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Microfinance, Financial Inclusion and Economic Welfare in Africa: A Panel Investigation

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This study explores the relationship between microfinance, financial inclusion, and economic welfare in a sample of 23 African countries for the period of 2004 to 2023 using annual time series data. We measured microfinance with the number of Branches of Microfinance banks, Microfinance Borrowers, Microfinance outstanding deposits, Microfinance outstanding loans; financial inclusion number of registered mobile money accounts per 1,000 adults; the number of mobile money agent outlets par 1,000 adults; and digital card ownership; governance and institutional quality with Rule of law, regulatory quality, and government effectiveness; and economic welfare with household consumption; while we controlled for the inflation rate, interest rate and exchange rate. These

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variables were estimated using Panel Least Squares, Fully Modified OLS (FMOLS), Dynamic OLS (DOLS), and Panel Autoregressive Distributed Lag (ARDL) estimation techniques. The result of the cointegration revealed that cointegration exists between the variables of the model. Findings from the aforesaid estimation techniques show that there is the existence of long-run relationships between microfinance, financial inclusion, and economic welfare since the coefficients of the microfinance and financial inclusion variables are statistically significant. The coefficients of the error correction terms which measure the effects of the short-run dynamics of the model suggest that the speeds of adjustment from the long run to the short run in the models would be 76%, 61%, 83%, 67%, 68%, 34%, and 80% respectively for all the specified models. Following the findings of the study, conclusions were drawn and the study suggests that microfinance institutions should adapt to the digitization of their products and services for wider coverage on one hand; the government should provide digital financial amenities to create a fertile ground for micro-financial institutions to rely on to maximize the welfare of the economy.

Keywords: Microfinance; financial inclusion; economic welfare.

1. INTRODUCTION

Microfinance has emerged as a vital tool for enhancing financial inclusion and improving economic welfare in developing countries, particularly in Africa. Financial inclusion refers to the access and usage of financial services by individuals and businesses, enabling them to participate in the economy and improve their livelihoods (Demirgüç-Kunt et al., 2018). In Africa, where a significant portion of the population remains unbanked, microfinance institutions (MFIs) play a crucial role in bridging this gap by providing financial services tailored to the needs of low-income individuals and small enterprises (Khan & Raza, 2017). The importance of microfinance in promoting financial inclusion cannot be overstated. According to the World Bank (2020), around 1.7 billion adults globally remain unbanked, with Sub-Saharan Africa exhibiting some of the highest rates of financial exclusion. Microfinance aims to provide these marginalized groups with access to credit, savings, and insurance products, empowering them to invest in income-generating activities and enhancing their economic stability (Ledgerwood, 1999). This, in turn, contributes to broader economic development goals by fostering entrepreneurship, reducing poverty, and improving household welfare. Research has shown that microfinance can have significant positive impacts on economic welfare. For instance, studies by Zeller and Meyer (2002) indicate that access to microfinance can lead to increased household income, improved consumption patterns, and better educational outcomes for children. In a comparative analysis, Otero (1999) highlights that microfinance not only alleviates poverty but also enhances the overall quality of life for beneficiaries by providing them with the financial tools necessary for growth and sustainability.

Despite its potential, the effectiveness of microfinance in achieving financial inclusion and improving economic welfare has been a subject of debate. Some scholars argue that while microfinance can provide essential services, it may also lead to over-indebtedness among borrowers, ultimately harming their economic situation (Morduch, 1999). Additionally, there is evidence suggesting that the impact of microfinance varies significantly across different contexts, influenced by factors such as local economic conditions, institutional frameworks, and cultural attitudes toward finance (Pitt & Khandker, 1998). Microfinance has become a significant instrument in the global effort to alleviate poverty and enhance economic welfare, particularly in developing countries. It provides financial services to individuals and businesses that are typically excluded from traditional banking systems by offering small loans, savings accounts, and insurance products, microfinance institutions (MFIs) empower low-income individuals to manage their finances more effectively (Morduch, 1999). Access to microfinance allows poor households to invest in income-generating activities. Studies have shown that microfinance can significantly reduce poverty levels by enabling beneficiaries to start small businesses, leading to increased income and improved living standards (Pitt & Khandker, 1998; Zeller & Meyer, 2002). Microfinance so ubiquitous in improving economic welfare, especially in low-income communities by facilitating access to financial services, empowering women, and fostering entrepreneurship, microfinance not only addresses immediate economic challenges but

also contributes to long-term sustainable development. The importance of microfinance in enhancing economic welfare underscores its potential as a transformative tool in the fight against poverty and inequality.

Financial inclusion is also a vital driver of economic welfare in Africa. It provide access to financial services, it empowers individuals and communities, promotes economic growth, and supports poverty reduction efforts. In playing its role in welfare optimization, financial inclusion allows households to build savings and access insurance, which enhances their resilience to economic shocks, such as illness, unemployment, or natural disasters, thereby enables families to afford healthcare services and educational expenses, ultimately contributing to long-term economic welfare [1] enables aspiring entrepreneurs to secure the capital needed to start or expand their businesses, fostering innovation, job creation, and economic growth (Klapper et al., 2016), facilitates access to credit, savings, and insurance products, enabling low-income individuals to invest in income-generating activities which is crucial for poverty alleviation, as it allows households to increase their earnings, improve their standard of living, and break the cycle of poverty (Demirgüç-Kunt et al., 2018), allows households to smooth consumption over time, ensuring that they can meet their basic needs consistently, and contributes to overall economic growth by increasing the efficiency of resource allocation. When more people and businesses have access to financial services, it leads to higher levels of investment and consumption, which can stimulate economic activity and growth (Beck & Demirgüç-Kunt, 2008). Hence, participation in financial inclusion programs often encourages community engagement and cooperation, facilitating group lending and savings initiatives, foster social networks that enhance collective action and community support, and contribute to social cohesion and welfare (Narain, 2009) and by promoting financial inclusion, countries can advance their progress toward achieving these global goals, leading to improved economic welfare for their populations (United Nations, 2015).

Based on the above discussions, it has become clearer that improvement in micro-financing and financial inclusion can greatly foster economic welfare which directly influences the household standard of living, income level, inclusivity, employment, and entrepreneurship in every economy. One of the primary roles of both microfinance and financial inclusion is to alleviate poverty by providing the underserved with access to financial services. Microfinance institutions (MFIs) offer small loans, savings accounts, and insurance products to low-income individuals who lack access to traditional banking. These financial services enable individuals to start or expand businesses, invest in productive assets, and generate income, which ultimately reduces poverty (Amin et al., 2018). Financial inclusion, through expanded access to formal banking systems, also ensures that individuals can save, borrow, and manage risks more effectively, contributing to long-term economic welfare (Demirgüç-Kunt et al., 2018). Microfinance and financial inclusion are therefore very essential tools that enhance economic welfare in Africa. They provide vital financial resources to underserved populations, empower women, support SMEs, reduce income inequality, and foster economic growth. Hence, the synergistic effect of these two creates a more inclusive financial ecosystem, which is crucial for achieving sustainable economic development and improving the welfare of African populations. In this light, we investigated the nexus between microfinance – explored through – the number of microfinance branches, microfinance borrowers, microfinance deposits and microfinance outstanding loans – financial inclusion – measured with number of registered mobile money accounts per 1,000 adults, number of mobile money agent outlets per 1,000 adults and digital card ownership and economic welfare – indicated by – household consumption expenditure in Africa. This paper therefore address the following questions. a). What are the effects of the number of microfinance branches on economic welfare in Africa? b). How does microfinance borrowers affect economic welfare in Africa? c). Do microfinance deposits significantly influence economic welfare in Africa? d). Is there significant relationships between microfinance outstanding loans and economic welfare in Africa? e). To what extent does number of registered mobile money accounts influence economic welfare in Africa? f). What are the effects of number of mobile money agent outlets on economic welfare in Africa? g). Do digital card ownership significantly affects economic welfare in Africa?

To address these questions, we employed multiple regression analysis estimation techniques – panel least square (P-OLS), fully modified ordinary least squares (FMOLS),

dynamic ordinary least squares (DOLS) and panel autoregressive distributed lag model (PARLD) to estimate the relationships that exist between microfinance – explored through – the number of microfinance branches, microfinance borrowers, microfinance deposits and microfinance outstanding loans – financial inclusion – measured with number of registered mobile money accounts per 1,000 adults, number of mobile money agent outlets per 1,000 adults and digital card ownership and economic welfare – indicated by – household consumption expenditure in Africa. From the previous studies, we found that researchers mostly paid interest on microfinance and economic growth (Khalat & Saqfalhait 2019, Shabir 2016, Apere 2016, and Mhlanga et al. [2] as well as financial inclusion and economic growth (Hulme & Mosley 1996, and Amin & Uddin, [1]. Some prior studies also find positive relationships between microfinance and economic welfare [3,4,5]. while [6,7] found negative association between them. Hence, this has led to inconsistent conclusions and policies regarding improvement of economic welfare. Despite numerous literature [1,3,4,8] as well as policies and reforms by the government such as Kenya (M-Pesa), Financial Inclusion Roadmap and Strategy, 2015-2021 in Ethiopia, Financial Education Framework, 2016-2020 in Tanzania, Morocco's policies on expansion of Health Insurance and Social Protection, South Africa's Comprehensive Social Security and Retirement Reform, National Development Plan - NDP III, 2020-2025 in Uganda, Growth and Transformation Plan – GTP in Ethiopia, National Social Investment Programme (NSIP) in Nigeria, Livelihood Empowerment Against Poverty (LEAP) Program in Ghana, and National Financial Inclusion Strategy, 2017-2020 in Rwanda, Africa's economic welfare is yet optimized compared to other continents globally. Therefore, it is crucial to re-examine the nexus between microfinance, financial inclusion and economic welfare in Africa.

To this end, this paper lends to the body of existing literature in the following ways. Firstly, we holistically examined the synergy between microfinance – explored through – the number of microfinance branches, microfinance borrowers, microfinance deposits and microfinance outstanding loans – financial inclusion – measured with number of registered mobile money accounts per 1,000 adults, number of mobile money agent outlets per 1,000 adults and digital card ownership and economic welfare – indicated by – household consumption expenditure in Africa given their importance in raising the living standards of the households. Secondly, distinct from the existing studies, we employed panel least square (P-OLS), fully modified ordinary least squares (FMOLS), dynamic ordinary least squares (DOLS) and panel autoregressive distributed lag model (PARLD) which allows for a comprehensive analysis of the synergy between microfinance, financial inclusion, and economic welfare in Africa. These methods address a range of econometric issues, including endogeneity, serial correlation, and cointegration, while also capturing both short-run and long-run dynamics. This ensures robust, reliable, and policy-relevant results that can inform strategies for improving economic welfare in Africa through enhanced financial inclusion and access to microfinance. Hence, other sections of the paper will be structured as follows: literature review (theoretical and empirical will be discussed in section 2, while data, methodology and model specification are contained in section 3, sections 4 and 5 house the discussion of the results from regression analysis, findings of the study and interpretations, summary conclusions and policy options of the study.

2. LITERATURE REVIEW ON FINANCIAL INCLUSION

Over the years, extensive research has been conducted by policymakers on the investigations of the nexus between microfinance, financial inclusion and economic welfare. This debate stems from numerous economic gains of microfinance and financial inclusion in economic welfare. In this section, the theories and empirical literature relating to microfinance and financial inclusion will be reviewed.

2.1 Theoretical Literature

In the economic growth theory of microfinance proposed by Hulme and Mosley (1996), they argued that capital investments and other financial services constitute the key determinants of economic growth. Income improvement was seen as the driver of most development efforts. They assumed that there is a positive relationship between financial investment and economic growth. However, financial investment to the poor through microfinance services will lead to increased incomes for the poor and ultimately result in poverty reduction (Hulme, 1997). Furthermore, El-solh (1999) argued that microfinance cannot by itself generate income

but should be perceived as an important input in the process of developing micro-enterprises which are integral to the private sector, in turn, are perceived as an engine of growth for economies of developing countries which have moved from state-directed to market-oriented economies.

To reinforce the above theory, El-Solh (1999) postulated two theoretical propositions on the macro-level for microfinance interventions which are "economic and human resources theories". By enabling the establishment of new micro-enterprises, microfinance supports the efficient use of labour and capital as factors of production and therefore contributing to economic growth and sustainable development. The human resource theory is quite similar to the economic theory. Thus, since it is generally accepted that microfinance is labour-intensive, facilitating access to microfinance is likely to result in the acquisition of new skills and upgrading of existing ones and thus, improve on the capacity of the poor to generate income and improve their livelihood. Furthermore, theories underlying microfinance entails the empowerment of the poor when they participate in microfinance activities (Hashemi, Schuler and Ruley 1996; Chester and Kuhn, 2002). By self-selecting themselves into groups self-managing their groups, and gaining control over the means of making a living, poor people become empowered and independent. Empowerment has been particularly relevant for women who are perceived as being marginalized in most developing countries.

As proposed by Peterson K. Ozili (2018) in his Public good theory of financial inclusion, he argued that the delivery of formal financial services to the entire population and ensuring that there is unrestricted access to finance for everyone, should be treated as a public good for the benefit of all members of the population. As a public good, individuals cannot be excluded from gaining access to financial services. All individuals will enjoy basic financial services without paying for it. Access to financial services to one individual does not reduce its availability to others which means that all members of the population can be brought into the formal financial sector and everyone will be better off. Under this theory, all members of the population are beneficiaries of financial inclusion and nobody is left out.

Furthermore in his "Vulnerable group theory of financial inclusion", Peterson K. Ozili (2018) argued that financial inclusion activities or programs in a country should be targeted to the vulnerable members of society such as the poor people, women, elderly people who suffer the most from economic hardship and crises. Vulnerable people are often the most affected by financial crises and economic recession, therefore, it is pertinent to bring these vulnerable people into the formal financial sector. One way to achieve this is through government-to-person (G2P) social cash transfers into the formal accounts of vulnerable people. Making G2P social cash transfer payments into the formal account of poor people, young people, women and elderly people will encourage others in the same category to join the formal financial sector to own a formal account to take advantage of the social cash transfer benefits, thereby increasing the rate of financial inclusion for vulnerable groups. The theory implies that it identifies some members of the population to be vulnerable people in society.

2.2 Empirical Literature

2.2.1 Microfinance and economic welfare

In an extensive study carried out by Mia (2017), some microfinance institute contributes to the socio-economic welfare of Bangladesh. Although the regulatory framework is still weak, but majority of the microfinance institutions – MFIs contribute to the welfare of households, the study further revealed that microfinance has made significant contributions to such growth and socio-economic development. Another study by Amin and Jala Uddin (2018), examined the long-run dynamic relationship between Grameen Bank loan financing and clients' deposits and economic growth using the cointegration test, and the Granger causality test. They conclude that both financing and depositing aspects of Grameen Bank have positive effects on economic growth in the long run. Raihan et al. [9] investigated the effect of microfinance on GDP in Bangladesh. They estimate that microfinance has added about 8.9% to 11.9% to GDP according to the assumptions about the working of the labour market. Furthermore, the results revealed that the contribution of rural GDP is even higher. To ascertain the relationship that exists between economic welfare and microfinance, Rauf and Mahood (2016) examined the development processes adopted by the microfinance sector and its impact on the performance of microfinance institutions in Pakistan and the well-being of the people. To

strike a balance between outreach and poverty alleviation, an intensive development technique was used and it shows that extra price is powerful at the initial levels of development which may reflect improved efficiency and productivity. As a substitute, the sector adopted huge progress procedures which created huge investments in physical infrastructure and fast broadened recruitment and department networks. In the like manner, [10] studied the impact of microfinance on socio-economic growth in Nigeria using multiple regression analysis to estimate time series data and cross-sectional data spanning from 1992 to 2012. Their main findings show that microfinance investment has a significant impact on economic performance in Nigeria in the long run.

Most of the earlier studies contented that microfinance institutions have a positive effect on economic performance while others refute it. For instance, Khalaf and Saqfalhait [3] investigated the effect of microfinance institutions on economic growth in Arab countries using a panel model for six Arab countries from 1999 to 2016 and they discovered that micro-financial institutions (MFIs) do not affect improving economic growth in Arab countries. Shabbir [4] posits from his study the impact of microfinance institutions have a positive impact on economic growth in Morocco. Apere [5] used the Augmented Dickey-Fuller Unit root test, Cointegration test, Error correction model (ECM) and the parsimonious test to study the impact of microfinance banks on economic growth in Nigeria from 1992-2013. They discovered that the activities of the microfinance bank can influence the entire economy if it is well coordinated. The results of the study further show that microfinance bank loans and domestic investment significantly and positively impact the growth of Nigeria's economy. In contradictory to this finding, Wachukwu et al. [8] examined the impact of microfinance institutions on the economic growth of Nigeria, using per capita income as a measure of economic growth for the period covering 1992 – 2016 and Cochranorcutt regression model on time series annual. The results revealed that a very strong but negative relationship was found between microfinance banks' credit growth and per capita income.

Recently, Kasali [11] analysed the impact of microfinance loans on poverty alleviation in Southwest Nigeria using primary research. The study adopted a stratified sampling technique to collect cross-sectional data through a structured questionnaire. The Propensity Score Matching (PSM) methodology was utilised to analyse the results. The study revealed that microfinance loan has favourable contributions to poverty alleviation in the study area, but there is still a need for government aid. Governments should support the MFIs with funds that would be disbursed at concessionary interest rates. The availability of more infrastructural facilities and a more enabling environment would effectively spur the establishment of more MFIs in rural areas. Mhlanga et al. [2] used simple regression analysis where financial inclusion was the basis to find if smallholders are getting funding, and access to financial institutions and credit facilities. The results showed that if farmers are financially included, there is a positive impact on poverty reduction. The study was based on smallholder farmers' values and level of financial inclusion. The study discovered that, to tackle poverty, especially among the smallholder farmers, it is vital to ensure that farmers participate in the financial sector through saving, borrowing, and taking out insurance, among other services. Even though the study notes an increase in financial inclusion, there is tenacious growth of poverty in Zimbabwe. The current study ought to incorporate the lending issue through MFIs to assess its impact on poverty eradication. Jaka and Shava [12] examine the implementation of rural women's livelihoods towards the economic empowerment of women in the Chivi District of Zimbabwe. Using a case study approach that triangulates interviews, focus groups, and documents, the article found that women faced numerous challenges, including a lack of access to credit facilities. The paper concludes that access to competitive markets and entrepreneurial education supported by adequate funding is fundamental to achieving economic empowerment through resilient rural women's livelihoods.

Christensson [6] investigated the relationship between access to microfinance institutions and poverty reduction on a State level in Nigeria. The study utilized the ordinary least square regression, and their results show a negative relationship between the number of microfinance institutions and poverty levels. Thus, the study concluded that microfinance institutions decrease the poverty levels in Nigeria. This implies that an increasing number of microfinance institutions in poor areas can reduce the poverty levels in a country. Osei-Assibey, Agyapong, & Gyamfi, [13] conducted a study to assess the influence of microfinance on poverty alleviation in rural

Ghana. Using household data, their study concluded that microfinance contributes significantly to improving economic welfare by increasing income levels and household savings. The research showed that access to microcredit allowed small businesses to grow, thus raising living standards in rural communities [13]. Njenga, Gathungu, & Wachira [14] examined the role of microfinance institutions in promoting the economic welfare of women in Kenya. Their study utilized a mixed-method approach to evaluate microfinance services and their socio-economic impacts. The results indicated that microfinance services led to higher household income and improved healthcare access, although challenges such as high interest rates limited further benefits. Adusei, & Fenny, [15] explored the relationship between microfinance and economic welfare among low-income households in Sub-Saharan Africa. Their findings, based on data from five African countries, revealed that access to microcredit was linked to reduced financial exclusion and improved household welfare. However, the study highlighted the need for better financial literacy programs to optimize these benefits. Kamau, Muturi, & Waweru, [16] focused on the impact of microfinance services on small and medium enterprises (SMEs) in Uganda. Their findings indicated that microfinance significantly improved access to capital for SMEs, leading to enhanced business performance and increased income generation. However, they also identified that loan repayment periods and high interest rates posed challenges to long-term business sustainability.

Agbenyo, Koomson, & Peprah, [17] investigated the role of microfinance institutions in enhancing economic welfare through housing improvements in Ghana. They found that access to microfinance loans improved housing quality and infrastructure, contributing positively to household welfare. Nevertheless, they emphasized that the sustainability of these benefits depended on appropriate financial management and regulatory frameworks. Okech, & Wanyonyi, [18] analyzed the effects of microfinance on poverty reduction in rural Kenya. Their study revealed that microfinance positively affected household consumption and education access. However, they also found that many households struggled with debt repayment, which could undermine long-term welfare improvements. Mensah, & Abor, [19] conducted a study in Ghana focusing on the economic impacts of microfinance services on women's empowerment. Their research indicated that microfinance improved women's access to capital and entrepreneurship opportunities, which in turn enhanced their household economic welfare. They noted, however, that the high cost of credit sometimes negated the benefits. Manasseh et al. [20] describe economic development as a country's long-term increase in its ability to deliver a growing variety of products to its inhabitants, which is based on available technologies, institutions, and ideological adjustment.

2.2.2 Financial inclusion and economic welfare

Financial inclusion has numerous advantages in the welfare optimization process in an economy, it changes the way we save, transact, receive, and spend money. Financial inclusion breaks the shackles of cross-border transactions, by integrating and globalizing financial system through digitalization. According to the World Bank (2019) report on financial inclusion, "being able to access a transaction account is a first step towards broader financial inclusion" because a transaction account enables people to store money, and send and receive payments. In other words, a transaction account serves as a gateway to other financial services. In light of this, in Evaluating the determinants of financial inclusion, Evans and Adeoye [21] used a panel regression approach to study 15 countries in Africa from 2005-2014. The result shows that lagged financial inclusion implies "catch-up effects" showing that GDP per capita, money supply as a percentage of GDP, adult literacy rate, internet access, and banking activities have great significance in explaining the level of financial inclusion in Africa. Focusing on economic welfare and financial inclusion, Park and Mercado [22] assessed the cross-country impact of financial inclusion on poverty and income inequality across countries by introducing a new financial inclusion index for 151 economies, using principal component analysis and a cross-sectional approach. The results indicate that higher financial inclusion significantly co-varies with economic growth and lower poverty rates, but only for high and middle-income economies, not those that are low-income. However, they did not find a significant effect of financial inclusion on income inequality in any income group. In an extensive research conducted by Jabir et al. [23] they analyzed the effect of financial inclusion on reducing poverty among low-income households level for 35

countries in sub-Saharan Africa. Taking cross-sectional data from 2011, they found that financial inclusion significantly reduced the level of poverty in sub-Saharan Africa by providing net wealth and larger welfare benefits to the poor. Uddin et al. [24] on their part investigated the determinants of financial inclusion in Bangladesh from 2005 through 2014 by distinguishing between the supply and demand side determinants of financial inclusion using a quantile regression approach. The study established that the size of a bank, efficiency, and interest rates represent the supply-side determinants, while literacy rate and age dependency ratio were demand factors.

In the same vein, Zins and Weill (2016) studied the determinants of financial inclusion in Africa using the World Bank's Global Findex data based on 37 African countries. The study employed the probit estimation method and found that financial inclusion was determined by gender, age and educational levels with a higher influence of education and income. Zhang and Posso [25] constructed an indicator of financial inclusion using the information on transactions and payments, savings, credit and insurance and they discovered a strong positive effect on household income in China. Dimova and Adebowale [26] in the context of Nigeria, find that financial inclusion, measured as owning a bank account increases per capita expenditure but also increases intra-household inequality. Adebowale and Lawson [27] find that financial inclusion reduces transient poverty in the same context as Dimova and Olabimtan [26]. DeLoach and Smith-Lin [28] in the Indonesian economy, find that financial inclusion measured in terms of access to savings and credit enables households to borrow or liquidate assets in response to adult health shock.

Recently, Adegboye, Fakunle, and Alabi [29] conducted a study on the relationship between financial inclusion and poverty reduction in Nigeria. Using a dynamic panel model and data from 2004 to 2018, they found that increased access to mobile banking and digital financial services significantly reduces poverty levels. Their findings suggest that financial inclusion can foster economic welfare through enhanced access to financial resources for low-income households. Relatedly, Agyapong, Osei, and Asamoah [30] examined the effect of financial inclusion on household welfare in Ghana, focusing on rural households. Their study employed a difference-in-difference methodology and found that financial inclusion, particularly mobile money services, had a positive and significant impact on household welfare, measured by income growth and expenditure patterns. They concluded that access to digital financial services improves economic welfare in rural areas. Furthermore, Dibba, Jammeh, and Faal [31] explored the relationship between financial inclusion and economic welfare in The Gambia. The authors used survey data and found that financial literacy plays a crucial role in improving the economic welfare of the Gambian population. Their study shows that financial inclusion through mobile banking and savings groups contributes to increased income and economic empowerment, particularly for women. Tchamyou, Asongu, and Odhiambo (2021) conducted a comprehensive study across 43 African countries, analyzing the effect of financial inclusion on economic development and welfare using panel data from 2000 to 2018. Their findings revealed that financial inclusion, particularly through mobile payments and microfinance, positively affects economic welfare, reduces inequality, and enhances inclusive economic growth. They emphasize the role of government policies in supporting financial inclusion to maximize its welfare impacts. Osei-Assibey and Aboagye [7] focused on the role of microcredit and financial inclusion in improving economic welfare in Ghana. They found that microcredit schemes lead to increased household welfare by improving access to finance for small-scale entrepreneurs. However, they caution that while financial inclusion enhances economic opportunities, it may also increase household debt, which could negatively impact long-term welfare if not managed properly.

Mwangi and Wambugu [32] investigated the impact of financial inclusion on poverty alleviation in Kenya. Using data from the FinAccess Household Survey, they found that access to digital financial services significantly improves household welfare by increasing savings rates, providing credit access, and enhancing income-generating activities. Their findings also highlight the role of financial literacy in maximizing the benefits of financial inclusion on economic welfare. Ncube, Nyasha, and Masunda [33] examined the nexus between financial inclusion and economic welfare in Zimbabwe. Their study used a time-series econometric model to assess the effect of financial inclusion on economic welfare from 1990 to 2020. They found that while mobile banking and savings services contribute

to economic welfare, the lack of infrastructure and financial literacy poses significant challenges to realizing the full potential of financial inclusion in the country. Amponsah and Sarpong [34] conducted a study in West Africa, focusing on the impact of financial inclusion on income inequality and economic welfare. Their study, which employed a panel data approach, showed that financial inclusion reduces income inequality by providing previously excluded populations with access to financial services. This, in turn, contributes to increased economic welfare and poverty alleviation, particularly in rural areas. Kebede and Kifle [35] explored the role of financial inclusion in improving economic welfare in Ethiopia. Using data from the Ethiopian Household Consumption Survey, they found that financial inclusion through microfinance and mobile money services enhances economic welfare by providing credit for small-scale enterprises and facilitating savings. However, they also noted that financial inclusion initiatives in rural areas face significant challenges due to poor infrastructure and low financial literacy levels. Chironga and Munyanyi [36] studied the impact of financial inclusion on women's economic welfare in Southern Africa. Their study found that women who have access to mobile banking services experienced a significant improvement in economic welfare, measured by increased business opportunities, income, and savings. They highlighted the importance of gender-focused financial inclusion policies to reduce gender inequality in access to financial services.

3. DATA AND METHODOLOGY

3.1 Data and Sources

We used annual time series data spanning from 2004 to 2023 which was sourced from the IMF database, the World Bank's Global Findex, the World Bank's World Development Indicators (WDI), and World Governance Indicators (WGI). The data, definitions, and expected apriori economic signs are shown in Table 1.

To vividly investigate microfinance, financial inclusion, and economic welfare, we measured economic welfare by using household consumption (HHC) following Gangopadhyay and Wadhwa [37] Gandhimathi et al (2012), and Gupta Anil [38] microfinance is measured with the number of microfinance branches (NOB), microfinance borrowers (MFBs), microfinance outstanding deposits (MOD) and microfinance

Table 1. Definition of research variables

Variable	Definition	Sign
EWM	Household Consumption (HHC) is all transactions of the national account representing consumption expenditure by resident households on individual consumption of goods and services.	---
MFM	The number of microfinance branches (NOB); Microfinance borrowers (MFBs); Microfinance outstanding deposits (MOD); and Microfinance outstanding loans (MOL).	Positive
FIM	Number registered mobile money accounts per 1,000 Adults (NRMA); Number of mobile money agent outlets per 1,000 Adults (NAMO); and Digital Card Ownership (DCO).	Positive
GIM	Rule of Law (ROL); Regulatory Quality (REQ) and Government Effectiveness (GEF).	Positive
Control Variables		
EXR	The exchange rate (EXR) is defined as the rate at which one currency will be exchanged for another.	Positive
INF	Inflation is seen as a general rise in price level relative to available goods which results to a substantial and continuing drop in purchasing power in an economy over some time.	Negative
INTR	Interest rate is the amount a lender charges for the use of his assets or money expressed as a percentage of the principal.	Positive

Source: Author's Conception. Note: EWM represents economic welfare measures; MFM denotes microfinance measures; FIM represents financial innovation measures; and GIM represents governance and institutional quality measures. For Selected Countries which Include: Angola, Benin Republic, Burkina Faso, Burundi, Cameroon, Cote D'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Madagascar, Mali, Niger, Nigeria, Rwanda, Senegal, Sudan, Tanzania, Togo, Uganda, Zambia, and Zimbabwe

outstanding loans (MOL) following Yaidoo, Lindsay & Kalaish, Vishwanatha [39] financial inclusion was measured by the number of registered mobile money agents (NRMA), number of active mobile money agent outlets (NAMO) and digital card ownership following Peterson K. Ozili [40] governance and institutional quality were measured by using rule of law (ROL), regulatory quality (REQ) and government effectiveness (GEF) following Mankiw, Romer et al. [41] while controlling for the exchange rate, inflation, and interest rate.

3.2 Model Specification

In this study on microfinance, financial inclusion and economic welfare, we employed microfinance, financial inclusion, governance and institutional quality measures and economic welfare measures to investigate their nexus. However, the mathematical form of the model of the study is presented below:

$$EWM = f(MFM, FIM, GIM, Control) \quad (1)$$

Where EWM represents economic welfare measures; MFM denotes microfinance measures; FIM represents financial innovation measures; GIM represents governance and institutional quality measures; and control signifies the control variables. The econometric version of the model is expressed as follows:

$$EWM = \vartheta_0 + \vartheta_1 MFM + \vartheta_2 FIM + \vartheta_3 GIM + \vartheta_4 Control + \mu_t \quad (2)$$

Where t is time; ϑ_0 is the constant; $\vartheta_1 to \vartheta_4$ represents the coefficients and μ_t denotes the error term.

In empirical studies, the use of time series data is widely used by scholars and if not properly managed, it may lead to spurious regression. Thus, utilizing the fully modified OLS (FMOLS), Dynamic OLS (DOLS) and Panel Autoregressive Distributed Lag (ARDL) model we aim to provide optimal estimates of cointegrating regressions. It is highly beneficial to combine these models and the main reasons why we combined the three models in this study are explained as follows. To effectively assess the robustness of the parameter estimates of different specifications and also to account for the short-run dynamics of the model. Although FMOLS and DOLS are nonparametric approaches, they are appropriate in dealing with nuisance parameters, which may sometimes be problematic, especially in small samples. To apply FMOLS, and DOLS for the estimation of long-run parameters, there must be the existence of a cointegration relationship among the series of the variables at the order I(1). Based on this reason, we test for the presence of unit roots to determine the cointegrating status of the variables. We employed we employed Levine, Lin and Chu (2002), Im, Pesaran and Shin (2003) and Fisher-type tests using ADF and PP tests (Maddala and Wu, 1999). After this Pedroni (1999, 2004) and Kao (1999) cointegration tests were used to test the presence of cointegration relationships among the variables.

The advantage of the FMOLS is that to attain asymptotic efficiency, FMOLS modifies the least squares for serial correlation and endogeneity of the regressors, which arise as a result of a cointegrating relationship (Hansen and Kim, 1995; Phillip and Hansen, 1990). As developed by Phillips and Hansen (1990), Phillips and Moon (1999) and Pedroni (1995, 2000), the FMOLS estimators use initial estimates of the symmetric and one-sided long-term covariance matrices of the residuals. Consider the n+1 dimensional time series vector process (Y, X), with the cointegrating equation,

$$Yt = Xt\beta + D_{1t}\Psi + \mu_{1t} \quad (3)$$

Where Xt are the n stochastic regressors, $Dt = (D_{1t}, D_{2t})$ are deterministic trend regressors and μ_{1t} are the residuals. The μ_{2t} is obtained $\mu_{2t} = \Delta\Sigma_{2t}$ from the levels regression.

$$Xt = \Gamma D_{1t} + \Gamma D_{2t} + \Sigma_{2t} \quad (4)$$

Alternatively, from differenced regressions

$$\Delta Xt = \Gamma\Delta D_{1t} + \Gamma\Delta D_{2t} + \mu_{2t} \quad (5)$$

Let φ and ζ be the long – run covariance matrices which can be calculated using the residuals $\mu_{2t} = (\mu_{1t}, \mu_{2t})$.

The modified data can be defined as follows:

$$Y_t = Y_t - \Phi_{12}\varphi_{22}\mu_2 \quad (6)$$

And the estimated bias correlation terms are

$$\zeta = \zeta_{12} - \Phi_{12}\varphi_{22}\zeta_{22} \tag{7}$$

The FMOLS estimator is therefore given by the following equations

$$\theta = \begin{bmatrix} \beta \\ \Psi_1 \end{bmatrix} = \left[\sum_{t=1}^{T} Z_t Z_t\right]^{-1}\left[\sum_{t=1}^{T} Z_t Y_t - T\begin{bmatrix} \zeta_{12} \\ 0 \end{bmatrix}\right] \tag{8}$$

Where $Zt = (X_t, D_t)$

The DOLS model as developed by Stock and Watson (1993), involves the regression of the dependent variable on all independent variables, leads and lags of the first difference of all I(1) variables (Masih and Masih, 1996). The advantage is that it applies to a system of variables with different orders of integration, small sample biases are taken care of leads and lags of the differenced independent variables among regressors (Stock and Watson, 1993). According to Saikonnen (1991), the DOLS estimator corrects for serial correlation and endogeneity by including lags and leads of the differenced I(1) regressors in the regression. The DOLS model is derived by augmenting I(1) the cointegrating regression with leads and lags of ΔXt so that the resulting cointegrating equation term is orthogonal to the entire history of the stochastic innovations. However, the DOLS model is specified as follows:

$$Yt = X_t\beta + D_{1t}\gamma_1 + \sum_{j=-q}^{T} \Delta X_{t+j}\delta + V_{1t} \tag{9}$$

Where Yt is the dependent variable, Xt a vector of independent variables, and Δ is the lag operator. It is assumed that adding q lags and r leads of the differenced regressors absorbs all the long-run correlation between μ_{1t} and μ_{2t} Besides, least squares estimates of $\theta = (\beta, Y)$ using equation 7 possess equivalent asymptotic distribution as those from FMOLS.

The autoregressive distributed lag model (ARDL) is used in this study because it allows for both long-run and short-run dynamic error correction models (ECM) using linear transformation (Banerjee et al. 1993). The basic features of the ARDL model lie in its characteristics such as generating superior estimates regardless of the sample size which can be either small or finite (Ghatak and Siddiki, 2001); suitable for all variables regardless of their order of integration; when modelled with appropriate lags, it corrects both serial correlation and endogeneity problems (Pesara et al 2001); and ARDL model can simultaneously estimate both long run and short run cointegration relationships and provide unbiased estimation for the study (Pearan et al. 2001). However, an ADRL model for a, b and c can be expressed as follows:

$$Gt = \sum_{f=0}^{e} \Omega_f G_{t-1} + \sum_{h=0}^{r} MhX_{t-1} + \mu_t \text{ ----------} \tag{10}$$

In a differencing form, the equation can be re-written as follows:

$$\Delta G_t = \beta_1 G_t - 1 + \beta_2 X_t - 1 + \sum_{f-1}^{e-1} \Omega f \Delta Y_{t-f} + \sum_{h=0}^{r-1} M_h \Delta X_{t-h} + \mu_t \text{ ----------} \tag{11}$$

$$\Delta G_t = \beta_1 V_{t-1} + \sum_{f-1}^{M-1} \Omega f \Delta Y_{t-f} + \sum_{h=0}^{r-1} M_h \Delta X_{t-h} + \mu_t \text{ ----------} \tag{12}$$

Where $V_{t-1} = G_{t-1} + (\frac{\beta_2}{\beta_1}) X_{t-1}$ and this is based on the assumption that in the long run, $Y_t = Y_{t-1}$ and $X_t = X_{t-1}$.

Equation 10 signifies the standard ARDL model expressing the dependent variable (G_t) as a function of its lag $(Y_{t-1})(AR)$ and the lag of the dependent variable X_{t-h} DL. Equation 11, shows the short-run and long-run relationships between the dependent variable and the independent variables, where

$\beta_1 and \beta_2$ are the long-run parameters M_f and Ωh are the short-run parameters. For equation 12, $V_{t-1} = Y_{t-1} + (\frac{\beta_2}{\beta_1}) X_{t-1}$ - is based on the assumption that in the long run, there is convergence such that $Y_t = Y_{t-1}$ and $X_t = X_{t-1}$.

However, re-parameterizing equation 12 with the variables of the study, we have the following:

$$\Delta LHHCt = \beta_1 V_{t-1} + \sum_{f=1}^{e-1} Gf \Delta LHHC_{t-f} + \sum_{h=0}^{r-1} M_h \Delta LNOB_{t-1} + \sum_{i=0}^{r-1} \rho i \Delta LMFBS_{t-1} + \sum_{m=0}^{s-1} \beta m \Delta LMOD_{t-1} + \sum_{e=0}^{w-1} \alpha e \Delta LMOL_{t-1} + \sum_{n=0}^{t-1} \delta n \Delta LNRMA_{t-1} + \sum_{i=0}^{r-1} \omega i \Delta LROL_{t-1} \sum_{i=0}^{c-1} \Phi i \Delta LREQ_{t-1} + \sum_{j=0}^{t-1} \gamma j \Delta LGEF_{t-1} + \sum_{k=0}^{t-1} \wp_k \Delta LEXR_{t-1} + \sum_{g=0}^{t-1} \hbar_g \Delta LINF_{t-1} + \sum_{x=0}^{t-1} \ell_x \Delta LINTR_{t-1} + \mu_t \quad (13)$$

Equation 13, $\beta_1 V_{t-1}$ measures the long-run relationships, G_f is the parameter that measures the short-run relationships between microfinance, financial inclusion and economic growth. M_k Measures the short-run relationship between NOB and HHC; ρi measures the short-run relationship between MFBS and HHC; βm measures the short-run relationship between MOD and HHC; αe measures the short-run relationship between MOL and HHC; δn measures the short-run relationship between NRMA and HHC; ϕa measures the short run relationship between REQ and HHC; ψd measures the short run relationship between GEF and HHC; ϖi measures the short run relationship between ROL and HHC; γj measures the short run relationship between GEF and HHC; $\wp_k$ measures the short run relationship between EXR and HHC; $\hbar_g$ measures the short run relationship between INF and HHC; ℓ_x measures the short run relationship between INTR and HHC; while μt is the error term.

4. DISCUSSION OF THE EMPIRICAL FINDINGS

This study investigates the nexus between microfinance, financial inclusion and economic welfare in Africa from 2004 to 2023 owing to data availability in Africa. We employed panel least square (P-OLS), fully modified ordinary least squares (FMOLS), dynamic ordinary least squares (DOLS) and panel autoregressive distributed lag model (PARLD) for the analysis. However, before conducting the analysis, we ensure that we carried basic econometric tests like descriptive statistics, Spearman's correlation test, and unit root test to ascertain the nature of the variables. We also, take our models through normality, serial correlation, Ramsey Reset model specification test, and heteroscedasticity test since there outcomes would be very beneficial in decision making on both the variables and models. Hence, we describe the variables to ascertain their nature in the next section.

4.1 Data Description

To get a good knowledge of the basic behavious of the variables, we conducted both descriptive statistics and Spearman's correlations on the variables. The descriptive statistics measures the basic summary of the model variables using the measures of central tendency such as mean, median, standard deviation, Skewness and Kurtosis. From the results as shown in Table 2, we found that minimum and maximum values in the series revolves around -6.431 and 10.62 which represent the least and highest values among the variables. Furthermore, the values of mean, median, standard deviation, Skewness, and Kurtosis for each of the model variables did not drift so much from each other and this suggests that variables are normally distributed and suitable for the analysis of the relationship between financial inclusion, microfinance and economic welfare in Africa.

Lessons drawn from Table 2 also revealed that there is existence of correlations between

microfinance, financial inclusion and economic welfare in Africa. From the results of Spearman's correlation, we found that number of microfinance borrowers (NOB), had no correlations with economic welfare, while number of microfinance branches (MFBS), microfinance outstanding deposits (MOB) and microfinance loans (MOL) have moderate positive correlations with economic welfare in Africa. On the opposite ends, we found that financial inclusion indicators – number of registered mobile money accounts (NRMA) had moderate positive correlations on economic welfare, while the number of mobile money agent outlets (NAMO) and digital card ownerships (DCO) showed weak negative correlation on economic welfare in Africa. Findings from the results also shows that the control variables – exchange rate, inflation rate have weak correlations with economic welfare, while interest rate showed moderate correlations with economic welfare in Africa. In addition, measures of institutional quality – government effectiveness have positive correlations on economic welfare, while the rule of law, and regulatory quality have negative correlations with economic welfare in Africa.

4.2 Test for Stationarity (Unit Root Test)

Granger and Newbold (1974) opined that if time series data are non-stationary, estimates of the regression result would be spurious. Based on this inference, we employed the following panel unit root tests Levine, Lin and Chu (2002); Im, Pesaran and Shin (2003); and Fisher-type tests using ADF and PP tests (Maddala and Wu, 1999) following Hurlin and Mignon [42] to determine the level of Stationarity and order of integration of the variables of the model and the results are presented in Table 4. From Table 3, all the variables are statistically significant at a 1% level of significance except for MOL in IPS, ADF-Fisher and PP-Fisher tests, however, virtually all the variables are integrated at I(0) except MFBs and ROL which are integrated at the order I(1), and none of the variables integrated at I(2).

4.3 Cointegration Test

The result of the unit root test concluded that all the variables are integrated at the order I(0) or at first difference i.e. order I(1) but no variable integrated at the order I(2). Thus, we set out to investigate further whether cointegrating relationships exist between the variables of the model. We employed Pedroni's (1999; 2004) cointegration and also Kao's (19990) tests as a robustness check. The null hypothesis for the test is "no cointegration" and the decision rule is to reject the null hypothesis if the P-values of the calculated values are less than (0.05). Thus, the results are presented below.

From the results of the Pedroni cointegration test in Table 4 above, the P-values of most of the estimates are less than 0.05 which led to the rejection of the null hypothesis "no cointegration" and acceptance of the alternative hypothesis, thus, suggesting that there is the existence of cointegration among the variables of the model. However, to truly ascertain if there is the existence of cointegration among the variables, we also carried out the Kao cointegration test as a robust check for the initial finding from the Pedroni test. Findings from the test confirmed that there is the existence of cointegration since the P-value of the ADF statistic is less than 0.05.

4.4 Analysis of OLS Estimation and Hausman Tests for the Specified Models

To fulfil the assumptions of OLS, all the specified models of the study were taken through pre and post-OLS estimation tests to ensure that our result would yield the desired estimates. Also, we conducted the Hausman test for panel ARDL regression analysis to enable us to ascertain the suitable models for the specified equations. Thus, the results are presented in Table 5.

Following wing the outcomes of the results in Table 5, we concluded the normality test that the error terms of the specified models are normally distributed, since their P-values are less than 0.05; also evidence from the Breusch-Godfrey Serial Correlation test, White Heteroskedasticity test and Ramsey Reset test shows that there is no evidence of serial correlation, in the specified model; the variance distribution of the model are homoscedastic and the models are well specified. On the other hand, the result of the Hausman test shows that random effects is suitable for the specified models since their estimated P-values are greater than 0.05 (see Table 6).

Table 2. Nature of variables used in the study

Descriptive Statistics														
	HHC	**NOB**	**MFBS**	**MOD**	**MOL**	**NRMA**	**NAMO**	**DCO**	**EXR**	**INF**	**INTR**	**ROL**	**REQ**	**GEF**
Mean	0.812	0.768	6.584	1.345	3.731	1.148	-0.691	1.694	0.837	0.946	0.909	-0.779	-0.293	-0.818
Median	0.962	0.979	6.513	1.494	3.710	1.193	-0.355	0.317	1.188	0.228	0.913	-0.689	-0.489	-0.778
Maximum	4.102	2.620	9.021	2.719	5.027	3.626	3.977	13.80	3.861	10.62	2.643	0.149	1.990	0.266
Minimum	-6.431	-6.350	4.717	-2.512	2.789	-4.008	-33.54	0.012	-2.325	-1.662	0.000	-1.852	-1.848	-1.766
Std. Dev.	1.231	1.026	0.888	0.743	0.469	1.131	3.788	3.009	1.561	2.545	0.447	0.465	0.923	0.400
Skewness	-1.173	-2.018	0.626	-1.578	0.688	-0.607	-6.082	2.415	-0.246	2.529	0.199	-0.149	0.920	0.140
Kurtosis	7.746	12.02	3.421	7.049	3.441	4.167	51.38	7.878	1.871	9.061	3.405	2.142	3.272	2.542
Correlation Matrix														
HHC	1.000													
NOB	0.219	1.000												
MFBS	0.675	0.120	1.000											
MOD	0.535	0.948	0.049	1.000										
MOL	0.690	0.162	0.316	0.022	1.000									
NRMA	0.629	0.059	0.169	0.072	-0.121	1.000								
NAMO	-0.304	0.023	-0.156	0.050	-0.211	-0.083	1.000							
DCO	-0.390	0.240	-0.153	0.243	0.057	-0.125	0.167	1.000						
EXR	0.294	-0.102	-0.232	-0.117	0.308	-0.022	-0.074	0.125	1.000					
INF	-0.734	0.019	0.017	0.078	0.015	-0.119	-0.035	0.179	0.049	1.000				
INTR	0.608	0.013	0.208	-0.012	0.132	0.015	-0.158	-0.232	0.081	0.041	1.000			
ROL	-0.574	0.129	0.018	0.195	0.198	0.078	0.051	0.098	0.254	-0.134	0.041	1.000		
REQ	-0.340	0.044	-0.019	-0.055	0.467	0.013	-0.073	0.171	0.275	0.122	0.004	0.303	1.000	
GEF	0.680	0.028	0.110	0.038	0.120	0.119	0.013	-0.133	0.180	-0.225	0.124	0.835	0.146	1.000

Source: Author's conceptualization

Table 3. Summary of unit root tests

Variables	LLC	IPS	ADF-Fisher	PP-Fisher	Integ. Order	
					Level	First Diff.
HHC	-5.052***	-4.054***	94.25	162.3		
	(0.000)	(0.000)	(0.000)	(0.000)	I(0)	-----
NOB	-5.778***	-5.737***	112.0***	179.4***		
	(0.000)	(0.000)	(0.000)	(0.000)	I(0)	-----
MFBs	-8.740***	-5.584***	110.0***	173.2***		
	(0.000)	(0.000)	(0.000)	(0.000)	-----	I(1)
MOD	-4.482***	-4.632***	94.96***	146.3***		
	(0.000)	(0.000)	(0.000)	(0.000)	I(0)	-----
MOL	-3.050***	-1.740**	70.03**	70.76**		
	(0.001)	(0.040)	(0.017)	(0.010)	I(0)	------
NRMA	-8.114***	-4.711***	97.343***	95.92***		
	(0.000)	(0.000)	(0.000)	(0.000)	I(0)	------
NAMO	-4.354***	-8.711***	112.2***	130.8***		
	(0.000)	(0.000)	(0.000)	(0.000)	I(0)	-----
DCO	-3.877***	-2.890***	85.41***	89.30***		
	(0.001)	(0.001)	(0.004)	(0.000)	I(0)	-----
EXR	-9.354***	-3.764	90.43	108.8		
	(0.000)	(0.000)	(0.000)	(0.000)	I(0)	-----
INF	-8.527***	-5.963***	118.5***	132.1***		
	(0.000)	(0.000)	(0.000)	(0.000)	I(0)	-----
INTR	-2.778***	-3.075***	82.58***	80.75***		
	(0.002)	(0.001)	(0.000)	(0.001)	I(0)	-----
ROL	-10.39***	-9.373***	194.5***	215.0***		
	(0.000)	(0.000)	(0.000)	(0.000)	___	I(1)
REQ	-10.39***	-9.373***	171.2***	162.9***		
	(0.000)	(0.000)	(0.000)	(0.000)	I(0)	----
GEF	-4.128***	-3.111***	84.20***	91.82***		
	(0.000)	(0.009)	(0.000)	(0.000)	I(0)	----

*Source: Author's computation (.) represents the Probability values; while ***, ** and * represents 1%, 5% and 10% levels of significance*

Table 4. Cointegration results

Pedroni Cointegration Test				
Within-Dimension				
	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	-2.601	0.995	-5.121	0.000
Panel rho-Statistic	3.867	0.947	5.004	0.000
Panel PP-Statistic	-9.879	0.000	-2.409	0.008
Panel ADF-Statistic	-6.518	0.000	-1.241	0.107
Between-Dimension				
Group rho-Statistic	6.8536	0.000		
Group PP-Statistic	-9.601	0.000		
Group ADF-Statistic	-2.349	0.009		
Robustness Check Kao Cointegration Test				
ADF-Statistic	2.979			
Probability	0.001			

Source: Author's Computation. Decision made based on α=0.0

4.5 Long Run Estimated Results

Having ascertained the existence of cointegration among the series, and that the models satisfied the assumptions of OLS, we therefore set to investigate the long-run relationships that exists between the variables of the study. To do this, we employed multiple regression techniques ranging from the panel least squares model, fully modified OLS, and dynamic OLS to the panel autoregressive distributed lag (ARDL) model. Our study aimed at using the aforementioned estimation techniques to explore the long-run relationship of microfinance, financial inclusion and economic welfare in selected African countries on one hand, and then using the short-run component of the panel ARDL model to account for the short-run error correction of the long run effects of the model. To lessen the ambiguity, the models were segmented into three parts namely: microfinance and economic welfare; financial inclusion and economic welfare; and microfinance, financial inclusion and economic welfare. Thus, the results are presented in Table 6.

We employed the measures of microfinance such as (Number of Branches of Microfinance banks (NOB), Microfinance Borrowers (MFBs), Microfinance outstanding deposits (MOD), Microfinance outstanding loans (MOL)); measures of financial inclusion (number of registered mobile money accounts per 1,000 adults – NRMA; number of mobile money agent outlets par 1,000 adults – NAMO; and digital card ownership (DCO)); measures of governance and institutional quality (Rule of law (ROL), regulatory quality (REQ), and government effectiveness (GEF); and economic welfare measure (household consumption (HHC)) while controlling for inflation rate, interest rate and exchange rate. The main finding of this study is that there is existence of positive long run relationship between microfinance, financial inclusion and economic welfare since the coefficients of the microfinance, and financial inclusion are positive and statistically significant. This finding however is in line with some extensive studies conducted by Wachukwu et al. [8] Christensson [6] and (Mhalanga et al. 2020) among others [43,44].

Table 5. Summary of results of pre and Post-OLS estimation tests and hausman test

Model	Normality Test	Serial Correlation	Ramsey Test	Heteroskedasticity	Hausman Test
1A	6072. (0.000)	0.134 (0.874)	-0.544 (0.003)	1.019 (0.418)	5.239 (0.630)
1B	6809. (0.000)	0.163 (0.849)	-0.061 (0.000)	0.464 (0.991)	3.044 (0.880)
2A	4911. (0.000)	0.060 (0.941)	-0.077 (0.000)	1.259 (0.081)	6.603 (0.359)
2B	5676. (0.000)	0.142 (0.867)	-0.413 (0.000)	1.721 (0.117)	4.794 (0.570)
3A	540.1 (0.000)	0.061 (0.940)	-0.317 (0.000)	0.913 (0.633)	7.230 (0.613)
3B	5342. (0.000)	0.054 (0.947)	0.445 (0.001)	0.762 (0.863)	1.444 (0.997)
3C	5393. (0.000)	0.785 (0.906)	-0.318 (0.008)	0.794 (0.823)	5.689 (0.770)

Source: Computed by the Author Using Eviews 10

Table 6. Results for empirical models of the study

Microfinance and Economic Welfare **Model 1a: Dependent Variable (HHC)**				
Variable	P-Least Square	FMOLS	DOLS	P-ARDL
NOB	0.308*** (0.000)	0.131*** (0.000)	-0.154*** (0.000)	0.411*** (0.000)
MOD	0.273*** (0.000)	0.088*** (0.000)	0.137*** (0.002)	0.751*** (0.939)
MOL	0.608*** (0.001)	0.755*** (0.000)	0.076*** (0.000)	0.012*** (0.004)

EXR	-0.117**	-0.060***	-0.388**	0.141***
	(0.017)	(0.000)	(0.019)	(0.000)
INF	-0.839	-0.531	-0.066	0.069***
	(0.785)	(0.408)	(0.818)	(0.000)
INTR	0.008	0.331***	0.218	0.736***
	(0.946)	(0.000)	(0.121)	(0.000)
D(MFBS)	0.511***	0.162***	0.123***	0.014***
	(0.000)	(0.000)	(0.000)	(0.004)
Model 1B: Dependent Variable (HHC)				
NOB	0.115**	0.774**	0.120**	0.532***
	(0.036)	(0.013)	(0.015)	(0.000)
MOD	0.098	0.576	0.098**	0.331***
	(0.060)	(0.946)	(0.030)	(0.001)
MOL	0.159***	0.965***	0.049***	0.814***
	(0.000)	(0.000)	(0.000)	(0.008)
REQ	-0.249**	-0.352**	0.249***	0.273
	(0.018)	(0.000)	(0.006)	(0.129)
GEF	-0.032	-0.284***	-0.032	2.493***
	(0.851)	(0.002)	(0.828)	(0.000)
D(MFBS)	-0.108***	-0.108***	0.898***	0.822***
	(0.000)	(0.000)	(0.000)	(0.000)
D(ROL)	0.609***	1.084***	0.609***	4.039**
	(0.006)	(0.005)	(0.000)	(0.010)
Financial Inclusion and Economic Welfare				
Model 2A: dependent Variable (HHC)				
NRMA	0.014***	0.025***	0.014	0.401***
	(0.000)	(0.000)	(0.127)	(0.000)
NAMO	0.03*	0.029***	0.034***	0.969
	(0.049)	(0.000)	(0.007)	(0.856)
DCO	0.102***	0.093***	0.168***	0.235***
	(0.008)	(0.008)	(0.004)	(0.000)
EXR	0.751**	0.016**	0.031**	0.108***
	(0.032)	(0.029)	(0.021)	(0.000)
INF	0.038	0.032	0.038	0.109***
	(0.268)	(0.156)	(0.263)	(0.000)
INTR	0.526***	0.564***	0.526***	0.529***
	(0.000)	(0.000)	(0.000)	(0.000)
Model 2B: Dependent Variable (HHC)				
NRMA	0.018***	0.031***	0.018***	0.006***
	(0.000)	(0.008)	(0.009)	(0.000)
NAMO	0.026***	0.013	0.549**	-0.318***
	(0.000)	(0.077)	(0.023)	(0.000)
DCO	-0.109***	-0.112***	-0.109***	0.029***
	(0.000)	(0.000)	(0.000)	(0.006)
REQ	-0.031	-0.032	-0.314	-0.915***
	(0.989)	(0.441)	(0.987)	(0.000)
GEF	-0.827***	-0.746***	-0.827***	2.615***
	(0.000)	(0.000)	(0.000)	(0.000)
D(ROL)	1.363	2.094***	1.363	-4.913***
	(0.146)	(0.000)	(0.088)	(0.000)
Microfinance, Financial Inclusion and Economic Welfare				
Model 3A: Dependent Variable (HHC)				
NOB	0.175***	0.348***	0.175***	0.277**
	(0.000)	(0.000)	(0.000)	(0.039)
MOD	0.169***	0.249***	0.169***	-0.096
	(0.000)	(0.000)	(0.000)	(0.262)

MOL	0.607***	0.826***	0.107***	-0.126**
	(0.000)	(0.000)	(0.000)	(0.015)
NRMA	0.347	0.038***	0.047	0.443***
	(0.719)	(0.000)	(0.681)	(0.000)
NAMO	0.026**	0.043***	0.929**	0.023
	(0.038)	(0.000)	(0.017)	(0.614)
DCO	-0.131***	0.097***	-0.131***	-0.297***
	(0.000)	(0.000)	(0.000)	(0.000)
EXR	0.485	0.149***	0.485	0.087***
	(0.686)	(0.000)	(0.643)	(0.009)
D(ROL)	0.864***	0.662	0.864	0.492
	(0.000)	(0.084)	(0.272)	(0.652)
D(MFBS)	-0.014***	0.386	-0.114***	-2.654
	(0.000)	(0.253)	(0.004)	(0.349)
Model 3B: Dependent Variable (HHC)				
NOB	0.132**	0.128***	-0.371***	0.577**
	(0.017)	(0.000)	(0.006)	(0.039)
MOD	0.123**	0.178***	0.823***	-0.370
	(0.019)	(0.000)	(0.007)	(0.265)
MOL	0.168***	0.859***	0.0118***	-0.526**
	{0.000)	(0.000)	(0.000)	(0.015)
NRMA	0.708	-0.167***	0.781	0.443***
	(0.558)	(0.000)	(0.504)	(0.000)
NAMO	0.729	0.965***	0.729**	0.813
	(0.056)	(0.000)	(0.029)	(0.614)
DCO	0.156***	-0.195***	-0.456***	-0.355***
	(0.000)	(0.000)	(0.000)	(0.000)
INF	0.781***	0.209***	0.678	-0.396***
	(0.009)	(0.000)	(0.112)	(0.000)
REQ	0.836***	-0.548	-0.836***	-1.253***
	(0.007)	(0.094)	(0.004)	(0.000)
D(MFBS)	0.149***	-0.628***	-0.149	0.858
	(0.000)	(0.000)	(0.207)	(0.229)
Model 3C: Dependent Variable (HHC)				
NOB	0.145	0.392	0.683	0.577
	(0.009)	(0.000)	(0.003)	(0.039)
MOD	0.141***	0.812***	0.106***	-0.096
	(0.005)	(0.000)	(0.001)	(0.265)
MOL	0.856***	0.612***	0.656***	-0.126**
	(0.000)	(0.000)	(0.000)	(0.015)
NRMA	0.451**	0.041***	0.351	0.443***
	(0.013)	(0.000)	(0.746)	(0.000)
NAMO	0.226	0.543***	0.926**	0.813
	(0.056)	(0.000)	(0.029)	(0.614)
DCO	0.763***	0.261***	0.146***	0.343***
	(0.000)	(0.000)	(0.000)	(0.000)
INF	0.314	0.706	0.341	0.797***
	(0.365)	(0.536)	(0.301)	(0.000)
GEF	0.212***	1.323***	0.287***	6.577***
	(0.000)	(0.000)	(0.001)	(0.000)
D(MFBS)	0.153	0.546***	0.053	0.528***
	(0.259)	(0.000)	(0.198)	(0.007)

Source: Author's Computation Aided by Eviews 10. Note: (.) denotes P-values

Table 7. Short run error correction model

Variables	Model 1A	Model 1B	Model 2A	Model 2B	Model 3A	Model 3B	Model 3C
COINTEQ01	-0.765*** (0.000)	-0.613*** (0.000)	-0.831*** (0.000)	-0.677*** (0.000)	-0.683*** (0.000)	-0.348*** (0.000)	-0.805*** (0.000)
D(NOB)	-5.504 (0.323)	-2.841 (0.615)			-12.03 (0.311)	19.04*** (0.000)	-5.200 (0.434)
D(MOD)	5.506 (0.310)	2.914 (0.595)			11.70 (0.310)	14.70 (0.310)	5.025 (0.442)
D(MOL)	-0.045 (0.404)	-0.060 (0.497)			0.054 (0.460)	-2.424** (0.017)	0.036 (0.614)
D(NRMA)			0.213 (0.399)	0.258 (0.278)	0.079 (0.650)	0.770 (0.937)	0.280 (0.335)
D(NAMO)			3.984** (0.032)	2.664 (0.118)	3.443 (0.115)	3.343 (0.919)	3.836 (0.058)
D(DCO)			1.239 (0.875)	-0.504 (0.953)	4.618 (0.371)	4.556 (0.994)	-0.532 (0.937)
D(REQ)		0.696 (0.771)		0.948*** (0.006)		0.562 (0.723)	
D(GEF)		15.21 (0.080)		7.045 (0.222)			12.78 (0.087)
D(EXR)	0.303 (0.819)		1.154 (0.396)		-0.564 (0.548)		
D(INF)	0.883 (0.466)		1.315** (0.035)			-0.754 (0.550)	
D(INTR)	0.094 (0.987)		0.047*** (0.000)				7.407 (0.214)
D(ROL,2)		10.16* (0.041)		3.621 (0.588)	7.917** (0.031)		
D(MFBS,2)	-0.366 (0.677)	0.283 (0.307)			0.295** (0.024)	0.640 (0.226)	-2.434 (0.997)

Source: Author's concept

4.6 Short Run Dynamics

To account for the short run dynamics of the model, emanating from the long run components of the specified equations, we employed the short run compartment of our earlier specified panel autoregressive distributed lag model (ARDL) and the results are presented below.

The cointegrating equation (COINTEQ01) or the error correction term (ECT) measures the speed of adjustment from short run to long run. Following the findings made by Phalavani et al (2005), an error correction term should possess negative sign and statistically significant. In our study, the coefficients of the error correction terms for the specified models have negative signs and statistically significant at 1% level. This implies that the speeds of adjustment from long run to short run in the models would be 76%, 61%, 83%, 67%, 68%, 34%, and 80% respectively for all the specified models. Thus these findings tallied with previous study such as (Shabbiar 2016, and Aboagye 2021) among others.

5. SUMMARY AND CONCLUSION

Our study focus on microfinance, financial inclusion and economic welfare in the 23 selected African countries (see Table 2 for list of countries) and annual time series data spanning from 2004 to 2019 was utilized. We employed Panel Least Square, Fully modified OLS, Dynamic OLS and Panel Autoregressive distributed lag model (ARDL) techniques. And our major aim was to investigate the long run relationship between microfinance, financial inclusion and economic welfare as well as the short run dynamics of the model using the short run component of the panel ARDL model. The following variables was utilized in the study; the measures of microfinance such as (Number of Branches of Microfinance banks (NOB), Microfinance Borrowers (MFBs), Microfinance

outstanding deposits (MOD), Microfinance outstanding loans (MOL)); measures of financial inclusion (number of registered mobile money accounts per 1,000 adults – NRMA; number of mobile money agent outlets par 1,000 adults – NAMO; and digital card ownership (DCO)); measures of governance and institutional quality (Rule of law (ROL), regulatory quality (REQ), and government effectiveness (GEF); and economic welfare measure (household consumption (HHC)) while controlling for inflation rate, interest rate and exchange rate.

Evidence from Pedroni cointegration test shows that there is cointegration among the variables of the study since the P-values of 5 out of 7 tests of Pedroni (1999, 2004) cointegration tests are less than 0.05 which led to rejection of the null hypothesis “no cointegration” and the acceptance of the alternative. In addition, the result of the robustness check (Kao cointegration test as proposed by Kao (1999) also confirmed the existence of cointegraion among the variables since the ADF-statistic is statistically significant at 1%, which connotes the presence of cointgration between the variables. Before estimating the model, pre and post OLS estimation tests (Normality test, Breusch-Godfrey Serial correlation test, Whit Heteroskedasticity test and Ramsey Reset test were carried out to ensure the model satisfies the basic assumptions of the OLS. Findings from the results shows that, the error terms of the specified models are normally distributed and serially uncorrelated, the variance of the error terms are homoscedastic and the models are correctly specified (see Table 6). The result of Hausman test also shows that random effects are suitable for the estimation process since their P-values are greater than 0.05. Findings from Panel least square, DOLS, FMOLS and Panel ARDL results shows that there is existence of positive long run relationships between microfinance, financial inclusion and economic welfare since most of the coefficients of the microfinance and financial inclusion are positive and statistically significant in the studied countries which is in line with studies by Wachukwu et al. [8] and Amin & Uddin, [1] among others. We further investigated the error correction of the long run effects of the model using the short run components of the panel ARDL model. The outcome of the result shows that the speeds of adjustment from long run to short run in the models would be 76%, 61%, 83%, 67%, 68%, 34%, and 80% respectively for all the specified models.

Based on these findings, we therefore recommend that the government should make policies that would enhance management of micro financial institutions since they can easily transcends inclusive financial access in the society. The level of their capital stock should be increased. Also digitalizing most of the African micro financial institutions will broaden access to gainful financial opportunities for people to assess. Therefore government provide amenities like power supply, internet broadband connections, and other digital financial tools to enable the microfinance institutions to have digital presence which would make them to reach wider coverage thereby promoting the welfare of the economy.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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