

Understanding the Determinants of Mobile Money Usage and its Effect on Firm Performance: Cross-Country Evidence from Sub-Saharan Africa

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Abstract

A growing number of studies have examined the roles of mobile money usage in relation to firms' outcomes, but little emphasis has been placed on the cross-country determinants of mobile money usage as well as its impact on firms' performance. This paper examines the determinants of mobile money usage and its impacts on firms' total sales and profits (proxied as firm performance) using a sample of firms across 14 countries in sub-Saharan Africa. To investigate the determinants or drivers of mobile money usage by firms in sub-Saharan Africa, this paper adopts both the ordinary least squares (OLS) method, probit model, ordered probit model approach. The paper identifies a few variables (factors) such as firm level as well as macro-level variables as determinants of mobile money usage by firms. In addition, this paper estimates the impact of mobile money on firms' performance by adopting the ordinary least squares, and an instrumental variable (IV) estimation approach. Further, using the OLS and IV approaches, the paper finds statistically significant effect of mobile money usage on firms' performance for the sample of firms in our analysis. The findings lend credence to the growing consensus about the relevance of mobile money in addressing issues of credit constraint of firms and its implications on firms' performance in developing countries, especially in the context of sub-Saharan Africa.

Keywords: Determinants; mobile money; firm; performance; cross-country; sub-Saharan Africa

1. Introduction

In recent years a number of countries in sub-Saharan Africa (henceforth, SSA) witnessed innovations in digital financial technologies (e.g., fintech), which resulted in mobile money adoption among households and firms.¹ Evidence from the SSA based on Global Findex survey reveals that ownership of mobile money accounts has grown significantly in recent times. For example, account ownership grew from 12% of adults in 2014 to 33% of adults in 2021. Between 2014 and 2021, for developing economies, account ownership increased by an 8-percentage point largely due to mobile money accounts (Demirgüç-Kunt, et al., 2022). The rapid spread of mobile money across SSA is, to a large extent, connected to mobile phone subscription rate, which significantly influenced use of mobile money services in the region (Demirgüç-Kunt, et al., 2022).

The trajectory of mobile money evolution in SSA began in Kenya in 2007. Subsequently, Tanzania, and Uganda, respectively, reported the adoption of mobile money for the first time in 2008 and 2009². Mobile money has extended across several countries both within and outside sub-Saharan Africa (Tyce, 2020; GSMA, 2019). Specifically, in Gabon, ownership of mobile money accounts rose to 57% in 2021 from 7% in 2014; and in Uganda, it grew from 35% in 2014 to 54% in 2021; in Ghana, it grew from 39% in 2017 to 60% in 2021; in Benin, it grew from 18% in 2017 to 37% in 2021, from 28% to 42% in Zambia, and from 15% to 42% in Cameroon (Demirgüç-Kunt, et al., 2022; Demirguc Kunt et al., 2018)³.

One of the aftermaths of the evolution and adoption of mobile money in SSA is the spate of financial inclusion of significant aspects of the population, which provides opportunities to firms and households to partake in the conventional banking system by providing them with an easy, reliable and accessible means of payment (Suri, 2017; Sawadogo and Wandaogo, 2021). Consequently, in relation to firms, the evolution and adoption of mobile money significantly changed how firms pay, borrow, save, and transact with one another (Ky et al., 2018; Suri, 2017; Naito et al., 2021). Firms' usage of mobile money helps in making the following payments: bill payments, supplier payments, employee payments, and customer payments for goods or services (Islam et al., 2018). Moreover, using mobile money services by firms could foster intra-African trade and other international transactions among micro and medium-sized firms through an enhanced firm's performance by increasing recognition in bill payments and commerce (Burns, 2015; Demir and Dahi, 2011; Sawadogo and Wandaogo, 2021; Hajilee and Niroomand, 2019).

¹ Mobile money is designed such that financial transactions are linked to a phone number and allows traditional banking transactions to be carried out (Suri, 2017; Sawadogo and Wandaogo, 2021).

² For the other countries in the analysis, the year of introduction of mobile money is as follows: Benin in 2020; Cameroon in 2012; Chad in 2012; Cote d'Ivoire in 2008; Ghana in 2009; Guinea in 2012; Liberia in 2011; Mali in 2011; Niger in 2010; Sierra Leone in 2009; and Togo in 2013.

³ Moreover, by 2016, it was reported that, globally, mobile money account ownership reached half a billion, and sub-Saharan Africa accounted for 277 million (GSMA, 2016).

Notwithstanding the spate of mobile money in SSA, there has been limited adoption of mobile money among firms and businesses compared to households (Beck et al., 2015). Hence, several factors or variables are responsible for a firm's usage of mobile money, which include the number of employees, differences in gender of the top manager, the firm's size, the age of firm, export status, the nature of ownership of the business, export status, and other characteristics of the firms, among others (Demirguc Kunt et al., 2018; World Bank, 2019b; Islam et al., 2018).

In light of the foregoing, this paper investigates the following research questions. (i) what factors determine firms' use of mobile money in SSA? (ii) does mobile money usage affect a firm's performance? This paper focuses in investigating the following objectives: (i) to investigate the drivers (factors) of mobile money usage among firms in SSA. (ii) to investigate the effect of using mobile money on a firm's performance. This study identifies the following research hypothesis: (i) mobile money adoption by firms is influenced by firm-level and macro-level (variables) factors. (ii) mobile money adoption by firms positively affects firms' performance. This paper uses firm-level data of the World Bank Enterprise Surveys drawn from 14 countries across sub-Saharan Africa⁴, using the ordinary least squares (OLS) regression, and the instrumental variable approach. The paper identifies a few variables (factors) such as firm-level as well as macro-level variables as determinants of mobile money usage by firms. Further, using OLS and the instrumental variable approach, the paper finds statistically significant effect of mobile money usage on firms' performance for the sample of firms in our analysis.

The contribution of this paper relates broadly to a growing literature on the roles of mobile money (Islam, Muzi, and Meza, 2018; Aker et al. 2016; Munyegera and Matsumoto, 2016; Wright et al. 2014; Bångens and Björn Söderberg, 2011; Konte and Tetteh, 2023; Jack and Suri, 2014). For example, a few studies related to this paper explore firm-level analysis of the roles of mobile money in saving time in financial transactions, reducing financial risk such as theft, and reducing dependence on conventional banks (Gosavi, 2015; Bångens and Björn Söderberg, 2011). Further, while Islam, Muzi, and Meza (2018) reveal that using mobile money is positively associated with a firm's purchase of fixed assets, Konte and Tetteh (2023) discuss how mobile money interacts with traditional financial services to promote a firm's performance.

This paper is organised as follows. Section 2 presents the theoretical framework and the empirical literature of this paper. Section 3 presents the data sources. Section 4 discusses the empirical methodology. Section 5 presents the findings and discussions of the results. Section 6 concludes the paper.

⁴ Further details on the sample of firm-level data for the respective countries used in this paper are discussed in section 3 of this paper.

2. Theoretical Framework and Empirical Literature

2.1 Theoretical Framework

The evolution of mobile money is associated with fostering financial inclusion through reaching a previously unbanked population (firms and households). The nature of innovations relating to mobile money is known as inclusive innovation (Kaplinsky, 2011; Pansera and Owen, 2018). In relation to understanding mobile money adoption by firms, several theoretical postulations have shown that mobile money usage is likely to affect firms' performance through a few channels. First, a firm's use of mobile money is often associated with a decline in costs incurred to carry out financial transactions (Jack and Suri, 2014). Moreover, compared to traditional banking services that incur 'sundry' charges when used to transfer funds, using mobile money can lead to transfer of funds (either in terms of receipts or payments) by firms at reduced financial costs. The decline in transaction costs allows for rapid business transactions, which can potentially lead to an increase in the volume of operations of firms, such as sales or revenue. For instance, evidence shows that mobile money usage by employers for the purposes of salary payments can result in cost savings, which can have positive implications on a firm's profit (Frederick, 2014; Blumenstock et al., 2015).

Second, stemming from reduced costs in financial transactions and the *almost absence of difficulties* in money transfers, which mobile money usage provides, can lead to an increase in the liquidity of the firms and allow for cash flow at a faster rate across firms. Enhanced or sustained cash flows can have impact on a firm's investments, which could have implications on a firm's performance, which is proxied as sales per worker and profits per worker, respectively (Islam et al., 2018; Kadapakkam et al., 1998; Bångens and Björn Söderberg, 2011; Jack and Suri, 2014). Third, using mobile money to store money, payments purposes – either from customers and suppliers for goods and services, can lead to a reduction in exposure to transaction risks such as theft (Wright et al., 2014; Beck et al., 2015). The reduction or mitigation of losses from theft due to the usage of mobile money help to prevent losses that can affect firms' financial performance, such as profits.

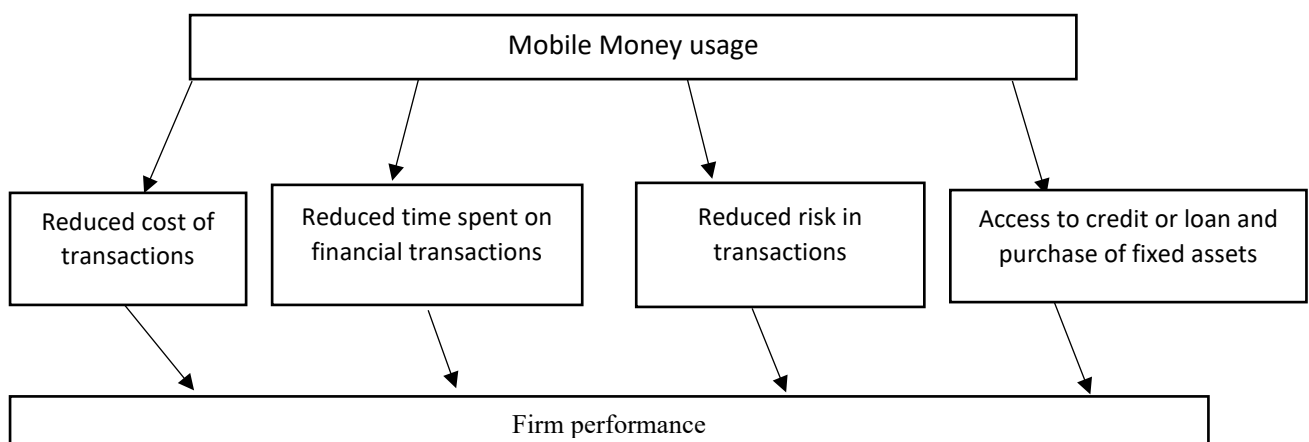


Figure 1. Potential pathways of mobile money and firm performance

Fourth, mobile money usage by firms facilitates access to external finance e.g., trade credit or loan, by reducing information asymmetry and allowing mobile network operators to monitor the transactions or profile of mobile money operators to track their creditworthiness to check their likelihood of repayment (Dalton et al., 2019; Beck et al., 2015; Gosavi, 2018; Beck et al., 2018). For instance, evidence reveals that access to finance among Kenyan firms increased due to the adoption of mobile money (Lipa Na M-PESA). The access to finance is mainly through and access to mobile money loans by users of mobile money (Dalton et al., 2019). Therefore, the use of mobile money can circumvent the problem of access to finance required for business operations, which can lead to a firm's performance (Konte and Tetteh, 2022). Figure 1 shows the potential channels through which using mobile money influences a firm's performance.

2.2 Mobile Money Adoption and Its Determinants

Mobile money usage in SSA could largely be influenced by country-level institutional and firm-level factors (Kabengele and Hahn, 2021; Erumban and De Jong, 2006; Lashitew et al., 2019; Rogers, 2003). Institutions in this context comprise, among others, the state of the financial service sector, appropriate regulation, and the infrastructural quality of mobile networks, which are pivotal to the growth and expansion of mobile money (Kabengele and Hahn, 2021). With the spate of mobile phone subscribers in SSA, the growth of mobile money is significantly enhanced across several countries (Kabengele and Hahn, 2021; GSMA, 2019b). Although a mobile network is necessary for having mobile money in place, it is, however, not sufficient because other variables or factors, such as the education level of the local population and ATM density, are necessary for the adoption of mobile money (Munyegera and Matsumoto, 2016; Munyegera and Matsumoto, 2018; Lashitew et al., 2019).

A few studies have linked the diffusion of mobile money in SSA to the absence of accessible and fully developed financial markets. For example, in Kenya, M-Pesa thrives largely because most Kenyan households had limited access to formal financial services (Kabengele and Hahn, 2021; Onsongo, 2019). Lashitew et al. (2019) revealed that in addition to mobile phone penetration, institutional and regulatory factors are required for the mobile money innovation and adoption. Further, well-designed, appropriate, and reliable regulations are pivotal for the diffusion of mobile money services (Aron 2017; Suri, 2017). The diffusion of mobile money services in SSA has been partly attributed to proper regulations, such as competition regulation, banking regulation, privacy, prudential and financial regulation, and customer protection (GSMA, 2019a; Aron, 2017).

At the macro-level, money adoption and usage can be influenced by a few factors such as demand factors, supply factors, and contextual factors (Erumban and De Jong, 2006; Lashitew et al., 2019; Rogers, 2003). Demand factors are largely motivated by the need or desire for financial products or services that are affordable to consumers, convenient to use, and safe, which characterised the innovation and growth of mobile money (Van der Boor et al., 2014; Muwanguzi and Musambira, 2009; Lashitew et al., 2019). Examples of some of the demand factors include accounts in formal financial

institution (% of adults), Automated Teller Machines (ATMs) depth, and the level of bank concentration in the country (Lashitew et al., 2019; Demirgüç-Kunt et al., 2015). Theoretically, there is likely to exist an inverse relationship between percentage of formal account ownership and ATMs penetration, and the demand or use of mobile money.

Moreover, a telecom sector with strong regulatory supervision, accessibility of networks, and quality of service, is likely to stimulate mobile money innovations (Demirgüç-Kunt and Klapper, 2013; Van der Boor et al., 2014). Some of the supply factors include mobile phone penetration across countries, the coverage as well as the quality of mobile internet networks, and telecom regulatory quality (Waverman and Koutroumpis, 2011; Lashitew et al., 2019). Lastly, mobile money adoption can be influenced by contextual factors, which include Gross Domestic Products (GDP) per capita, Gross Domestic Products (GDP) growth, rule of law, and urbanisation. For example, a high Gross Domestic Products per capita and Gross Domestic Products growth rates are likely to lead to greater demand, adoption, and usage of mobile money services (World Bank, 2016; Lashitew et al., 2019).

In addition, undertaking a firm-level analysis of some selected countries in SSA, Islam and Muzi (2022) reveal that the likelihood of using mobile money for financial transactions is statistically and negatively associated with the top managers' experience and labour productivity, but positively associated with firms without registration when operations started, bribery depth, firms experienced losses due to crime, and establishment has checking or savings accounts. Although this study provides useful insights into the determinants of mobile money usage by firms in SSA, however, one limitation of the study is the non-inclusion of control variables in the regression for potential confounding factors across countries such as mobile phone penetration across countries, the coverage as well as the quality of mobile internet networks, and telecom regulatory quality, Gross Domestic Products (GDP) per capita, Gross Domestic Products (GDP) growth, rule of law, and urbanisation, among others.

2.3 *Mobile Money and Firms' Outcomes*

Financial technologies such as mobile money have been shown to play significant roles in granting access to credit and shaping or predicting repayment behaviour, which can have implications for firms' outcomes. For instance, empirical analysis by Gosavi (2018) shows that mobile money usage influences access to credit for a sample of countries in East Africa. Moreover, the access to credit benefit of mobile money could stem from the predictability of repayment behaviour through the provision of information to lenders about the borrowers (Björkegren and Grissen, 2019).⁵ To the extent that mobile money mitigates the problem of access to finance, which is an essential factor in a firm's growth and expansion, it could be related or linked to a firm's performance (Ayyagari et al., 2008; Beck et al., 2005).

⁵ Other factors such as access to internet services and communication have been found to influence formal firms and women-owned businesses in developing countries (Clarke et al. 2015; Menon, 2015).

Hence, the emergence of mobile money plays a significant role in providing opportunities that influence business outcomes, including creating employment opportunities and leapfrogging into the future (World Bank, 2019). A plausible pathway through which mobile money could influence firms' performance is through investment or purchase of fixed assets as a result of mobile money adoption (Islam et al., 2018; Islam and Muzi, 2022). For example, from a theoretical standpoint, the result of how using mobile money influences the purchase of fixed assets stems from a decline in transaction costs, increased liquidity, and increased creditworthiness (Islam et al., 2018). Further, other explanations for how using mobile money relates to a firm's investment could stem from theoretical understanding that using mobile money increases creditworthiness by connecting suppliers and customers, which could lead to the flow of information and reduce enforcement frictions among economic agents (Ahmad et al., 2020; Paulson et al., 2006; Gosavi, 2018). For example, Gosavi (2018) reveals that mobile money usage by firms is associated with obtaining loans or lines of credit among firms.

Firms could use of mobile money alongside other variables as an interaction term to influence a firm's performance. For example, access to traditional banking services could be one of the pathways through which mobile money could influence a firm's performance (Konte and Tetteh, 2023). Moreover, empirical evidence using firm-level data for a sample of countries in SSA indicates that using traditional financial services with mobile money leads to a firm's performance but found no impact direct impact of mobile money usage a firm's performance.

There has been a growing interest among researchers to show whether a connection exists between mobile money adoption and firms' performance for several contexts (Hassan, 2023; Mohammed & Nor 2021; Talom & Tengeh, 2020; Bosire & Ntale, 2018; Mararo & Ngahu, 2017; Akyoo & Sife, 2015; Kirui & Onyuma, 2015; Chale & Mbamba, 2015; Nyaga & Okonga, 2014). It is imperative to note that a few of the existing studies that seek to demonstrate the connection between mobile money usage and a firm's performance adopt a single-country case study, and the measures or proxies for firms' performance adopted have some limitations. For instance, Hassan (2023) examines whether mobile money usage affects the business performance of informal firms in Zambia, and the findings reveal that mobile money leads to an improvement in informal business performance (proxied as profit), using a binary variable that takes a value of 1 if the business made a profit in the month prior to the survey and 0 otherwise. Similarly, Chale & Mbamba (2015) investigate whether using mobile money services influences the expansion of SMEs in the Dar es Salaam region of Tanzania, and the findings reveal that mobile money usage promotes business growth proxied as market share, revenue and profitability.

However, the studies discussed above failed to consider variation in firm size in the choice of the measures of firm performance. Consequently, large firms are likely to report higher profits compared to small firms; the difference in outcome may be largely due to firm size. To circumvent this problem, outcome variables are normalised by dividing the performance measures by the number of workers. Another limitation associated with single-country studies is the lack of generation of findings

beyond the context of the study (external validity). To mitigate the concerns of external validity, the use of cross-country studies such as the focus of this paper will allow for the generalisation of findings on the impact of mobile money on firms' performance in the context of sub-Saharan Africa.

3. Data Sources

The paper uses firm-level data obtained from the World Bank Enterprise Surveys (WBES) for a sample of 14 countries in SSA. See Table A1 in the appendix for the selected countries and years of data used in the analysis. The countries drawn for the analysis of this paper are based on the information on mobile money by the surveyed firms. The study combines data for the periods only after mobile money was introduced across the 14 selected countries. We are able to combine the selected countries in our analysis because the data obtained from the WBES are comparable across countries over time. The WBES are designed in a manner that information regarding the firms was collected. The WBES provide a detailed information on firm characteristics, including access to finance, annual sales, nature of employment as well as the operating cost of the firms, intermediate input, capacity utilisation and performance measures, among others.

In addition to using the WBES, we used several country-level data in the analysis to control for heterogeneities across countries regarding demand, supply and contextual factors, which could influence the usage of mobile money by firms. The data are obtained from the following sources. (i) The Global Financial Development Database (GFDD) provides data on bank branches per 100,000 adults and bank accounts per 1,000 adults. (ii) The World Development Indicators (WDI) provide data on the gross mobile phone subscription rate, access to electricity (% of population), and GDP per capita. (iii) The International Monetary Fund (IMF) database provides data on the number of registered mobile money outlets per 1,000 per square km, and the number of automated teller machines (ATMs) per 100,00 adults. (iv) The data on telecommunications regulatory governance quality (index) is obtained from Waverman and Koutroumpis (2011)⁶; and the data on mobile connectivity index is obtained from the GSMA database. The mobile connectivity index measures the performance of countries against key enablers of mobile internet adoption. The score ranges between 0 and 100 across a number of indicators, with a higher score indicating stronger performance in delivering mobile internet connectivity (GSMA, 2024).

Table 1 presents descriptive statistics based on responses from the interviewed firms regarding the rationale or reasons for the adoption of mobile money services (as well as reasons for non-usage or non-adopters of mobile money).

⁶ The index comprises the following variables: regulatory transparency, independence, resource availability, enforcement on licensees, and per capita income (Waverman and Koutroumpis, 2011).

Table 1: Reasons for and against mobile money adoption

Reasons for using mobile money by firms (% firms)	Mean
Reduction in costs of transactions due to mobile money	20.3
Decline in the time spent on financial transactions due mobile money	42.0
Reduction in transaction risks due to mobile money	9.4
Satisfying suppliers' requests due to mobile money	7.0
Satisfying costumers request due to mobile money	20.0
Aligning with competitors' use due to mobile money	2.2
Reasons for not using mobile money by firms (% firms)	
Lack of enough knowledge about mobile money	17.0
Fees too high to use mobile money	12.0
Payments too large for mobile money	32.0
Difficult to use mobile money	10.0
Do not use mobile money (customers)	33.0
Do not use mobile money (Suppliers)	32.1

Source: Authors' computation using WBES data for 14 countries

From the descriptive statistics in Table 1, reasons for using mobile money include the following: about 20% of the firms reported a reduction in transaction costs, 42% reported a reduction of time spent on financial transactions, 9% reported a reduction in the risks of transactions, 7% reported using mobile money because it satisfies suppliers' requests, 20% reported to satisfy customers' requests, and 2% reported to align with competitors. On the contrary, non-adopting firms identified reasons which include the following: 17% reported not knowing enough about money mobile, 12% reported high fees, 32% reported payments too large, 10% reported not easy to use, 33% reported lack of usage by customers, and 32% reported suppliers do not use mobile money.

Table 2 presents the descriptive statistics of the intensity of mobile money usage. The descriptives presented include variables such as the number of uses of mobile money (0.43 uses), the number of days money mobile used in a month in the last year (8 days), % of total labour cost paid using mobile money in the last year (31%), % of the annual cost of raw materials paid using mobile money last year (21%), % annual cost of utilities paid using mobile money in the last year (30%), and % annual sales to receive payments from customers using mobile money in the last year (17%).

Table 2: Intensity of Mobile Money Usage by firms

Variables	Mean	Std. dev.	Max.	Min.	Obs.
Number of uses of mobile money	0.425	0.861	4	0	3,614
In a typical month no. of days MM used in the last fiscal year	8.375	8.616	31	1	263
% Total labour cost paid using MM last year	30.647	25.232	100	0	142
% Annual cost of raw materials paid using MM last year	20.995	20.604	100	0	318
% Annual cost of utilities paid using MM in the last year	29.554	29.660	100	1	319
% Annual sales to receive payments from customers using MM last yr	17.234	17.186	90	0	567

Source: Author's computation using WBES data for 14 countries. The number of observations vary across the outcomes reported due to lack of responses by a number of firms on some of the questions.

From Table 3, we present the summary statistics for both the dependent variables and the independent variables used in the analysis of this study. The dependent variables for this analysis are profit per worker (total annual sales minus total annual costs divided by total number of workers employed), and total annual sales per worker (revenue divided by total number of workers employed), respectively. On average, the log of profit per worker was 8.172, while the log of total sales per (revenue) worker is 14.4. For the explanatory variables, about 28% reported using mobile money for financial transactions, the log of firm size was 2.9, the log of the age of the firms was 2.6, the years of experience for top managers was about 17 years is, and 13% of the top managers are female.

Table 3: Descriptive Statistics 16.72302

Variables	Mean	Std. dev.	Minimum	Maximum
<i>Outcome variables</i>				
Log. profit per worker	8.172	2.344	0	17.216
Log. total sales (revenue) per worker	14.430	3.082	4.861	24.818
<i>Independent variables (firm-level variables)</i>				
Use Mobile money (=1 if Yes)	0.278	0.448	0	1
Intensity of Mobile Money usage	0.424	0.858	0	4
Log. firm size	2.943	1.199	0.693	8.987
Log. firm age	2.635	0.797	0	4.718
Experience top manager (years)	16.723	10.343	1	68
Female top manager (=1 if Yes)	0.127	0.333	0	1
Foreign ownership (=1 if Yes)	0.152	0.358	0	1
Crime as an obstacle to firm growth (1 if Yes)	0.674	0.468	0	1
Firm largest owner is female (1 if Yes)	0.294	0.455	0	1
Purchased fixed assets by firm (1 if Yes)	0.471	0.499	0	1
Firm applies for a loan (1 if Yes)	0.212	0.408	0	1
<i>Macro-level variables</i>				
Telecommunications regulation quality (index)	0.330	0.125	0	0.470
Log. mobile phone subscription rate	16.689	0.662	14.793	17.275
Log. Gross Domestic Products (GDP) per capita	7.925	0.408	7.053	8.421
Bank accounts per 1,000 adults	141.940	148.30	0	448.25
Bank branches per 100,000 adults	3.874	1.574	0.940	6.080
No. of reg. mobile money agent outlets per 1,000 square km	126.766	81.288	0	267.110
Mobile connectivity index	31.442	5.773	17.400	37.850
Number of automated teller machines (ATMs) per 100,00 adults	5.740	2.540	1.240	9.600
Access to electricity (% of population)	38.370	21.229	10.100	70.700
Observations	3,614			

Source: Author's computation using WBES data for 14 countries

Further, other explanatory variables used in the analysis include dummy variables indicating foreign ownership (15%), 67% of the firms reported that crime was an obstacle to the growth of the firms, and about 29% of the firms reported purchase of fixed assets.

From Table 4, the results indicate the test of the mean difference by mobile money usage status. The descriptive statistics reveal that firms using mobile money, on average, reported 8.217 as the log of profit per worker, while non-users of mobile money had 8.055 as the log of profit per worker.

Table 4: Test of Mean Difference by Mobile Firm Money Usage (Firm-level variables)

	Mobile Money usage	Non-Mobile Money usage	Difference (NMM-MM)
Log of profit per worker	8.217 (0.045)	8.055 (0.073)	-0.162* (0.087)
Log of total sales per worker	14.866 (0.080)	14.262 (0.063)	-0.603*** (0.113)
Log of firm size	2.771 (0.035)	3.009 (0.023)	0.239*** (0.044)
Log firm age	2.574 (0.024)	2.658 (0.015)	0.084*** (0.029)
Top manager experience (years)	16.967 (0.205)	16.090 (0.313)	0.876** (0.384)
Female top manager (1 if Yes)	0.113 (0.009)	0.132 (0.006)	0.019 (0.012)
Foreign ownership (1 if Yes)	0.089 (0.009)	0.175 (0.007)	0.086*** (0.013)
Crime as an obstacle to firm growth (1 if Yes)	0.722 (0.014)	0.656 (0.009)	-0.066*** (0.017)
Firm largest owner is female (1 if Yes)	0.316 (0.014)	0.286 (0.008)	-0.030* (0.016)
Firm purchased fixed assets (1 if Yes)	0.522 (0.015)	0.450 (0.009)	-0.072*** (0.018)
Firm applies for a loan (1 if Yes)	0.210 (0.012)	0.212 (0.008)	0.002 (0.015)
Observations		3,614	

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

On average, mobile money users had 14.87 as the total sales per worker, which is higher compared to firms that do not use mobile money, with an average of 14.3. The mean difference of the outcome variables by mobile money adoption status was statistically significant at 10% and 1% for profit per worker and sales per worker, respectively. Moreover, Table 4 shows the mean difference in mobile money usage status of explanatory variables used in the analysis. Using data from the WBES, Figure 1 presents the Kernel density plots of the dependent variables (log of profit per worker & total sales per worker) by mobile money usage status. The density shown in blue is for non-mobile money usage (mobile money adoption =0), and the density shown in red is for firms that adopt mobile money. Figure 2 reveals higher densities for mobile money users compared to non-users for both outcomes (log of profit per worker & total sales per worker).

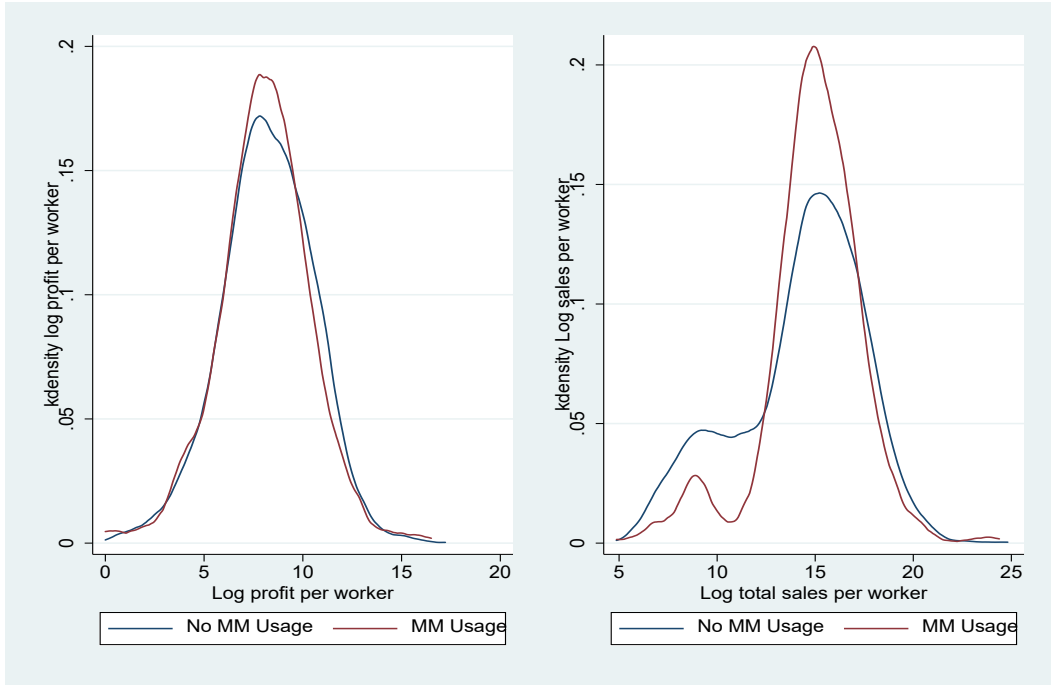


Figure 2: Kernel density plots of profit per worker and sales per worker

4. Empirical Methodology

This paper adopts a number of empirical approaches to undertake the research objectives identified above. First, this paper uses a probit model to investigate the determinants of firms using mobile money services for transaction purposes. Hence, we estimate the equation as shown below:

$$MM_{ij} = \beta_0 + \beta_1 X_{ij} + \beta_2 Z_j + c_i + \varepsilon_{ij} \quad (1)$$

where MM_{ij} (dependent variable) denotes a binary variable equal to 1 for a firm's mobile money use for transaction purposes (and 0 otherwise)⁷ by firm i in country j , X_{ij} denotes firm-level covariates (regressors) that are likely to influence mobile money usage (adoption) by firms (e.g. firm size, top manager is female, the firm's age, experience of managers (years), foreign ownership, crime as an obstacle for firm growth, firm largest owner is female, firm purchased fixed assets, and firm applies for a loan), Z_j country-level covariates or regressors (mobile phone subscription rates, and Gross Domestic Products (GDP) per capita, bank accounts per 1,000 adults, bank branches per 100,000 adults, telecommunications governance regulation quality (index), number of registered mobile money outlets per 1,000 square km, mobile money connectivity index, and number of ATMs per 1,000 square km), c represents country fixed effects (categorical variables) to control for unobserved differences across countries, and ε_{ij} captures error terms for firm i in country j . The choice of country-level covariates is related to Lashitew, van Tulder and Liasse (2019). Table A2 in the appendix presents the expected signs of the regressors from the regression results using equation (1). The estimation of equation (1) basically

⁷ We conducted a further analysis using the intensity of mobile money adoption as another dependent variable in a separate regression.

shows how several firm characteristics and country-level characteristics are related to a firm's usage of mobile money for transaction purposes. We estimate equation (1) using a binary choice model (probit regression) for the marginal effects results presented in Table 5.

In addition to the estimation in equation (1) above, in a separate regression, the study estimates the determinants of the intensity of mobile money usage by firms. Specifically, the paper estimates equation (1) to examine the intensity of mobile money adoption as a categorical variable (ordered response), which captures the number of reasons firms adopt or use mobile money. For example, we identify the number of uses that firms put mobile money into, which include the following payments: (i) to pay employees, (ii) to make payments to suppliers (iii) to make payments for utilities (iv) payments from customers. We generate a count variable that ranges from 0 to 4, with 0 for firms not using mobile money, and 4 being the maximum number of uses a firm can put mobile money into. The same explanatory variables as the probit model regression discussed above are used. In addition, we present the results of the intensity of adoption of mobile money using an ordered probit model and the results are presented in Table 6.

Second, this paper examines the interplay between mobile money use and a firm's performance, using the ordinary least squares (OLS) method and instrumental variables estimation, respectively. The econometric model estimated is presented below:

$$Y_{ij} = \beta_0 + \beta_1 MM_{ij} + \beta_2 X_{ij} + \beta_3 Z_j + c_i + \varepsilon_{ij} \quad (2)$$

where the dependent variable represents a firm's performance (log. sales per worker or profit per worker)⁸ for firm i in country j , MM_{ij} is a binary variable that indicates whether firm i in country j used mobile money for financial transactions, X_{ij} represents firm-level covariates (regressors) that are likely to influence firm performance, Z_j country-level covariates or regressors, c represents country fixed effects, and ε_{ij} denotes error terms for firm i in country j . See beneath the results presented in Table 7 for the control variables used in the regression. The parameter, β_1 is the coefficient of interest, which measures the impact of mobile money, while β_2 and β_3 capture the effects of firm-level control variables and country-level control variables, respectively.

5.2 Further Analysis: Instrumental Variable (IV) Approach

This study undertakes further analysis by examining the relationship between mobile money adoption and a firm's performance using an instrumental variable approach. The decision to use mobile money by firms is not random, hence, there is a possibility that the decision to adopt mobile money services

⁸ We divide the outcome variables, total sales by total number of workers employed, and profit by number of workers employed to normalize the variation in firm size for the sample used for this study.

could be correlated with unobserved factors (confounding factors) that influence firms' performance. To mitigate the concerns or potential bias that could arise from the endogeneity of mobile money adoption, this paper employs an instrumental variable approach, by using the number of registered mobile money outlets in (agents) per 1,000 square km in each country as an instrument for firms' mobile money adoption. The choice of the instrument follows Abiona & Koppensteiner, 2022; Ajefu & Massacky, 2023; Riley, 2018; Islam, Muzi, & Meza, 2018; Suri and Jack 2014)⁹. The justification for the use the number of registered mobile money outlets in (agents) per 1,000 square km as an instrument stem from positive correlation between firms' adoption of mobile money services and the number of registered mobile money outlets in (agents) per 1,000 square km. See Figure 3 for a graphical illustration of the correlation between mobile money outlets and firms' adoption of mobile money. From theoretical standpoint, the instrument (the number of registered mobile money outlets in (agents) per 1,000 square km), however, is unlikely to directly affect firms' performance. The arguments for the use of the instrument in the two-stage least squares (2SLS) analysis rely on satisfying both the relevance and the validity (exclusion restriction) assumptions. First, mobile money usage is correlated with the instrument (the number of registered mobile money outlets in (agents) per 1,000 square km) used in the 2SLS analysis. See Table A3 in the appendix for the first-stage results from the 2SLS analysis. Second, although we are unable to empirically test for the exclusion restriction assumption, we make the claim that the instrument does not directly affect a firm's performance except through the first-stage regressions (firms' mobile money adoption).

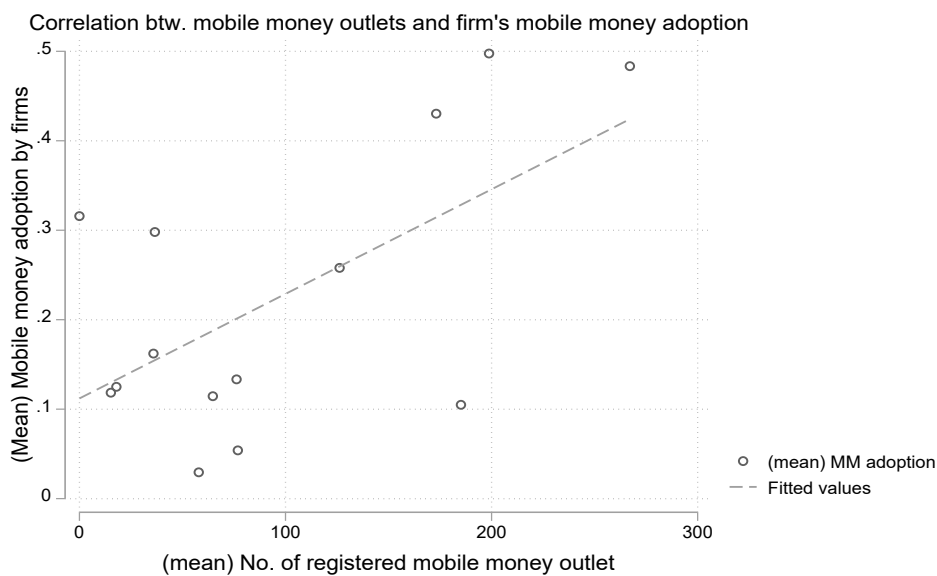


Figure 3: correlation between mobile money outlets and firms' adoption of mobile money

⁹ These papers used presence or availability of mobile money agent in a community and households' distance to the nearest mobile money agent as instruments for mobile money adoption by households.

5. Results and Discussions

In Table 5, the results show the marginal effects from the probit model of the drivers of mobile money usage by firms in SSA. From the results in Table 5, the likelihood of using mobile money for transaction purposes is negatively associated with firm size, long-established firms, firms with female top managers, and foreign ownership. This finding on the gender of the manager is consistent with the gender gap in financial inclusion that is prevalent in SSA (Demirgu-Kunt et. al., 2018; Roy & Patro, 2022). In addition, mobile money adoption is negatively associated with GDP per capita, bank accounts per 1,000 adults, bank branches per 100,000 adults, and the number of ATMs per 1,000 square km.

Moreover, years of experience of managers is positively related to the likelihood of using mobile money for financial purposes. The result reveals the relevance of a manager's years of experience in the use of mobile money services, and this finding is consistent with Islam and Muzi (2022). Firms exposed to crime indicate the likelihood of using mobile money, and this evidence speaks to Vaughn (2007), who reveals that mobile money usage increases with the likelihood or exposure to crime. Firms that provide formal training are prone to using mobile money relative to firms that provide no formal training to workers. In addition, mobile money is positively associated with firms' purchase of fixed assets, telecommunications governance quality (index), number of registered mobile money outlets per 1,000 square km, and mobile money connectivity index.

Table 5: Drivers of Mobile Money Adoption using Probit Model (Marginal Effects)

Dependent variable: MM usage for transaction purposes	
Log. of firm size	-0.052*** (0.014)
Log. of age of firm	-0.028*** (0.008)
Log. manager experience (years)	0.021 (0.020)
Female top manager (1 if Yes)	-0.054*** (0.019)
Foreign ownership (1 if Yes)	-0.097*** (0.016)
Crime as an obstacle to firm growth (1 if Yes)	0.026 (0.023)
Firm largest owner is female (1 if Yes)	-0.005 (0.018)
Firm purchased fixed assets (1 if Yes)	0.098 (0.024)
Firm applies for a loan (1 if Yes)	0.020 (0.023)
Log. of mobile phone subscription rate	0.075*** (0.003)
Log. of Gross Domestic Products (GDP) per capita	-0.259*** (0.027)
Bank accounts per 1,000 adults	-0.002*** (0.000)
Bank branches per 100,000 adults	-0.075*** (0.007)
Telecom regulation index	0.124*** (0.042)
No. of registered mobile money outlets per 1,000 square km	0.001*** (0.000)

Mobile connectivity index	0.058***
	(0.001)
No. of automated teller machines per 1,000 sq. km	-0.109***
	(0.002)
Country dummies	Yes
Pseudo R ²	0.1809
No. of observations	3,614

Note: Standard errors are in parentheses and are clustered at the country level. *, **, and *** indicate significance level at 10%, 5%, and 1%, respectively.

In Table 6, we present the results of the marginal effects based on the ordered probit model, which captures the intensity of mobile money usage. To generate the dependent (outcome) variable, we identify the number of uses that firms put mobile money into, which include the following modes of payment: (i) to pay employees, (ii) to make payments to suppliers, (iii) to make payments for utilities, and (iv) payments from customers. We generate a count variable that ranges from 0 to 4, with 0 for firms not using mobile money, and 4 being the maximum number of uses a firm can put mobile money into. Table 6 presents the marginal effects for each category of the intensity of mobile money adoption (between 0 and 4). Figure 4 reveals the probability of the intensity of mobile money adoption, which declines as the number of uses of mobile money increases. Moreover, the graph reveals that firms are likely to use mobile money services for a service (e.g. payment to employees) rather than for all four services that mobile money could provide (which is the maximum number of uses or services).

Table 6: Determinants of Intensity of Mobile Money Adoption using ordered probit model (marginal effects)

Dependent variable: No. of uses of mobile money	0	1	2	3	4
Log. of firm size	0.051*** (0.007)	-0.022*** (0.003)	-0.019*** (0.003)	-0.008*** (0.001)	-0.001*** (0.000)
Log. of age of firm	0.022*** (0.006)	-0.009*** (0.002)	-0.008*** (0.002)	-0.003*** (0.001)	-0.001*** (0.000)
Log. manager experience (years)	-0.017 (0.015)	0.007 (0.006)	0.006 (0.006)	0.002 (0.002)	0.000 (0.000)
Female top manager (1 if Yes)	0.037** (0.017)	-0.016** (0.008)	-0.014** (0.006)	-0.005** (0.002)	-0.001** (0.000)
Foreign ownership (1 if Yes)	0.071*** (0.010)	-0.032*** (0.006)	-0.026*** (0.004)	-0.010*** (0.001)	-0.001 (0.000)
Crime as an obstacle to firm growth (1 if Yes)	-0.009 (0.015)	0.004 (0.006)	0.003 (0.006)	0.001 (0.002)	0.000 (0.000)
Firm largest owner is female (1 if Yes)	-0.018 (0.024)	0.008 (0.010)	0.007 (0.009)	0.003 (0.004)	0.001 (0.001)
Firm purchased fixed assets (1 if Yes)	-0.096*** (0.023)	0.041*** (0.011)	0.036 (0.008)	0.015*** (0.003)	0.002*** (0.001)
Firm applies for a loan (1 if Yes)	-0.033* (0.020)	0.014* (0.008)	0.012* (0.007)	0.005* (0.003)	0.001* (0.000)
Log. of mobile phone subscription rate	-0.074*** (0.004)	0.032*** (0.003)	0.028*** (0.001)	0.012*** (0.001)	0.001*** (0.000)
Log. of Gross Domestic Products (GDP) per capita	0.225*** (0.015)	-0.097*** (0.008)	-0.085*** (0.008)	-0.036*** (0.003)	-0.005*** (0.001)
Bank accounts per 1,000 adults	-0.043*** (0.005)	0.018*** (0.002)	0.016*** (0.002)	.006*** (0.001)	0.001*** (0.000)
Bank branches per 100,000 adults	0.001*** (0.000)	-0.001*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)	-0.000*** (0.000)
Telecom regulation index	0.128*** (0.026)	-0.055*** (0.010)	-0.048*** (0.011)	-0.020*** (0.004)	-0.003*** (0.001)
No. of registered mobile money outlets	-0.001*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000** (0.000)

Mobile connectivity index	-0.045*** (0.001)	0.019*** (0.001)	0.017*** (0.001)	0.007*** (0.001)	0.001*** (0.000)
No. of automated teller machines per 1,000 sq. km	0.078*** (0.002)	-0.034*** (0.002)	-0.029*** (0.001)	-0.012*** (0.001)	-0.002*** (0.000)
Country dummies	Yes	Yes	Yes	Yes	Yes
No. of observations	3,614				

Note: Standard errors are in parentheses and are clustered at the country level. *, **, and *** indicate significance level at 10%, 5%, and 1%, respectively.

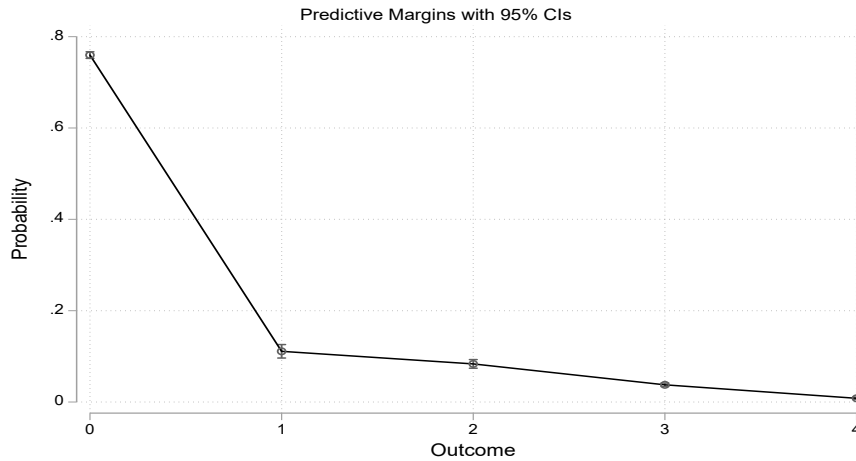


Figure 4: predictive margins from ordered probit regression

The results presented in Table 7 reveal the relationship between mobile money usage a firm's performance, denoted by profit per worker, and total sales (revenue) per worker, using the ordinary least squares regression. The results for both dependent variables reveal a positive association between the adoption of mobile money and a firm's performance for the sample of countries under consideration. These findings imply that, although there are positive patterns of relationship between the independent variable (mobile money) and the dependent variable (firms' performance). However, we are unable to reject the null hypothesis at 1% for profit per worker and 5% for sales per worker, respectively.

Moreover, these findings are similar to a previous study on mobile money and a firm's performance for a single-country and three-country case study, which found a statistically weak but positive effect on a firm's productivity resulting from mobile money adoption (Frederick, 2014; Gosavi, 2018).

Table 7: The Adoption of Mobile Money and Firm Performance using OLS Regression Method

Variable	Log. profit per worker	Log. sales per worker
Use mobile money	0.123** (0.051)	0.170* (0.079)
Control variables	Yes	Yes
Country dummies	Yes	Yes
R ²	0.119	0.709
Observations	3,614	3,614

Note: *, **, and *** indicate significance level at 10%, 5%, and 1%, respectively. The control variables used include the following: firm size, age of the firm, gender of the manager, experience of manager (years), foreign ownership, crime as an obstacle for firm growth, firm largest owner is female, firm purchased fixed assets, firm applies for a loan, mobile phone subscription rates, mobile connectivity index, and access to electricity.

From Table 8, the results indicate the 2SLS regressions, using the number of registered mobile money outlets per 1,000 square km as an instrument for mobile money adoption by firms. The results reveal that mobile money usage is positively associated with firms' performance (proxied as sales per worker and profit per worker). Comparing the OLS and 2SLS regressions, in terms of the magnitude of the coefficients of mobile money usage, the results indicate that OLS regressions underestimate the effect of mobile money usage on firms' performance in the context of sub-Saharan Africa.

Table 8: Mobile Money and Firm Performance (Instrumental variable method)

Dependent variable:	Log. Profit per worker	Log. Sales per worker
Use mobile money	0.879* (0.458)	0.393** (0.174)
Control variables	Yes	Yes
Country dummies	Yes	Yes
Observations	3613	3614

Note: *, **, and *** indicate significance level at 10%, 5%, and 1%, respectively. The control variables used include the following: firm size, gender of the manager, age of the firm, experience of manager (years), foreign ownership, crime as an obstacle for firm growth, firm largest owner is female, firm purchased fixed assets, firm applies for a loan, mobile phone subscription rates and GDP per capita.

5.3 Potential pathways or mechanisms

This study investigates the potential pathway or mechanism through which mobile money usage affects firms' performance. Table 9 identifies the purchase of fixed assets as a potential pathway used in the regressions. The results show that mobile money usage is positively associated with the purchase of fixed assets (although not statistically significant). The motivation for the regressions in Table 9 stems from the theoretical discussions presented in Figure 1. The findings are related to Islam & Muzi (2022), and Islam et al. (2018), which find that mobile money adoption is associated with firms' purchase or investment of fixed assets in countries in sub-Saharan Africa.

Table 9: mobile money, purchase of fixed assets, and firm performance

Dependent variable	Log. Profit per worker	Log. Sales per worker
Use mobile money	0.049 (0.117)	0.012 (0.102)
MM*purchase of fixed assets	0.141 (0.125)	0.167 (0.117)
Purchase of fixed assets	0.360*** (0.085)	0.331*** (0.096)
Control variables	Yes	Yes
Country dummies	Yes	Yes
Observations	3,613	3,614

Note: *, **, and *** indicate significance level at 10%, 5%, and 1%, respectively. The control variable are the same as reported in Table 9.

5.4 Heterogeneities

The paper examines heterogeneities across firms' size identified in the sample. There are four categories of firms, based on the number of workers employed. The categories are micro (1 to 4 workers), small (5 to 19 workers), medium (20 to 99 workers), and large (100 or more workers). To undertake the regressions presented in Table 10, we generated interaction terms for three categories of the firms' size, and large firms is the omitted category in the regression analysis. We found statistically significant effect of the interaction of mobile money and micro firms (1 to 4 workers) in relation to profit per worker as the dependent variable, while for sales per worker as the dependent variable, we found statistically significant effect of the interaction of mobile money and micro firms as well as the interaction of mobile money and small firms (5 to 19 workers). We, however, do not find a statistically significant effect of the interaction term of mobile money and medium firms (20 to 99 workers).

Table 10: mobile money, firm size, and firm performance

Dependent variable	Log. Profit per worker	Log. Sales per worker
Mobile money use	0.207 (0.160)	0.325** (0.153)
MM*Micro firm	1.419*** (0.255)	0.379* (0.200)
MM*Small firm	0.224 (0.149)	0.365** (0.153)
MM*Medium firm	0.048 (0.195)	0.202 (0.172)
Micro firm	0.013 (0.246)	0.069 (0.270)
Small firm	0.428** (0.148)	0.417** (0.175)
Medium firm	0.146 (0.153)	0.170 (0.146)
<u>Observations</u>	3,613	3,614

Note: *, **, and *** indicate significance level at 10%, 5%, and 1%, respectively. The control variable are the same as reported in Table 9.

6. Conclusion and Policy Implications

The evolution of mobile money triggered financial inclusion across several developing countries. The use of mobile money could be associated with benefits for firms, such as the provision of a simple, efficient, and accessible means of payment for businesses. Moreover, using mobile money for transaction purposes by firms could lead to improvement in a firm's profits and revenue (proxied as firms' performance). The increases in firms' performance occur through channels such as a decline in transaction costs, a reduction in transaction time, a reduction in transaction risk, and access to loans.

The extent to which a firm's use of mobile money results in several benefits to the firm in terms of the firm's performance is the focus of this paper. This paper is essentially concerned with investigating the determinants of a firm's mobile money adoption and whether the use of mobile money affects a firm's performance, measured as profit per worker and revenue per worker, respectively. This

paper uses firm-level data obtained from the World Bank Enterprise Surveys (WBES). To investigate the determinants of firms' mobile money adoption, this paper uses a probit model and an ordered probit model. In addition, the study adopts the ordinary least squares regressions and the instrumental variables approach to the nexus between mobile money usage and firms' performance.

Based on the empirical analysis, the study reveals that firm-level characteristics and country-level characteristics are determinants of mobile money adoption by firms in SSA. Some of the factors or variables include, but are not limited to, mobile phone subscription rates, bank branches per 100,000 adults, number of registered mobile money outlets per 1,000 square km, mobile connectivity index, and telecommunications governance regulation quality (index), among others. Moreover, we explore whether using mobile money matters for a firm's performance, and this paper uses both the ordinary least squares and the instrumental variables methods in the empirical analysis. The results indicate a statistically significant relationship between using mobile money and firms' profits and revenue. We undertake further analysis by exploring the potential pathway and heterogeneities in the relationship between mobile money and firms' performance. The findings of this paper reinforce the growing consensus on the roles of mobile money services in firms' performance, particularly in the context of developing countries.

Appendix

Table A1: WBES for periods after the introduction of mobile money

Countries	WBES After MM adoption	Sample size covered in the analysis
Benin	2016	143
Cameroon	2016	345
Chad	2018	152
Cote d'Ivoire	2016	252
Ghana	2013	519
Guinea	2016	68
Kenya	2013	611
Liberia	2017	151
Mali	2016	148
Niger	2017	104
Sierra Leone	2017	152
Tanzania	2013	416
Togo	2016	131
Uganda	2013	422

Source: World Bank Enterprise Surveys

Table A2: Definition of the explanatory variables expected to impact firm mobile money usage

Variable	Expected sign
Log of firm size	±
Log of age of the firm	±
Log top manager experience (years)	+
Female top manager Y/N (1 if Yes)	-
Foreign ownership Y/N (1 if Yes)	-
Crime as an obstacle to firm growth Y/N (1 if Yes)	+
The firm's largest owner is female Y/N (1 if Yes)	-

Firm provides formal training Y/N (1 if Yes)	±
Firm purchased fixed assets Y/N (1 if Yes)	+
Firm applies for a loan Y/N (1 if Yes)	+
Log of mobile phone subscription rate	+
Log GDP per capita	-
Bank accounts per 1,000 adults	-
Bank branches per 100,000 adults	-
Telecomm governance regulation quality (index)	+
No. of registered mobile money outlets per 1,000 sq. km	+
Mobile connectivity index	+
No. of ATMs per 1,000 square km	-

Table A3: First-stage regressions

Dependent variable: Mobile money usage	
No. of registered mobile money outlet in 1,000 sq. km	0.001*** (0.000)
Control variables	Yes
Country dummies	Yes
Observations	Yes
Weak identification test (Cragg-Donald Wald F statistic):	16.00

Note: *, **, and *** indicate significance level at 10%, 5%, and 1%, respectively. The control variable are the same as reported in Table 9.

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