African Review of Economics and Finance (2022), **2**, 1–18
ISSN (Print) 2042-1478
ISSN (Online) 2410-4906

ARTICLE

The Role of Mobile Money Banking Service in Financial Development: Evidence from Ghana

Andrew Osei Agyemang,[*,1] Angelina Kissiwaa Twum,[2] Joseph Dery Nyeadi,[1] Joseph Owusu Amoah,[1] and Anasford Nti Appau[3]

[1]School of Business, S.D.D University of Business and Integrated Development Studies, Wa, Ghana.
[2]School of Finance Economics, Jiangsu University, Zhenjiang, 212013, China.
[3]Economics Department, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana
[*] Corresponding Author: aagyemang@ubids.edu.gh

Abstract

Mobile money services have shown to be quite beneficial in enhancing and promoting the fundamental responsibilities of the banking sector by establishing and meeting the financial needs of the unbanked and making different financial instruments accessible. An increase in mobile money services is vital for economic success in the financial industry. Before mobile money services were introduced in Ghana, formal banking services had little access to individuals, particularly in rural communities. The study employed a quantitative research design using secondary data sources for the analysis. Monthly time series from 2012 to 2020 was used for the empirical analysis. The study utilized the Vector Error Correction Model (VECM) estimation technique to show the short-run and long-run relationship among the integrated variables. The results from the primary model for the long-run relationship revealed that the number of active mobile money account users has a positive and statistically significant relationship with the proportion of domestic credit to private sector (DCPS). Similarly, the number of active mobile money agents revealed a positive and significant relationship with DCPS. Also, a positive and significant relationship was found between the total volume of transactions and DCPS in Ghana. The findings add to existing literature and give policymakers a clue about improving mobile money services in Ghana.

Keywords: Financial Development; Financial Services; Mobile Money Services; Ghana

JEL classification: G23; A12; O14

Article history: Received: 12 February, 2020 || Accepted: 15 September, 2022

1. Introduction

A rise in financial services provided in an economy may explain financial development and financial inclusion, as they are often defined in terms of financial sector expansion (Quartey and Afful-Mensah, 2014). This comprises an increase in the system of financial efficiency due to changes in financial institutions' functions and mechanisms, methods of providing financial services, and the implementation of the new instruments. Mobile money is a sort of electronic financial payment instrument that enhances trade in goods and services. Mobile money services have promoted the growth of financial services by establishing and meeting the financial needs of the unbanked and

making different financial instruments accessible, such as mobile banking (Amoah et al., 2020). The introduction of mobile money services has led to improved financial development in Ghana, particularly in the financial or banking sector. Mobile money was introduced in Ghana by MTN Ghana Limited in July 2009, then in March 2010 by Airtel. In October 2010 and July 2015, Tigo Ghana Limited and Vodafone Cash, respectively (Appiah et al., 2021). In 2018, 13% of the Ghanaian population were registered as active users of mobile money services. 2019 and 2020 saw a significant improvement where 38.9% and 39% of the population respectively had registered as active members of mobile money services (Appiah et al., 2021). The significant increase in mobile money services in 2019 and 2020 shows the contribution of mobile money to the financial development of the Ghanaian economy. The mobile money service has progressed from normal cash transfer services to a standardized and monitored payment. This has eventually improved the financial development in Ghana over the years.

Before mobile money services were introduced in Ghana, individuals had little access to formal banking services, particularly in rural communities, because bank offices are situated in largely populated district capitals. Financial services such as cash payments and transfers were mostly worrying because banking services were contained either in the bank building or at Automated Teller Machines (ATMs) on a stand-still operation (Alhassan et al., 2021). Personal savings were also difficult for individuals excluded from conventional banking services (Ahmad et al., 2020). Furthermore, the provision of financial services via formal banking platforms was inaccessible to the poor, as well as the centralization of financial services in big cities within the country made the majority of rural communities take a long journey to conduct financial transactions (Lal and Sachdev, 2015). In the last quarter of 2019, mobile money services in Ghana increased from a system of transfer to various financial products (Amoah et al., 2020). Even though it is a mobile-oriented service, it provides functions undertaken by most financial service providers in Ghana. Mobile money services seek to increase, improve, and sustain the provision of financial services for economic development in Ghana Hinson (2011) and Ahmad et al. (2020); however, this objective is not fully achieved.

The majority of earlier studies in Ghana have focused on mobile money penetration, financial development, and economic growth (Cobla and Osei-Assibey, 2018, Osei-Assibey, 2015, Mensah et al., 2020). Very few studies from other developing economies in Africa concentrated on mobile money services and financial development (Akomea-Frimpong et al., 2019). To the best of the authors' knowledge, no previous studies in Ghana have explored the nexus between mobile money services and financial development. Hence, there is a need for empirical studies on this subject.

This study aims to empirically examine the contribution of mobile money banking services to Ghana's financial development using the most recent data. The specific objectives are to (1) assess the contribution of the number of active mobile money banking services to Ghana's financial development. (2) evaluate the impact of the number of active mobile money agents on financial development in Ghana, and (3) examine the effect of the total volume of transactions on the financial development in Ghana. Regarding the contribution of the study, the results of the study will provide empirical evidence that will be relevant for policymakers and monetary authorities (the Bank of Ghana) in developing monetary policies which would improve financial development and boost economic growth.

This study is arranged into the following sections; Section 2 discusses related literature on the topic. The empirical review was effectively covered in the second part. Section three focuses on methods and research designs. Section four presents the results and findings from the study. The final part concludes the study and brings out some policy implications.

2. Literature review

2.1 Definition of Concepts

2.1.1 Mobile Money Transactions

Mobile cash technology comes under the large spectrum of electronic money (E-money), according to (Donovan, 2012). This includes all payments and transactions done with credit and debit cards, prepaid cards, platinum cards, ATM cards, and mobile phones. Mobile money is thus the component of electronic money relating to financial delivery and mobile telephone transactions that could either directly or not be connected to a private bank account (Lwanga Mayanja and Adong, 2016). Asongu (2015) emphasized that mobile money transactions in major growing nations offer customers an opportunity to save money on the internet via mobile telephones. Formal savings require a bank account. However, mobile money services as an infrastructure network allow users without a bank account to have a near-bank account that both network operators administer (Asongu, 2013). Mobile cash users can check balances from these accounts and cash out them. The system allows a customer to move saved funds among multiple related accounts. Asongu (2013) emphasizes that when access to savings is regarded as commodities and services which users can purchase, then mobile money allows mobile telephones to be used for the collection and delivery of cash as Point of Sale (POS) devices. The mobile money system provides a wide variety such as purchases and selling of e-floats, paying for products and services, including airtime purchases, service bills, salary for certain workers, taxi fares, micro credits, and micro insurance, for retail outlets and households, and reduces the cost of access to financial services (Donovan, 2012).

2.1.2 Financial Development

Financial development encourages financial movements related to emerging and capital markets. It promotes a country's long-term economic path and finally enhances production and customers' interests and wealth through accessing financial services (Zhu et al., 2020). It lowers the investment costs of private investors in a country and makes financing more available, enhancing the economic resilience to external shocks (Briguglio, 2016, Ibrahim and Alagidede, 2020). Financial development contributes to smooth consumption and investment patterns, therefore increasing economies' growth. The introduction of mobile money services is one of the financial developments in Ghana (Ibrahim and Alagidede, 2020).

2.2 Overview of Mobile Money in Ghana

In Ghana, mobile money services are somehow a new development in comparison with other nations such as South Africa. It was originally introduced in Ghana by MTN Ghana Limited in the month of July 2009, then in March 2010 by Airtel. In October 2010 and July 2015, Tigo Ghana Limited and Vodafone Cash respectively were also introduced respectively (Abdul-Rahaman and Abdulai, 2021). About seventeen million Ghana subscribers are currently recognized as active users of mobile money services in Ghana for the year 2020 (Senyo et al., 2021). Furthermore, several mobile money transfer operators foresee an exponential increase in the sector, as customers are educated and trained to use electronic payments rather than traditional cash transactions. The increasing interest in the field has led to strong competition between Ghana's telecoms organizations. Although in the Ghanaian economy, mobile money is relatively young, research on mobile money's role in financial development is rising.

According to industry data, Business Financial Times, the total amount of mobile money transactions of 37,105.91 million US$ in 2017, which indicates a 98.% increase over the 2016 position by GH¢18,692.60 million US$ (Akomea-Frimpong et al., 2019). The total amount of mobile money transactions in specific was over one-third of the total amount of 28 banks' debt deposit by the end of 2019 Abdul-Hamid et al. (2019), and illustrates the key role telecom firms play in pushing ahead the central bank's cashless economic plan and also ensuring that millions of Ghanaians strive for wider financial inclusion. Currently, four (4) mobile operators in Ghana – MTN Ghana Limited, Airtel-Tigo, Vodafone and GLO provide mobile phone services (Akomea-Frimpong et al., 2019).

In 2012, mobile money services experienced a rise in the sector from a transaction amount of around GH¢ 1.171million to multi-billion cedi in 2015. An increase in the value of the transactions over the years is in line with a closer pattern in transaction volume. The quantum of transactions has virtually doubled from 2012, from approximately 30 million to approximately 106.4 million in 2014. (Adaba et al., 2019).

Sector analysts such as Li et al. (2020), and Ahmad et al. (2020) believe that mobile money has enabled millions of Ghanaians, who are excluded from the conventional banking system, to execute relatively secure, fast, reliable, affordable, and easy financial transactions.

2.3 The structure of mobile money services

Mobile money services cover three key interfaces: mobile payments, mobile banking, and mobile finance, as described by (Donovan, 2012; Lwanga Mayanja and Adong, 2016). Figure I presents the pictorial view of the mobile money services in Ghana. Figure 1: Mobile Money Services

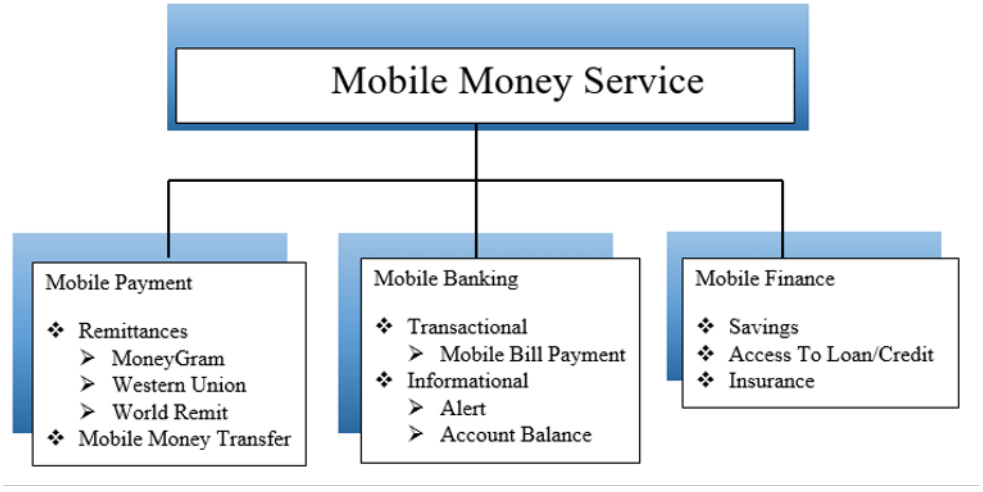

Figure 1. Mobile Money services

2.3.1 Mobile Payment Services

MNOs began by providing money transfer services from person to person. However, technological progress has extended the breadth and variety of services now available by these MNOs (Lwanga Mayanja and Adong, 2016). The MNOs payment services using mobile money platforms now include the payment of utility bills, national and international transfers, online betting, and tuition fees payment (Serbeh et al., 2021).

2.3.2 Mobile Banking services

The MTN mobile money network has taken enormous steps to improve banking services to mobile money consumers since its launch. This was achieved in large part by the establishment of Mobile Network Operators (MNOs) in cooperation with numerous banks throughout the country. Mobile users use this opportunity to connect to their bank accounts for a number of services through their mobile money accounts, such as payment of bills and assessing account information. This approach has influenced Ghana's financial integration by lowering commercial banking costs (Aron, 2018).

2.3.3 Mobile Finance Services

Financial services such as savings, insurance, and access to loans can be supplied to consumers at a lower cost through the advent of mobile money. In 2018, 19% of Ghanaians paid for insurance services using MNO (Senyo et al., 2021). With the advent of mobile financial services, customers can access quick loans without providing several documents with just a click on their phones. The majority of the rural population without access to commercial and rural banks are now using mobile money financial services to save their surplus income (Ahmad et al., 2020).

2.4 Theoretical Perspective

The financial development – economic growth nexus has gotten a lot of attention in economic research since Schumpeter's initial work in 1911. According to the theory, a well-functioning financial system would drive technical advances (growth) via effective resource allocation from unproductive to productive sectors (Becker et al., 2012). This idea is similar to Patrick's Supply-Leading Hypothesis who suggests that the creation of a strong financial sector may boost economic growth (Adeyeye et al., 2015). Furthermore, the growth-led finance theory highlights that a rising economy (real sector) would result in high demand for financial sector services, and so a developed financial sector is a consequence of the increasing real sector's needs. Several explanations have been offered in the literature about the positive link direction of causation between economic growth and financial development (Erdoğan et al., 2020, Čižo et al., 2020).

2.5 Empirical Framework

Etim (2014) explained that an increasing partnership between banks and network providers in Sub-Saharan Africa (SSA) is a key indicator of the positive push towards financial development for Africa's unbanked population). Donovan (2012) further emphasized that the integration of mobile money serves as a fundamental requirement for a successful market engagement and growth for those excluded from the formal financial system. It has helped to improve the financial sector in Ghana. Also, Jenkins (2008) observed that mobile money helps to grow finance by utilizing money transfers, utility payments, and government revenues. Suhud and Hidayat (2014) discovered that mobile phone users who do not have bank accounts in Nigeria and South Africa are currently accessing mobile money for financial-related activities, payroll deposits, international transfers, bill and payment receipts, airtime purchases, grocery stores, bus tickets, and many more financial products. All these arguments point to the fact that mobile money services have improved financial services and hence financial development.

Ghana cannot be left out of the benefits of mobile money services to financial development and economic growth at large. Agrawal (2016) discovered that mobile telephone usage is a major driving force behind recent advances in financial development for mobile money services in Ghana. Aker and Wilson (2013) obtained data on the use of mobile money for saving in Ghana from 97 participating parties. Using an overview and a research survey on the use of mobile money and the savings habit of the same participants. In the earlier stages, it was realized that mobile money was utilized primarily for sending and receiving funds. The research study showed that twenty-six percent (26%) of participants used mobile money for savings and transfer of funds. It was further observed that mobile money reduces the cost of transactions and encourages households to save, which is essential to rural people's smooth consumption in times of shock.

Furthermore, Asiama et al. (2020), using 2015 to 2018 monthly time series data from Ghana, employed the Dynamic Ordinary Least Square (DOLS) analysis and concluded that mobile money penetration has a favourable impact on financial development and economic growth in Ghana.

Ejemeyovwi and Osabuohien (2018) carried out a cross-sectional analysis on mobile money services and economic development using the Generalized Method of Moment (GMM) on a sample of 6 West-African countries from 2005 to 2017. Statistically, the authors found that the number of

active mobile money agents and number of active mobile money account users have a positive and statistically significant connection with financial development.

In South Africa, Olayungbo and Quadri (2019) evaluated the relationship between the volume of mobile money transactions and financial development using annual time series from monthly time series from 2010 to 2020. The authors performed the ARDL estimation techniques and concluded that the volume of mobile money transactions has a positive relationship with financial development.

Glavee-Geo et al. (2019) have analysed household data designed to evaluate access to finance related to the effect of mobile banking services in Ghana. The authors performed the Hausman Test to select between Fixed Effect (FE) and Random Effect (RE). Their results supported FE. The authors further examined the exact relationship between mobile money and financial development. The findings revealed that mobile banking services have a positive relationship with access to finance.

The majority of previous research in Ghana has been on mobile money adoption, financial development, and economic growth (Cobla and Osei-Assibey, 2018, Osei-Assibey, 2015, Mensah et al., 2020). There is limited research on mobile money services and financial growth in other African emerging nations (Akomea-Frimpong et al., 2019). To the best of the authors' knowledge, no prior research in Ghana has looked at the relationship between mobile money and financial development. As a result, empirical research on the nexus between mobile money services and financial development is essential since it will provide some policy implications to stakeholders in developing financial innovations. Therefore, the above discussions lead to the following hypotheses:

H1: A positive relationship exists between the number of active mobile money users and the proportion of domestic credit to private sector in Ghana.

H2: There exists a positive connection between the number of active mobile money agents and the proportion of domestic credit to private sector in Ghana.

H3: A positive slope correlation subsists between the total volume of transactions and the proportion of domestic credit to private sector in Ghana.

3. Materials and Methods

3.1 Research Design

The authors utilized a quantitative research design for the empirical analysis. Due to the nature of the study, the authors used secondary data extracted from reliable public institutions. Secondary sources of data for financial development, Interest rate and inflation were extracted from the Bank of Ghana database. Data on the number of active mobile money users and number of active mobile agents were extracted from the National Communication Authority Ghana, and Mobile Network Operators in Ghana. Data employed for this study ranged from 2012 to 2020 on a monthly times series base. The study considered this period because mobile money services in Ghana commenced full operations in the latter part of 2009 and data on mobile money services surfaced in 2012. The monthly time series data was analyzed by using STATA, and EVIEWS, similar to the studies by (Jijian et al., 2021, Agyemang et al., 2020, Ostic et al., 2022, Twum et al., 2021).

3.2 Variable Description

3.2.1 Dependent Variable

Financial Development refers to the process which improves the quality, quantity, and efficiency of intermediary financial services leading to effective financial markets and intermediation (Song et al., 2021). Financial development encourages financial movements related to emerging and capital markets. It promotes a country's long-term economic path and finally enhances production and customers' interests and wealth through accessing financial services (Zhu et al., 2020). Different proxies have been used to measure financial development from previous studies. In our study, financial development is measured as the domestic credit of the private sector in proportion to the Gross Domestic Product (GDP). The recent World Bank categorization of financial development shows

four components of financial development; financial stability, depth, efficiency and accessibility (Kong et al., 2019). Financial depth is one of the major compartments among the four, and domestic credit to the private sector is also a major determinant often used as a proxy in this respect (Zhu et al., 2020). The authors selected this proxy because it is the most used proxy in earlier studies related to financial innovation, financial development, and economic growth (Ahmad et al., 2020, Burns, 2015). Data were extracted from the Bank of Ghana database, and it is represented by the symbol DCPS.

3.2.2 Independent Variables

Number of Active Mobile Money Users.

The study measures the penetration of the account by the number of active users on the mobile money platform with data from the Bank of Ghana, as opposed to finding out only how many people have mobile money accounts. Unless these accounts are operational, account ownership cannot represent the true extent of financial inclusion (Etim, 2014). Therefore, an active user base would enhance the development of the financial industry. The number of active mobile account users is measured as the number of people who actively use their registered mobile money wallet within a month. It is denoted by the symbol AMMU, and the expected sign is positive.

Number of Active Mobile Money Agents.

Registered mobile money users make cash deposits and withdrawals with agents receiving a sliding fee for both deposits and withdrawals (that is, making purchases and selling e-float). Mobile money agents are also significant stakeholders in the ecosystem of mobile money services (Ahmad et al., 2020). Sometimes called retailers or merchants, they may be persons or companies contracted in order to enable financial transactions for users. Mobile money agents' function is to turn fiat money into e-money, and e-money into cash so that e-money can be transferred from one consumer to another consumer. The number of active mobile money agents is measured as a proportion of active mobile money users. The expected sign is positive, and the variable is denoted by the symbol AMMA.

Total Volume of Transactions .

The total volume of transaction amount is the total amount traded as inflows and outflows of mobile money services. Since mobile money services were introduced in Ghana in 2009, the Telecom Giant MTN has had significant growth in terms of the number of subscribers and agents. This has eventually increased the overall volume of mobile money transactions. Total volume of transactions is measured as the amount transacted on mobile money within a month in billions of US$. It is denoted by the symbol TVT and the expected sign is positive.

3.2.3 Control Variables

Interest Rate.

The prime rate is the annualized central bank interest rate charged on trade and depository banks to provide loans to cover temporary money shortages. High prime rates hinder the provision of bank lending as banks cannot borrow huge sums of money to provide loans to the private sector to improve intermediary financial services. Lower interest rates help to boost financial intermediaries' operations to encourage financial sector development. According to Saymeh and Orabi (2013), interest rates are positively associated with financial development. Interest rate is denoted by the symbol IR and the expected sign is negative.

Inflation.

Inflation is described as 'a continuous increase in the level of overall goods and services prices' (Boyd et al., 2001). The cost of purchasing a given basket of products and services at certain periods, such as annual, months, daily, etc. is calculated as a proportional change. 'It is projected that inflation will be negatively linked to financial progress' (Kim and Lin, 2010). Inflation is represented by the symbol INF and the expected sign is negative.

3.3 Model Specification

The authors modified a model by Burns (2015) to examine the impact of mobile money services on financial development. The model is given as:

$$DCPS_t = \beta_0 + \beta_1 AMMU_t + \beta_2 AMMA_t + \beta_3 TVT_t + \beta_4 IR_t + \beta_5 INF_t + \varepsilon_t \quad (1)$$

$$DCPS_t = \beta_0 + \beta_1 (AMA * INF)_t + \beta_2 (AA * INF)_t + \beta_3 (TVT * INF)_t + \beta_4 IR_t + \beta_5 INF_t + \varepsilon_t \quad (2)$$

Where *DCPS* represents financial development, *AMMU* denotes the number of active mobile money user, *AMMA* denotes the number of active mobile money agents, *TVT* represents the total volume of transactions, *IR* denotes interest rate, and *INF* represents inflation. The coefficients β_1, β_2, β_3, β_4, and β_5, represent parameters of the various variable described, indicates the constant term, t connotes time period and ε represents the error term.

Equation (1) was used to explore the impact of mobile money services on financial development. In Equation (2), the authors examined the interactive effect of mobile money and inflation on financial development. The authors utilized the Vector Error Correction Model (VECM) estimation technique to examine both the short-run and long-run relationship among the study variables. Since the VECM, in theory, is just a VAR representation, the cointegrated VAR has VECM representation and vice versa.

4. Results and Discussions

4.1 Summary Statistics

Table I revealed that Ghana's average Domestic Credit to Private Sector (DCPS) was 19.4254 %, with minimum and maximum values of 9.3050% and 32.4850%, respectively. This indicates that, in general, the average level of financial development is encouraging. In terms of the statistics that measure the dispersion of a dataset relative to its mean, DCPS recorded a standard deviation of 6.6457%, implying that most of the points are very far from the average.

Table 1. Descriptive Statistics Results

Statistics	DCPS	AMMU	AMMA	TVT	IR	INF
Mean	19.4254	10.0617	0.0162	5.1788	7.3400	11.6388
Median	18.5610	9.3400	0.0158	4.1214	7.5500	10.7900
Maximum	32.4850	17.1000	0.0201	16.1190	7.9700	20.9200
Minimum	9.3050	3.1100	0.0138	2.4548	6.4000	7.6000
Std. Dev.	6.6457	3.9870	0.0017	3.2090	0.5139	2.9665
Skewness	0.3892	0.0173	0.5842	1.7874	–0.7423	1.0585
Kurtosis	2.0530	1.7928	2.3829	5.5149	2.3681	3.7324
Observations	108	108	108	108	108	108

For the explanatory variables, the number of active mobile money account users (AMMU) recorded a mean of 10.0617 million and a standard deviation of 3.9870 million. The average number of active mobile money account users indicates that a good number of the population subscribe to the usage of electronic banking, which is good for the economy. The low standard deviation for AMMU indicates that most of the points are very far from the average. AMMU recorded maximum and minimum values of 17.1000 million and 3.1100 million, respectively. The high maximum value affirms that more than half of Ghanaians have subscribed to electronic banking provided by mobile telecommunication systems.

The number of active mobile money agents (AMMA) recorded a mean and standard deviation value of 0.0162 and 0.0017, respectively, with maximum and minimum values of 0.0201 and 0.0138. This shows that the proportion of active mobile money agents to active mobile money users is on average 0.02. This indicates that, for every one hundred active mobile money users, there are two active mobile money agents who provide needed services.

In terms of the total volume of transactions (TVT), the mean and standard deviation recorded 5.1788 billion US$ and 3.2090 billion US$ respectively. The low standard deviation for TVT indicates that most of the points are very far from the average. TVT recorded maximum and minimum values of 16.1190 billion US$ and 2.4548 billion US$, respectively. The high maximum value affirms that for some of the months, the total volume of transactions went very high, affirming high patronage of mobile money services which is an indication of financial innovation in Ghana.

For the control variables, the study revealed average values of 7.3400%, and 11.6388% for interest rate (IR) and inflation (INF), respectively. The standard deviation for the control variables revealed that, the values were very far from the average.

4.2 Stationarity Analysis

To further comprehend the stationarity aspects, the Augmented Dickey-Fuller (ADF) unit root analysis is used to obtain the test statistics. The authors selected the ADF because it performs better with complex models and also it is robust to serial correlation (Haibo et al., 2019, Twum et al., 2022). The null hypothesis is rejected if the coefficient is 0, indicating that the variable does not have a unit root issue. The results of the Unit Root Test are presented in Table 2.

Table 2. Augmented Dickey-Fuller Unit Root Results

Variables	Level		First Difference	
	Intercept	Trend & Intercept	Intercept	Trend & Intercept
DCPS	−1.3479	−2.268	−8.6291 ∗ ∗∗	−8.5773***
AMMU	−0.5679	−3.3053	−10.2239***	−10.1516***
AMMA	−1.1932	−1.6236	−14.2175***	−14.3274***
TVT	1.036	−2.1683	−7.9776***	−8.7546***
IR	−1.791	−1.8823	−8.2514***	−8.3134***
INF	−2.2438	−3.0346	−9.6574***	−9.5901***

*** 1% significant level, ∗ ∗ 5% significant level, ∗10% significant level

The unit root test displayed in Table 2 shows a combination of results from level and first difference for the variables. From the unit root tests at levels, all the variables were not stationary at both trend and trend with intercept. Hence, the first difference unit root test was conducted. After the first differencing, all the study variables were statistically significant at both intercept and trend intercept at the 1% significance level. This indicates that the variables were integrated at the first difference level. The economic implication of first-order integration implies that the authors can perform a cointegration analysis. After establishing cointegration, regression analysis can be performed to show both the long-run and short-run relationship among the study variables.

4.3 Multicollinearity Analysis

The table below presents the Variance Inflation Factor (VIF) analysis that explains the presence or absence of multicollinearity. The presence of it indicates weak variables while the absence of it indicates strong or good variables which truly reflect the relation of the variables. Table 3 presents the results of the collinearity analysis.

Table 3. Multicollinearity Test Results

Variables	VIF	1/VIF
LnAMMU	3.72	0.2689
LnTVT	3.58	0.2793
LnINF	2.39	0.4188
LnIR	2.23	0.4487
LnAMMA	1.46	0.6858
Mean VIF	2.67	

The findings from the VIF test for multicollinearity are presented in Table 3 above. The VIF values range from 1.46 to 3.72, which suggests the absence of multicollinearity in the data. If multicollinearity does not exist, then regression analysis can be carried out to assess the contributions of mobile money services on financial development in Ghana. In addition to the VIF test results, the coefficients from the correlation matrix were below 0.7 which also shows the absence of multicollinearity.

4.4 Results of the Cointegration Test

The Johansen cointegration test generally allows for several cointegrating connections to exist. As a result, long-term connections between the variables may be investigated. The authors' assessment was in keeping with the fact that most empirical applications analyze multivariate systems. The authors estimated the cointegration using the unrestricted cointegration rank test (Trace). The results of the cointegration are provided in Table 4.

Table 4. Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.468269	114.1189	83.93712	0.0001
At most 1 *	0.445571	70.53720	60.06141	0.0051
At most 2	0.195747	29.83989	40.17493	0.3629
At most 3	0.107909	14.80884	24.27596	0.4708
At most 4	0.095215	6.929895	12.32090	0.3321
At most 5	0.000375	0.025882	4.129906	0.8953

The Johansen Cointegration results in Table IV revealed that the null hypothesis of no cointegration connection among the five variables was rejected at the 5% significance level. However, we failed to reject the null hypothesis of at most one cointegration equation. The eigenvalue statistic and the trace statistic method supported the findings. As a result, it can be concluded that there exists a long-run relationship among the study variables. Hence, regression analysis can be conducted to show the exact long-run relationship among the variables.

4.5 Long and Short-run Results

The authors utilized the Vector Error Correction Model (VECM) estimation technique to examine both the short-run and long-run relationship among the study variables. Since the VECM in theory is just a representation of VAR, hence, the cointegrated VAR has VECM representation and vice versa.

The study used two models for the empirical analysis. Model 1 was used to examine the relationship between mobile money and financial development in Ghana, while Model 2 was used to analyze the interactive effect of mobile money and inflation on financial development. The regression analysis results for model 1 are shown in Table 5, while the results of model 2 are shown in Table 6.

Table 5. Short and Long-run Relationship Analysis

	Long-term coefficient		Short-term coefficients based on VECM procedure					
	ECT	Intercept	lnDCPS-1	lnAMMU-1	ln AMMA-1	lnTVT-1	lnIR-1	lnINF-1
Equation	0.0300***	–0.2743*	0.9051***	3.5972	0.2247	–0.3565*	–0.0002	0.1969
lnDCPS	(0.0021)	(0.1362)	(0.3194)	(4.0419)	(0.1705)	(0.1875)	(0.0015)	(0.2227)
Equation	0.1171*	0.5424**	0.0932	–45.4264	–1.0166	1.5022	–0.0096	6.0232 * *
lnAMMU	(0.0617)	(0.2230)	(0.2035)	(55.3690)	(2.2264)	(2.4486)	(0.0191)	(2.9084)
Equation	0.8242*	–1.1673	0.1834	–262.7729	–35.8998*	15.3932	0.3563**	61.4326**
lnAMMA	(0.4200)	(0.8138)	(–0.4091)	(440.8441)	(18.3271)	(20.1556)	(0.1568)	(23.9409)
Equation	0.6722***	–0.2743*	–0.0092	–0.0174	0.0008	–0.1071	–0.1074	–0.1542
lnTKKT	(0.2231)	(0.1362)	(0.0115)	(0.0165)	(0.0021)	(0.2445)	(0.2689)	(5.7289)
Equation	–0.3420***	–6.0710*	0.2899*	–0.0068	0.0009	–0.0561	0.2995*	4.7028
lnLR	(1.5987)	(3.1816)	(0.1500)	(0.0105)	(0.0013)	(0.1558)	(0.1713)	(3.6483)
Equation	–0.8902 * **	0.5892***	–0.1587	–0.0107	0.0012	–0.0964	–18.1563	9.4187
lnLNE	(0.2224)	(0.1701)	(1.2345)	(–0.0229)	(–0.0028)	(–0.3174)	(14.639)	(–7.289)

Note: Standard errors in parenthesis. * * *, **, and * indicate significance at 1%, 5%, and 10% levels, respectively.

The findings from the relationship between mobile money services and financial development in Ghana are shown in Table 5. The findings using the Vector Error Correction Model provided results for both the long-run effect which is provided under the error correction term (ECT) and the short-run relationship by comparing the results of the pairs of variables.

From the long-run relationship results, the number of active mobile money account users (AMMU) recorded a positive relationship with the dependent variable. This indicates that a percentage change in AMMU resulted in a 0.1171 change in financial development and vice versa. The positive relationship is statistically significant at 10% since the probability value recorded was less than 0.1. Hence, we fail to reject the first hypothesis of the study. Similarly, the number of active mobile money agents (AMMA) revealed a positive relationship with financial development (DCPS). The positive relationship indicates that a 1% change in the number of active mobile agents in Ghana reflects a change of 0.8242 in financial development. The positive relationship was also statistically significant at the 10% level. Therefore, the second hypothesis of the study cannot be rejected. Lastly, the long-run relationship results revealed a positive and significant relationship between the total volume of transactions and financial development in Ghana. This implies that whenever there is a percentage change in the total volume of transactions, it corresponds to an increase of 0.6722 in the financial development in Ghana. Therefore, the last hypothesis cannot be rejected.

From the short-run relationship results in Table 5, the findings revealed a positive but insignificant relationship exists between the number of active mobile money account users (AMMU) and financial development (DCPS). Also, a positive but insignificant link was found between the number of active Agents (AMMA) and financial development (DCPS). Based on the short-run relationship, hypotheses one and two are rejected. Contrarily, a positive and significant relationship was found between TVT and DCPS in the short-run similar to the findings in the long-run. Therefore, the last hypothesis cannot be rejected using the short-run relationship.

Therefore, it can be concluded that in the long-run, a positive relationship exists between AMMU and DCPS, AMMA and DCPS, and TVT and DPS. However, in the short-run, a positive but insignificant relationship exists between AMMU and DCPS, as well as AMMA and DCPS. Only

TVT and DPS recorded a positive and significant relationship in the short-run.

Table 6. Long-run and Short-run Analysis using Interactive Effect of Inflation

	Long-term coefficient		Short-term coefficients based on VECM procedure					
	ECT	Intercept	lnDCPS-1	lnAMMUinf-1	ln AMMAinf-1	lnTVTinf-1	lnIRinf-1	lnINFinf-1
Equation	0.0297*	0.5424**	–0.1542	–0.3565*	0.9051***	–0.0174	3.5972	–0.0092
lnDCPS	(0.0073)	(0.2230)	(5.7289)	(0.1875)	(0.3194)	(0.0165)	(4.0419)	(0.0115)
Equation	0.1363*	103.7916***	4.7028	1.5022	–0.0932	–0.0068	–45.4264	0.2899*
lnAMMUinf	(0.0717)	(29.2172)	(3.6483)	(2.4486)	(0.2035)	(0.0105)	(55.3690)	(0.1500)
Equation	–0.0738	0.5892***	9.4187	15.3932	–0.1834	–0.0107	–262.7729	–0.1587
lnAMMAinf	(0.0648)	(0.1701)	(–7.289)	(20.1556)	(–0.4091)	(–0.0229)	(440.8441)	(1.2345)
Equation	0.7014 * **	–1.1673	0.1074*	0.2247	0.1969	–0.0002	0.0008	–0.1071
lnTXTinf	(0.1109)	(0.8138)	(0.2689)	(0.1705)	(0.2227)	(0.0015)	(0.0021)	(0.2445)
Equation	–3.3158***	–0.2743*	0.2995*	–1.0166	6.0232 * *	–0.0096	0.0009	–0.0561
lnLRinf	(0.6586)	(0.1362)	(0.1713)	(2.2264)	(2.9084)	(0.0191)	(0.0013)	(0.1558)
Equation	1.4344 * **	–6.0710*	–18.1563	–35.8998*	61.4326**	0.3563 * *	0.0012	–0.0964
lnLNEinf	(0.4761)	(3.1816)	(14.639)	(18.3271)	(23.9409)	(0.1568)	(–0.0028)	(–0.3174)

Note: Standard errors in parenthesis. * * *, **, and * indicate significance at 1%, 5%, and 10% levels, respectively.

Table 6 provides results for the interactive effect of mobile money and financial development. From the long-run effect results in Model 2, except for the number of active agents (AMMA), the other variables recorded similar relationships in Model 1. AMMA recorded an inverse but insignificant relationship with financial development (DCPS). That is, a positive and statistically significant relationship at the 10% level was found between active mobile money users and financial development. This implies that a percentage increase in AMMU reflects in a 0.1363 change in financial development. Similarly, TVT revealed a positive and statistically significant relationship at the 1% level. Using the long-run effect for the interactive relationship, we fail to reject hypotheses 1 and 3. While the second hypothesis is rejected.

From the short-run effect in the interactive relationship, a positive but insignificant relationship was found between the three independent variables and the dependent variable. The insignificant relationship leads to the rejection of all three hypotheses.

4.6 Discussion

The growth and extension of financial services to the non-banked people through mobile money services have contributed to the increased economic and business transactions especially for small and medium enterprises. This process might become a tough issue for financial authorities if the non-bank public controls the cash. The inception of mobile money has brought about innovation in the financial instruments in Ghana. New finance instruments and payment methods are introduced by financial innovations that might change fund monitory, costs, and impact how funds are handled (Chibba, 2009). Banks and utility services providers have included mobile money services which is relatively fast and cheap in making cash payments and transfers. Hence, influenced a good number of Ghanaians to be active on mobile money accounts. This allows for innovations such as mobile money services to change people's way of keeping cash and the flow of the currency. Based on this background, the study in the first hypothesis assumed a positive relationship between the number of active mobile money account users and financial development. The results revealed a positive and statistically significant relationship between active mobile money account users and financial development for the long-run. The findings are similar to the findings of Aker and Wilson (2013), who noted that cash transfer through mobile services contributes to minimize cash transactions cost which enhances household investment. This eventually influences more of the population to subscribe

to active mobile money accounts in Ghana. It should be noted that an increase in the size of mobile service agents, users and transactions indicates a massive improvement in the number of financial services available to the general public. Mobile cash users can check balances from these accounts and cash out via mobile money agents. The availability of mobile money agents outlet provides confidence in Ghanaians to subscribe to mobile money services provided by telecommunication networks in Ghana. Having more active mobile money agents increases the number of active mobile money account users, which eventually increases financial services in the country. Based on this background, the authors hypothesized a positive relationship between active mobile agents and financial development in Ghana. The findings were in line with the assumption. Hence, the second hypothesis was not rejected. The findings from the study are similar to the findings by Burns (2015), who suggested that the availability of mobile money agents has changed the way people handle cash. The author further noted that this change has also improved financial innovation system in Ghana. Aker and Wilson (2013) discovered that mobile money was mostly used for sending and receiving money which increased the overall number of transactions each month. By developing and addressing the financial requirements of the unbanked cash, mobile money services have aided the expansion of financial services. Hence, the authors anticipated a positive slope association between the total number of transactions and financial growth in Ghana in the final hypothesis. The regression results revealed a positive and statistically significant relationship between the total volume of transactions and financial development at the 1

5. Conclusion and Recommendations

5.1 Conclusion

The introduction of mobile money services has improved Ghana's financial growth, particularly in the financial and banking sectors. Prior to the introduction of mobile money services in Ghana, citizens had limited access to traditional banking services, especially in rural areas where bank branches were concentrated in the cities. Most of the earlier studies on mobile money in Africa focused on mobile money penetration, financial innovations and economic growth. Hence, there is limited literature on mobile money services and financial development for developing economies such as Ghana. This motivated the authors to examine the nexus between mobile money services and financial development in Ghana. For the empirical analysis, the study used a quantitative research approach by employing monthly time re from 2012 to 2020. The authors utilized the Vector Error Correction Model (VECM) estimate approach to reveal the integrated variables' short and long term relationships. From the long-run relationship analysis results in the primary model, the number of active mobile money account users (AMMU) recorded a positive and statistically significant relationship with the dependent variable (DCPS) for the long-run relationship. Similarly, the number of active mobile money agent (AMMA) revealed a positive and significant relationship with domestic credit to private sector (DCPS) in the long-run relationship analysis. Also, a positive and significant relationship was found between the total volume of transactions and DCPS in the Vector Error Correction Model analysis for long-run in Ghana. The findings for the long-run relationship were in line with their theoretical assumptions. Hence, all three hypotheses are not rejected in Model 1 for the long-run effect. From the short-run relationship results in model 1, the findings revealed a positive but insignificant relationship exists between the number of active mobile money account users (AMA) and financial development (DCPS). Similarly, a positive but insignificant connection was found between the number of active mobile money agents (AMMA) and financial development (DCPS). Contrarily, a positive and significant relationship was found between TVT and DCPS in the short-run similar to the findings in the long-run. Therefore, the last hypothesis is not rejected using the short-run relationship, whereas the first and second hypotheses are rejected using the short-run effect. From the empirical results, mobile money services are seen to have a positive impact on the financial development in Ghana.

5.2 Recommendations

Mobile money services are seen to have a positive impact on the financial development in Ghana. Hence, policymakers need to formulate strategies that will encourage the majority of the poor population to use mobile money services. Policies such as eliminating or making the transaction cost of mobile money insignificant (about 0.1%) may motivate the less deprived Ghanaians to subscribe to active mobile money accounts.

In addition to the above, the number of mobile agents to mobile money users in Ghana is meagre. The availability of more active agents will give confidence to Ghanaians to subscribe to active mobile money accounts. This is because when a mobile money account user wants to withdraw cash, they can only do so through the agents. Hence, the limited number of mobile money agents poses a problem in getting more active account holders in deprived communities. The MNTs should provide enabling environment that will attract more mobile agents, especially, in deprived communities.

Lastly, the findings affirm the positive impact of digitization in the financial sector of Ghana. Policymakers should therefore uphold policies that will improve digitization in the financial sector and minimize or avoid policies that can affect the level of digitization and financial development such as excessive taxation which will result in decline of the financial sector development.

5.3 Limitation and Future Studies

In terms of the limitation of the study, there seems to be no consensus on a financial development metric. Many researchers have reached various findings depending on the indicator used to proxy for financial development in their empirical studies. Our study used credit to the private sector as a percentage of GDP as a proxy for financial development. This proxy captures only the extent of financial systems and neglects other essential factors such as access and efficiency of financial development. Future studies can consider proposing an index as a proxy for financial development, which will take into account all the metrics of financial development rather than just an aspect of financial development.

Biographical Notes

Andrew Osei Agyemang holds PhD degree in Management Science and Engineering with major in Accounting from Jiangsu University, China. He is currently a postdoctoral scholar at Jiangsu University and a Faculty Member at SDD – University of Business and Integrated Development Studies, Ghana. His research areas are Corporate Governance, Accounting Disclosure, Environmental Accounting, and Sustainability Reporting.

Angelina Kissiwaa Twum is a PhD candidate at Jiangsu University, China, pursuing PhD in Management Science and Engineering with major in Environmental and Energy Economics. She holds MSc in Applied Economics from Jiangsu University, China. Her research areas are Credit Risk Management, Corporate Governance, Environmental Economics, Energy Economics and Green Finance.

Joseph Dery Nyeadi holds a PhD in Development Finance from University of Stellenbosch, South Africa. He is both a member of the Institute of Chartered Accountants, Ghana and CIMA-UK. He is a Faculty Member at SDD – University of Business and Integrated Development Studies, Ghana where he heads the Department of Banking and Finance. His current research interest is Corporate Finance and Development Finance.

Joseph Owusu Amoah is a PhD candidate at SDD – University of Business and Integrated Development Studies pursuing PhD in Finance. He is also a faculty member of the School of Business under SDD – University of Business and Integrated Development Studies. His research

areas are capital flows, corporate finance, educational financing, and green finance.

Anasford Nti Appau holds MSc in Development Finance from the Kwame Nkrumah University of Science and Technology, Ghana. His research interest is Financial Development.

Conflicts of interest

The authors declare no conflict of interest.

References

Abdul-Hamid, I. K., Shaikh, A. A., Boateng, H., & Hinson, R. E. (2019). Customers' Perceived Risk and Trust in Using Mobile Money Services—an Empirical Study of Ghana. International Journal of E-Business Research (IJEBR), 15(1), 1-19.

Abdul-Rahaman, A., & Abdulai, A. (2021). Mobile money adoption, input use, and farm output among smallholder rice farmers in Ghana. Agribusiness, 16(3), 83-99.

Adaba, G. B., Ayoung, D. A., & Abbott, P. (2019). Exploring the contribution of mobile money to well-being from a capability perspective. The Electronic Journal of Information Systems in Developing Countries, 85(4), 12079.

Adeyeye, P. O., Fapetu, O., Aluko, O. A., & Migiro, S. O. (2015). Does supply-leading hypothesis hold in a developing economy? A Nigerian focus. Procedia Economics and Finance, 30, 30-37.

Agrawal, R. (2016). Mobile Money Empowering People Living at Bottom of Pyramid and Boosting Socio-Economic Development in a Big Way. Economic Analysis, 49(1-2), 15-23.

Agyemang, A. O., Yusheng, K., Ayamba, E. C., Twum, A. K., Chengpeng, Z., & Shaibu, A. (2020). Impact of board characteristics on environmental disclosures for listed mining companies in China. Environmental Science and Pollution Research, 27(17), 21188-21201.

Ahmad, A. H., Green, C., & Jiang, F. (2020). Mobile money, financial inclusion and development: A review with reference to African experience. Journal of Economic Surveys, 34(4), 753-792.

Aker, J. C., & Wilson, K. (2013). Can mobile money be used to promote savings? Evidence from Northern Ghana, Swift Institute

Akomea-Frimpong, I., Andoh, C., Akomea-Frimpong, A., & Dwomoh-Okudzeto, Y. (2019). Control of fraud on mobile money services in Ghana: an exploratory study. Journal of Money Laundering Control, 22(2), 300-317.

Alhassan, T. F., Guryanov, S. A., & Kouadio, A. J. (2021). The impact of mobile money, remittances, and financial development on innovative growth in sub-Saharan Africa. Экономика региона. 2021. Том 17, выпуск 1, 17(1), 276-287.

Amoah, A., Korle, K., & Asiama, R. K. (2020). Mobile money as a financial inclusion instrument: what are the determinants? International Journal of Social Economics, 47(10), 1283-1297.

Appiah, B., Tampuri Jnr, M. Y., & Katso, B. (2021). Evaluating the Impacts of Mobile Money Remittances on Household Development: A Descriptive Study of Rural Ghana. International Journal of Creative Research Thoughts, 9(9), 455-473.

Aron, J. (2018). Mobile money and the economy: a review of the evidence. The World Bank Research Observer, 33(2), 135-188.

Asiama, R. K., Amoah, A., & Ahiabor, G. (2020). Does Mobile Money Business Influence Non-Performing Loans in the Traditional Banking Sector? Evidence from Ghana. African Journal of Business & Economic Research, 15(4), 481-497.

Asongu, S. (2015). The impact of mobile phone penetration on African inequality. International Journal of Social Economics, 42(8), 706-716.

Asongu, S. A. (2013). How has mobile phone penetration stimulated financial development in Africa? Journal of African Business, 14(1), 7-18.

Becker, M. C., Knudsen, T., & Swedberg, R. (2012). Schumpeter's theory of economic development: 100 years of development. Journal of Evolutionary Economics, 22(5), 917-933.

Boyd, J. H., Levine, R., & Smith, B. D. (2001). The impact of inflation on financial sector performance. Journal of monetary economics, 47(2), 221-248.

Briguglio, L. P. (2016). Exposure to external shocks and economic resilience of countries: evidence from global indicators. Journal of Economic Studies, 43(6), 1057-1078.

Burns, S. (2015). Mobile money and financial development: The case of M-PESA in Kenya. Available at SSRN 2688585.

Chibba, M. (2009). Financial inclusion, poverty reduction and the millennium development goals. The European Journal of Development Research, 21(2), 213-230.

Čižo, E., Lavrinenko, O., & Ignatjeva, S. (2020). Analysis of the relationship between financial development and economic growth in the EU countries. Insights into Regional Development, 2(3), 645-660.

Cobla, G. M., & Osei-Assibey, E. (2018). Mobile money adoption and spending behaviour: the case of students in Ghana. International Journal of Social Economics, 45(1), 29-42.

Donovan, K. (2012). Mobile money for financial inclusion. Information and Communications for development, 61(1), 61-73.

Ejemeyovwi, J. O., & Osabuohien, E. S. (2018). Investigating the relevance of mobile technology adoption on inclusive growth in West Africa. Contemporary Social Science, 15(1), 48-61.

Erdoğan, S., Yıldırım, D. Ç., & Gedikli, A. (2020). Natural resource abundance, financial development and economic growth: an investigation on Next-11 countries. Resources Policy, 65, 101559.

Etim, A. S. (2014). Mobile banking and mobile money adoption for financial inclusion. Research in Business and economics Journal, 9(1), 1-14.

Glavee-Geo, R., Shaikh, A. A., Karjaluoto, H., & Hinson, R. E. (2019). Drivers and outcomes of consumer engagement: Insights from mobile money usage in Ghana. International Journal of Bank Marketing, 38(1), 1-20.

Haibo, C., Ayamba, E. C., Agyemang, A. O., Afriyie, S. O., & Anaba, A. O. (2019). Economic development and environmental sustainability—the case of foreign direct investment effect on environmental pollution in China. Environmental Science and Pollution Research, 26(7), 7228-7242.

Hinson, R. E. (2011). Banking the poor: The role of mobiles. Journal of Financial Services Marketing, 15(4), 320-333.

Ibrahim, M., & Alagidede, I. P. (2020). Asymmetric effects of financial development on economic growth in Ghana. Journal of Sustainable Finance & Investment, 10(4), 371-387.

Jenkins, B. (2008). Developing mobile money ecosystems. Washington, DC: International Finance Corporation and Harvard Kennedy School.

Jijian, Z., Twum, A. K., Agyemang, A. O., Edziah, B. K., & Ayamba, E. C. (2021). Empirical study on the impact of international trade and foreign direct investment on carbon emission for belt and road countries. Energy Reports, 7, 7591-7600.

Kim, D.-H., & Lin, S.-C. (2010). Dynamic relationship between inflation and financial development. Macroeconomic Dynamics, 14(3), 343-364.

Kong, Y., Musah, M., & Agyemang, A. O. (2019). Liquidity and financial performance: A correlational Analysis of Quoted Non-financial firms in Ghana. International Journal of Trend in Scientific Research and Development (IJTSRD), 3(5), 133-143.

Lal, R., & Sachdev, I. (2015). Mobile money services: Design and development for financial inclusion: Citeseer, 21(3), 15-83.

Li, K., Musah, M., Kong, Y., Adjei Mensah, I., Antwi, S. K., Bawuah, J., . . . Andrew Osei, A.(2020). Liquidity and firms' financial performance nexus: panel evidence from non-financial firms listed on the Ghana Stock Exchange. SAGE Open, 10(3), 2158244020950363.

Lwanga Mayanja, M., & Adong, A. (2016). A pathway to financial inclusion: mobile money and individual Savings in Uganda.

Mensah, I. K., Chuanyong, L., & Zeng, G. (2020). Factors determining the continued intention to use mobile money transfer services (MMTS) among university students in Ghana. International Journal of Mobile Human Computer Interaction (IJMHCI), 12(1), 1-21.

Olayungbo, D., & Quadri, A. (2019). Remittances, financial development and economic growth in sub-Saharan African countries: evidence from a PMG-ARDL approach. Financial Innovation, 5(1), 1-25.

Osei-Assibey, E. (2015). What drives behavioral intention of mobile money adoption? The case of ancient susu saving operations in Ghana. International Journal of Social Economics, 42(11), 962-979.

Ostic, D., Twum, A. K., Agyemang, A. O., & Boahen, H. A. (2022). Assessing the impact of oil and gas trading, foreign direct investment inflows, and economic growth on carbon emission for OPEC member countries. Environmental Science and Pollution Research, Online version.

Quartey, P., & Afful-Mensah, G. (2014). Financial and monetary policies in Ghana: A review of recent trends. Review of Development finance, 4(2), 115-125.

Rogers, E. M., & Singhal, A. (2003). Empowerment and communication: Lessons learned from organizing for social change. Annals of the International Communication Association, 27(1), 67-85.

Saymeh, A. A. F., & Orabi, M. M. A. (2013). The effect of interest rate, inflation rate, GDP, on real economic growth rate in Jordan. Asian Economic and Financial Review, 3(3), 341.

Senyo, P., Karanasios, S., Gozman, D., & Baba, M. (2021). FinTech ecosystem practices shaping financial inclusion: the case of mobile money in Ghana. European Journal of Information Systems,1-16.

Serbeh, R., Adjei, P. O.-W., & Forkuor, D. (2021). Financial inclusion of rural households in the mobile money era: insights from Ghana. Development in practice, 1-13.

Song, C.-Q., Chang, C.-P., & Gong, Q. (2021). Economic growth, corruption, and financial development: Global evidence. Economic Modelling, 94, 822-830.

Suhud, U., & Hidayat, N. (2014). A Qualitative Study to Explore Stage of Readiness and Mobile Money Acceptance of Micro and Small Enterprises in Indonesia. LISTENING TO CONSUMERS OF EMERGING MARKETS, 188.

Twum, A. K., Agyemang, A. O., & Sare, Y. A. (2022). Revisiting credit risk and banks performance of China's commercial banks before and after Covid 19 pandemic. Journal of Corporate Accounting & Finance, 33(3), 16-30

Twum, A. K., ZhongMing, T., Agyemang, A. O., Ayamba, E. C., & Chibsah, R. (2021). The impact of internal and external factors of credit risk on businesses: An empirical study of Chinese commercial banks. Journal of Corporate Accounting & Finance, 32(1), 115-128.

Zhu, X., Asimakopoulos, S., & Kim, J. (2020). Financial development and innovation-led growth: Is too much finance better? Journal of International Money and Finance, 100, 102083.