Mobile Money Payment: An Antidote to Petty Corruption?

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Abstract

Using a two-period panel comprising firm-level data from the 2007 and 2013 World Bank Enterprise Surveys, this paper investigates the impact of mobile money use on bribe payments in Kenya. Results based on a matched difference-in-differences estimator demonstrate that adopting mobile money for financial transactions leads to a 3.1 percentage point reduction in bribe payments. This can be explained considering that mobile money transactions leave behind a detailed trail of digital records and accounts, which may curb acts of bribery. Our findings suggest that official mobile money payments can be a practical and effective anti-corruption intervention.

Key words: Bribe payments; Kenya; Matched difference-in-differences; Mobile money; Petty corruption.

Executive summary

Petty corruption undermines the business climate in a majority of countries in sub-Saharan Africa. It involves petty informal payments including bribes and gifts made to government officials. Most bribe payments are made to facilitate non-compliance with government rules and regulations. Bribes are also paid to facilitate speedy fulfilment of government services with regard to licences, taxes, customs, regulations and securing government contracts.

Despite being viewed as an unethical practice, bribery is a predominant form of petty corruption that is practised in many regions across the world. A majority of anti-corruption interventions have traditionally focused on initiatives aimed at strengthening government transparency and accountability. In view of this, anti-corruption interventions that are amenable to implementation by firms have remained sparse, with perhaps the most common involving reporting of complaints to an official anti-corruption ombudsman.

This study argues that petty corruption is more prevalent in cash-based economies. Government officials and firm managers are more likely to engage in acts of bribery where transactions involve the exchange of cash. Cash payments can easily be concealed and remain undocumented and anonymous whether intentionally or unintentionally. Accordingly, monitoring, detection and prevention of petty corruption based on accurate transactional records poses a challenge. However, this challenge can be overcome when digital financial innovations such as mobile money payment systems are used for financial transactions. Thus, mobile money may offer a practical and effective anti-corruption intervention. Kenya is among the first countries in the world to adopt mobile money services. Thus, firms adopting mobile money payment services benefit from the transparency and traceability features that are instrumental in curbing petty corruption.

This study investigates the impact of mobile money use on bribe payments in Kenya using a two-period panel data set from the World Bank Enterprise Surveys (WBES). This data consists of nationally representative firms from the private sector in Kenya. The first wave of data is from the 2007 WBES. The second wave of data comes from the 2013 WBES. This study uses the launch of mobile money services in 2007 as a means of identifying the impact of mobile money use on bribe payments. The first wave – the baseline – represents data collected before the introduction of mobile money. The second wave constitutes data collected after the introduction of mobile money.

A matched difference-in-differences approach is used to estimate the impact of mobile money on bribe payments. This study finds that firms that adopted mobile money experienced a 3.1 percentage point reduction in bribe payments. This economically meaningful result suggests that mobile money use diminishes petty corruption.

Policy implications arising from the findings of this study relate to the adoption of financial digital innovations for enhancing transparency and accountability mechanisms. Mobile money enhances payment data transparency. This limits economic rents that may be gained by manipulating billing and payment processes. Mobile money also reduces the bureaucratic red tape, which diminishes incentives arising from physical proximity of enterprise managers and public officials. Policy makers have shown immense interest in fighting petty corruption at all levels; hence, adopting mobile money use as an anti-corruption intervention provides a practical solution that can be embedded in public policy.

An important managerial implication arising from the findings of this study pertains to the adoption of financial digital innovations for payment processes. Enterprise managers adopting mobile money payment systems are likely to see reduction in bribe payments. Another possible benefit could be a reduction in the amount of time spent on dealing with public officials when handling government regulations with numerous payment processes. Similarly, mobile money use may decrease transaction costs involved in seeking government services. Furthermore, the use of mobile money payment systems may be useful in monitoring financial transactions carried out by employees. This, in turn, improves transparency and accountability that is driven by the authentication procedures required for carrying out mobile money transactions.

1.0 Introduction

Petty corruption at the firm level encompasses corruption that takes place on a small scale in the private sector and the public sector. Petty corruption in the private sector may include bribery, corporate fraud, kickbacks, insider trading and collusion. In the public sector, petty corruption involves informal payments including bribes and gifts made to government officials. Most bribe payments are made to facilitate non-compliance with government rules and regulations. Bribes are also paid to facilitate speedy fulfilment of government services with regard to licences, taxes, customs, regulations and securing government contracts. Bribery is generally viewed as an unethical practice. Yet, it is a predominant form of petty corruption that is practised in many regions across the world, and more so in sub-Saharan Africa.[1]

The 2006/07 World Bank Enterprise Survey (WBES) revealed that firms in sub-Saharan Africa reported bribe payments ranging between 2.5% and 4.5% of sales. Petty corruption cost the average manufacturing firm about 30%-80% of the cost of fuel and power, and about 10%-20% of the cost of labour. These amounts are not immaterial since they are likely to suffer from downwards bias due to the self-reporting nature of the survey measures (Clarke, 2011). Hence, the burden of petty corruption on firms is relatively high (Azfar and Murrell, 2009).

Theoretical and empirical evidence regarding the effects of petty corruption remains inconclusive. One argument cites bribery as a major impediment to firm growth in Africa (Faruq et al., 2013; Kimuyu, 2007; McArthur and Teal, 2002). Another polar opposite argument views bribe payments as a viable option for reducing bureaucratic inefficiencies associated with the procurement of government services in developing countries in Africa. In line with this argument, Williams et al. (2016) show that petty corruption significantly enhances, rather than harms, firm performance in developing countries.

Nevertheless, petty corruption has been found to undermine national growth and development (Mauro, 1995; Mogens and Bjørnskov, 2014). Accordingly, anti-corruption interventions have traditionally focused on initiatives aimed at strengthening government transparency and accountability. In view of this, anti-corruption interventions that are amenable to implementation by firms have remained sparse

1 This paper concerns itself with petty corruption, as opposed to other forms of corruption (i.e., grand corruption involving the abuse of high-level power) that is also problematic.

with perhaps the most common involving reporting of complaints to an official anti-corruption ombudsman.

The focal argument of this paper lies in the fact that petty corruption is more prevalent in cash-based economies. Government officials and firm managers are more likely to engage in acts of bribery where transactions involve the exchange of cash. Cash payments can easily be concealed and remain undocumented and anonymous whether intentionally or unintentionally. Accordingly, monitoring, detection and prevention of petty corruption based on accurate transactional records poses a challenge. However, this challenge should not arise when firms use mobile money payment systems. Hence, digital financial innovations such as mobile money payment systems offer a practical and effective anti-corruption intervention.

Mobile money is a digital financial innovation that enables electronic payment transactions using mobile phones. Mobile money transactions are usually backed by a trail of digitized transaction records including comprehensive details of account holders. This increases transparency, accountability and traceability. In addition, mobile money payments are likely to reduce the frequency of meetings or potentially eliminate physical contact between government officials and managers. This may diminish incidental corruption involving opportunistic individuals.

Mobile money payments are, therefore, likely to eliminate conditions under which petty corruption thrives including, but not limited to, anonymity, limited transparency and accountability, and the frequency of meetings with government officials. Although anecdotal reports suggest that mobile money use discourages petty corruption, there are virtually no empirical studies investigating this pertinent issue in the context of firms in sub-Saharan Africa (Blumenstock et al., 2015; Krolikowski, 2014).

This paper aims to narrow this knowledge gap by using non-experimental methods to examine the causal impact of mobile money use on petty corruption in firms. Specifically, the main objective of this study is to investigate the impact of mobile money use on bribe payments in manufacturing, service and retail firms in Kenya.

Mobile money services—used for person to person transactions—were first launched in Kenya in East Africa. Mobile money has experienced much success in Kenya relative to other countries in sub-Saharan Africa (Aker and Mbiti, 2010; Donovan, 2012; Etim, 2014; Johnson, 2016; Mas and Morawczynski, 2009; Maurer, 2012). Furthermore, Kenya has one of the highest rates of mobile money payment penetration for government to business services (e.g., licenses, tax administration, customs, etc.). This is attributed to the relatively advanced mobile money ecosystem (Heyer and Mas, 2011).

This study analyses the impact of mobile money use on bribe payments using the newly available WBES two-period panel data of nationally representative firms from the private sector in Kenya. The first wave of data is from the 2007 WBES. The second wave of data comes from the 2013 WBES. In particular, this study utilizes the launch of mobile money services in 2007 as a means of identifying the impact

of mobile money use on bribe payments.[2] The first wave—the baseline—represents data collected before the introduction of mobile money. The second wave constitutes data collected after the introduction of mobile money.

This study estimated the impact of mobile money use on bribe payments by means of four estimators: ordinary least squares (OLS), difference-in-differences (DID), inverse probability weighting (IPW) and matched difference-in-differences (MDID). This was done to show how the estimated impact change as selection bias is addressed. Thus, the estimations were carried out using the simple OLS estimator to the more complex MDID estimator that has the advantage of increasing the robustness of the estimated counterfactuals. Based on the results of the MDID estimator, this study found that firms that adopted mobile money experienced a 3.1 percentage point reduction in bribe payments. This economically meaningful result suggests that mobile money use diminishes petty corruption.

This study makes several contributions. First, it provides fresh insights to the existing body of literature on fighting corruption by focusing on mobile money adoption as an anti-corruption intervention at the firm-level. This is important as economic literature generally concentrated on the adverse effects of corruption on firm growth, and economic growth and development. Second, anti-corruption interventions typically target strengthening institutions at the macro-level as opposed to the micro-level. This study departs from previous studies by investigating the impact of mobile money use as an intervention against petty corruption at the firm-level. Third, this study demonstrates how various methods may tackle selection bias by moving from the simple OLS to the more complex MDID estimator.

The findings of this study demonstrate that mobile money use can effectively mitigate petty corruption at the firm-level. Accordingly, policy makers should place emphasis on enforcing digitization of payments with focus on mobile money, which is widespread in Kenya and sub-Saharan Africa.

The remainder of the paper proceeds as follows: Section 2 provides a background and context of petty corruption interventions and mobile money. Section 3 describes the data. Section 4 provides the empirical strategy encompassing the non-experimental approach used in the study. Section 5 provides the results and discussion; Section 6 is the conclusion with some policy insights.

2. Vodafone Group launched Kenya's M-PESA mobile money service by Safaricom Ltd. in March 2007. ZAP mobile money services by Zain Ltd. (now Airtel Money by Airtel Ltd.), being the primary competitor against M-PESA in Kenya, was launched in February 2009.

2.0 Background and context

Overview of petty-corruption interventions

Petty corruption interventions can be classified into three categories: top-down interventions, social accountability interventions and behavioural interventions (Stahl et al., 2017). Top-down interventions enhance the mechanism by which management holds government officials accountable. These types of interventions are aimed at combating incidental corruption by reducing the opportunity space in which petty corruption thrives. They also address incentives of government officials through changes in contractual stipulations, and by enhancing internal workplace controls.

Social accountability interventions, on the other hand, relate to direct citizen engagement. This involves awareness campaigns and capacity building activities pertaining to rights and entitlements of citizens. These activities strengthen citizenry efforts in denouncing corruption and holding government officials and the state accountable.

The principal-agent problem arising from divergent interests and asymmetric information underlies both the top-down and social accountability interventions. These two interventions are non-behavioural since they are based on the assumption that individuals are rational decision makers. Maximization of self-interests results in rational responses to changes in incentive structures.

Contrastingly, behavioural interventions are usually determined by non-rational and quasi rational factors. These include mental shortcuts, environmental, and social and cultural norms that individuals rely on for decision making. Behavioural interventions, including education and media campaigns, therefore, target changes in the wider environment. These work by influencing mental modes, social and cultural norms, and the ways in which information is communicated to elicit decision maker's response to cues (Stahl et al., 2017).

Increased awareness of the deleterious effects of corruption has led to the formulation and implementation of anti-corruption interventions in Africa. These have generally involved the creation of anti-corruption agencies with emphasis on promoting transparency and accountability. Narrowing the scope further, anti-corruption legislation in Kenya began with the 1956 Prevention of Corruption Act which was amended in 1997 to pave way for the establishment of the Kenya Anti-Corruption Authority. In 2003, the anti-corruption authority was replaced by the

Kenya Anti-Corruption Commission that was subsequently replaced by the Ethics and Anti-Corruption Commission (EACC) in 2011. The EACC is charged with educating the public and raising awareness of ethical issues, law enforcement, and establishing preventive measures for any acts of corruption, bribery and economic crimes.

Notwithstanding, conventional anti-corruption reforms and interventions have had limited success in sub-Saharan Africa and more so in Kenya (Camargo and Faustine, 2016; Persson et al., 2013). Various authors suggest that anti-corruption reforms and interventions often fail to take into account the local operational context for which they are prescribed (Hope Sr, 2014; Persson et al., 2013).

Furthermore, it has been argued that anti-corruption intervention strategies are usually unsuccessful because corruption is a collective action problem. For example, petty corruption involving bribe payments "to get things done" presents a sensible choice for a majority of individuals because it is simply a means to an end. Such individuals also expect everyone to engage in bribery (Mungiu-Pippidi, 2013; Persson et al., 2013).

In summary, petty corruption interventions offer strategies that foster transparency and accountability. However, their limited success in the context of developing countries implies that exploring alternative mechanisms that enhance monitoring, detection and the likelihood of punishment may effectively deter petty corruption.

Mobile money as an anti-corruption mechanism

Existing literature demonstrates that individuals engaging in corruption systematically underestimate the likelihood of getting caught. This is particularly reinforced in an environment characterized by the culture of corruption impunity (Basu et al., 2016; Navot and Cohen, 2015).

This phenomenon suggests that transactional information plays a vital role in deterring corruption. Accordingly, transactional information that increases the likelihood of detection and punishment is critical for the success of anti-corruption interventions. Moreover, credible information relating to improved monitoring and detection mechanisms is associated with this success. Such information has been found to be crucial in altering perceptions of individuals even where oversight mechanisms have showed no improvement (Navot and Cohen, 2015; Stahl et al., 2017). Essentially, credible transactional information increases transparency and accountability which is likely to deter opportunistic petty corruption.

Theoretical and empirical evidence reveals that mobile money payment systems inhibit corrupt practices. A pilot project involving the adoption of mobile money for payment of police officers' salaries in Afghanistan demonstrates that mobile money is instrumental in uncovering corrupt practices. Transitioning from cash-based to mobile money based payment of salaries resulted in the police officers receiving their actual salary entitlement. The cash-based system was riddled with corrupt practices that saw high ranking police officers take pay outs from junior police officers' salaries without

their knowledge (Blumenstock et al., 2015). The authors posit that in the short run, mobile money payment systems accrue significantly larger benefits to those making payments relative to those receiving the payments.

Similarly, Krolikowski (2014) employed qualitative techniques to examine whether mobile money payment systems curb petty corruption in urban water systems in Tanzania. Mobile money payments were found to mitigate petty corruption by increasing transparency and accountability, and eliminating the corruption opportunity space. The author concluded that mobile money payment systems reduce information asymmetries.

Theoretically, mobile money use is expected to have a negative impact on bribe payments. Nevertheless, related empirical evidence is scant since this is a relatively new area of research. Existing literature commonly focuses on mobile money and financial inclusion (Aker and Mbiti, 2010; Donovan, 2012; Etim, 2014; Johnson, 2016; Mas and Morawczynski, 2009; Maurer, 2012). Essentially, firms may adopt mobile money payment systems because they lower transaction costs and risks associated with doing business (Clarke, 2011; Islam et al., 2018).

Distinctive features of mobile money payment systems that increase transparency, accountability, and traceability include digital real-time records and stringent identification documentation that is required for authentication when carrying out mobile money transactions.

Additionally, the maturity of the mobile money ecosystem determines the success of mobile money payment systems. Mobile money financial services have evolved over time in Kenya. While original mobile money applications entailed person to person transactions only, mobile money is now used for person-to-business transactions. Individuals can use mobile money to pay utility bills and perform mobile banking transactions. Similarly, firms use mobile money services to pay utility bills, salaries, and suppliers, and to receive money from clients (Heyer & Mas, 2011). Firms adopting mobile money in Kenya do so to satisfy customers' requests and to reduce the costs and risks of transactions. Conversely, non-adopters cite large payments that are beyond the daily mobile money limit, and non-adoption by customers and suppliers as major reasons for not using mobile money (Islam et al., 2018).

The application of mobile money payments by firms in Kenya is relatively advanced (Heyer & Mas, 2011). Kenya is among the first countries in the world to adopt mobile money services. Thus, firms adopting mobile money payment services benefit from the transparency and traceability features that are instrumental in curbing petty corruption.

Theory of change and hypothesis

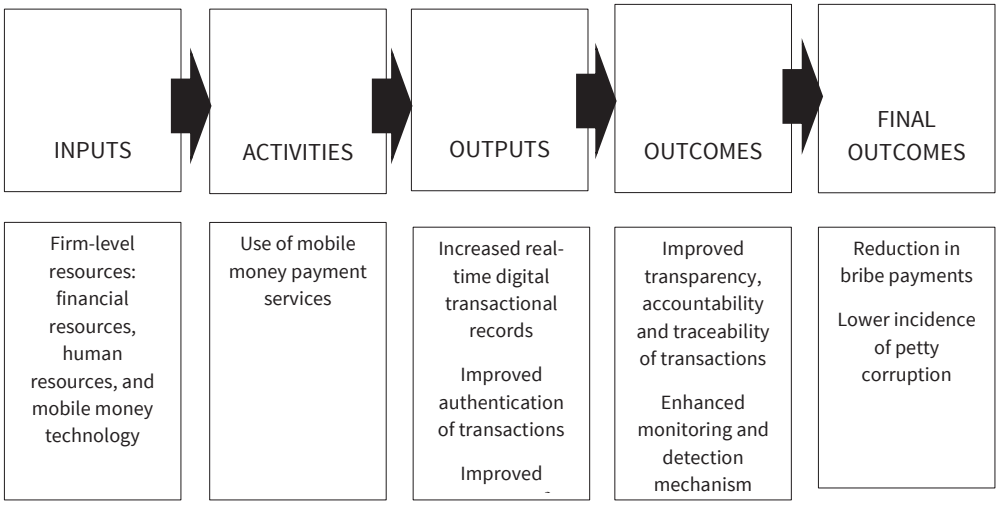
The foregoing discussion is instrumental for developing a theory of change outlining how mobile money use impacts petty corruption. This provides a basis for determining the anticipated outcome relating to a decrease in bribe payments. The theory of

change attempts to clarify the causal logic underlying the rationale of this study. With the aid of a results chain shown in Figure 1, this study sets out a theory of change outlining the sequence of implementation involving the use of mobile money payment systems and outcomes relating to lowering the incidence of petty corruption.

Figure 1 illustrates that firms may use financial and human resources, and mobile money technology as inputs for implementing mobile money use as an activity. The expected output of mobile money use includes increased real-time accurate digital transactional records and authenticated transactions. Hence, improved transparency, accountability and traceability of transactions, and reduced corruption opportunity space are immediate outcomes of the expected output. Similarly, enhanced monitoring and detection is likely to occur at this stage. This increases the likelihood of punishment. A reduction in bribe payments constitutes the final outcome of using mobile money as an intervention to petty corruption. The main assumption underlying the theory of change is that firms might have been predominantly using cash payments for informal payments prior to the introduction of mobile money services.

In line with this, the rationale behind the results chain is that petty corruption is prevalent in cash-based economies. Bribe payments are likely to occur when transactions between firms and government officials involve the exchange of cash. Such transactions may be concealed, anonymous, or undocumented. Hence, an intervention mechanism that generates and stores accurate real-time digital records offers a solution where lack of records is a challenge. Mobile money use also offers a potential solution to this challenge by providing transaction authentication information. This enhances monitoring, detection and the likelihood of punishment. Mobile money use is therefore likely to reduce bribe payments (Blumenstock et al., 2015; Krolikowski, 2014) and deters petty corruption by increasing the probability of getting caught (Basu et al., 2016; Navot and Cohen, 2015). In view of the results chain, the main hypothesis this study seeks to investigate is: H1: Mobile money use has a negative impact on bribe payments.

Figure 1: Results chain for mobile money payment services



Source: Adapted from Impact Evaluation in Practice, 2nd ed., p. 35, by P.J. Gertler, S. Martinez, P. Premand, B.L. Rawlings and C.M J. Vermeersch, 2016, Washington, D.C.: Inter-American Development Bank and The World Bank. Copyright 2016 by The World Bank. Adapted with permission.

3.0 Data

Data description

The analysis of this study is based on the WBES two-period panel data for Kenya. The first wave of data is from the 2007 WBES. It represents the pre-treatment period. The second wave of data is from the 2013 WBES. The second wave represents the post-treatment period. The surveyed firms are a nationally representative sample of the country's private sector. The WBES applies the stratified random sampling technique. The firms are stratified by sector, firm size and geographical location. The survey instruments collect data on firm characteristics, mobile money use, business-government relations, performance measures and the business environment. The primary survey respondents include business owners and top managers (https://www.enterprisesurveys.org).

The sample used for the analysis includes a panel of 104 firms surveyed in both time periods. Hence, the data was set up as a two-period panel. The first wave of data covering 2005-2006 was collected before the launch of mobile money services in Kenya. The second wave of data was collected after the launch and covers 2010-2012.[3] This study utilized the launch of mobile money services in 2007 as a means of identifying the impact of mobile money use on petty corruption in Kenya.[4]

{B}Variables of interest

The treatment variable concerns the use of mobile money payment services. The WBES asks respondents whether the "establishment uses mobile money for any of its financial transactions". Thus, the treatment is measured as a dummy variable taking a value of "1" where firms reported using mobile money for financial transactions and "0" if otherwise.

3 Data from the WBES generally suffers from missing observations. This compromises the representativeness of the sample (Williams et al., 2016). There were several missing observations on bribe payments. About 48 firms chose not to answer the question on informal payments: 16 firms out rightly refused to answer questions on informal payments; 19 firms opted for the "don't know" option, while 13 firms had missing data. These firms were excluded from the sample.

4 An investigation of the recent 2018 WBES revealed that only 60 firms could be matched over the three existing waves of data: 2007 WBES, 2013 WBES and 2018 WBES. After discarding observations with missing information on bribe payments, the sample further reduced to 54 firms. Due to this small sample size, we decided to use only the 2007 WBES (the baseline survey, before treatment) and 2013 WBES (post-treatment survey) in our analysis. This panel resulted in fact in a larger sample of 104 firms.

The outcome variable of interest is petty corruption, which is measured as bribe payments: the percentage of total annual sales paid in informal payments. The WBES introduces the subject of petty corruption by stating that firms are at times required to make gifts or informal payments to government officials to "get things done". This is with regards to taxes, customs, business permits and licenses, regulations, services, and securing government contracts, etc. The respondent is then asked to report, on average, the percentage of total annual sales that "establishments like this one" pay as informal payments or gifts to public officials for this purpose.

Informal payments can provide an objective measure of petty corruption since they may be measured directly like any other cost. However, Azfar and Murrell (2009) claim that respondents are usually reticent during surveys on such sensitive topics, which introduces downward bias in estimates. To address this, most surveys including the WBES phrase questions in a manner that allows respondents to provide answers without admitting to paying bribes. Also, while bribe payments—the outcome variable—are self-reported measures, the treatment and pre-treatment variables are objectively measured. Furthermore, self-reported data generally correlate well with objective measures of the investment climate (Gelb et al., 2011). Finally, firms are more likely to provide accurate or honest answers when given the alternative of measuring informal payments as a percentage of sales (Iarossi, 2006).

Indeed, previous empirical literature on corruption employs self-reported measures as these are the most widely available. They are also the best form of measurement so far especially in the context of sub-Saharan Africa (Kaufmann et al., 2011).

4.0 Empirical strategy

Model specification

The econometric methods used in estimating the impact of mobile money use on bribe payments were based on the theory of change discussed in the preceding section. The first step involved estimating the determinants of mobile money adoption. This was accomplished using pre-treatment data from the first wave of data from the 2007 WBES. Not all firms in the sample adopted mobile money; this study therefore modelled a probit regression for mobile money adoption as follows:

$$MobileMoney_{it=1} = \beta_x X_{it=0} + \varepsilon_{it},$$
$$MobileMoney_{it=1} = MobileMoney^{*}_{it=1} \; if \; MobileMoney^{*}_{it=1} > 0; \; MobileMoney_{it=1} = 0 \; otherwise \quad (1)$$

Where, $MobileMoney_{it=1}$ is a latent variable representing mobile money use, which is observed when the firm uses mobile money for its financial transactions in the post-treatment period; $X_{it=0}$ is a vector of firm characteristics that are associated with mobile money adoption and petty corruption in the pre-treatment period. These include age, size, foreign ownership, export status, managerial experience, access to credit, quality certification and sector dummies. ε_{it} is the idiosyncratic error term which is assumed to be $\sim$ iid $N(0, \sigma^2)$.

The second step entailed investigating the impact of mobile money use on bribe payments as follows:

$$\Delta Y_i = f(MobileMoney_{it=1};\, \beta) + \delta_T C_{it=0} + \varepsilon_{it},$$
$$\Delta Y_i = Y_{it=1} - Y_{it=0} \Delta Y_i = Y_{it=1} - Y_{it=0} \quad (2)$$

Where, ΔY_i represents the difference in bribe payments in the post-treatment period $Y_{it=1}$ and the pre-treatment period $Y_{it=0}$ for firm i; $MobileMoney_{it=1}$ represents mobile money use in the post treatment period; $C_{it=0}$ represents a vector of firm characteristics in the pre-treatment period: age, size, foreign ownership, export status, managerial experience, access to credit, quality certification and sector dummies. ε_i is the idiosyncratic error term.

Based on theory and previous empirical literature, several firm characteristics are associated with mobile money adoption (Islam et al., 2018; Gosavi, 2015) and petty corruption in developing countries in sub-Saharan Africa: age, small enterprises,

foreign ownership, export status, quality certification, managerial experience, access to credit and sector dummies (Birhanu et al., 2016; Pelizzo et al., 2016). Table 1 shows the definition and measurement of the variables used in the empirical analysis.

Table 1: Definition and measurement of variables

Variables	Measurement
Outcome variable	
Bribe payments	Percent of total annual sales paid in informal payments.
Treatment variable	
Mobile money	Dummy variable. 1 if mobile money is used for financial transactions, 0 = otherwise.
Baseline controls	
Age (log)	Difference between the year of survey and the year the firm began operations.
Small enterprise	Dummy variable. 1 = if firm has 5-19 employees, 0 = otherwise.
Medium-sized enterprise	Dummy variable. 1 = if firm has 20-99 employees, 0 = otherwise.
Large enterprise	Dummy variable. 1= if firm has at least 100 employees, 0 = otherwise.
Foreign ownership	Percentage owned by private foreign individuals, companies or organizations.
Export status	Percentage of direct and indirect exports.
Managerial experience	Dummy variable. 1 = managerial experience is >= 10 years in sector, 0 = otherwise.
Access to credit	Dummy variable. 1 = line of credit or loan from a financial institution, 0 = otherwise.
Quality certification	Dummy variable. 1 = if firm has internationally recognized quality certification, 0 = otherwise.
Retail sector	Dummy variable. 1 = if firm is in retail sector, 0 = otherwise.
Service sector	Dummy variable. 1 = if firm is in service sector, 0 = otherwise.
Manufacturing sector	Dummy variable. 1 = if firm is in manufacturing sector, 0 = otherwise.
Nairobi region	Dummy variable. 1 = if firm is in the Nairobi region, 0 = otherwise.
Other regions	Dummy variable. 1 = if firm is in Kisumu, Mombasa or Nakuru region, 0 = otherwise

Identification strategy

The main challenge in identifying the impact of mobile money use on petty corruption encompasses the effects of unobserved time-varying characteristics. Using the OLS estimator to estimate Equation 2 may result in biased estimates because it ignores selection bias. There is the possibility that firms facing a higher bribery incidence may adopt mobile money payment systems to curb petty corruption. Also, unobserved firm characteristics such as managerial ability may have influenced bribe payment decisions and mobile money use. Hence, firms adopting mobile money may be

systematically different from non-adopters. This would result in an upward bias in the estimated impact of mobile money use on bribe payments. The OLS estimator also ignores the time trend in bribe payments. The time trend can therefore be confounded as a part of the treatment effect. Hence, the OLS estimator may suffer from upward bias. Notwithstanding, the first estimation of the impact of mobile money use on bribe payments was carried out using the OLS estimator.

Equation 2 was then estimated using the DID approach. The DID estimator is an improvement over the OLS estimator because it controls for both observed and unobserved time-invariant characteristics that may have influenced the decision to adopt mobile money. The DID estimator addresses selection bias when the parallel trends assumption holds. In this case, the DID estimator yields least biased and most precise estimates. It is expected that the estimated impact of mobile money use on bribe payments using the DID estimator will be less negative relative to that of the OLS estimator because it accounts for time-invariant characteristics. Notwithstanding, the DID estimator does not account for unobserved time-varying characteristics. Furthermore, failure of the parallel trends assumption leads to biased estimates.

The IPW estimator was also used to estimate the impact of mobile money use on bribe payments. This estimator addresses the selection bias inherent in the OLS and DID estimators by making the treatment group and comparison group more comparable. In the IPW estimator, comparison observations are weighted using the inverse of their propensity score to yield a fully efficient estimator (Hirano et al., 2003). The IPW estimator is also further improved by including pre-treatment covariates. As such, the estimated impact of mobile money use on bribe payments from the IPW estimator is expected to be less biased in comparison to the OLS estimator.

Applying the MDID estimator also results in less biased estimates as compared to the OLS estimator. Matching on observable pre-treatment covariates may improve the balance on unobserved characteristics with time-varying effects. Hence, the estimated impact of mobile money use on bribe payments using the MDID estimator declines as the model may account for unobserved characteristics with time-varying effects. Having the advantage of rich baseline data on comparison and treatment firms, this study combined DID with propensity score-matching (Dehejia & Wahba, 2002; Rosenbaum and Rubin, 1983) to estimate the impact of mobile money use on bribe payments. The availability of baseline data made it possible to carry out matching on the pre-treatment background characteristics to obtain a valid comparison group. When used in combination with DID, matching on pre-treatment variables allows for the correction of differences that are fixed over time between the comparison and treatment group. This reduces the risk of bias. Combining the two methods is useful in offsetting the limitations found in each method. This increases the robustness of the estimated counterfactuals (Blundell and Dias, 2009; Gertler et al., 2016; Heckman et al., 1997). Additionally, the launch of mobile money in Kenya was not in any way related to the outcome variable of interest encompassing petty corruption. Consequently, this study does not suffer from simultaneous causality.

The DID method accounts for time-invariant unobserved characteristics that may be correlated with bribe payments. Notwithstanding, the DID method does not eliminate time-variant differences. Hence, the validity of the parallel trends assumption was assessed to examine whether bribe payments moved in tandem before the introduction of mobile money payment services.

First, the balance on baseline characteristics was assessed. In addition, two falsification tests were conducted. The first test employed a placebo treatment group. The second test used a placebo outcome that is theoretically unaffected by mobile money use. The falsification tests were suited to assessing the parallel trends assumption in this study. The available data lacks two pre-intervention data points that are necessary for assessing the trends before the inception of mobile money services (Card and Krueger, 1994).

Pre-treatment covariates were first used for estimating the propensity scores for matching. The separate effect of the initial conditions during the baseline survey can bias the DID estimate. This study therefore took into account that initial conditions may have had a separate influence on the assignment to treatment or on the subsequent changes in the outcome (Khandker et al., 2009).

The DID estimator was then applied on the matched sample. Heckman et al. (1997) assert that the precision of propensity scores is usually improved when the same survey instrument or source of data is used as is the case for this study. This ensures that observed characteristics are measured in the same manner and reflect the same concepts. Other factors that increase the likelihood of producing valid results include using a representative sample of participants and nonparticipants that face the same economic incentives. For example, access to similar markets determines the choice of using mobile money payment services. This study addressed this by selecting participants and nonparticipants in the same country.

The choice of pre-treatment covariates was based on theory and previous empirical literature. The probability of firms paying bribes is higher when firms are small, and newly established. Such firms lack easy access to public officials. In contrast, foreign-owned firms have a lower incidence of bribery. This is attributed to foreign stakeholders wielding a higher bargaining power since governments aim to attract foreign capital (Birhanu et al., 2016; Pelizzo et al., 2016). In addition, exporting and quality certification signals strong internal control mechanisms and overall efficiency. Hence, export status and quality certification are negatively associated with bribery (Birhanu et al., 2016).

Experienced managers are more likely to obtain government services without resorting to making illicit payments. Firms with highly experienced managers are therefore likely to encounter lower bribe incidence (Hooker, 2009). Similarly, access to credit is negatively associated with bribery. In general, financially constrained firms exhibit a trade-off between investment and bribe payment (Birhanu et al., 2016). Lastly, sector characteristics such as the dependence on government services and the degree of pervasiveness of corruption are positively associated with bribe payments. For example, in the manufacturing sector, construction firms encounter

complex transactions involving numerous applications for permits and licenses. In addition, the scale of investment is usually large and the nature of operations enables the concealment of bribe payments (Chan and Owusu, 2017).

Balance on baseline characteristics

The baseline characteristics were used for confirming that the balancing property was satisfied. This was to confirm that firms with the same propensity scores had the same distributions on all covariates prior to the treatment. This is an important step taken to establish that there were no systematic differences between the treatment and comparison group prior to the launch of mobile money. This ensures that the study estimates the true impact of mobile money on petty corruption.

Table 2 shows that the balancing condition was satisfied as there were no statistically significant differences in the baseline characteristics of firms in the treatment group and comparison group. This indicates that baseline firm characteristics between treatment and comparison groups are similar. This is a key prerequisite for establishing the validity of the comparison group. In sum, both sets of firms begin with very similar average baseline characteristics before exposure to mobile money payment services.

Table 2: Balance on baseline characteristics (n=104)

Weighted variables	Mean control (n=56)	Mean treated (n=48)	Diff.	t	Pr(T>t)
Bribe payments	1.656	2.536	0.880	1.520	0.1310
Age (log)	2.533	2.544	0.011	0.060	0.9541
Medium-sized enterprise	0.265	0.271	0.005	0.060	0.9502
Large enterprise	0.253	0.333	0.081	0.900	0.3720
Foreign ownership	7.648	8.333	0.686	0.140	0.8882
Export status	6.835	6.667	-0.168	0.050	0.9592
Managerial experience	0.571	0.667	0.095	1.000	0.3213
Access to credit	0.568	0.604	0.037	0.380	0.7079
Quality certification	0.136	0.146	0.010	0.140	0.8856
Retail sector	0.221	0.208	-0.013	0.150	0.8780
Service sector	0.328	0.333	0.005	0.060	0.9551

* p<0.10, ** p<0.05, *** p<0.01

Note. Means and t-test are estimated by linear regression.

Several tests were also used to assess the performance of the propensity score-matching procedure (Arnold and Javorcik, 2009). The first test compared the sample means between the treatment group and the comparison group consisting of the matched sample. The results of this test, as shown in Table 3, indicate that there are no statistically significant differences in the means of all the variables used in the matching procedure. The weakest result was found for the service sector variable for which the null hypothesis of no difference between means could only be rejected at

the 10% level. Table 4 shows the second group of tests involving the standard tests of multivariate means—Wilks' lambda, Pillai's trace, Lawley–Hotelling trace, and Roy's largest root—and the Hotelling's T^2. They are of the joint null hypothesis of equal mean vectors on all variables. These tests were applied to the matched sample and the results show failure to reject the null hypothesis that the mean vectors between the treatment and comparison group are equal. The results of these tests suggest that the matching procedure grouped firms with relatively similar characteristics.

Table 3: T-test on matched sample

Variables	Mean control (n=94)	Mean treated (n=76)	Diff.
Bribe payments	1.720	1.547	0.173
Age (log)	3.034	2.876	0.158
Medium-sized enterprise	0.457	0.368	0.089
Large enterprise	0.298	0.329	-0.031
Foreign ownership	11.543	6.947	4.595
Export status	12.907	9.029	3.877
Managerial experience	0.723	0.724	0.000
Access to credit	0.479	0.447	0.031
Quality certification	0.755	0.724	0.032
Retail sector	0.085	0.145	-0.060
Service sector	0.266	0.395	-0.129*

* p<0.10, ** p<0.05, *** p<0.01

Note. Estimation based on firms within common support only.

Table 4: Test for equality of mean vectors on matched sample (n=170)

Test	Statistic	F(df1,	df2)	= F	Prob>F
Wilks' lambda	0.9266	11.0	158.0	1.14	0.3350
Pillai's trace	0.0734	11.0	158.0	1.14	0.3350
Lawley-Hotelling trace	0.0793	11.0	158.0	1.14	0.3350
Roy's largest root	0.0793	11.0	158.0	1.14	0.3350
Hotelling T^2	13.3100	11.0	158.0	1.14	0.3350

Notes. Estimation based on firms within common support only. Tests assume homogenous covariance matrices across the treatment group and comparison group.

Balance on parallel trends

The main assumption underlying the DID approach is that, in the absence of mobile money, bribe payments by the treatment group would have moved in tandem with those of the comparison group. In the event that the outcome trends are different, the DID estimator will yield an invalid estimate of the impact of mobile money. Two falsification tests were used to assess the validity of the comparison group. The tests entailed estimating the impact of mobile money using a placebo treatment group, and a placebo outcome.

The placebo treatment group comprises firms in Malawi. The data used for assigning fake treatment to firms was from the 2005 and 2009 WBES for Malawi. Mobile money was launched in 2012 in Malawi. This implies that firms were not using mobile money in transactions in Malawi over the two survey periods. Furthermore, it is highly unlikely that the launch of mobile money in Kenya affected firms in Malawi. Firms in the East African Community partner states such as Rwanda, Tanzania and Uganda might not form a suitable placebo treatment group since there is a high probability that they were affected by the launch of mobile money in Kenya.

The placebo outcome includes power outages, which are a common phenomenon in Kenya. Nevertheless, there is no theoretical link between their occurrence and mobile money use. The 2007 and 2013 WBES for Kenya measures power outages as "the number of power outages experienced in a typical month in the last fiscal year". A non-zero impact for placebo effects implies that reported impacts cannot be attributed to causal effects of mobile money use (Gertler et al., 2016).

The DID results from the falsification tests are shown in Table 5. A zero impact was observed across both tests. The falsification tests therefore suggest that the treatment and comparison firms can be assumed to have parallel trends in the absence of mobile money.

Table 5: Balance on parallel trends falsification tests with DID

	Placebo outcome with DID		Placebo treatment group with DID	
	Before	After	Before	After
Treatment group	5.919	8.000	2.536	0.667
Control group	7.266	8.982	1.745	1.256
ATTa		0.365		-1.381
		(2.319)		(1.074)
Baseline controls		No		No
No. of observations		208		324

Standard errors in parentheses.
* p<0.10, ** p<0.05, *** p<0.010
a Average Treatment Effect on the Treated (ATT).
Notes. The placebo outcome is power outages for firms in Kenya. The placebo treatment group comprises 104 firms from Kenya and 58 firms from Malawi.

Empirical analysis

Having assessed the validity of the parallel trends assumption, the estimation procedure for analysis entailed using the propensity score for matching treated firms and comparison firms in the base year. The DID estimator was then used to estimate the treatment impact across treated and matched comparison firms within

common support. Khandker et al. (2009) contend that researchers can only ensure internal validity as opposed to external validity. Thus, only the average treatment-on-the-treated (ATT) effect can be estimated reliably. In addition, validity of the ATT estimates is based on weaker assumptions of conditional independence assumption and common support.

This study considered a panel data structure of two-time periods such that $t = \{0, 1\} t = \{0, 1\}$. Hence, the DID estimator for mean difference in outcomes Y_{it} Y_{it} across treatment participants ii and comparison nonparticipants jj within the common support was calculated as:

$$ATT_{PSM}^{DID} = \frac{1}{N_T}\left[\sum_{i\in T}\left(Y_{it=1}^{T} - Y_{it=0}^{T}\right) - \sum_{j\in C}\omega(i,j)_{KM}\left(Y_{jt=1}^{C} - Y_{jt=0}^{C}\right)\right] \quad (3)$$

Where, ATT_{PSM}^{DID} represents the ATT estimated by the MDID; N_T is the number of participants i; $(Y_{it=1}^{T} - Y_{it=0}^{T})$ represents the difference in outcomes for the treated participant firms where $Y_{it=1}^{T}$ is the outcome in the post-treatment period and $Y_{it=0}^{T}$ is the outcome in the pre-treatment period; $\omega(i,j)_{KM}$ represents the kernel matching weights that are given to the jth comparison nonparticipants matched to treatment participant ii; $(Y_{jt=1}^{C} - Y_{jt=0}^{C})$ represents the difference in outcomes for comparison nonparticipants where $Y_{jt=1}^{C}$ represents the outcome in the pre-treatment period and $Y_{jt=0}^{C}$ represents the outcome in the post-treatment period (Khandker et al., 2009). The one-to-one nearest neighbour matching procedure is used to generate a matched sample for analysis (Leuven & Sianesi, 2018).[5]

5 The weights are calculated as: $\omega(i,j)_{KM} = \frac{K\left[\frac{P_j - P_i}{a_n}\right]}{\sum_{k\in C} K\left[\frac{P_k - P_i}{a_n}\right]}$, where $K(.)K(.)$ is a kernel function, and if P_i is the propensity score for participant firm i, P_j is the propensity score for nonparticipant firm j, and a_n is a bandwidth parameter. The default bandwidth of 0.06 is used for kernel matching.

5.0 Results and discussion

Main results

Table 6 shows the differences in sample means of all variables based on the time period including the pre-treatment period and the post-treatment period. The mean value of bribe payments was lower in the post-treatment period; however, the difference was not statistically significant. As expected, the mean values for mobile money use and firm age were higher in the post-treatment period. These differences were statistically significant. Similarly, there were statistically significant differences in managerial experience, quality certification and service sector. This suggests that firms had managers with more experience in the post-treatment period. In addition, more firms had quality certification in the post-treatment period. Furthermore, a larger number of firms reported being in the service sector in the post-treatment period. Lastly, fewer firms accessed credit in the post-treatment period.

Table 6: T-test on unmatched sample, based on survey period

Variables	Mean (t = 0)	Mean (t = 1)	Diff.
Bribe payments	1.879	1.452	0.427
Mobile money use	0.000	0.462	-0.462***
Age (log)	2.742	3.039	-0.297**
Medium enterprise	0.394	0.413	-0.019
Large enterprise	0.337	0.250	0.087
Foreign ownership	12.020	8.510	3.511
Export status	9.702	13.879	-4.177
Managerial experience	0.654	0.760	-0.106*
Access to credit	0.529	0.394	0.135*
Quality certification	0.192	0.317	-0.125**
Retail sector	0.135	0.125	0.01
Service sector	0.212	0.442	-0.231***

* p<0.10, ** p<0.05, *** p<0.01

Notes: t=0 represents the pre-treatment period; t=1 represents the post-treatment period.

Table 7 shows the descriptive statistics and correlation matrix. The mean value for bribe payments was 1.67% of the total annual sales. In addition, about 46% of the firms used mobile money for financial transactions. The mean age of the firms was 24 years. Also, the mean value of foreign ownership was about 10%. Similarly, the mean value of exports was about 12%. It was also noted that 40% of the firms were medium-sized enterprises. Similarly, about 71% of the firms had a manager with at least ten years of experience in the firms' sector. About 46% of the firms accessed credit. A small number of firms had quality certification (25%). Finally, 54% of the firms belonged to the manufacturing sector. The correlation matrix shows that the main variable of interest —mobile money—was negatively correlated with bribe payments. Similarly, age, large enterprises, foreign ownership, export status, managerial experience, and the manufacturing and retail sectors were negatively correlated with bribe payments. The correlation coefficients for medium-sized enterprise, access to credit, quality certification and service sector were positive. A majority of the pre-treatment variables had the expected correlation coefficients

This study first models the likelihood of firms adopting mobile money using a probit regression. These results are shown in Table 8. The likelihood of adopting mobile money was 24 percentage points higher for firms with a manager with at least ten years of experience in the sector. Similarly, the effect of access to credit on mobile money adoption was 20 percentage points higher for firms with a line of credit or loan in comparison to those without. In addition, the likelihood of adopting mobile money was 38 percentage points higher for firms in the retail sector in comparison to those in the manufacturing sector. Lastly, the likelihood of adopting mobile money was 41 percentage points higher for firms in the service sector relative to those in the manufacturing sector (Gosavi, 2015; Islam et al., 2018). The coefficients for age, medium enterprise, large enterprise, foreign ownership, and export status and quality certification were non-significant.

Table 9 shows the results from estimating the impact of mobile money use on bribe payments using the OLS estimator. It can be observed that the coefficient for the treatment was negative and significant. In addition, coefficient for service sector was positive and statistically significant. This indicates that bribe payments in the service sector were about 4 percentage points higher in comparison to the manufacturing sector. Table 10 shows the results for the DID, IPW and MDID

Table 7: Descriptive statistics and correlation matrix (n=208)

	Variables	Mean	Std. Dev.	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12
1	Bribe payments	1.67	4.64	0.00	40.00	1.00											
2	Mobile money	0.46	0.50	0.00	1.00	-0.01	1.00										
3	Age	24.14	16.99	1.00	87.00	0.10	-0.16	1.00									
4	Medium-sized enterprise	0.40	0.49	0.00	1.00	0.00	-0.15	-0.01	1.00								
5	Large enterprise	0.29	0.46	0.00	1.00	-0.09	-0.00	-0.24	-0.53	1.00							
6	Foreign ownership	10.26	27.36	0.00	100.00	-0.02	-0.13	-0.06	-0.06	-0.07	1.00						
7	Export status	11.79	22.50	0.00	100.00	-0.06	-0.10	-0.17	-0.10	-0.32	-0.18	1.00					
8	Managerial experience	0.71	0.46	0.00	1.00	-0.03	-0.05	-0.25	-0.06	-0.14	-0.02	-0.13	1.00				
9	Access to credit	0.46	0.50	0.00	1.00	-0.02	-0.07	-0.07	-0.00	-0.10	-0.02	-0.10	-0.09	1.00			
10	Quality certification	0.25	0.44	0.00	1.00	-0.08	-0.01	-0.21	-0.14	-0.33	-0.31	-0.41	-0.04	-0.05	1.00		
11	Manufacturing sector	0.54	0.50	0.00	1.00	-0.02	-0.31	-0.27	-0.20	-0.21	-0.17	-0.13	-0.22	-0.13	-0.05	1.00	
12	Retail sector	0.13	0.34	0.00	1.00	-0.03	-0.19	-0.18	-0.17	-0.15	-0.11	-0.18	-0.25	-0.01	-0.09	-0.42	1.00
13	Service sector	0.33	0.47	0.00	1.00	-0.04	-0.20	-0.16	-0.09	-0.11	-0.09	-0.01	-0.05	-0.13	-0.02	-0.76	-0.27

Table 8: Predicting mobile money adoption (n=104)

Variables	Probit coefficients		Marginal effects	
Age (log)	-0.233	(0.201)	-0.073	(0.062)
Medium-sized enterprise	-0.296	(0.408)	-0.093	(0.127)
Large enterprise	0.139	(0.479)	0.043	(0.150)
Foreign ownership	-0.002	(0.006)	-0.001	(0.002)
Export status	-0.006	(0.008)	-0.002	(0.003)
Managerial experience	0.769**	(0.383)	0.240**	(0.113)
Access to credit	0.647**	(0.310)	0.202**	(0.091)
Quality certification	0.231	(0.436)	0.072	(0.136)
Retail sector	1.228**	(0.525)	0.384**	(0.151)
Service sector	1.325***	(0.424)	0.414***	(0.112)
Constant	-0.426	(0.714)		

Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1
Note: Baseline characteristics used in estimation.

Table 9: Impact of mobile money use on bribe payments in Kenya (n=104)

Variables	OLS coefficients	
Mobile money use	-3.587***	(1.318)
Age (log)	0.260	(0.801)
Medium-sized enterprise	2.066	(1.769)
Large enterprise	2.239	(1.998)
Foreign ownership	0.006	(0.022)
Export status	-0.022	(0.036)
Managerial experience	-1.326	(1.509)
Access to credit	0.352	(1.278)
Quality certification	-0.534	(1.827)
Retail sector	3.418	(2.294)
Service sector	3.869**	(1.816)
Constant	-1.939	(3.031)

Standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

Table 10: Impact of mobile money use on bribe payments in Kenya

	DID		IPW	MDID[A]	
	Before	After		Before	After
Treatment group	4.467	2.832		2.384	0.711
Control group	3.532	4.352		1.334	2.727
ATT[a]		-2.454*	-5.082*		-3.067*
		(1.324)	(2.895)		(1.701)
Baseline controls		Yes	Yes		Yes
No. of observations		208	208		170

Standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

[a] Average Treatment Effect on the Treated (ATT).

Note: Estimation using MDID for firms within common support.

estimators. The matching procedure for the MDID estimator was based on the propensity scores from the probit regression. The coefficient for the treatment was negative and significant across all models.[6]

The results from the MDID estimator – the preferred model – indicated that the treatment had a negative and significant impact on bribe payments. This finding was in line with the hypothesis. Specifically, firms using mobile money for financial transactions experienced a 3.1 percentage point reduction in bribe payments. This result bears economic significance given the sign and magnitude of the treatment effect. Thus, the use of mobile money for financial transactions had a substantial

6 The results from these estimations were robust to winsorizing all the continuous variables at the 1st and 99th percentile: bribe payments, age, export status, foreign ownership. In addition, the results remained robust to re-estimating the MDID model using multiple imputations for missing data on bribe payments.

negative impact on bribe payments. This finding suggests that mobile money based systems were effective in reducing petty corruption. This result also offers support to the hypothesized theory of change that maps the causal pathway showing how mobile money use deters petty corruption.

In conformity with the theory of change, there are several reasons why mobile money use may reduce bribe payments at the firm-level. First, use of mobile money reduces, and may potentially eliminate, physical contact between government officials and firm managers. This reduces opportunities that prompt petty corruption. Second, the real-time digital transaction records arising from mobile money use increase transparency and accountability. Thus, mobile money limits the manipulation of billing and payment processes. Third, mobile money use is governed by stringent authentication encompassing identification documentation and procedures that rule out the possibility of anonymity. Identification information increases the traceability of transactions. Overall, the adoption of mobile money payment systems for transactions deters petty corruption by reducing the bureaucratic red tape. This diminishes the opportunity space and incentives for corruption (Blumenstock et al., 2015; Krolikowski, 2014).

Individuals who engage in corruption typically underestimate the likelihood of getting caught particularly in an environment characterized by impunity (Basu et al., 2016; Navot and Cohen, 2015). This phenomenon implies that lack of information pertaining to financial transactions underlies petty corruption. Mobile money payment systems are therefore likely to be an effective anti-corruption intervention in such a context because they are designed in a manner that reduces information asymmetries (Navot and Cohen, 2015; Stahl et al., 2017). Essentially, digital transaction records arising from mobile money use are tools that enhance monitoring and detection mechanisms that are critical in the detection and punishment of corrupt individuals.

Additional results

Additional estimations were also conducted to examine the effect of mobile money use on bribe payments by size, sector and geographical location. Table 11 shows the results of the impact of mobile money use on bribe payments by firm size: small enterprises, medium enterprises and large enterprises. Mobile money use was found to have a negative and significant impact for large firms only. This category of firms experienced a 1.9 percentage point reduction in bribe payments. Mobile money service providers typically impose maximum daily transaction values. This is likely to present a barrier to large firms since they are more likely to conduct transactions involving large amounts of money.[7] As such, increasing the daily transaction value might benefit large firms with regards to reducing bribe payments.

7 M-PESA mobile money service by Safaricom Ltd. and Airtel Money by Airtel Ltd. have a maximum daily transaction limit of about US$1400 only.

Table 11: Impact of mobile money use on bribe payments in Kenya, by size

	Small enterprises		Medium enterprises		Large enterprises	
	Before	After	Before	After	Before	After
Treatment group	1.757	0.000	4.513	2.857	1.644	0.167
Control group	2.747	10.199	1.238	0.520	0.299	0.741
ATT[a]		-9.209		-0.937		-1.919*
		(5.943)		(2.760)		(1.051)
Baseline controls		Yes		Yes		Yes
No. of observations		38		55		35

Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1
a Average Treatment Effect on the Treated (ATT).
Notes. Estimation using MDID for firms within common support. Small enterprise (5-19 employees); medium enterprise (20-99 employees); large enterprise (>=100 employees).

Table 12 shows the impact of mobile money use on bribe payments by sector. The impact of mobile money use was non-significant across the sectors: manufacturing, and retail and service. The impact of mobile money on bribe payments is sensitive to conducting a sectoral sub-group analysis. This suggests that sectoral differences account for the variation in bribe payments. Thus, a significant impact is observed when sector dummies are included in the full sample. This suggests that it is important to take sectoral differences into consideration.

Table 12: Impact of mobile money use on bribe payments in Kenya, by sector

	Manufacturing		Retail and Service	
	Before	After	Before	After
Treatment group	3.219	1.667	1.585	0.357
Control group	1.186	1.213	2.136	8.906
ATT[a]		-1.579		-7.997
		(1.652)		(5.058)
Baseline controls		Yes		No
No. of observations		97		48

Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1
a Average Treatment Effect on the Treated (ATT).
Note: Estimation using MDID for firms within common support only.

Lastly, Table 13 displays the results from estimating the impact of mobile money use by geographical location: the Nairobi region and other regions (i.e., Kisumu, Mombasa and Nakuru). Mobile money use had a negative impact on bribe payments

for firms located in the Nairobi region only. Firms in the Nairobi region therefore experienced a 5.5 percentage point decrease in bribe payments as a result of using mobile money for financial transactions. This suggests that taking into account the differences in geographical location might be critical in fighting petty corruption. It is likely that some geographical locations have certain characteristics that predispose firms to petty corruption. The Nairobi region includes the major capital city that generally encounters poor urban governance. This is due to insufficient infrastructure brought about by a high population density that results in high water and energy consumption. In addition, there is the presence of organized crime that might interact with petty corruption. Notwithstanding, the Nairobi region contains advanced telecommunications infrastructure and was among the first regions where mobile money services were rolled out (Hughes & Lonie, 2007). It is therefore very likely that firms in the Nairobi region might adopt mobile money to circumvent bribery that is connected to accessing urban infrastructure.

Table 13: Impact of mobile money use on bribe payments in Kenya, by geographical location

	Nairobi region		Other regions	
	Before	After	Before	After
Treatment group	2.912	0.913	1.900	0.429
Control group	2.027	5.477	0.924	0.000
ATTa		-5.449*		-0.548
		(2.977)		(1.035)
Baseline controls		Yes		Yes
No. of observations		98		48

Standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

a Average Treatment Effect on the Treated (ATT).

Notes. Estimation using MDID for firms within common support only. The Nairobi region includes the official capital city. Other regions include Kisumu, Mombasa and Nakuru.

6.0 Conclusions and policy implications

The key objective of this study was to examine the impact of mobile money use on petty corruption in firms in Kenya. The launch of mobile money services in the country in 2007 was utilized as a means of identifying the impact of mobile money use on bribe payments using non-experimental methods. The results from the analysis of the two-period firm-level data demonstrated that the use of mobile money for financial transactions reduced bribe payments.

Mobile money use is linked to increased transparency, accountability and traceability of transactions. Furthermore, stringent identification documentation eliminates anonymity. Hence, mobile money use limits the opportunity space under which petty corruption thrives. Also, the availability of digital financial records fosters stronger monitoring and detection mechanisms that enhance detection and the likelihood of punishment of corrupt individuals. Firms can leverage mobile money technology to circumvent acts of bribery. Mobile money use can, therefore, effectively decrease a firm's vulnerability to petty corruption.

Considering the widespread nature of petty corruption in sub-Saharan Africa, a commonplace solution such as the adoption of mobile money for financial transactions by firms is likely to present an effective anti-corruption intervention in the context of Africa. The dominance of mobile money in Africa makes it a practical anti-corruption intervention since the information and communications technology infrastructure relating to mobile network operators is already in place. Furthermore, mobile money use in Africa has generally outpaced that of the rest of the world.

Policy implications arising from the findings of this study relate to the adoption of financial digital innovations for enhancing transparency and accountability mechanisms. Mobile money enhances payment data transparency. This limits economic rents that may be gained by manipulating billing and payment processes. Mobile money also reduces the bureaucratic red tape, which diminishes incentives arising from physical proximity of enterprise managers and public officials. Policy makers have shown immense interest in fighting petty corruption at all levels; hence, adopting mobile money use as an anti-corruption intervention provides a practical solution that can be embedded in public policy.

An important managerial implication arising from the findings of this study pertains to the adoption of financial digital innovations for payment processes. Enterprise managers adopting mobile money payment systems are likely to see reduction in

bribe payments. Another possible benefit could be a reduction in the amount of time spent on dealing with public officials when handling government regulations with numerous payment processes. Similarly, mobile money use may decrease transaction costs involved in seeking government services. Furthermore, the use of mobile money payment systems may be useful in monitoring financial transactions carried out by employees. This in turn improves transparency and accountability that is driven by the authentication procedures required for carrying out mobile money transactions.

Nevertheless, this study suffers some limitations. First, the small sample size may be decreasingly representative of the entire population. However, policy interventions targeting enterprises within a randomized experimental design are very rare. As such, the launch of mobile money can be regarded as a natural experiment that provided a unique opportunity to investigate the impact of mobile money using quasi-experimental techniques.

Second, while an attempt was made to assess the parallel trends assumption, this study relied on falsification tests to establish the validity of the comparison group. Lack of two pre-intervention observations constrained the assessment of the parallel trends assumption. However, pre-treatment background characteristics were used for matching, and to account for initial conditions that may have affected the treatment status and the outcome.

Third, this study used the propensity score-matching to create a valid comparison group. This is a nonparametric technique that may adversely affect statistical inference in the case of a small sample size. Thus, it is recommended that the estimated treatment effects be interpreted with caution (Autio and Rannikko, 2016). Nevertheless, this study tested the sensitivity of the estimated treatment effect to using different estimators: OLS, DID and IPW. The quantitative results remained robust to using these estimators. Hence, the qualitative conclusions remain unchanged.

Despite the limitations of the study, rigorous impact evaluation of anti-corruption interventions has been lacking. This study provides robust evidence that supports the hypothesis that mobile money use delivers a negative impact on petty corruption. The findings of this study contribute towards policy debate surrounding practical and effective anti-corruption measures in Africa.

Some of the issues not addressed in this paper that form interesting areas of future research include establishing external validity of the results for other regions in Africa. Furthermore, examining the mechanisms by which mobile money payment systems affect bribe payments may uncover the underlying mechanisms by which mobile money impacts petty corruption. Also, investigating how mobile money adoption affects different forms of petty corruption, such as securing government contracts, can provide deeper insights into fighting petty corruption. Finally, subject to availability of data, using fine-grained measures of mobile money use that explicitly capture the use of mobile money for government to business transactions is likely to yield superior estimates of the impact of mobile money on bribe payments.

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