Poverty Reduction, Economic Growth, and Mobile Money Proliferation in Ghana

Nicholas Bamegne Nambie
Valley View University, Oyibi, Accra-Ghana
nicnam27@gmail.com

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Abstract

The study analysed the impact of poverty reduction, economic growth, on proliferation of mobile money in Ghana. Using data from the world development indicators and factor analysis, an index measuring mobile money, economic growth, and poverty reduction in Ghana was developed. The data ranged from 1980 to 2021, and a convenience sampling method was used to select the series from world development indicators (WDI) and indexes created to measure the primary variables. The Johansen cointegration method revealed that cointegration exists between the variables, indicating that the variables have long-term relationships. The results of Vector error correction indicated that there is both a long-term and a short-term relationship between the proliferation of mobile money, economic growth, and poverty reduction in Ghana. The findings indicated the existence of a short-term relationship between the variables. Granger causality test also confirmed that mobile money proliferation, economic growth, and poverty reduction in Ghana have a short-run causal relationship. Given the significant role that mobile money service plays in Ghana's economic growth, the study concluded that policymakers in Ghana would do well to pay attention to mobile money service. In order to reduce mobile money and cyber fraud, policymakers are also encouraged to make mobile money and banking services accessible, including financial literacy education, and to strengthen internal controls. Future research could examine the relationship between the proliferation of mobile money, credit assessment, employment, and investment in Africa.

Keyword: *Economic growth, Remittance, Poverty, Mobile-money, Employment, Investment*

Introduction

Subscriber Identity Module (SIM) cards and airtime, have become commonplace in many economies due to the widespread adoption of mobile phones (Addotey-Delove, Scott, & Mars, 2023). In 2019, the International Telecommunication Union's Global Telecommunication Indicators Database found that India had 1.15 billion and sub-Saharan Africa had 858.8 million users (Lee, Chen, & Chu, 2023). The benefits of mobile phones have been extensively documented with a number of studies demonstrating the power of text messaging on topics as varied as debt repayment, savings habits, medication adherence, and even political participation (Fang, Kwon, & Zhang, 2023; Lamberton, Rucker, & Spiller, 2023). Financial services, in particular, have benefited from the proliferation of mobile phone markets and networks because of the innovations that have been made to add great value and

give beneficial services to consumers. There were 1.35 billion registered accounts in 2021, an increase of 18% from the previous year and a tenfold increase from 2012 to the tune of $134,000,000 (Martin & Kaminski-Ozturk, 2023). There has been a near 15 fold and a near 13 fold increase, respectively, in the number of accounts that are active for 30 and 90 days since 2012 (Ashworth, et al., 2023). There was a major increase in the number and regularity of business dealings. More people have access to financial services because the number of active agents increased by more than 10 times, from 534,000 in 2012 to 5.6 million in 2021 (Liu, 2023). In 2021, the value cashed in and digitalized through mobile money agent networks climbed by 18%, reaching a total of $261 billion, or more than $715 million each day, despite closures and mobility limitations caused by the COVID-19 epidemic (Rajan, 2021). Even the largest and most established agent networks grew rapidly between 2020 and 2021, with the 25 largest networks seeing an average growth of more than 25%.

More than a trillion dollars' worth of transactions was handled by the mobile money industry in 2021 (Quartey & Nyarko, 2022). Increases in transaction value from one year to the next can be attributed to both rising client numbers and a wider variety of applications for mobile currency. Less than 10% of all transactions in 2012 were ecosystem transactions like bill payments, bulk disbursements, merchant payments, and overseas remittances, the fact that this number is now 20% ten years later shows that mobile money providers are open to variety (Aboagye & Anong, 2020). According to our Global Adoption Study, nearly half of mobile money providers (44%) provide credit, savings, or insurance products (Aron & Muellbauer, 2019). In 2021, there was a promising uptick in the adoption of these products in both established and emerging mobile money markets, as consumers in both types of markets looked for ways to safeguard their households and businesses from economic downturns, increase their incomes, and generally improve their standard of living. In low- and middle-income countries, women continue to be less likely than males to use mobile money. This occurs for a variety of reasons, such as low mobile phone penetration, unfamiliarity with mobile money, and a general feeling of insignificance and incapability (Guo, Wang, & Khan, 2021). Once women have access to mobile money, however, their usage rates are very close to those of men. As part of the Group Special Mobile Association (GSMA) Connected Women Commitment Program, 26 mobile operators in Africa, Asia, and Latin America have made formal promises to increase the number of female customers using mobile money services (Pinet, Sanyu, & Youn, 2021; Reynolds, Biscaye, & Leigh, 2023). Access to basic utilities, support for subsistence farmers and quick financial relief for disadvantaged people are just a few examples of how mobile money can help address pressing social, economic, and environmental problems. Many mobile money service providers have already capitalized on the diversification opportunities presented by these usage scenarios.

Mobile money has overcome one of the challenges faced by the traditional financial industry because it is a more accessible and user-friendly payment channel. Even though nearly half of persons in Senegal reported having major difficulties reading and writing or being completely illiterate 71% of adults reported using mobile money over the prior 30 days (Anderson, Reynolds, & Biscaye, 2023; Tang, 2022). This indicates that, with careful planning and teaching, mobile money may overcome even the most formidable obstacles to financial inclusion. Survey conducted by the Group Special Mobile Association (GSMA) forecasts a rise in mobile money accounts worldwide over the next few years, especially in developing regions (Meli, Djoumessi, & Djiogap, 2022). Most Central Banks in Africa have given Approvals in Principle to the leading Mobile Network Operators (MNOs) to run mobile money services in Africa. The vast majority of new 30-day-active accounts were created in 2021 in Africa and Asia, particularly in Sub-Saharan Africa, East Asia, and the Pacific.

Nonetheless, the Middle East and North Africa (MENA) region saw the largest expansion (Zambo, 2022).

Ghana's economy, like those of many other countries, is still bouncing back from the coronavirus outbreak. Despite the pandemic's effects, the mobile money sector in Ghana expanded rapidly (Ameyaw-Brobbey, 2023; Tuffour, Opoku-Mensah, & Asiedu-Ayeh, 2022). According to sources, by 2019, interoperability-supported payments had reached 308 million Ghanaian cedis ($57 million) (onzález-García, et al., 2021; Kocur-Bera, 2019). In 2018, Ghana inaugurated one of the first interoperable systems in Africa, allowing transactions between different telecom service providers in Ghana (Ofori-Acquah, Avortri, & Preko, 2023). Since then, mobile money has exploded in popularity, to the point where Ghana is now widely considered to be one of the largest and quickest-growing mobile money markets in Africa. The number of mobile money accounts was estimated by the Bank of Ghana to have climbed to 40.9 million in February 2021, up from 32.7 million in February 2020 (Akanferi, Asampana, & Matey, 2022). Customers of the mobile money service have access to digital wallets linked to their phone numbers, where they can send and receive money. This service is convenient and easy to use, making it an ideal digital financial service solution for many Ghanaians. However, cybercrime, the need for infrastructure and digital capacity, and government policies like the new Electronic Transactions Levy and digital ID systems have all acted as roadblocks to greater digital financial inclusion in Ghana (Mpofu & Mhlanga, 2022).

According to the Branchless Banking Guidelines, Ghana's leading telecoms service provider, MTN, teamed with nine banks in July 2009 to launch mobile money services (Duho & Quansah, 2021; Anong & Aboagye, 2020). MTN spent heavily promoting the service by sending merchants to under banked and unbanked areas of the country to spread awareness and encourage the use of mobile money. All of the businesses that reached out to previously unbanked parts of Ghana had ties to financial institutions that were interested in expanding into such areas. When a business owner signed up for mobile money, they were actually linking their business bank account. Yet another difficulty was encountered when trying to sign up new clients and set up accounts. Consumers had to provide a valid national ID during registration, which was a hurdle for many. In contrast to services that can be completed instantly in response to a customer's need, registrations have to be planned in advance. Despite this, the unbanked benefit more from mobile money accounts than they would from checking or savings accounts at a traditional bank. Less consumer ID was needed, and the service was cheaper overall. Merchants were also more approachable to the unbanked in some rural areas. As of October 2009, MTN had a subscriber base of roughly 20,000 users for its mobile money service in Ghana (Yator & Kipchumba, 2023; Ahmad & Wongsurawat, 2023). Due to the fact that most operational choices were made by partner institutions, MTN was unable to run mobile money to the extent and in the manner that it intended (McKemey, Kibombo, & Sakyi-Dawson, 2023).

After revising the Branchless Banking Guidelines, the Bank of Ghana released the Guidelines for E-Money Issuers and Agents in 2015. These rules replaced the Branchless Banking Guidelines and laid out new standards for how mobile money services must be operated (Senyo, Gozman, & Karanasios, 2023). The Bank of Ghana claims the regulations were established as part of a larger goal to boost financial inclusion by increasing the use of electronic money as a retail payment medium. According to the E-Money Issuer Guidelines, businesses that get a license to issue e-money alongside regulated financial institutions are eligible for the Dedicated Electronic Money Issuer designation (Coffie & Hongjiang, 2023).

Telecommunications companies might issue funds to their consumers for transactions without obligatorily linking each mobile money account to a financial institution. Dedicated Electronic Money Issuer must adhere to the criteria for systems and controls, as well as technological and security requirements, set forth in the E-Money Issuer Guidelines (Huber, 2023). Account types, transaction limits, permissible transactions, Know Your Customer standards, capital and liquid money requirements, and consumer protection principles were also defined as general operational requirements for Dedicated Electronic Money Issuer (Appendino, et al., 2023). In order to better coordinate with the new e-money rules and payment systems framework being implemented by the Bank of Ghana, the Branchless Banking Guidelines were superseded with the Agent Guidelines. In effect, the 2015 guidelines freed Telco's from acting as middlemen and provided them the opportunity to take on a more direct role as principals in the relationship (Polyák & Kerševan, 2023). Notwithstanding the fact that Telcos are no longer obligated to operate as bank agents, several Telcos and banks have formed mutually advantageous agreements to make it easier for customers to move money between their mobile wallets and their bank accounts and pay for goods and services. Several mobile network providers entered the mobile money services market in Ghana after seeing the regulatory climate and MTN's success in the market. In October of 2010, Tigo Cash was released, then in 2011, Airtel Money, and in 2015, Vodafone Cash. When Airtel and Tigo joined in 2017, they became AirtelTigo (Hongjiang & Coffie, 2023).

Recent trends in digital financial services, particularly mobile money, have resulted in an explosion of research on the topic. Baumüller, et al., (2023) examined the adoption and intensity of mobile money use among smallholder farmers in rural Ghana. Mamun, Abdullah, and Rana (2023) modelled the adoption of mobile money transmission using an analysis of consumer behaviour. Similar research has been conducted on this topic by Mapanje, Karuaihe, and Machethe (2023) who examined mobile money adoption, input use, and farm output among small holder rice producers in Ghana. Ngo, Nguyen, and Tram (2023) researched on the efficacy of monetary policy and with the advent of mobile money activity in Africa. Djahini-Afawoubo, Couchoro, and Atchi (2023) investigated the determinants of mobile money adoption, output, and welfare among smallholder farmers in Ghana. On the determinants of consumer engagement in the context of mobile money usage in Ghana, Kiburu, Njiraini, and Boso (2023) examined the relationship and arrived at significant conclusion. Perdana and Kulkarni (2023), Shaikh, Glavee-Geo, and Karjaluoto (2023), and Avom, Bangaké, and Ndoya (2023) conducted similar studies on Fintech ecosystem practices influencing financial inclusion, using mobile money in Ghana as a case study. Literature demonstrates that research on mobile money has primarily focused on a limited comparison of mobile money adoption and acceptability level among customers in the mobile money industry, rather than the relationship between mobile money, economic development, and poverty reduction in Ghana. As a result, the generalizability of the abundantly published research on this subject is problematic, as it focuses on the utilization, accessibility, and quality of mobile money adoption. What is not yet obvious is the impact of mobile money proliferation on economic growth and poverty reduction in Ghana, and this study aims to close the knowledge gap on the topic and contribute to academic literature. Therefore, this study examines the relationship between the proliferation of mobile money, economic development, and poverty reduction in Ghana. The remainder of the paper is structured as follows: the work is situated within the context of the proliferation of mobile money in Ghana, and the literature on mobile money is analysed in section two (2). The methodology

will be explained in section three (3), followed by the discussion and analysis in chapter four (4), and then section five (5) will provide a conclusion.

Literature Review

Past research on understanding individuals' adoption of mobile banking mainly relies on considering mobile banking as a technological innovation (Karjaluoto & Shaikh, 2015; Alalwan, Dwivedi, & Rana, 2017). The diffusion of innovation theory could be considered as one of the most popular theories that have attempted to explore factors that affect an individual to adopt an innovation or a new technology. Diffusion of innovation theory is a theory that seeks to explain how, why, and at what rate new ideas and technology spread through cultures. Rogers defines diffusion as the adoption of an innovation over time by the given social system, as a consequence diffusion processes result in the acceptance or penetration of a new idea, behaviour, or physical innovation (Sulaiman, Jaafar, & Mohezar, 2007). Rogers identified several attributes of an innovation that are key influences on adoption behaviour. According to Rogers, these attributes are relative advantage, complexity, compatibility, trial-ability, and observability (Labay & Kinnear, 1981; Nazari, Khosravi, & Babalhavaeji, 2013). A number of previous studies have examined these factors in adoption and diffusion of Internet-based technologies and have consistently concluded these attributes, particularly those of relative advantage, ease of use, and compatibility, as the most frequently salient factors for adoption of Internet and mobile (Al-Jabri & Sohail, 2012; Sohail & Al-Jabri, 2014; Shah, Alam, & Jani, 2011).

Relative advantage refers to the degree to which an innovation is perceived as providing more benefits than its predecessor. Relative advantage results in increased efficiency, economic benefits and enhanced status (Pacio & Wetzel, 2013; Sahin, 2006). Past research has found that relative advantage of an innovation is positively related to the rate of adoption (Mohamad, Hsbollah, & Kamil, 2009). Research suggests that when user perceive relative advantage or usefulness of a new technology over an old one, they tend to adopt it, in the context of mobile banking adoption, benefits such as immediacy, convenience and affordability to customers have been reported (Dzogbenuku, 1970; Agrawal & Jain, 2019). Therefore, it is hypothesized that, when customers perceive distinct advantages offered by mobile banking, they are more likely to adopt it. Oly, Ndubisi, and Sinti (2006) defined complexity as the extent to which an innovation can be considered relatively difficult to understand and use, and they found that complexity negatively influences the adoption of internet usage. Ease of use refers to the extent to which mobile banking is perceived as easy to understand and operate. A vast body of research suggests that there is a strong impact of perceived ease of use of new technology on its adoption (Amin, Rezaei, & Abolghasemi, 2014; Venkatesh & Bala, 2008). As mobile banking services have very user friendly interfaces, users see them as easy to use, and hence form positive attitude. There is considerable amount of empirical research on the mobile technology to suggest that users' intention to adopt mobile banking is inhibited by the perceived complexity of the innovation. Much of the extant literature on barriers of mobile banking adoption is predominantly related to technical complexity. Complexity in use, technical infrastructure, and design of technology are reported as individual barriers in a number of studies (Rodríguez, Svensson, & Mehl, 2020). Users will be inhibited to use mobile banking if it require more mental effort, is time-consuming or frustrating. Therefore, it is hypothesized that perceived complexity inhibits adoption of mobile banking (Brown, Davies, & Stroebel, 2003; Ramdhony & Munien, 2013).

Compatibility refers to the degree to which a service is perceived as consistent with users' existing values, beliefs, habits and present and previous experiences, compatibility is a vital feature of innovation as conformance with user's lifestyle can propel a rapid rate of adoption (Shi, Wang, & Zhang, 2020; Jun, Cho, & Park, 2018). Research has shown that compatibility is a significant antecedent in determining consumers' attitude towards internet banking adoption, and has been found influential in the adoption of virtual store, m-payment, and mobile banking in many African countries (KoenigLewis, Palmer, & Moll, 2010; Liébana-Cabanillas, Marinković, & Kalinić, 2017). Hanafizadeh, Behboudi, and Koshksaray (2014) found that compatibility had significant correlation with computer adoption and use, thus, it is also likely that the relation between compatibility and adoption will hold in the context of mobile banking. Observability of an innovation describes the extent to which an innovation is visible to the members of a social system, and the benefits can be easily observed and communicated (AlGahtani, 2003). Weick (1984) simplified the original construct by redefining observability into two constructs: visibility and result demonstrability. In the context of mobile banking, observability is defined as the ability to access the banking services at any time and from any location without any delay or queue, and seeing the effect of mobile banking transactions immediately, and conveying the accessibility benefits to others. Through such exposure, customers gain knowledge about mobile banking and its benefits, thereby facilitating adoption.

Trialability refers to the capacity to experiment with new technology before adoption; potential adopters who are allowed to experiment with an innovation will feel more comfortable with it and are more likely to adopt (Lin & Chen, 2012; Pannell, Marshall, & Barr, 2006). Further support is given by Talke and Heidenreich (2014) who argue that if customers are given a chance to try the innovation, it will minimize certain unknown fears, and lead to adoption. With banks providing assistance and demonstrations on mobile banking usage while in the trial period, fears about mobile banking can be minimized and this will also motivate potential adopters to use mobile banking. The provision of financial services to the unbanked is a central tenet of discussions on the welfare benefits of mobile money since it increases the unbanked ability to address a number of restraints on their level of life. Mobile money gives the impoverished a way to save money and put it toward improving their economic standing (Dissaux, 2023; Aker & Blumenstock, 2015). From a different angle, but with a similar tone of optimism Okello, Candiya, and Bongomin (2018) argues that mobile money boosts consumption in low-income households. This is because impoverished households' income and consumption rise along with the level of investment. Helsper (2021) counter these positive statements by arguing that mobile money helps to perpetuate the digital divide between the poor and the wealthy. The need for digital literacy and the expense of transactions limit the benefits for low-income individuals and families while boosting profits for the well-off (Donovan, 2012; Khanna, Ratan, & Davis, 2010). As a result, it's probable that low-income households won't receive the necessary welfare payments through mobile money. The viability of mobile money in rural areas is affected by a variety of issues. To begin, mobile money is more affordable than traditional banking services (Aron, 2018; Lashitew, vanTulder, & Liasse, 2019). Given that the demand for financial services falls off as transaction costs rise, it stands to reason that high transaction costs would have the opposite effect. Due to the low overhead for both service providers and their customers, mobile money has quickly gained in popularity. Also, mobile money is more secure than conventional, unregulated means of exchanging cash. Mobile money's already high security standards are bolstered with the addition of PIN protection for each user. Those tasked with

distributing funds through informal networks may divert some of the funds for their own use (Ledeneva, 2009; Prahalad & Hammond, 2002; Benson, 1975).

The adoption of monetary services such as mobile money constitutes usage, and empirical research suggests that lowering barriers to entry could enhance participation in financial services (Ahmad, Green, & Jiang, 2020). The theory of innovation diffusion shows that adoption depends on several factors, including competitive advantage, compatibility, and the complexity of the innovation itself. Mobile money's potential as a tool for expanding access to banking services depends on its suitability to life in rural areas. The term compatibility refers to the degree to which mobile money features and the rural setting work well together. As a result, people will rely more on mobile money, which emphasizes local services, than on conventional banking institutions. Similar to Technology Acceptance Model's (TAM) perceived ease of use as a factor explaining technology adoption, the introduction of complexity as a moderator of financial inclusion proposes taking into account people's capacities while designing a user-friendly system for rural families. If these conditions hold, then mobile money is the best option for delivering financial services. According to (Osei-Assibey, 2015; Mawejje & Lakuma, 2019) mobile money serves as both an alternative to and supplement to traditional forms of saving.

Yeboah and Ewur (2014) used a sizable group of Ghanaian families to investigate the social effects of mobile phone features and found that there is a strong correlation between mobile phone use and financial inclusion. Furthermore, the authors revealed that households where women are the primary breadwinner do not reap additional welfare advantages from mobile telephony and financial inclusion. The impact of social networks on the link between mobile money use and financial inclusion was studied by Teutio, KalaKamdjoug, and Gueyie (2023) in rural Uganda. Social networks were found to significantly and positively affect the association between mobile money use and financial inclusion in rural Uganda. They also found that the combination of mobile money and social networks significantly increased the number of people in rural Uganda who had access to formal financial services. The research also shows that mobile money users in rural Uganda benefit from greater financial inclusion because of the existence of social networks with both strong and weak links.

Based on information from the World Bank and the Global Islamic Finance Report, Rabbani, et al., (2021) analysed the progress made by Islamic and traditional financial systems with regards to financial inclusion and financial technology. Between 2011-2017 Rabbani, et al., (2021) examined information from eleven nations with both Islamic and traditional financial systems. According to Rabbani, et al., (2021) research, conventional finance countries have more users of FinTech, but Islamic finance countries are more inclusive in terms of financial inclusion and women's financial empowerment. Bagozzi, Davis, and Warshaw (1992) argued that people's attitudes and intentions toward learning to use the new technology may not be a direct or immediate result of such attitudes and intentions because new technologies, like personal computers, are complex and there is an element of uncertainty in the minds of decision makers regarding their successful adoption. This research suggests that people's early impressions of and plans for using new technologies may be vague or uncommitted, and that they may only solidify once they've had some practice with the tools in question.

According to research when rural farmers lack access to suitable financial goods and services, they can resort to borrowing money from unsavoury sources like loan sharks, moneylenders, or even friends and family (Chakrabarti & Sanyal, 2016). The cycle of low agricultural investment and production typical of many rural producers in Ghana is broken through saving

(Quisumbing & Pandolfelli, 2010). Empowering farmers in rural areas with savings accounts could help alleviate some of their economic woes. Some research show that providing households with greater access to financial services lead to more effective allocation of resources, higher productivity, more money spent on education, higher welfare, and greater financial stability (Mendoza & Thelen, 2008; Demirgüç-Kunt & Singer, 2017).

Methodology

Using annual time series data derived from the WDI from 1980 to 2021, this study analysed the connection between poverty reduction, economic growth, and the spread of mobile money in Ghana. There are five components used to gauge the prevalence of mobile money: the rate of mobile cellular subscriptions per 100 people, the share of the population over the age of 15, the share of the population with a secondary degree or higher, the share of the poorest 40% of the population, and the share of the population with a secondary degree or higher. Exploratory factor analysis was used to model these sub variables and produce an index of the spread of mobile money. In a similar vein, GDP growth, yearly percentage, export and import of goods and services annual percentage, general government final consumption expenditure, manufacturing value added, and GNI per capita growth are used to calculate an index that measures economic growth. An index measuring poverty reduction is calculated by factoring together the percentage of the population living below 50% of the median income, the percentage of the population living in extreme poverty, the multidimensional poverty headcount ratio as a percentage of the total population, and the annualized average growth rate of per capita real survey mean consumption or income.

Time series econometric approach is used to examine how the growth of mobile money interacts with poverty reduction and GDP expansion in Ghana. Time series analysis helps businesses learn what drives long-term tendencies and patterns. Businesses can use data visualizations to spot seasonal trends and dig deeper into what's behind them. With the support of contemporary analysis technologies, these visualizations can go well beyond simple line graphs. Time series forecasting is a method for estimating the likelihood of future events based on historical data that has been analysed at regular intervals. The first step in estimating the relationship is to test for stationarity of the series or their order of integration; this is necessary because the series must be integrated in the same order throughout the estimation process. The second step is to investigate the existence of a long-run relationship between all variables in the equation; this is done by applying the co-integration model proposed by (Johansen, Mosconi, & Nielsen, 2000). Once co-integration is proven, the residuals from the equilibrium regression can be utilized to estimate the error-correction model in the third step. To ensure that the residual error values are random, tests for normality, autocorrelation, and heteroscedasticity in the error term and the stability model are performed.

Table 1. Variable measurement

Variable	Measurement and definition	Data Source	notation
Mobile Money Proliferation	**i)** Mobile Cellular subscription (per 100 people), **ii)** Account ownership at a financial institution or with a mobile-money-service provider (% of population age 15+) **iii)** Account ownership at a financial institution or	World Development Indicators (WDI)	MOMO

	with a mobile-money service provider, secondary education or more (% of population ages 15+), **iv)** Account ownership at a financial institution or with a mobile-money service provider, poorest 40% (% of population ages 15+), **v)** Account ownership at a financial institution or with a mobile-money service provider, richest 60% (% of population ages 15+)		
Economic Growth	**i)** GDP growth (annual %), **ii)** Exports of goods and service (annual % growth), **iii)** general government final consumption expenditure (annual % growth) **iv)** Manufacturing value added (annual % growth), **v)** GNI per capita growth (annual %)	WDI	ECONS
Poverty Reduction	**i)** Gini index, **ii)** Income share held by highest 10%, **iii)** Proportion of people living below 50% of median income (%), **iv)** Income share held by highest 20%, **v)** Multidimensional poverty headcount ratio (% of total population), **vi)** annualized average growth rate in per capita real survey mean consumption or income, total population (%)	WDI	POVERTY

Empirical analysis and discussion

Unit Root Test

Prior to further evaluation, it is essential to conduct preliminary diagnostics on the time series properties of the variables, as the effectiveness of the VAR model depends on establishing the stationarity of the variables (Wooldridge, 2006). Therefore, the first stage is to test for the presence of unit-roots to determine the order of integration of the variables. The augmented Dickey-Fuller (ADF) test by Dickey and Fuller (1979) and the Phillips-Perron test by Phillips and Perron (1988) and (Shin & Schmidt, 1992) are the most widely used methods Dickey and Fuller initially proposed them under the premise that the error terms adhere to an Autoregressive process with a known order. Models without a trend and intercept, models with just an intercept, and models with both a trend and an intercept are defined for estimated unit root equations as follows:

$$\Delta Y_t = \gamma y_{t-1} + \sum_{i=1}^{k} \beta_i \Delta y_{t-1} + \varepsilon_t \text{ ---------- (1)}$$

$$\Delta Y_t = \alpha_0 + \gamma y_{t-1} + \sum_{i=1}^{k} \beta_i \Delta y_{t-1} + \varepsilon_t \text{---------- (2)}$$

$$\Delta Y_t = \alpha_0 + \alpha_2 + \gamma y_{t-1} + \sum_{i=1}^{k} \beta_i \Delta y_{t-1} + \varepsilon_t \text{-------- (3)}$$

Where; $\Delta Y_t = y_t - y_{t-1}$, is the first difference of the series y_t

$\Delta Y_{t-1} = y_{t-1} - y_{t-2}$, is the first difference of y_{t-1}

$\alpha, \gamma, and\ \beta_i$ are parameters to be estimated; ε_t is a stochastic disturbance term

Table 2. Unit Root Test

	At level			At first Difference		
variable	**ADF statistics**	**Phillip Perron statistics**	**KPSS Statistics**	**ADF statistics**	**Phillip Perron statistics**	**KPSS statistics**
Momo	-0.932671 (0.7674)	-0.988724 (0.7482)	0.660240 (0.739000)	-5.4703333 (0.0000)	-5.472716 (0.0000)	0.091393 (0.739000)
Econs	-0.599068 (0.8595)	-0.511608 (0.8783)	0.718837 (0.739000)	-6.403340 (0.0000)	-6.414295 (0.0000)0	0.089060 (0.739000)
Poverty	-0.965191 (0.7564)	-0.965191 (0.7564)	0.675524 (0.739000)	-6.312360 (0.0000)	-6.313441 (0.0000)	0.076324 (0.739000)

Author's Computation, 2023

Since this is a time series study, the first step in the estimating process is to check for stationarity to see if the variables are suitable for the VAR specification. As a result, we utilize the tests developed by Dickey and Fuller (1979), Phillips and Perron (1988), and KPSS (1996). The outcomes of the ADF-test, PP-test, and KPSS-test are listed up above. Both the Augmented Dickey Fuller (ADF) and Phillip Perron (PP) analyses show that the original set of variables stabilized after differentiation. Because of this, VAR and cointegration analysis cannot be used. There may be cointegration correlations between variables since all series are non-stationary at levels and integrated of order one (1). As a result, we test for the presence of cointegration vectors.

Table 3. Determination of optimal lag length

Lag	LogL	LR	FPE	AIC	SC	HQ
0	17.51062	NA	9.35e-05	-0.763717	-0.634434	-0.717719
1	103.1170	153.1905*	1.66e-06*	-4.795634*	-4.278502*	-4.611642*
2	108.9002	9.435641	1.99e-06	-4.626325	-3.721344	-4.304340
3	117.5643	12.76819	2.08e-06	-4.608648	-3.315817	-4.148669

Author's Computation, 2023

In the VECM parameter estimation procedure, the optimal lag length is used to ensure parameter consistency. The results of the lag order selection criteria, including Likelihood Ratio (LR), Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Information Criterion (SBIC) and the Hannan-Quinn Information Criterion (HQIC) indicate a tie in the selection. In accordance with the Final Prediction Error (FPE), Likelihood Ratio (LR), and Akaike Information Criterion (AIC), a period of one (1) observation is selected. Atigala, Maduwanthi, and Gunathilake (2023) demonstrate that misspecification of lag numbers in a VECM can result in finite-sample bias and serial correlation. For the purposes of the investigation, a lag of one (1) periods of AIC is employed.

Co-integration Test

For a time series system to be co-integrated, it must have non-stationary levels. An integrated series of order d is one that requires d differentiations to become stationary, denoted by I (I), where I is the order of integration (Engle & Granger, 1987). Cointegration is examined by integrating both series in the same direction. The analysis here draws heavily on the empirical work of Johansen (1988) and Juselius and Johansen (1990) as well as Engle and Granger (1987). The number of co-integrating vectors is determined using the Johansen and Juselius test using the maximum likelihood procedures of the VAR model. Bates and Granger (1969) and Sims (1972) tests can only rule out the possibility of no causality between two variables if they are uncorrelated. Unidirectional or bidirectional causation must exist if the two variables are trending in the same direction or are co-integrated. Co-integration can reveal whether or not Granger-causality exists, but it cannot reveal the direction of causality. This Granger or temporal causality direction can be determined by employing the vector error correction model (VECM) that is derived from long-run co-integrating vectors. In this analysis, we used the Trace test statistic and the Max Eigen value statistic to identify the co-integrating vector r. In addition, we used co-integration in the multivariate models to examine how the variables had settled into a long-term equilibrium. The analysis will be based on the following equations:

$$\Delta l_n Y_t = \alpha_0 + \sum \varphi_i \Delta lnY_t + \sum \delta_i \Delta lnX_t + \varepsilon_t \text{---------- (4)}$$

$$\Delta lnX_t = \gamma_0 + \sum \partial_i \Delta lnX_t + \sum \forall_i \Delta lnY_t + \varepsilon_t \text{---------- (5)}$$

Where (Y_t, X_t--X_n) are poverty reduction, economic growth, and mobile money proliferation; Δ is a difference operator, ε_t is a random error term with mean zero $\alpha_0 and \gamma_\circ$ are drift terms, φ_i, δ_i , ∂_i , $\forall_i$ are predicted values of the coefficients on the independent variables. A null hypothesis for the co-integration test is constructed with the assumption that there is no co-integration between variables (r = 0). Co-integration is rejected as a null hypothesis if the Trace statistic or Max Eigen value is larger than the critical value. This means that the coefficients of the independent variables are not equal to zero. If this is the case, then the variables are co-integrated.

Table 4. Cointegration Test Statistics

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.439527	30.69365	29.79707	0.0393
At most 1*	0.187570	15.13623	8.49471	0.0033
At most 2*	0.000317	3.012346	0.841466	0.0413

Table 5. Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**

None *	0.439527	22.58003	21.13162	0.0311
At most 1*	0.187570	14.01277	8.26460	0.0085
At most 2*	0.000317	3.012346	0.841466	0.0413

Author's Computation, 2023

According to table 4, the null hypothesis of no cointegration is rejected since the results of Johansen cointegration imply that the trace statistics exhibits three cointegration equations. Positive significance can be observed for the probability values of the three equations. Also, the results of the maximal eigenvalues confirmed the results of the trace statistics with three (3) cointegration equations, indicating that the null hypothesis is rejected. This implies that there is a causal relationship between the variables over an extended period of time. On the assumption that cointegration exists a vector error correction modelling is feasible.

Vector Error-Correction Modelling

Granger's representation theorem states that if the series are co-integrated, an error correction model can be used to characterize the dynamic relationship. For non-stationary series with known co-integration, the VECM is a limited VAR. To ensure that the long-run behaviour of endogenous variables converges to their co-integrating relationships while still permitting short-run adjustment processes, the VECM is specified with co-integration relations. The co-integration term is also known as the error correction term since it makes a number of partial short-run changes to bring the system back to long-run equilibrium. Both the dynamic short-term behaviour and the equilibrium long-term behaviour of a pair of series can be described within the ECM framework. If it is known that the dependent variable shows short-run variations in response to changes in the independent variables, then the error correction model can be used, as determined by (Obayelu & Salau, 2010). If two variables Xt and Yt, are found to be co-integrated, then the change in the dependent variable will be a function of both the degree of disequilibrium in the co-integrating relationship represented by the error-correction term and the changes in the other explanatory variables. Engle and Granger (1987) provided the proof supporting this theory. To describe the ECM, the following equations are presented:

$$\Delta Y_t = \pi \sum_{j=1}^{k-1} \gamma_i \, \Delta Y_{t-j} + \sum_{i=1}^{k-1} \eta_i \, \Delta X_{t-i} + \sum_{m-1}^{k-1} \xi_m \, \Delta R_{t-m} + \lambda ECT_{t-1} + \mu_t \quad \text{---------- (6)}$$

$$\Delta lnMomo_t = \partial + \sum_{i=1}^{k-1} \beta_i \, lnMomo_{t-1} + \sum_{j=1}^{k-1} \varphi_j \Delta lnEcons_{t-j} + \sum_{m=1}^{k-1} \omega_m \, \Delta lnPoverty_{t-m} \lambda ECT_{T-1} + \mu_{1t} \quad \text{-------- (7)}$$

$$\Delta lnEcons_t = \partial + \sum_{i=1}^{k-1} \beta_i \, lnEcons_{t-1} + \sum_{j=1}^{k-1} \varphi_j \Delta lnMomo_{t-j} + \sum_{m=1}^{k-1} \omega_m \, \Delta lnPoverty_{t-m} \lambda ECT_{T-1} + \mu_{1t} \quad \text{-------- (8)}$$

$$\Delta lnPoverty_t = \partial + \sum_{i=1}^{k-1} \beta_i \, lnPoverty_{t-1} + \sum_{j=1}^{k-1} \varphi_j \Delta lnEcons_{t-j} + \sum_{m=1}^{k-1} \omega_m \, \Delta lnMomo_{t-m} \lambda ECT_{T-1} + \mu_{1t} \quad \text{-------- (9)}$$

Table 6. Vector Error Correction Estimates

Cointegrating Eq:	CointEq1
MOMO(-1)	1.000000
ECONS(-1)	-0.455310 (0.25739) [-1.76898]
POVERTY(-1)	0.197068 (0.17856) [-1.10365]
C	0.108197

	Coefficient	Std. Error	t-Statistic	Prob.
CointEq1	-0.894015	0.238650	-3.746135	0.0002
Momo	-0.727891	0.226097	-3.219376	0.0014
Econs	-0.051696	0.016718	-3.092208	0.0021
Poverty	0.035166	0.016661	-2.110714	0.0353
C	0.042187	0.016841	2.505069	0.0126

R-squared	0.224900	Mean dependent var	0.076833
Adjusted R-squared	0.190659	S.D. dependent var	4.488828
S.E. of regression	4.038301	Akaike info criterion	5.672667
Sum squared resid	8121.322	Schwarz criterion	5.860541
Log likelihood	-1454.730	Hannan-Quinn criter.	5.746258
F-statistic	6.568097	Durbin-Watson stat	1.991507
Prob(F-statistic)	0.000000		

Author's Computation, 2023

$$\Delta lnMomo_t = \mathbf{-0.125513}ECT_{t-1} + -0.412613Momo_{t-1} + -0.428907Econs_{t-1} + 0.383947Poverty_{t-1} + 0.016900 - - - -(10)$$

Vector Error Correction

The error correction coefficient indicates the rate at which the model will re-establish equilibrium after disturbances. The coefficient of the ECT is negative and statistically significant (-0.894015), indicating a convergence of short-run dynamics to long-run equilibrium. In a situation of disequilibrium, the adjustment coefficient is -8.89, or 89% of the way to long-term equilibrium. The negative coefficient indicates a causal relationship between momo, economics, and poverty. The coefficient of 89% demonstrates the model's ability to return to equilibrium following a disturbance. The short run coefficients indicate that, all other things being equal, a percentage change in mobile money proliferation will result in a 72% increase in mobile money usage in Ghana. Moreover, a percentage change in economic growth will result in a 5% increase in mobile money proliferation, all else being equal. There is also a significant relationship between the proliferation of mobile money and

poverty, such that an increase in mobile money leads to a decrease in poverty and vice versa, all else being equal.

According to the results of Juselius and Johansen (1990) the normalized cointegration equation shows that the widespread use of mobile money in Ghana is positively correlated with Economic growth over the long term. Since people can receive remittances more regularly through mobile money transfers, this suggests that people's consumption is both higher and more stable. Income-based welfare benefits and economic growth are made possible by mobile money because of its significant influence on households' ability to share risk. The correlations point is in a positive direction, suggesting that financial aid has contributed to the expansion of Ghana's banking sector and overall economic expansion. The results also show that mobile money has been useful in promoting a range of poverty reduction activities, and that specific policy prescriptions can be established to aid the development of economies that are too poor to have access to mobile financial services. Poverty has been shown to have a negative effect on economic growth over the long term; poverty is the inability to afford fundamental necessities such as food, clothing, and shelter. However, poverty is significantly more than just a lack of money. Poverty is starvation according to the World Bank Organization. The absence of adequate housing is a defining characteristic of poverty. This suggests that less poverty leads to more economic growth and that higher income inequality correlates with poor economic growth.

Serial correlation, heteroscedasticity, normality test, and model stability diagnostics are displayed in Tables 7, 8, and Figure 1 and 2 respectively. The p-value of the serial correlation output in table 7 is greater than the 0.05 threshold, indicating that there is no serial correlation in the model. In addition, the vec residual heteroscedasticity test in table 8 indicates that estimates lack heteroscedasticity. The jarque bera coefficient in figure 2 is 3.309139 with a p-value of 0.191744, indicating that the null hypothesis is rejected and the residuals are therefore normally distributed. Regarding the model's stability, figure 1 demonstrates that the blue line lies between the two 5% critical lines, indicating that the model is stable. As shown in Figure 3, the characteristic polynomial stability test is conducted to validate the estimates' stationary level. All of the roots are located within the inner circle, indicating that the series are stationary.

Table 7. Serial correlation test

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	8.307755	9	0.5035	0.931710	(9, 61.0)	0.5046
2	6.588590	9	0.6799	0.728937	(9, 61.0)	0.6807
3	9.688616	9	0.3763	1.098541	(9, 61.0)	0.3775

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	8.307755	9	0.5035	0.931710	(9, 61.0)	0.5046
2	11.06535	18	0.8916	0.590165	(18, 62.7)	0.8935
3	18.23032	27	0.8963	0.632514	(27, 56.1)	0.9023

*Edgeworth expansion corrected likelihood ratio statistic.

Author's computation, 2023

Figure 1 Cusum stability test

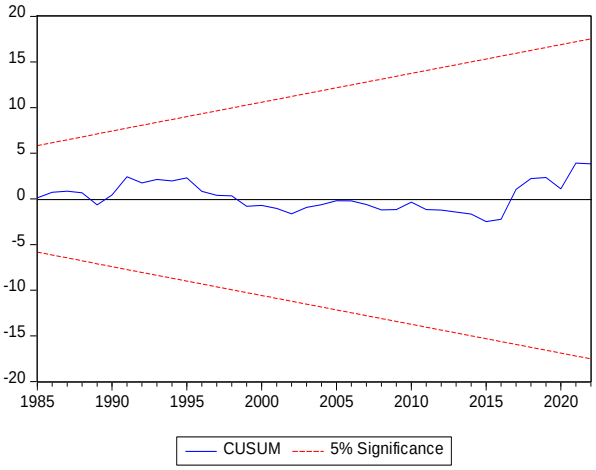

Figure 2 Histogram normality test

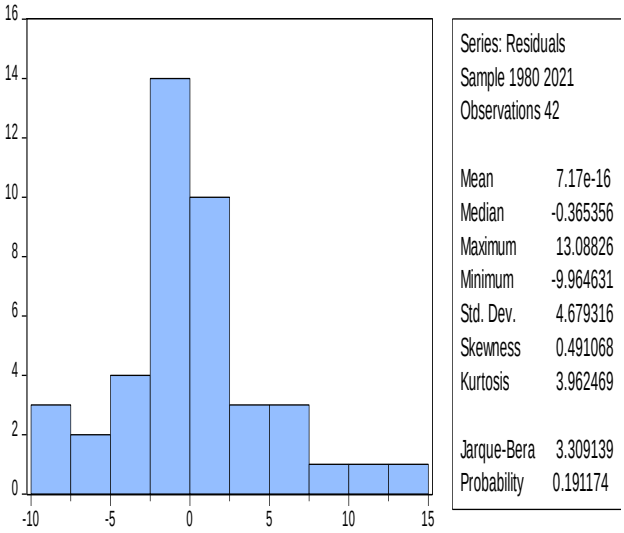

Figure 3

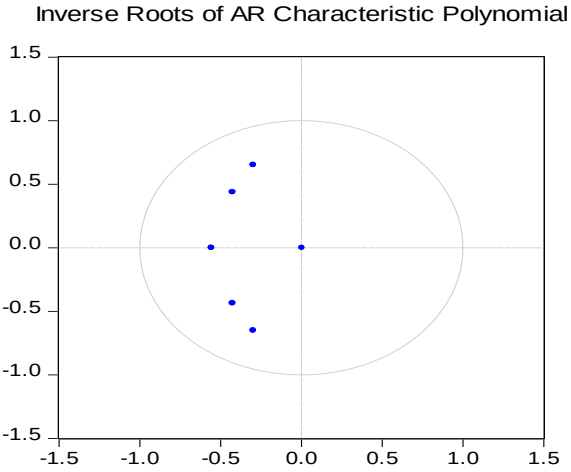

Table 8. VEC Residual Heteroskedasticity Tests (Levels and Squares)

Joint test:

Chi-sq	df	Prob.
72.88152	84	0.8015

Granger causality test

The Granger causality test is used to determine whether mobile money, economic growth, and poverty reduction in Ghana have a significant short-run causal relationship. Table 8 demonstrates that the proliferation of mobile money causes economic growth and poverty. This indicates that the variables are affected in the short term by the proliferation of mobile money. This is demonstrated by the F-statistics values of 4.06801 and p-value of 0.0255 for economic growth and 4.56147 and p-value of 0.0172 for poverty reduction. There is no Granger causality between poverty reduction and economic growth, however. The implication is that a change in poverty reduction has no effect on economic growth in the short term.

Table 9. Granger Causality Analysis

Null Hypothesis:	Obs	F-Statistic	Prob.
MOMO does not Granger Cause ECONS	41	4.06801	0.0255
ECONS does not Granger Cause MOMO		3.22807	0.0513
POVERTY does not Granger Cause ECONS	41	1.73007	0.1917
ECONS does not Granger Cause POVERTY		1.82100	0.1765
POVERTY does not Granger Cause MOMO	41	3.39073	0.0448
MOMO does not Granger Cause POVERTY		4.56147	0.0172

Author's Computation, 2023

Conclusion, recommendations, and policy implications

In 2019, over 500 million people in Africa used mobile money instead of a traditional bank account. The goal of expanding people's access to credit is to promote economic development, increased productivity, and reduction in poverty. A reliable payment system is crucial to the security, stability, and credibility of any economic system. An effective payment system allows for the rapid settlement of financial transactions, which in turn promotes economic growth, employment opportunities, and overall quality of life. A broad improvement in payment systems influences the entire economy due to its interconnectedness with the fiscal, external, and real sectors. This research aims to learn how mobile money has affected economic growth and poverty alleviation in Ghana. The spread of mobile money, economic growth, and the reduction of poverty in Ghana were found to be interconnected in both the short and long terms by use of the Johansen cointegration and vector error correction models.

The research shows that mobile money enable consumers save money safely, which may subsequently be invested and help the economy grow. Granger causality test findings are consistent with mobile money services helping to alleviate poverty. Having no way to enter the formal financial system is also a hallmark of poverty. Mobile money services can help the economy grow and more people gain access to the financial system by expanding access to deposit, credit, and insurance options. Payments for things like airtime, energy bills, Gold and DSTV, salaries of some employees, tax fees, micro-credit, savings, and micro-insurance, as well as person to person money transfers, are commonly made through mobile money wallets in Ghana. Although mobile money has great potential in Ghana, its growth has been stymied by factors such as extensive system failures, disadvantageous tax regimes, a lack of a well-streamlined regulatory framework, and fraud. Research has demonstrated that replacing cash payments for social benefits and remittances with digital transfers improves transparency, productivity, and savings rates. The introduction of digital payments that don't require cash or a physical wallet has been hailed as a major technological advance in the struggle to alleviate poverty. Policymakers in Ghana would be well served to pay more attention to mobile money given its significance to economic growth and poverty alleviation. Decision-makers should have easy access to relevant data on mobile money and banking services. Internal dispute resolution processes, public financial literacy education, and strengthened internal controls are also important for reducing mobile money and cyber fraud. If investors are unable to obtain credit facilities from telecommunications companies in order to pursue meaningful

investment opportunities, then future research can examine the impact of mobile money on employment, economic growth, and foreign direct investment to determine if mobile money necessarily reduces poverty in Africa. The connection between mobile money, credit rating, and investment in Ghana is an area that requires further study.

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