recommended to enhance agricultural productivity and address food shortages.

Feeny et al. (2021) adopted mixed methods to assess poverty reduction progress in Africa across seven nations. Employing focus groups and nationally representative surveys, they found that education levels, weather shocks, and urbanisation patterns influenced poverty reduction. They concluded that more inclusive economic development was necessary to reduce poverty effectively. Neglo et al. (2021) analysed survey data on 430 agricultural households using multinomial and probit regression in Sri Lanka. The study found that asset poverty, subsistence livelihoods, and long distances to facilities limited loan acceptance. They recommended modifying loan conditions and outreach strategies to better support rural, credit-constrained populations.

Elimuu (2019) investigated women's access to microfinance in Tanzania, interviewing 150 female entrepreneurs and stakeholders. Findings revealed that financial awareness deficits, strict collateral requirements, and gender stereotypes hindered women's participation in credit markets. The study suggested culturally sensitive loan policies and financial literacy programs to address these barriers. Herbohn et al. (2019) examined loan market performance in Thailand using panel data. Their theoretical analysis highlighted the vulnerability of shared responsibility, as it encouraged risky borrowing behaviour. However, mechanisms such as penalty threats and reputational repercussions enhanced repayment rates. The study emphasised the importance of careful loan screening and well-designed group structures.

Titumir (2021) compared the effects of microcredit programs in Bangladesh, India, and Thailand. Survey results indicated that microcredit improved incomes and productive assets in all three countries, with the most significant impacts observed in Bangladesh. This was attributed to institutional characteristics tailored to local economic conditions, such as extended loan sequences and increased child schooling.

2.4.2. Financial inclusion and poverty alleviation across diverse countries

Financial inclusion has been widely studied as a tool for poverty alleviation, with significant evidence of its impact on poverty reduction across diverse contexts. Omar and Inaba (2020) examined financial inclusion's influence on poverty in 116 developing countries from 2004 to 2016. Using unbalanced panel data, their findings revealed that financial inclusion significantly alleviated poverty and inequalities in these nations. Park and Mercado (2021) conducted a cross-country study of 151 countries, finding that financial inclusion significantly reduced poverty and promoted economic growth in high- and middle-income economies. However, its impact on inequality was inconclusive. In Ghana, Koomson et al. (2020) used survey data from 2016 to 2017 and three-stage least squares to analyse the impact of financial inclusion on poverty and vulnerability. Their findings showed that increased financial inclusion reduced households' likelihood of poverty and enhanced resilience against future shocks.

Financial inclusion in SSA remains a persistent developmental challenge due to inadequate infrastructure, regulatory constraints, and socioeconomic disparities that hinder access to essential financial services for underserved populations (Mhlanga, 2025; Osabutey and Jackson, 2024; Osuma, 2025). In addressing these barriers, Osuma (2025) examined the relationship between financial inclusion, economic growth, and poverty reduction across 28 countries in East, West, and Southern Africa from 2016 to 2023. The study employed a System Generalised Method of Moments (GMM) and Quantile Regression approach, using the availability of Automated Teller Machines (ATMs) and digital financial services as proxies for financial inclusion. The findings revealed that digital financial services significantly improved access to finance in East and Southern Africa, while disparities remained prevalent in West Africa. Importantly, digital financial services were more impactful than ATMs in fostering financial inclusion. Additionally, the quantile regression results showed that inflation negatively affected GDP growth across all quantiles, whereas foreign direct investment had a consistent positive influence. The study concluded that expanding digital financial services and investments in infrastructure and financial literacy is vital for enhancing financial inclusion and achieving inclusive economic growth in SSA.

Khan et al. (2022) explored financial inclusion across 54 African countries from 2001 to 2019, employing multiple regression methods. Their results indicated that financial inclusion reduced poverty, lowered income inequality, and improved financial stability. Using static and dynamic panel estimation methods, Saha and Qin (2023) analysed data from 156 countries between 2004 and 2019. Their findings concluded that financial inclusion significantly impacted poverty reduction in developing economies but was less effective in developed countries, where inclusion levels were already high.

Polloni-Silva et al. (2021) examined the role of financial inclusion in reducing poverty and inequality in 13 South American nations. Using Limited Information Maximum Likelihood (LIML) and Feasible Generalised Least Squares (FGLS), the study highlighted the importance of

integrating technology, such as mobile banking, into financial inclusion efforts. Churchill and Marisetty (2020) assessed 45,000 Indian households using the poverty probability index. Their study found that financial inclusion significantly reduced poverty rates and recommended its promotion across India. In Zimbabwe, Mhlanga et al. (2020) demonstrated that financial inclusion significantly alleviated poverty among farmers. Their findings emphasised the importance of savings, insurance, and borrowing transactions for improving farmers' financial resilience.

Dogan et al. (2022) used a two-stage least squares regression to evaluate the impact of financial inclusion on 11,595 Turkish households. The result of their study showed that financial inclusion significantly reduced poverty levels. Nsiah et al. (2021) employed the difference Generalised methods of moment (GMM) and Hansen's estimation to study financial inclusion in SSA between 2010 and 2017. They found that financial inclusion significantly reduced poverty rates in the region. Inoue (2019) analysed the effects of financial inclusion in India from 1973 to 2004 using GMM. Results indicated an inverse relationship between financial inclusion and poverty, suggesting that financial inclusion effectively reduces poverty. Hussaini and Chibuzo (2018) focused on Nigeria, using partial least squares (PLS) and structural equation modelling (SEM) to analyse survey data from 384 respondents. Their findings confirmed that financial inclusion significantly alleviates poverty. The summary of empirical review is seen in Table 1.

Unlike prior research that often examines digital financial inclusion and microfinance in isolation, this study adopts an integrated approach by combining digital inclusive finance, financial intermediation theory, and dynamic threshold analysis to explore their joint impact on poverty alleviation in SSA. By applying the Dynamic Panel Threshold (DPT) model, the study captures the nonlinear and context-specific effects of digital financial access proxied by ATM and mobile banking penetration on poverty reduction and economic growth. This methodological innovation enables the identification of critical thresholds beyond which financial infrastructure significantly enhances microfinance outcomes. Moreover, our study conducted a disaggregated fixed effects analysis across SSA sub-regions (West and East Africa), revealing significant heterogeneities.

Table 1
Summary of empirical review.

No	Author(s)	Location	Time frame	Estimators	Result
1	Inoue (2019)	India	1973–2004	GMM	Negative
2	Hussaini and Chibuzo (2018)	Nigeria	Single year (Survey)	PLS & SEM	Negative
3	Dogan et al. (2022)	Turkey	Single year (Survey)	Two Stage least square	Negative
4	Nsiah et al. (2021)	Sub-saharan Africa	2010–2017	GMM	Negative
5	Mhlanga et al. (2020)	Zimbabwe	Single year (Survey)	OLS	Negative
6	Park and Mercado (2021)	151 countries	Single year (Survey)	OLS	Negative
7	Polloni-Silva et al. (2021)	13 South American Nations	2004–2017	FGLS & LIML	Negative
8	Churchill and Marisetty (2020)	India	Poverty probability index Data	OLS	Negative
9	Saha and Qin (2023)	156 Nations	2004–2019	Dynamic panel estimation methods	Negative
10	Koomson et al. (2020)	Ghana	Survey of 2016 & 2017	Three-stage feasible least square	Negative
11	Osuma (2025)	28 SSA Countries across East, West and Southern Africa	2016–2023	System GMM and Quantile Regression	Negative
12	Khan et al. (2022)	54 African Nations	2001–2019	Multiple regression/	Negative
13	Omar and Inaba (2020)	116 nations	2004–2016	Panel data Regression	Negative

Source: Authors Compilation (2024).

3. Materials and methods

3.1. Data and variable description

Our study relies on annual data to examine the impact of microfinance and financial inclusion on poverty alleviation, focusing on its potential to drive sustainable development in 10 SSA countries (see Table A in the appendix section). It also explores the influence of key macroeconomic variables on this relationship. Due to data limitations, the analysis covers 24 years, from 2000 to 2023. The study incorporates control variables such as Foreign Direct Investment (FDI), inflation rate (INFLA), labour force participation (LABOUR), and unemployment rate (UNEMPLOY) to understand the financial inclusion-poverty alleviation nexus in SSA comprehensively. These control variables were included to ensure the broader economic dynamics influencing the relationship are thoroughly examined for more accurate and robust findings.

Following Ngong et al. (2022), this paper expands on the discourse on Microfinance, financial inclusion and poverty alleviation by incorporating 10 SSA countries. Our study also considered commonly adopted proxies for poverty alleviation and sustainable development, which are the poverty rate (PR) and the GDP growth rate (GDPGR). To capture the influence of microfinance and financial inclusion, two independent variables were adopted: the availability of ATMs, otherwise known as ATMs per 100,000 adults and mobile money. These independent variables reflect financial inclusion by improving access to financial services, especially in underserved areas. They enhance microfinance by enabling convenient transactions, reducing barriers, and fostering broader participation in the formal financial system (Lenka and Bairwa, 2016; Lopez and Winkler, 2018; Neaime and Gaysset, 2018). Table 2 shows the description of the variables adopted in this study.

3.2. Model estimation

3.2.1. Restatement of research objectives

Our study seeks to address two key research objectives. Firstly, our paper aims to investigate the effects of microfinance on poverty alleviation and sustainable development using the moderating role of financial inclusion, adopting the Discroll-Kraay Fixed Effects and the Panel Fixed Effect Regression model. Secondly, using the DPT regression model, our paper seeks to establish the threshold level at which microfinance-financial inclusion impacts poverty alleviation and sustainable economic development.

3.2.2. Impact of microfinance-financial inclusion on poverty alleviation and sustainable development

Based on the first research objective of this study, our paper investigates the effects of microfinance on poverty alleviation and sustainable development using the moderating role of financial inclusion. Therefore, PR and GDPGR are used as proxies for poverty alleviation and sustainable development, respectively, as the dependent variables. Following the works of (Aluko et al., 2023; Maket, 2024), which explored panel analysis, our study estimates objective one using the following econometric model in equations (1) and (2).

$$PR_{it} = \beta_0 + \beta_1 ATM_{it} + \beta_2 UNEMPLOY_{it} + \beta_3 MOBILE_{it} + \beta_4 INFLA_{it} + \beta_5 FDI_{it} + \beta_6 LABOUR_{it} + \delta_i + \theta_t + \epsilon_{it} \quad (1)$$

Table 2
Variable description.

Variable	Identifier	Description	Measurement/Definition	Source
Dependent	PR	Poverty Rate	Percentage of the population living below the national poverty line (or $1.90/day)	TheGlobalEconomy.com
	GDPGR	GDP Growth Rate	Annual percentage growth rate of GDP at market prices based on constant local currency	WDI
Independent	ATM	ATM Availability	Number of ATMs per 100,000 adults, indicating physical access to financial services	TheGlobalEconomy.com
	MOBILE	Mobile Service Availability	Percentage of population with access to mobile phone services; proxy for digital financial access potential	TheGlobalEconomy.com
Control	FDI	Foreign Direct Investment	Net inflows of investment to acquire a lasting interest in enterprises operating in an economy other than that of the investor (% of GDP)	WDI
	INFLA	Inflation Rate	Annual percentage change in consumer prices (CPI)	WDI
	LABOUR	Labour Force Participation	The proportion of the working-age population that is economically active, including employed and actively seeking employment (%)	WDI
	UNEMPLOY	Unemployment Rate	Percentage of the total labour force that is unemployed but actively seeking employment and willing to work	TheGlobalEconomy.com

Source: Author's Synthesis (2024).

$$GDPGR_{it} = \beta_0 + \beta_1 ATM_{it} + \beta_2 UNEMPLOY_{it} + \beta_3 MOBILE_{it} + \beta_4 INFLA_{it} + \beta_5 FDI_{it} + \beta_6 LABOUR_{it} + \delta_i + \theta_t + \epsilon_{it} \quad (2)$$

Where i denotes the panel of 10 selected SSA countries, t denotes the sample period from 2000 through 2023. β_0 is the constant, δ_i and θ_t denotes the country and time-fixed effects. ϵ_{it} indicates the error term.

3.2.3. Estimating the moderating factors

Poverty is a complex and multifaceted issue that transcends the lack of financial resources (Ihemeje et al., 2014). It encompasses various dimensions, including limited access to essential services, social exclusion, and lack of employment opportunities (Ihemeje et al., 2014). Financial inclusion and accessibility to banking and microfinance services, mainly through ATMs, have been widely recognised as crucial factors in driving poverty alleviation and sustainable development (Coulibaly and Yogo, 2018; Ihemeje et al., 2014). The extant literature highlights the pivotal role of financial inclusion in empowering people experiencing poverty and unlocking their productive capacities. Studies have shown that improved access to financial services, such as micro-savings and mobile banking, can enable people experiencing poverty to invest in their future, participate in economic activities, and ultimately improve their standard of living (Muchandigona and Kalema, 2023).

Furthermore, research has indicated that increasing the number of bank branches and ATMs can reduce poverty and income inequality in developing countries (Coulibaly and Yogo, 2018). Interestingly, the relationship between financial access and poverty alleviation is not straightforward. The moderating effect of LABOUR in this dynamic is a crucial consideration. Increased LABOUR, facilitated by greater financial inclusion, can enhance the ability of the poor to engage in productive activities, generate income, and ultimately escape the cycle of poverty. Therefore, our study estimates the moderating role of ATM and LABOUR in equations (3) and (4), respectively.

$$PR_{it} = \beta_0 + \beta_1 ATM_{it} + \beta_2 UNEMPLOY_{it} + \beta_3 MOBILE_{it} + \beta_4 INFLA_{it} + \beta_5 FDI_{it} + \beta_6 LABOUR_{it} + \beta_7 (ATM \times LABOUR)_{it} + \delta_i + \theta_t + \epsilon_{it} \quad (3)$$

$$GDPGR_{it} = \beta_0 + \beta_1 ATM_{it} + \beta_2 UNEMPLOY_{it} + \beta_3 MOBILE_{it} + \beta_4 INFLA_{it} + \beta_5 FDI_{it} + \beta_6 LABOUR_{it} + \beta_7 (ATM \times LABOUR)_{it} + \delta_i + \theta_t + \epsilon_{it} \quad (4)$$

3.2.4. Dynamic panel threshold analysis

Given the diverse socioeconomic conditions across SSA countries, the impact of microfinance and financial inclusion on poverty alleviation may vary significantly at different levels of financial inclusion. Our study provides actionable insights for policymakers, practitioners, and stakeholders seeking to optimise microfinance as a tool for poverty reduction and inclusive growth, offering evidence-based guidance on leveraging financial inclusion to maximise the role of microfinance in fostering sustainable development across the region. Therefore, our study applied the DPT model with fixed effects as used by (Horvey and Odei-Mensah, 2024; Maket, 2024).

The DPT model with fixed effects is relevant to this study as it identifies non-linear relationships and threshold effects, capturing the varying impact of microfinance and financial inclusion on poverty alleviation and sustainable development across diverse SSA contexts. As applied by Horvey and Odei-Mensah (2024) and Maket (2024), our study adopted the DPT model to examine non-linear relationships and threshold effects in the data. Moreover, it shows the potential impact of the threshold variable when it falls below or exceeds the estimated threshold value, while also illustrating the confidence intervals and bootstrap significance levels (Lee et al., 2024). The DPT model is estimated in equation (5).

$$y_{it} = x_{it}'\beta + (1, x_{it}')\delta 1(q_{it} > \gamma) + \mu_i + \epsilon_{it}\ i, \ldots, N; t = 1, \ldots, T \quad (5)$$

Where y_{it} is the dependent variable (PR and GDPGR) for country i at time t; q_{it} is the threshold variable (ATM and MOBILE) and x_{it}' connotes the lagged dependent variables. Time T is fixed, and the cross-sectional unit N grows independently (Maket, 2024). In determining the threshold values of ATM and MOBILE, the model is re-specified in equations (6) and (7).

$$PR_{it} = \begin{cases} \propto_1 PR_{it-1} + \varnothing_{11} ATM_{it} + \varnothing_{12} MOBILE_{it} + \varnothing_{13} Controls + \mu_i + \epsilon_{it} \text{ if } ATM_{it} \leq \gamma \\ \propto_2 PR_{it-1} + \varnothing_{21} ATM_{it} + \varnothing_{22} MOBILE_{it} + \varnothing_{23} Controls + \mu_i + \epsilon_{it} \quad \text{if } ATM_{it} \leq \gamma \end{cases} \quad (6)$$

$$GDPGR_{it} = \begin{cases} \propto_1 GDPGR_{it-1} + \varnothing_{11} ATM_{it} + \varnothing_{12} MOBILE_{it} + \varnothing_{13} Controls + \mu_i + \epsilon_{it} \text{ if } MOBILE_{it} \leq \gamma \\ \propto_2 GDPGR_{it-1} + \varnothing_{21} ATM_{it} + \varnothing_{22} MOBILE_{it} + \varnothing_{23} Controls + \mu_i + \epsilon_{it} \quad \text{if } MOBILE_{it} \leq \gamma \end{cases} \tag{7}$$

Where i denotes the panel of 10 selected SSA countries, t denotes the sample period, which spanned from 2000 through 2023. q_{it} is the threshold variable consisting of ATM_{it} and $MOBILE_{it}$ and γ denote the parameter of the model threshold that splits the coefficient estimates into regimes.

Based on equations (6) and (7), the use of ATM and MOBILE penetration as threshold variables in the DPT model is theoretically grounded in their central role in facilitating access to digital financial services. Mobile phone penetration has emerged as a transformative tool for delivering financial products to underserved populations, enabling real-time access to savings, credit, and payment systems regardless of physical location (Chu, 2018; Osuma, 2025; Zanden & Jan 2023). Similarly, ATMs extend the reach of financial institutions by providing convenient, self-service access to cash and account management tools, particularly in semi-urban and rural areas (David-West et al., 2018; Mukherjee and Gaur, 2024). These channels represent key elements of the digital financial infrastructure that influence how effectively individuals engage with microfinance services. This aligns with the Financial Intermediation Theory, which emphasises the role of financial institutions and technologies in reducing transaction costs and bridging the gap between savers and borrowers. As such, ATM and MOBILE penetration can serve as indicators of a functional and inclusive financial system, determining whether digital microfinance has a meaningful impact on financial inclusion and broader development outcomes.

4. data analysis and result interpretation

4.1. Summary statistics and multicollinearity test

As seen in Table 3, the descriptive statistics summarise the key variables, revealing insights into the economic and social dynamics. PR has a mean of 43.054, indicating significant poverty across SSA, with a moderate range from 36.7 to 56. ATM averages 10.491 but shows high variability (Std. Dev. 14.322), reflecting unequal financial infrastructure distribution across SSA. MOBILE penetration, averaging 27.511, indicates significant variability ranging from 1.967 to 143.271, suggesting disparities in digital access critical for financial inclusion. FDI has a low mean of 2.409 with negative values, indicating inconsistent foreign investments' role in the economic growth of SSA. GDPGR averages 4.986, indicating moderate economic performance across the sampled SSA countries. Table 3 shows that INFLA highlights macroeconomic instability with a mean of 12.008 and extreme volatility (max: 324.997). LABOUR, averaging 5.69 million, and UNEMPLOY, reaching a maximum of 28.8 %, reflect varying labour market conditions, which indicate high joblessness, potentially driven by insufficient job creation, skill mismatches, or structural labour market challenges.

It is essential to ensure that no multicollinearity amongst the independent variables exists to avoid the spuriousness of our results. Therefore, our study estimated the variance inflation factor (VIF) test in Table 4 to assess the incidence of multicollinearity in the models. The rule of thumb for the VIF suggests that values above 10 indicate severe multicollinearity in the models (Osuma et al., 2024; Osuma and Nzimande, 2024). As seen in Table 4, all model 1 (PR) and model 2 (GDPGR) variables have VIF values below 5, suggesting low/no multicollinearity in the model. Specifically, ATM and UNEMPLOY have the highest VIF values at 4.307 and 3.675, respectively, indicating a moderate correlation with other variables. However, these values are within the acceptable rule of thumb, meaning their inclusion does not pose a significant multicollinearity issue. Other variables in the model exhibit lower VIF values, implying minimal correlation with other predictors. The mean VIF of 2.256 indicates that both models are robust for inference, and standard econometric methods can be confidently applied. Also, the results of the correlation matrix agree with the VIF as none of the variables has a correlation above 80 % (see Tables B and C in the appendix section).

Table 4
Variance inflation factor.

Variables	PR (Model 1)		GDPGR (Model 2)	
	VIF	1/VIF	VIF	1/VIF
ATM	4.307	0.232	4.307	0.232
UNEMPLOY	3.675	0.272	3.675	0.272
MOBILE	1.676	0.597	1.676	0.597
INFLA	1.475	0.678	1.475	0.678
FDI	1.241	0.806	1.241	0.806
LABOUR	1.163	0.86	1.163	0.86
Mean VIF	2.256	.	2.256	.

Source: Author's Extraction from Stata Output (2024).

Table 5
Cross-sectional dependence.

Variables	CD-test	p-value
PR	32.863	0.000
GDPGR	6.325	0.000
ATM	17.14	0.000
MOBILE	23.091	0.000
FDI	−1.498	0.134
INFLA	6.231	0.000
LABOUR	2.169	0.030
UNEMPLOY	−0.511	0.609

Notes: Under the null hypothesis of cross-section independence, CD ~ N(0,1), P-values close to zero indicate data are correlated across panel groups.

Table 3
Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
PR	240	43.054	6.577	36.7	56
ATM	234	10.491	14.322	0.02	68.96
MOBILE	240	27.511	25.262	1.967	143.271
FDI	240	2.409	3.403	−10.038	24.009
GDPGR	240	4.986	3.56	−5.963	15.329
INFLA	240	12.008	25.319	−8.238	324.997
LABOUR	240	5687558.7	17381424	45.49	75734592
UNEMPLOY	240	6.812	6.633	1.896	28.838

Table 6
Panel unit root test.

Variables	CIPS		PESCADF	
	Level	1st difference	Level	1st difference
PR	2.610	−2.610**	1.000	0.000**
GDPGR	−3.367**	−5.940**	0.043**	0.000**
ATM	N/A	N/A	0.633	0.000**
MOBILE	−2.805**	−5.859**	0.767	0.000**
FDI	−1.980	−4.712**	0.913	0.001**
INFLA	−3.456**	−4.871**	0.256	0.022**
LABOUR	−0.905	−2.263*	0.999	0.000**
UNEMPLOY	−1.287	−3.302**	0.994	0.000**

Notes: *p < 0.1; **p < 0.05; ***p < 0.01.

4.2. Cross-sectional dependence and panel unit root test

Table 5 presents the Cross-sectional dependence test results to determine whether variables are correlated across panel groups. A significant p-value (less than 0.05) rejects the null hypothesis of cross-sectional independence. The PR, GDPGR, ATM, MOBILE, INFLA, and LABOUR show significant cross-sectional dependence, with p-values of 0.000 (except LABOUR at 0.030). This indicates that these variables exhibit interconnectedness across panel groups, possibly due to shared economic, institutional, or structural factors. However, FDI and UNEMPLOY have non-significant p-values at 0.134 and 0.609, respectively, suggesting they are cross-sectionally independent. This could imply that these variables are more localised or less influenced by external shocks and regional dependencies.

Empirically, significant cross-sectional dependence warrants advanced estimation techniques like the Cross-Sectionally Augmented IPS test (CIPS) and Pesaran Cross-Sectionally Augmented Dickey-Fuller test (PESCADF) to address cross-sectional dependence in unit root testing by accounting for unobserved common factors (Pesaran, 2007). Also, the Driscoll-Kraay Fixed Effects Estimator was estimated to ensure a reliable baseline result, as it adjusts standard errors for cross-sectional correlation, autocorrelation and heteroskedasticity (Maket, 2024). From Table 6, the panel unit root test confirms stationarity at first differences for most variables, justifying advanced techniques to address cross-sectional dependence. Therefore, the null hypothesis is rejected for all variables at the first difference.

4.3. Effects of microfinance and financial inclusion on poverty alleviation and sustainable development

Our study applied the Discroll-Kraay Fixed Effect model to estimate the benchmark regression and analyse the effect of microfinance and financial inclusion on poverty alleviation and sustainable development as estimated in equations (1) and (2) of Table 7. Furthermore, the Driscoll-Kraay fixed effects model was estimated to address potential heteroskedasticity, autocorrelation, and cross-sectional dependence, which are common in panel datasets with country-level variables. Table 7 shows that the Driscoll-Kraay fixed effects results provide critical insights into the economic determinants of PR and GDPGR across the SSA countries. In the PR model in column 1, ATM significantly reduces poverty by 0.495, highlighting the role of financial inclusion. Greater ATM access facilitates improved access to financial services, enabling savings, credit, and smoother consumption, which can uplift low-income households. Similarly, MOBILE penetration reduces poverty by 0.093, reflecting the transformative impact of digital technology on financial inclusion and access to information, which enhance income opportunities.

Conversely, INFLA increases poverty by 0.031, as rising prices erode household purchasing power, disproportionately affecting people experiencing poverty. LABOUR's small and significant effect on poverty reflects the scaling effect of a large population with low productivity. The insignificant positive impact of UNEMPLOY suggests structural unemployment does not immediately translate into higher poverty.

From the GDPGR model in column 2 of Table 7, MOBILE penetration positively drives GDP growth by improving resource allocation, productivity, and market participation by 0.018. Inflation undermines growth by distorting investment and consumption decisions by 0.017. Similarly, unemployment lowers growth by reducing aggregate demand and labour market efficiency by 0.238.

Table 7
Discroll-Kraay fixed effects baseline results.

Variables	PR	GDPGR
	(1)	(2)
ATM	−0.495***(0.096)	−0.163***(0.039)
MOBILE	−0.093**(0.033)	0.018**(0.006)
FDI	−0.060(0.041)	0.125(0.079)
INFLA	0.031***(0.009)	−0.017*(0.009)
LABOUR	−0.000***(0.000)	−0.000**(0.000)
UNEMPLOY	0.293(0.410)	−0.238**(0.093)
Constant	50.303***(1.913)	8.770**(0.883)
F(6, 23)	142.27***	11.23***
Country/Time FE	No	No
Number of Observations	234	234
Number of groups (Countries)	10	10

Notes: Standard errors are in parentheses, ***p < 0.01; **p < 0.05; *p < 0.10.

4.3.1. The moderating effect of ATM in the relationship between LABOUR and poverty alleviation for sustainable development

As expressed in equations (3) and (4), Table 8 presents the moderating relationship between ATM and LABOUR for PR and GDPGR in columns 1 and 3, respectively. From the result, ATM negatively affects PR and GDPGR, indicating inefficiencies in ATM penetration for financial inclusion. LABOUR also has a negative effect on both outcomes. The moderating relationship between the two models implies that ATM usage becomes less effective as LABOUR inefficiencies increase. Economically, these findings highlight that financial infrastructure investments like ATMs may fail to drive meaningful poverty reduction or

Table 8
Discroll-Kraay moderating results.

Variables	PR		GDPGR	
	(1)	(2)	(3)	(4)
ATM		−0.569***		−0.166***
		(0.106)		(0.042)
MOBILE	−0.137**		0.011	
	(0.051)		(0.009)	
FDI	0.163**		0.197*	
	(0.058)		(0.098)	
INFLA	0.041***		−0.013	
	(0.011)		(0.010)	
LABOUR		−0.000***		−0.000**
		(0.000)		(0.000)
ATM × LABOUR	−0.000***		−0.000***	
	(0.000)		(0.000)	
UNEMPLOY	0.000		−0.443***	
	(0.213)		(0.123)	
Constant	48.994***	50.670***	8.646***	7.832***
	(2.396)	(2.294)	(1.366)	(0.600)
F(5, 23)	43.35***		9.04***	
F(2, 23)		30.37***		14.97***
Country/Time FE	No	No	No	No
Control	Yes	No	Yes	No
R-squared	0.2845	0.3648	0.1337	0.1628
Number of Observations	240	234	240	234
Number of groups (Countries)	10	10	10	10

Notes: Standard errors are in parentheses, ***p < 0.01; **p < 0.05; *p < 0.10.

Table 9
Threshold estimate for ATM and MOBILE.

Model 1: PR	Threshold	Lower	Upper	F-statistics	P-value
Threshold ATM	36.6478	35.1777	40.7021	42.35	0.0067
Threshold MOBILE	19.1300	18.9900	24.6100	19.67	0.0033
Model 2: GDPGR	Threshold	Lower	Upper	F-statistics	P-value
Threshold ATM	8.0700	5.8392	8.1110	8.14	0.0067
Threshold MOBILE	19.1300	18.9900	24.6100	19.67	0.0033

Source: Authors Compilation (2024).

Table 10
Dynamic panel threshold model results.

Variables	PR		GDPGR	
	(1)	(2)	(3)	(4)
ATM(0)	−1.0913**		−0.4193**	
	(0.0919)		(0.0573)	
ATM(1)	−0.2959**		−0.1107**	
	(0.0615)		(0.0384)	
MOBILE(0)		−0.5048**		0.4382**
		(0.0622)		(0.1414)
MOBILE(1)		−0.1693**		0.0296**
		(0.0192)		(0.0105)
Constant	52.9982**	56.7090**	6.9779**	5.9372**
	(0.7081)	(1.0411)	(0.4421)	(0.4617)
Country/Time FE	No	No	No	No
Number of Observations	240	240	240	240
Bootstrap p-value	0.0000	0.0000	0.0000	0.0000

Notes: Standard errors are in parentheses, ***p < 0.01; **p < 0.05; *p < 0.10.

economic growth without productive labour. These findings align with the studies of (Iqbal and Sami, 2017; Liu et al., 2022).

4.3.2. Dynamic panel threshold analysis results

The DPT regression in Table 9 reveals that ATM and MOBILE services have distinct threshold levels for influencing poverty reduction and economic growth. For Model 1, the ATM threshold is 36.65, indicating that ATM penetration above this level is necessary to significantly reduce poverty significantly, likely by enhancing access to formal financial services and improving financial inclusion (Nsiah et al., 2021). The MOBILE threshold is 19.13, underscoring mobile services' role in poverty alleviation by providing low-cost, accessible financial solutions to underserved populations. This aligns with the study of Seck et al. (2017), who argued that access to finance through financial inclusion helps the poor, who spend much of their income on consumption, to grow their businesses, support their children's education, and cover medical expenses, increasing their chances of escaping poverty. From Model 2, the ATM threshold is lower at 8.07, reflecting its initial contribution to infrastructure-driven growth. While MOBILE's consistent threshold at 19.13 highlights its enduring relevance in driving economic activities.

The dynamic panel threshold model's results in Table 10 indicate that ATM and MOBILE services significantly impact PR and GDPGR. In column 1, ATM penetration shows an immediate negative effect of 1.0913 in the prior year, which moderates to 0.2959 in the current year. This pattern suggests diminishing returns as ATM access becomes increasingly saturated. Similarly, column 2 highlights that MOBILE services have a negative impact on PR, with an effect size of 0.5048 in the previous year, reducing to 0.1693 in the current year. This decline may reflect the gradual resolution of adoption barriers over time. In column 3, ATMs exert a negative influence of 0.4193 on GDPGR, possibly due to over-reliance on physical banking infrastructure. In contrast, MOBILE services positively affect GDPGR, with an impact of 0.4382, underscoring their critical role in driving economic

Table 11
Fixed effect model.

	SSA Countries						West Africa				East Africa					
Variables	PR			GDPGR			PR			GDPGR	PR			GDPGR		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
ATM	−0.613***			−0.188***			−1.235***		−0.969***	−0.313***		−0.314**	−2.536***		−2.28***	−0.059		0.059
	(0.057)			(0.032)			(0.163)		(0.221)	(0.098)		(0.147)	(0.227)		(0.241)	(0.127)		(0.142)
MOBILE		−0.148***			0.009			−0.178***	−0.083***		0.044**	0.05***		−0.143***	−0.035		−0.004	0.003
		(0.021)			(0.011)			(0.035)	(0.028)		(0.019)	(0.018)		(0.031)	(0.023)		(0.013)	(0.014)
FDI			0.059			0.205***			−0.965***			0.052			−0.255			−0.13
			(0.145)			(0.071)			(0.249)			(0.166)			(0.341)			(0.201)
INFLA			0.059***			−0.014			0.062			−0.057			−0.21***			−0.012
			(0.02)			(0.01)			(0.08)			(0.053)			(0.06)			(0.035)
LABOUR			0*** (0)			0*** (0)			0 (0)			0 (0)			0.548			0.555***
															(0.335)			(0.198)
UNEMPLOY			−0.091			−0.436***			0.734**			−0.503**			−1.174**			−0.695**
			(0.284)			(0.138)			(0.325)			(0.217)			(0.59)			(0.348)
_cons	49.231***	47.122***	46.317***	7.112***	4.731***	8.862***	52.818***	46.953***	53.9***	7.089***	3.656***	9.747***	51.565***	46.595***	15.33	6.34***	6.245***	−34.453**
	(0.692)	(0.689)	(2.089)	(0.384)	(0.37)	(1.017)	(1.396)	(0.981)	(2.192)	(0.84)	(0.537)	(1.46)	(0.883)	(0.999)	(25.72)	(0.496)	(0.403)	(15.172)
Observations	234	240	240	234	240	240	96	96	96	96	96	96	96	96	96	96	96	96
R-squared	0.34	0.184	0.131	0.137	0.003	0.129	0.387	0.22	0.616	0.101	0.054	0.31	0.579	0.184	0.66	0.002	0.001	0.113
Hausman Test	0.0001			0.0038														

Standard errors are in parentheses.
***p < 0.01, **p < 0.05, *p < 0.1.

productivity. Tables 9 and 10 are based on the same Dynamic Panel Threshold (DPT) model but serve different purposes. Table 9 presents the estimated threshold values for ATM and mobile banking penetration, while Table 10 reports the marginal effects of these variables before and after the thresholds, including lagged impacts.

4.3.3. Panel Fixed Effect Regression

Table 11 presents the Fixed Effects regression outcomes evaluating how financial inclusion proxies ATMs and mobile service penetration alongside key macroeconomic variables influence poverty rates and GDP growth rates across SSA, West Africa, and East Africa. Table 11 provides results across 18 models. In the full sample, ATM penetration significantly reduces poverty, affirming the critical role of physical financial infrastructure in increasing access to formal banking services. In model 2, mobile services also exhibit a statistically significant and negative relationship with PR at −0.148, supporting the notion that digital financial access mitigates poverty by enabling savings, credit access, and income generation consistent with Nsiah et al. (2021) and Seck et al. (2017). However, their effect on GDPGR is less uniform. While mobile services show a slight positive effect on GDPGR at 0.009, ATM access negatively impacts GDPGR at −0.188, potentially due to high upfront infrastructure costs or inefficiencies in ATM utilisation.

Sub-regional analyses reveal stark contrasts. In West Africa, ATM and mobile usage significantly reduce PR at −1.235 and −0.178, respectively. This region demonstrates the strongest financial inclusion-poverty alleviation linkage, aligning with findings in the main study that underscore mobile banking's broader outreach. Yet, ATM usage again correlates negatively with GDPGR at −0.969, raising questions about whether ATM expansion is keeping pace with economic productivity or remains underutilised. In East Africa, ATM effects on PR are statistically significant only in models 13 and 15 at −2.536 and −2.28, respectively, but not statistically significant across GDPGR regressions. Mobile usage has a less robust and sometimes statistically insignificant relationship with PR and GDPGR, suggesting digital finance's transformative potential remains underleveraged in this sub-region. These regional disparities reinforce Osuma (2025), who emphasised that mobile financial services outperform ATMs in advancing financial inclusion in East and Southern Africa.

Macroeconomic controls reveal that inflation generally worsens poverty at 0.059 for SSA, and unemployment depresses GDPGR at −0.436. These findings are consistent with the literature that identifies macroeconomic volatility as a constraint on development (Coulibaly and Yogo, 2018). The Hausman test with p-values less than 5 % significance level supports the Fixed Effects model over Random Effects, confirming the significance of within-country variations over time. These insights validate policy recommendations to prioritise digital financial infrastructure, control inflation, and promote employment to ensure inclusive, sustainable development in SSA.

5. Conclusion and policy recommendations

5.1. Conclusion

In conclusion, the role of microfinance and financial inclusion in alleviating poverty and fostering sustainable development in SSA is both significant and multifaceted (Chibba, 2009; Danladi et al., 2023; Egharevba et al., 2016). This study highlights how MFIs have evolved from group-based models to embracing digital financial technologies, significantly expanding their outreach and impact (Mia et al., 2019). While ATMs and mobile banking platforms have emerged as critical tools for enhancing financial inclusion, their effectiveness is moderated by infrastructural limitations, skill shortages, and macroeconomic factors such as inflation and unemployment(Coulibaly and Yogo, 2018; Madialo, 2022).

The findings reinforce that access to financial services empowers individuals and communities by reducing poverty, enhancing economic resilience, and promoting gender empowerment (Chikwe et al., 2024; Kelikume, 2021; Neogi et al., 2017). However, achieving optimal outcomes necessitates addressing challenges such as high operational costs, limited product diversity, and over-indebtedness among vulnerable populations (Ouma, 2022). Importantly, dynamic panel threshold analysis reveals that financial infrastructure like ATMs becomes impactful only beyond specific penetration levels, underscoring the need for targeted investments (Nsiah et al., 2021).

The findings of this study further revealed that microfinance significantly reduces PR and enhances GDPGR when complemented by financial inclusion tools like ATMs and mobile banking (Brahim, 2024; El-Nasharty, 2022). The DPT model reveals that these tools must surpass specific thresholds to achieve substantial impact, highlighting the importance of targeted infrastructure investments. Additionally, moderated relationships show that efficient labour market participation enhances the effectiveness of financial inclusion. Policymakers must prioritise scalable digital solutions and sustainable policies to maximise microfinance's poverty alleviation and economic resilience potential.

In alignment with the SDGs, particularly Goal 1 on poverty eradication, our study highlights the transformative potential of microfinance when integrated with inclusive and context-sensitive policies (Ajaj et al., 2024; Leal Filho et al., 2021). Policymakers must foster collaborations among governments, MFIs, and international bodies to enhance financial literacy, build robust digital infrastructure, and tailor microfinance initiatives to local needs, ensuring sustainable growth across SSA. These efforts must also integrate innovations in mobile banking to address disparities in financial access (Kass-Hanna et al., 2022; Muchandigona and Kalema, 2023).

5.2. Policy recommendations

The findings of our study underscore the importance of prioritising financial inclusion to address poverty and foster sustainable development in SSA. Policymakers should focus on expanding access to financial services, particularly by deploying ATMs and encouraging mobile banking to reach underserved populations. Investments in digital infrastructure and financial literacy programs can enhance the effectiveness of microfinance (Jalil, 2021; Kass-Hanna et al., 2022; Kauffman and Riggins, 2012; Mushtaq and Bruneau, 2019). Moreover, addressing inflation and improving labour market efficiency are critical for poverty reduction and economic growth. Collaborative efforts between governments, microfinance institutions, and international organisations can ensure sustainable financial inclusion strategies aligned with broader development goals, such as the United Nations' SDGs.

The threshold findings from the dynamic panel threshold analysis offer critical empirical insights into the levels of financial infrastructure, specifically ATM and mobile banking penetration, required to influence poverty alleviation and economic growth in Sub-Saharan Africa significantly. Our study strongly recommends governments and development partners prioritise achieving and sustaining these thresholds through strategic investments in digital financial infrastructure, especially in rural and underserved regions. National financial inclusion roadmaps must incorporate these empirical targets to optimise microfinance impact. Moreover, these thresholds should inform broader financial governance reforms, including regulatory support for fintech expansion, public-private partnerships to deploy ATMs and mobile banking platforms, and targeted subsidies or incentives to extend digital infrastructure beyond urban centres. Doing so would strengthen financial access and enhance the effectiveness of microfinance interventions, thereby accelerating progress toward SDG 1 on poverty eradication and inclusive economic development.

6. Limitations and future research

This study's limitations highlight areas requiring deeper exploration. Firstly, it employs data from 10 SSA countries over a 24-year period,

which may not fully capture the distinctive nature of microfinance and financial inclusion across diverse regional contexts. The variations in institutional quality, cultural differences, and local economic structures may influence the findings. Secondly, while financial inclusion variables such as ATM and MOBILE were available and used as proxies, these indicators might not entirely reflect the multifaceted nature of financial inclusion in SSA.

Additionally, sustainable development in this study is proxied by GDP growth. While GDP growth is a widely used indicator of economic performance, it does not fully capture the broader dimensions of sustainability as outlined in the SDGs, such as environmental protection, social equity, and institutional resilience. Future studies should consider integrating multidimensional sustainability indicators (e.g., Human Development Index, ecological metrics, or social inclusion indices) to provide a more holistic assessment of sustainable development outcomes.

Future research should expand the geographical scope, including more countries, to enhance the generalizability of findings. Additionally, integrating qualitative methodologies could provide richer insights into the lived experiences of beneficiaries. Future studies could also explore the interplay between digital financial tools and emerging financial technologies. Investigating how other macroeconomic variables, such as governance quality or climate risks, interact with microfinance to impact poverty alleviation and sustainable development would further enrich this field.

CRediT authorship contribution statement

Godswill Osuma: Writing – review & editing, Writing – original draft, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Ntokozo Nzimande:** Writing – review & editing, Writing – original draft, Supervision, Funding acquisition. **Busola Simon-Ilogho:** Writing – review & editing, Writing – original draft, Validation, Methodology.

Data statement

The data for this study are obtained from *TheGlobalEconomy.com* and the *World Development Indicators* database, accessible online at https://www.theglobaleconomy.com and https://databank.worldbank.org/source/world-development-indicators, respectively. Both sources were accessed on November 26, 2024.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix

Table A
Selected 10 SSA Countries

S/no	Countries	Country Code	Region
1	Ethiopia	ETH	East Africa
2	Kenya	KEN	East Africa
3	Tanzania	TZA	East Africa
4	Uganda	UGA	East Africa
5	Ghana	GHA	West Africa
6	Nigeria	NGA	West Africa
7	Senegal	SEN	West Africa
8	Ivory Coast	CIV	West Africa
9	South Africa	ZAF	Southern Africa
10	Angola	AGO	Southern Africa

Table B
Matrix of Correlations for PR

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) PR	1.000						
(2) ATM	−0.236	1.000					
(3) MOBILE	−0.308	0.596	1.000				
(4) FDI	0.148	−0.201	−0.026	1.000			
(5) INFLA	0.204	−0.106	−0.165	0.350	1.000		
(6) LABOUR	−0.041	0.035	−0.114	−0.114	0.015	1.000	
(7) UNEMPLOY	0.001	0.790	0.423	−0.118	0.176	−0.135	1.000

Table C
Matrix of Correlations for GDPGR

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) GDPGR	1.000						
(2) ATM	−0.444	1.000					
(3) MOBILE	−0.171	0.596	1.000				
(4) FDI	0.208	−0.201	−0.026	1.000			

(*continued on next page*)

Table C (*continued*)

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(5) INFLA	0.001	−0.106	−0.165	0.350	1.000		
(6) LABOUR	−0.049	0.035	−0.114	−0.114	0.015	1.000	
(7) UNEMPLOY	−0.321	0.790	0.423	−0.118	0.176	−0.135	1.000

Data availability

Data will be made available on request.

References

Abebe, A., Kegne, M., 2023. The role of microfinance institutions on women's entrepreneurship development. Journal of Innovation and Entrepreneurship 12 (1), 17. https://doi.org/10.1186/s13731-023-00285-0.

Adams, J., Raymond, F., 2008. Did yunus deserve the nobel peace prize: microfinance or macrofarce? J. Econ. Issues 42 (2), 435–443. https://doi.org/10.1080/00213624.2008.11507152.

Ajaj, R., Buheji, M., Hassoun, A., 2024. Optimizing the readiness for industry 4.0 in fulfilling the sustainable development goal 1: focus on poverty elimination in Africa. Front. Sustain. Food Syst. 8, 1393935. https://doi.org/10.3389/fsufs.2024.1393935.

Alkhammash, E.H., Jussila, J., Lytras, M.D., Visvizi, A., 2019. Annotation of smart cities Twitter micro-contents for enhanced citizen's engagement. IEEE Access 7, 116267–116276. https://doi.org/10.1109/ACCESS.2019.2935186.

Aluko, O.A., Opoku, E.E.O., Ibrahim, M., Kufuor, N.K., 2023. Put on the light! foreign direct investment, governance and access to electricity. Energy Econ. 119, 106563. https://doi.org/10.1016/j.eneco.2023.106563.

Armendáriz, B., Morduch, J., 2010. The Economics of Microfinance. MIT press.

Babajide, A., 2012. Effects of microfinance on micro and small enterprises (MSEs) growth in Nigeria. Asian Econ. Financ. Rev. 2 (3), 463.

Babalola, F.I., Mhlongo, N.Z., Obinyeluaku, M.I., Oladayo, G.O., Daraojimba, C., 2023. Microfinance and economic empowerment in Nigeria: a critical review of impact and sustainability. Finance & Accounting Research Journal 5 (12), 381–404. https://doi.org/10.51594/farj.v5i12.640.

Bayulgen, O., 2008. Muhammad yunus, grameen bank and the nobel peace prize: what political science can contribute to and learn from the study of microcredit. Int. Stud. Rev. 10 (3), 525–547. https://doi.org/10.1111/j.1468-2486.2008.00803.x.

Bertoldi, P., Economidou, M., Palermo, V., Boza-Kiss, B., Todeschi, V., 2021. How to finance energy renovation of residential buildings: review of current and emerging financing instruments in the EU. Wiley Interdisciplinary Reviews: Energy Environ. 10 (1), e384. https://doi.org/10.1002/wene.384.

Brahim, B., 2024. Examining the Impact of Digital Financial Inclusion on Economic Growth University Center of Abdalhafid boussouf-MILA].

Chen, S., Ravallion, M., 2013. More relatively-poor people in a less absolutely-poor world. Rev. Income Wealth 59 (1), 1–28. https://doi.org/10.1111/j.1475-4991.2012.00520.x.

Chibba, M., 2009. Financial inclusion, poverty reduction and the millennium development goals. Eur. J. Dev. Res. 21, 213–230. https://doi.org/10.1057/ejdr.2008.17.

Chikwe, C.F., Kuteesa, C., Ediae, A.A., 2024. Gender equality advocacy and socio-economic inclusion: a comparative study of community-based approaches in promoting women's empowerment and economic resilience (2022). Int. J. Sci. Res. Updates 8 (2), 110–121. https://doi.org/10.53430/ijsru.2024.8.2.0066.

Chu, A.B., 2018. Mobile technology and financial inclusion. Handbook of Blockchain, Digital Finance, and Inclusion 1, 131–144. https://doi.org/10.1016/B978-0-12-810441-5.00006-3. Elsevier.

Churchill, S.A., Marisetty, V.B., 2020. Financial inclusion and poverty: a tale of forty-five thousand households. Appl. Econ. 52 (16), 1777–1788. https://doi.org/10.1080/00036846.2019.1678732.

Coulibaly, A., Yogo, U.T., 2018. Financial outreach and working poverty in developing countries: new evidence from bank penetration. World Bank policy research working 8687. *paper*.

Danladi, S., Prasad, M., Modibbo, U.M., Ahmadi, S.A., Ghasemi, P., 2023. Attaining sustainable development goals through financial inclusion: exploring collaborative approaches to fintech adoption in developing economies. Sustainability 15 (17), 13039. https://doi.org/10.3390/su151713039.

David-West, O., Umukoro, I.O., Iheanachor, N., 2018. Branchless banking and financial inclusion: agents as facilitators of financial access. In: Marketing and Mobile Financial Services. Routledge, pp. 227–255. https://doi.org/10.4324/9781351174466-11.

Dogan, E., Madaleno, M., Taskin, D., 2022. Financial inclusion and poverty: evidence from Turkish household survey data. Appl. Econ. 54 (19), 2135–2147. https://doi.org/10.1080/00036846.2021.1985076.

Egharevba, M., Eguavoen, A., Azuh, D., Iruonagbe, T., Chiazor, I., 2016. Microfinance and poverty reduction strategy for promoting national development: the challenge of social/financial inclusion. Soc. Sci. 11 (22), 5373–5386. https://doi.org/10.3923/sscience.2016.5373.5386.

El-Nasharty, H., 2022. The role of microfinance in poverty reduction: countries experiences by regions 2000-2018. Innovation Journal of Social Sciences and Economic Review 4 (1), 1–9. https://doi.org/10.36923/ijsser.v4i1.101.

Elimuu, R.J., 2019. The Factors Hindering Access to Loans: a Case of Arusha District in Tanzania. The Open University of Tanzania.

Feeny, S., Mishra, A., Trinh, T.-A., Ye, L., Zhu, A., 2021. Early-life exposure to rainfall shocks and gender gaps in employment: findings from Vietnam. J. Econ. Behav. Organ. 183, 533–554. https://doi.org/10.1016/j.jebo.2021.01.016.

Galal, S., 2023. African countries with the highest share of global population living below the extreme poverty line in 2023. https://www.statista.com/statistics/1228553/extreme-poverty-as-share-of-global-population-in-africa-by-country/#:~:text=In%202022%2C%20the%20extreme%20poverty,is%20also%20widespread%20in%20Africa.

Geraldo, G., de Souza Pinto, M.D., 2021. Informational Sustainability in Libraries: Enhancing More Inclusive, Egalitarian and Sustainable Services. NEW LIBRARIANSHIP SYMPOSIA.

Gupta, S., Kanungo, R.P., 2022. Financial inclusion through digitalisation: economic viability for the bottom of the pyramid (BOP) segment. J. Bus. Res. 148, 262–276. https://doi.org/10.1016/j.jbusres.2022.04.070.

Gurley, J.G., 1960. Money in a Theory of Finance.

Gurley, J.G., Shaw, E.S., 1956. Financial intermediaries and the saving-investment process. J. Finance 11 (2), 257–276.

Hambolu, A.T., 2021. Influence of Microfinance Banks and Cooperative Societies on Rural Women's Entrepreneurial Success Kwara State University (Nigeria)].

Hassel, J., 2022. From $1.90 to $2.15 a day: the updated international poverty line. Our world in data. https://ourworldindata.org/from-1-90-to-2-15-a-day-the-updated-international-poverty-line.

Herbohn, K., Gao, R., Clarkson, P., 2019. Evidence on whether banks consider carbon risk in their lending decisions. J. Bus. Ethics 158, 155–175. https://doi.org/10.1007/s10551-017-3711-3.

Horvey, S.S., Odei-Mensah, J., 2024. Navigating the climate challenges in Africa: exploring the synergy and threshold effects of renewable energy and foreign direct investment on climate risk. World Development Sustainability 4, 100143. https://doi.org/10.1016/j.wds.2024.100143.

Hussaini, U., Chibuzo, I.C., 2018. The effects of financial inclusion on poverty reduction: the moderating effects of microfinance. International Journal of Multidisciplinary Research and Development 5 (12), 188–198.

Ihemeje, J., Asogwa, B., Ezihe, J., 2014. Managing national poverty eradication programme for food security among all farmers association in Nigeria. Afr. J. Agric. Res. 9, 2309–2318. https://doi.org/10.5897/AJAR11.687.

Inoue, T., 2019. Financial inclusion and poverty reduction in India. Journal of Financial Economic Policy 11 (1), 21–33. https://doi.org/10.1108/JFEP-01-2018-0012.

Iqbal, B.A., Sami, S., 2017. Role of banks in financial inclusion in India. Contaduría Adm. 62 (2), 644–656. https://doi.org/10.1016/j.cya.2017.01.007.

Iyengar, D., Nilakantan, R., Rao, S., 2021. On entrepreneurial resilience among micro-entrepreneurs in the face of economic disruptions… A little help from friends. J. Bus. Logist. 42 (3), 360–380. https://doi.org/10.1111/jbl.12269.

Jalil, M.F., 2021. Microfinance towards micro-enterprises development in rural Malaysia through digital finance. Discover Sustainability 2 (1), 55. https://doi.org/10.1007/s43621-021-00066-3.

Kaltenborn, M., 2017. Overcoming extreme poverty by social protection floors–approaches to closing the right to social security gap. Law Dev. Rev. 10 (2), 237–273. https://doi.org/10.1515/ldr-2017-0014.

Karim, L., 2021. NGOs, state and neoliberal development in south Asia: the paradigmatic case of Bangladesh in a global perspective. In: Routledge Handbook of Gender in South Asia. Routledge, pp. 289–302.

Kass-Hanna, J., Lyons, A.C., Liu, F., 2022. Building financial resilience through financial and digital literacy in south Asia and Sub-Saharan Africa. Emerg. Mark. Rev. 51, 100846. https://doi.org/10.1016/j.ememar.2021.100846.

Kauffman, R.J., Riggins, F.J., 2012. Information and communication technology and the sustainability of microfinance. Electron. Commer. Res. Appl. 11 (5), 450–468. https://doi.org/10.1016/j.elerap.2012.03.001.

Kehinde, A.D., Ogundeji, A.A., 2022. The simultaneous impact of access to credit and cooperative services on cocoa productivity in south-Western Nigeria. Agric. Food Secur. 11 (1), 11. https://doi.org/10.1186/s40066-021-00351-4.

Kelikume, I., 2021. Digital financial inclusion, informal economy and poverty reduction in Africa. J. Enterprising Communities People Places Glob. Econ. 15 (4), 626–640. https://doi.org/10.1108/JEC-06-2020-0124.

Khan, I., Khan, I., Sayal, A.U., Khan, M.Z., 2022. Does financial inclusion induce poverty, income inequality, and financial stability: empirical evidence from the 54 African countries? J. Econ. Stud. 49 (2), 303–314. https://doi.org/10.1108/JES-07-2020-0317.

Koomson, I., Villano, R.A., Hadley, D., 2020. Effect of financial inclusion on poverty and vulnerability to poverty: evidence using a multidimensional measure of financial

inclusion. Soc. Indic. Res. 149 (2), 613–639. https://doi.org/10.1007/s11205-019-02263-0.
Ksoll, C., Lilleør, H.B., Lønborg, J.H., Rasmussen, O.D., 2016. Impact of village savings and loan associations: evidence from a cluster randomized trial. J. Dev. Econ. 120, 70–85. https://doi.org/10.1016/j.jdeveco.2015.12.003.
Kutty, A.A., Abdella, G.M., Kucukvar, M., Onat, N.C., Bulu, M., 2020. A system thinking approach for harmonizing smart and sustainable city initiatives with united nations sustainable development goals. Sustain. Dev. 28 (5), 1347–1365. https://doi.org/10.1002/sd.2088.
Lal, T., 2021. Impact of financial inclusion on economic development of marginalized communities through the mediation of social and economic empowerment. Int. J. Soc. Econ. 48 (12), 1768–1793. https://doi.org/10.1108/IJSE-12-2020-0830.
Leal Filho, W., Lovren, V.O., Will, M., Salvia, A.L., Frankenberger, F., 2021. Poverty: a central barrier to the implementation of the UN sustainable development goals. Environ. Sci. Pol. 125, 96–104. https://doi.org/10.1016/j.envsci.2021.08.020.
Leal Filho, W., Tripathi, S.K., Andrade Guerra, J., Giné-Garriga, R., Orlovic Lovren, V., Willats, J., 2019. Using the sustainable development goals towards a better understanding of sustainability challenges. Int. J. Sustain. Dev. World Ecol. 26 (2), 179–190. https://doi.org/10.1080/13504509.2018.1505674.
Lee, C.-C., Song, H., An, J., 2024. The impact of green finance on energy transition: does climate risk matter? Energy Econ. 129, 107258. https://doi.org/10.1016/j.eneco.2023.107258.
Lenka, S.K., Bairwa, A.K., 2016. Does financial inclusion affect monetary policy in SAARC countries? Cogent Economics & Finance 4 (1), 1127011. https://doi.org/10.1080/23322039.2015.1127011.
Lim, M.M., Jørgensen, P.S., Wyborn, C.A., 2018. Reframing the sustainable development goals to achieve sustainable development in the Anthropocene—A systems approach. Ecol. Soc. 23 (3).
Liu, D., Zhang, Y., Hafeez, M., Ullah, S., 2022. Financial inclusion and its influence on economic-environmental performance: demand and supply perspectives. Environ. Sci. Pollut. Control Ser. 29 (38), 58212–58221. https://doi.org/10.1007/s11356-022-18856-1.
Lopez, T., Winkler, A., 2018. The challenge of rural financial inclusion–evidence from microfinance. Appl. Econ. 50 (14), 1555–1577. https://doi.org/10.1080/00036846.2017.1368990.
Madialo, L.O., 2022. An Evaluation of the Effect of Prudential Regulations on the Social and Financial Performance of Microfinance Banks in Kenya Strathmore University].
Maket, I., 2024. Rethinking energy poverty alleviation through financial inclusion: do institutional quality and climate change risk matter? Util. Policy 91, 101820. https://doi.org/10.1016/j.jup.2024.101820.
Mhlanga, D., 2025. The state of financial inclusion in Sub-Saharan Africa. In: Financial Inclusion and Sustainable Development in Sub-saharan Africa. Routledge, pp. 8–31. https://doi.org/10.4324/9781003515715-2.
Mhlanga, D., Dunga, S.H., Moloi, T., 2020. Financial inclusion and poverty alleviation among smallholder farmers in Zimbabwe. Eurasian Journal of Economics and Finance 8 (3), 168–182. https://doi.org/10.15604/ejef.2020.08.03.004.
Mia, M.A., Lee, H.-A., Chandran, V., Rasiah, R., Rahman, M., 2019. History of microfinance in Bangladesh: a life cycle theory approach. Bus. Hist. 61 (4), 703–733. https://doi.org/10.1080/00076791.2017.1413096.
Muchandigona, A.K., Kalema, B.M., 2023. The catalytic role of Mobile banking to improve financial inclusion in developing countries. Int. J. E Serv. Mobile Appl. 15 (1), 1–21. https://doi.org/10.4018/IJESMA.317923.
Mukherjee, A., Gaur, A., 2024. Role of Atms in Financial Inclusion.
Mushtaq, R., Bruneau, C., 2019. Microfinance, financial inclusion and ICT: implications for poverty and inequality. Technol. Soc. 59, 101154. https://doi.org/10.1016/j.techsoc.2019.101154.
Mwansakilwa, C., Tembo, G., Zulu, M.M., Wamulume, M., 2017. Village savings and loan associations and household welfare: evidence from eastern and Western Zambia. African Journal of Agricultural and Resource Economics 12 (1), 85–97. https://doi.org/10.22004/ag.econ.258601.
Neaime, S., Gaysset, I., 2018. Financial inclusion and stability in MENA: evidence from poverty and inequality. Finance Res. Lett. 24, 230–237. https://doi.org/10.1016/j.frl.2017.09.007.
Neglo, K.A.W., Gebrekidan, T., Lyu, K., 2021. Determinants of participation in non-farm activities and its effect on household income: an empirical study in Ethiopia. J. Dev. Agric. Econ. 13 (1), 72–92. https://doi.org/10.5897/JDAE2020.1231.
Neogi, C., Bhandari, A.K., Ghosh, S., 2017. Women's Entrepreneurship and Microfinance. Springer.
Ngoasong, M.Z., Kimbu, A.N., 2016. Informal microfinance institutions and development-led tourism entrepreneurship. Tour. Manag. 52, 430–439. https://doi.org/10.1016/j.tourman.2015.07.012.
Ngong, C.A., Thaddeus, K.J., Onwumere, J.U.J., 2022. Microfinancial inclusion nexus poverty alleviation: the case of Nigeria. Journal of Economic and Administrative Sciences 38 (4), 581–601. https://doi.org/10.1108/JEAS-08-2020-0147.
Nguyen, Q.A.M., 2020. Financial Services for the Poor in Vietnam: a Comprehensive Analysis on the Performance and Sustainability of Microfinance Sector Doshisha University].
Niu, N., Ma, J., Zheng, D., Lu, Y., Zhang, B., 2025. Extreme weather and the green transition of energy firms: the moderating effect of digital technology and digital inclusive finance. Res. Int. Bus. Finance 76, 102858. https://doi.org/10.1016/j.ribaf.2025.102858.
Nsiah, A.Y., Yusif, H., Tweneboah, G., Agyei, K., Baidoo, S.T., 2021. The effect of financial inclusion on poverty reduction in sub-sahara Africa: does threshold matter? Cogent Social Sciences 7 (1), 1903138. https://doi.org/10.1080/23311886.2021.1903138.
Ojong, N., Simba, A., 2019. Fostering micro-entrepreneurs' structural and relational social capital through microfinance. J. Small Bus. Enterpren. 31 (1), 1–20. https://doi.org/10.1080/08276331.2017.1423161.
Omar, M.A., Inaba, K., 2020. Does financial inclusion reduce poverty and income inequality in developing countries? A panel data analysis. Journal of economic structures 9 (1), 37. https://doi.org/10.1186/s40008-020-00214-4.
Osabutey, E.L., Jackson, T., 2024. Mobile money and financial inclusion in Africa: emerging themes, challenges and policy implications. Technol. Forecast. Soc. Change 202, 123339. https://doi.org/10.1016/j.techfore.2024.123339.
Osuma, G., 2025. The impact of financial inclusion on poverty reduction and economic growth in Sub-Saharan Africa: a comparative study of digital financial services. Soc. Sci. Humanit. Open 11, 101263. https://doi.org/10.1016/j.ssaho.2024.101263.
Osuma, G., Ayinde, A., Ntokozo, N., Ehikioya, B., 2024. Evaluating the impact of systemic corruption and political risk on foreign direct investment inflows in Nigeria: an analysis of key determinants. Discover Sustainability 5 (1), 1–13. https://doi.org/10.1007/s43621-024-00676-7.
Osuma, G., Nzimande, N.P., 2024. Exploring the dynamic link between trade openness, external debt, and economic growth in Sub-Saharan Africa: challenges and considerations. Economies 12 (11), 283. https://doi.org/10.3390/economies12110283.
Ouma, C.A., 2022. Savings and Internal Lending Community Programme Strategies on Sustainability of Rural Women Livelihood Projects in Suna East Sub-county. *Kenya* University of Nairobi.
Parikh, T.S., 2006. Rural Microfinance Service Delivery: Gaps, Inefficiencies and Emerging Solutions, 2006 International Conference on Information and Communication Technologies and Development.
Park, C.-Y., Mercado, R.V., 2021. Financial inclusion: new measurement and cross-country impact assessment 1. In: Financial Inclusion in Asia and Beyond. Routledge, pp. 98–128.
Pesaran, M.H., 2007. A simple panel unit root test in the presence of cross-section dependence. J. Appl. Econom. 22 (2), 265–312. https://doi.org/10.1002/jae.951.
Polloni-Silva, E., da Costa, N., Moralles, H.F., Sacomano Neto, M., 2021. Does financial inclusion diminish poverty and inequality? A panel data analysis for Latin American countries. Soc. Indic. Res. 158 (3), 889–925. https://doi.org/10.1007/s11205-021-02730-7.
Purvis, B., Mao, Y., Robinson, D., 2019. Three pillars of sustainability: in search of conceptual origins. Sustain. Sci. 14, 681–695. https://doi.org/10.1007/s11625-018-0627-5.
Raub, S.P., Martin-Rios, C., 2019. "think sustainable, act Local"–A stakeholder-filter-model for translating SDGs into sustainability initiatives with local impact. Int. J. Contemp. Hospit. Manag. 31 (6), 2428–2447. https://doi.org/10.1108/IJCHM-06-2018-0453.
Saha, S.K., Qin, J., 2023. Financial inclusion and poverty alleviation: an empirical examination. Econ. Change Restruct. 56 (1), 409–440. https://doi.org/10.1007/s10644-022-09428-x.
Scholtens, B., Van Wensveen, D., 2003. The Theory of Financial Intermediation: an Essay on what It Does (Not) Explain. SUERF Studies.
Seck, O., Naiya, I.I., Muhammad, A.D., 2017. Effect of Financial Inclusion on Household Consumption in Nigeria. *IRTI Working Paper Series WP/2017/03*.
Sengupta, R., Patil, A., Lone, S., 2024. Revisiting microfinance as an instrument of sustainable development. In: Creating Pathways for Prosperity. Emerald Publishing Limited, pp. 67–84. https://doi.org/10.1108/978-1-83549-121-820241006.
Sievers, M., Vandenberg, P., 2007. Synergies through linkages: who benefits from linking micro-finance and business development services? World Dev. 35 (8), 1341–1358. https://doi.org/10.1016/j.worlddev.2007.04.002.
Soumaré, I., Tchuigoua, H.T., Hessou, H.T., 2020. Are microfinance institutions resilient to economic slowdown? Evidence from their capital ratio adjustment over the business cycle. Econ. Modell. 92, 1–22. https://doi.org/10.1016/j.econmod.2020.07.006.
Spring, A., 2009. African women in the entrepreneurial landscape: reconsidering the formal and informal sectors. J. Afr. Bus. 10 (1), 11–30. https://doi.org/10.1080/15228910802701296.
Stiglitz, J.E., Weiss, A., 1981. Credit rationing in markets with imperfect information. Am. Econ. Rev. 71 (3), 393–410.
Sudan, F.K., 2007. Livelihood diversification and women empowerment through self-help micro credit programme: evidence from Jammu and Kashmir. Indus Journal of Management & Social Sciences 1 (2), 90–106.
Tariq, S., Sangmi, M.-u.-D., 2020. Microfinance and women's economic empowerment: an experimental evidence. Abhigyan 38 (3), 10–19. https://doi.org/10.56401/Abhigyan_38.3.2020.10-19.
Titumir, R.A.M., 2021. Numbers and Narratives in Bangladesh's Economic Development. Springer.
Vachya, L., 2015. Microfinance livelihood initiatives and women empowerment in selected villages of Andhra Pradesh. J. Rural Dev. 31–48.
Vargas, C.M., 2000. Community development and micro-enterprises: fostering sustainable development. Sustain. Dev. 8 (1), 11–26.
Verhoef, G., 2001. Informal financial service institutions for survival: african women and stokvels in urban South Africa, 1930–1998. Enterprise Soc. 2 (2), 259–296. https://doi.org/10.1093/es/2.2.259.
Vyas-Doorgapersad, S., 2024. Transition towards eradication of poverty in Africa. Insights into Regional Development (Online) 6 (2), 78–91.
You, K., Dal Bianco, S., Amankwah-Amoah, J., 2020. Closing technological gaps to alleviate poverty: evidence from 17 sub-saharan African countries. Technol.

Forecast. Soc. Change 157, 120055. https://doi.org/10.1016/j.techfore.2020.120055.
Zanden, V., Jan, L., 2023. Examining the relationship of information and communication technology and financial access in Africa. Journal of Business and Economic Options 6 (3), 26–36. https://resdojournals.com/index.php/jbeo/article/view/242/247.
Zapalska, A., Stodder, J., Wingrove-Haugland, E., 2017. Female micro-entrepreneurship: the key to economic growth and development in Islamic economies. Entrepreneurship and Management in an Islamic Context, pp. 179–206. https://doi.org/10.1007/978-3-319-39679-8_12.