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Finding The Missing Stone: Mobile Money and Quality of Tax Policy and Administration

Ablam Estel Apeti
and Eyah Denise Edoh

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Summary

Making tax administration more efficient and maximising voluntary compliance is a very difficult task for developing countries. In this paper, we analyse the effect of mobile money payments on the quality of tax policy and administration for a large sample of countries in developing economies. We use the World Bank indicator on efficiency of revenue mobilisation as a measure of the quality of tax policy and administration and employ an entropy balancing method to show that mobile money payments improve the quality of tax systems. This result is robust to several robustness tests, including sample alteration, alternative measures of mobile money, controlling for other aspects of tax policy, and alternative estimation methods such as GMM-system, event study approach and ordinary least square. In addition, our results show that the positive effect of mobile money on tax systems depends on the level of development, financial development, the state's legitimacy, a country's fiscal space, the number of available products/companies, the type of mobile money services, and the geographic position of countries. Finally, we highlight some potential mechanisms underlying these findings through lower tax compliance burden, smaller informal sector, and lower corruption.

Keywords: mobile money, tax policy, tax administration, entropy balancing, developing countries.

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Acronyms

ATT	Average treatment effect on the treated
CPIA	Country policy and institutional assessments
ERM	Efficiency of revenue mobilisation
FAS	Financial Access Survey (IMF)
FDI	Foreign direct investment
GMM	Generalised method of moments
NTSA	National Transport Security Authority
ODA	Official development assistance
P2G	Person-to-government
P2P	Person-to-person
SSA	Sub-Saharan Africa
WDI	World development indicators

Introduction

Tax revenue mobilisation remains crucial for financing development. Domestic resource mobilisation is essential for several reasons, including reducing aid and commodity dependence and defining a social contract based on accountability or redistribution. While high-income countries generally collect tax revenues equal to 40 per cent of their GDP, low- and middle-income countries generally collect only 10–20 per cent. Although several reasons explain the low tax revenue mobilisation in these countries, the poor tax system, i.e., tax policy and administration, is an important or key factor (Prichard 2010; Moore 2020). As Tanzi (1983) has pointed out, tax administration plays a crucial role in determining the effective tax system, as opposed to the statutory tax system. A perfect illustration of the importance of the quality of tax administration can be seen in developing countries, where tax administration models are characterised by a greater reliance on manual systems and direct interaction between taxpayers and tax collectors, thus worsening corruption indicators in taxation and reducing tax performance (Okunogbe and Santoro 2023). Furthermore, the current global landscape, shaped by the economic downturn from the Covid-19 pandemic, international tensions, and the climate emergency, underscores the urgency for developing countries to establish robust tax revenue systems. In a post-Covid world marked by recession and financial market challenges, enhancing tax compliance and collecting sufficient revenue becomes a central feature for many countries. Compared to other financial means such as natural resource rents or foreign aid, domestic resources offer a more stable means of funding public services and addressing poverty, inequality, and governance issues. However, achieving financial self-sufficiency through taxes demands improvements in tax policy and administration to enhance efficiency. Specifically, overcoming existing shortcomings in tax systems is vital for developing nations to strengthen their revenue collection capabilities.

The spread of mobile phones as a means of communication in the developing world has led to the emergence of digital financial services like mobile money as an alternative to traditional financial services. As a result, for many governments, these digital services become critical components of domestic revenue mobilisation efforts and tax administration modernisation. Specifically, mobile money can help widen the tax base, enhance tax compliance or limit administrative burdens, improve the efficiency of back-end data, and increase revenue mobilisation (Arewa and Santoro 2022; Santoro *et al*. 2022; Apeti and Edoh 2023).[1] Although the literature recognises the positive impact of digital technologies on tax outcomes in developing countries in a more general context (Eissa and Zeitlin 2014; Ali *et al*. 2015; Kochanova, Hasnain and Larson 2020; Uyar *et al*. 2021; Okunogbe and Pouliquen 2022; Brockmeyer and Sáenz Somarriba 2022; Dzansi *et al*. 2022; Mascagni and Nell 2022; Okunogbe and Santoro 2023), relatively few studies, however, have looked at the effect of mobile money-type innovations on tax performance. In this handful of studies, Bernad *et al*. (2023) in Rwanda report a positive impact on VAT compliance of merchants after adopting mobile money payments, which however is only short lived – as arguably merchants do not believe that mobile money data could be used for tax enforcement. Similarly, in Kenya, Fichers and Naji (2020) report in a descriptive analysis that the National Transport Security Authority (NTSA) recorded an increase in revenue from US$1.1 million to US$2 million between 2015 and 2016 after migrating towards digital services, including mobile money. Finally, in a recent study, Apeti and Edoh (2023) analyse the effect of mobile money adoption on tax revenue. Based on a sample of 104 developing countries, the authors show that mobile money increases tax revenues in developing countries. However, although these studies analyse the potential of mobile money to generate tax revenues, the (direct) effect of these mobile money payments on the quality of tax policy and administration remains rather limited. We fill this gap in this paper by analysing the link between mobile money payments and the quality of tax policy and administration in developing countries, using the World

[1] See section 1 for more details.

Bank's indicator of 'efficiency of revenue mobilisation' (ERM).[2] To identify the effect of mobile money, we use entropy balancing developed by Hainmueller (2012). Based on a sample of 82 developing countries over the period 2006–2020, our findings suggest that mobile money payments improve the quality of tax policy and administration by 0.106.

Our result is robust to several robustness tests. First, we use mobile money from the IMF's Financial Access Survey as an alternative measure of our baseline mobile money variable. Second, we perform a placebo test to make sure that the effect we captured actually comes from mobile money adoption. Third, we test our results to sample alteration and additional control variables. Finally, we use alternative estimation methods such as panel fixed effects, GMM-system and event study approach. Furthermore, our results reveal some heterogeneous effects depending on the level of development, the level of financial development, the state's legitimacy, the fiscal space, i.e., public debt, the number of available products/companies, the type of mobile money services, and the geographic situation, i.e., comparing sub-Saharan Africa to the rest of the countries in our sample. Specifically, we show that the effect of mobile money is larger in countries with a low level of (economic) development, and a low level of financial development. Moreover, we show that the effect is greater with a high level of state legitimacy, high level of public debt, i.e., tight fiscal space, and in conditions where economic players have a wide range of mobile money products/companies available. Finally, we look for possible mechanisms behind these results and we show that lower compliance costs or administrative burden measured by time to prepare and pay taxes and the number of tax payments, a drop in the informal sector size and control of corruption are the main channels through which mobile money improves the quality of the tax system.

The remainder of the paper is structured as follows. In section 1, we describe the theoretical considerations/arguments of our study. Sections 2 and 3 present the data and the methodology. Section 4 presents the results. Sections 5 and 6 present the robustness exercises and the heterogeneous effects. Section 7 presents the estimate of the channels and section 8 concludes.

1 Mobile money and quality of tax policy and administration: the arguments

Mobile money can influence the quality of the tax system, i.e., tax policy and administration, in several ways. First, mobile money can improve voluntary tax compliance by taxpayers. Indeed, in most developing countries, not only are tax regimes already very complex and poorly drafted for the taxpayer,[3] but the bureaucratic hassle and long waiting lines to pay tax can also repel even the most loyal taxpayer. This may therefore encourage taxpayers to avoid paying tax (Beck, Lin and Ma 2014) eroding the tax base and reducing the quality of tax policy and administration. By offering the possibility of paying taxes seamlessly and remotely, mobile money can facilitate tax payments, especially for individuals who are always

[2] In this paper, we take advantage of our dependent variable by jointly analysing the quality of tax policy and administration. According to Mansfield (1988) the traditional view of separating tax administration from tax policy does not hold in developing countries. Specifically, the traditional separation of tax administration and tax policy used in the literature is eroded in developing countries, where tax officials/administration decide how (complex) tax legislation should be administered. As a result, since our sample is limited to developing countries, it appears relevant to study the issue of tax administration together with that of tax policy. In addition, tax reforms carried out by international institutions such as the IMF are simultaneously tax policy reforms, such as broadening the tax base and deepening the quality of tax administration (Akitoby *et al*. 2020). A number of authors, including Gillis, Shoup and Sicat (1990); Prichard (2010); Joshi, Prichard and Heady (2014); and Sebele-Mpofu (2020), express this concern about separating tax policy from the tax administration.

[3] Mascagni, Santoro and Mukama 2019.

on the go, and for businesses at locations where normal computer use is not convenient. In addition to the time-consuming procedures for tax compliance, the low tax revenue mobilisation and the pressure of budget constraints can lead tax authorities to introduce new taxes.[4] At the same time, taxpayers faced with a higher number of taxes may feel forced to evade or avoid the tax even more, in a vicious cycle. Accordingly, by providing the opportunity to collect hard taxes (Apeti and Edoh 2023) – determinant for building a strong and sustainable tax system (Besley and Persson 2014; Jensen 2022) – mobile money can reduce the number of new created taxes and increase taxpayer compliance with existing taxes.

Second, mobile money can improve the efficiency of tax revenue mobilisation by reducing the size of the informal or shadow economy/sector. The informal sector is defined as the underground economy and includes any economic activities that are hidden from tax officials or authorities for monetary, regulatory, and institutional reasons. Specifically, the monetary reasons include avoiding paying taxes and any social security contributions (Medina and Schneider 2018). In developing countries, a large part of the economy operates in the informal sector compared to developed countries.[5] Indeed, with an economy dominated by the informal sector, tax administrations are likely to struggle to identify the appropriate tax base for tax policy application as many businesses operate completely outside the tax net (Mascagni and Nell 2022). The negative association that may exist between informality and the tax system is also discussed by Okunogbe and Santoro (2023). For the authors, one of the main obstacles to optimising tax systems is informality, as many individuals and companies operate outside the scope of tax administration. In addition, the existence of an informal economy generates horizontal inequalities and economic distortions that can undermine tax policy and the moral fibre of a society (Okunogbe and Santoro 2023). As pointed out by Jacolin, Keneck Massil and Noah (2021), mobile money payments can reduce the size of the informal sector by increasing productivity and profitability, reducing operational costs of firms, and making commercial transactions more secure, more fluid, and less costly, thus increasing the 'opportunity cost' of staying in the informal sector. In addition, the authors argue that mobile money can reduce informal sector activity by facilitating access to credit, but also indirectly by increasing the performance of formal sector activity – which also benefits from mobile financial services. Thus, by reducing the informal sector and making transactions more transparent, mobile money can improve the efficiency of revenue mobilisation by facilitating taxpayers' identification, reducing opportunities for tax evasion, and broadening the tax base.

Finally, mobile money payments can reduce the scope of corruption among tax officials. In many developing countries the main problem is less the shortcomings of the statute than the means that taxpayers find to evade it. While no tax system is entirely free from corrupt practices, however, it's fair to say that conditions in many developing countries tend to make such practices even more prevalent. Corrupt practices can be seen as leakages, or inefficiencies in the tax system. However, by offering the ability to pay taxes electronically, mobile money payments are likely to reduce the conditions under which petty corruption thrives by reducing, for instance, the physical interaction between taxpayers and collectors, and the frequency of meetings with tax officials and hence incidences of fraud and evasion (IMF 2019; Santoro *et al*. 2023).

Taken together, we assume that the use of mobile money payments can improve the quality of tax policy and administration. Specifically mobile money can improve the quality of tax

4 Piketty 2018; Apeti 2023b.

5 For example, Medina and Schneider (2018) note that the informal sector accounts for more than 50 per cent of the economy of developing countries such as Zimbabwe (60.6 per cent) and Bolivia (62.3 per cent) while remaining below 10 per cent in developed economies including Austria (8.9 per cent) and Switzerland (7.2 per cent).

policy and administration by reducing administrative burdens, the size of the informal sector and the level of corruption.

2 Data

Our analysis covers a panel of 82 developing countries over the period of 2006–2020. Over the study period, 33 out of 82 countries have never adopted mobile money, while the remaining 49 have adopted it. In addition, it should be noted that none of the countries in our sample adopted mobile money prior to the analysis sample. We focus on developing countries because mobile money adoption is specific to them. Because data are not available for all countries and years, the number of observations depends on the choice of explanatory variables. The time period and sample are due to merging variables and missing observations, specifically those related to our dependent variable. Summary statistics of the control variables are presented in Table A7 in the appendix. Variables definition, data sources and the complete list of countries are also provided in the appendix. For our dependent variable, the quality of tax policy and administration, we use the World Bank's Country Policy and Institutional Assessments (CPIA) ratings especially those related to question 14, entitled 'efficiency of revenue mobilisation' (ERM).[6] The ERM assesses the overall pattern of revenue mobilisation, not only the tax structure as it exists on paper, but revenues from all sources, as they are actually collected. It covers tax policy and tax administration. The ratings are determined by members of the World Bank country teams working with each country, although they are reviewed and sometimes revised based on input from staff in the central departments responsible for ensuring consistency across countries and regions. The ERM criteria are divided equally between tax policy and tax administration issues. Tax policy issues include the size of the tax base, the use of trade or other distortionary taxes, the level of tariffs and the number of rates, the number of exemptions, and their transparency. Tax administration issues include collection and compliance rates, collection and compliance costs, the complexity of tax laws and discretionary enforcement, corruption of tax officials, and the existence of effective appeal mechanisms. These performance criteria are relatively uncontroversial and reflect a consensus among tax professionals employed by national tax administrations, international consultancy organisations, and financial institutions, but also members of regional and global professional associations and networks such as the International Tax Dialogue (Fjeldstad and Moore 2008). The variable ranges from 1–6 with 1 being the weakest and 6 the strongest level of the quality of tax policy and tax administration. Our interest/treatment variable is mobile money adoption. We measured mobile money adoption by a dummy variable taking the value 1 from the year that the service is adopted in each country and 0 otherwise.[7] To construct this variable, we based it on GSMA's mobile money deployment tracker to identify the adoption year for each country.[8] According to the GSMA, mobile money refers to the use of mobile phones to access financial services such as savings, credit, money transfers and payments, and to access social support. These services can be used without the need for an internet connection. For further tests, we also use the IMF's FAS database. This contains yearly data on access to and use of financial services, including mobile money.

Concerning covariates used in this paper, we select the control group of units with no mobile money, that is, on average, as similar as possible to the treatment group (i.e., mobile money units) in terms of relevant pre-treatment characteristics. Variables are selected based on

6 See for example for similar approach Knack (2009), Independent Evaluation Group (2010), World Bank (2021).

7 See for instance Kikulwe, Fischer and Qaim 2014; Munyegera and Matsumoto 2016; Riley 2018; Jacolin *et al*., 2021; Apeti and Edoh 2023; Apeti 2023a.

8 https://www.gsma.com/mobilemoneymetrics/#deployment-tracker

previous studies (Della Peruta 2018; Eftimoski and Josheski 2020; Jacolin *et al*. 2021; Apeti 2023a; Apeti and Edoh 2023) and data availability. We control by GDP per capita in logarithm, mobile cellular access, urban population growth, inflation, labour force, and government effectiveness. All these data are collected from World Development Indicators (WDI). We expect a negative correlation between mobile money adoption and GDP per capita as mobile money adoption is a low-cost solution for low-income countries. We expect a positive sign for mobile cellular access as the deployment of mobile money is fundamentally linked to the cell phone market's dynamism. Since mobile money transactions are mainly from urban to rural areas and fulfil a need for distant payments, we expect a positive sign for urban population growth and labour force. However, the correlation between mobile money and inflation could be ambiguous. High inflation periods could incite economic agents to adopt mobile money in order to mitigate the shoe leather cost effect (Apeti and Edoh 2023). In addition, it could also be argued that a healthy economic environment could promote the effectiveness of reforms such as mobile money (Apeti 2023a; Apeti and Edoh 2023). Finally, the correlation between mobile money and government effectiveness can be ambiguous. First, efficient governments, i.e., sound institutions, are able to produce and implement the right policies and provide the necessary public goods that create a good environment for the deployment of mobile money (Jacolin *et al*. 2021). Second, as the literature emphasises, government effectiveness is positively associated with economic development (Alam, Kiterage and Bizuayehu 2017). Finally, as mobile money is a low-cost solution for poor countries, we can also expect a negative correlation between government efficiency and the adoption of mobile money.

3 Methodology

The goal of this paper is to evaluate the relationship between mobile money adoption and the quality of tax policy and administration – measured by the CPIA ERM rating. One potential concern with this analysis is that mobile money adoption is far from being a random feature (see Apeti 2023a; Apeti and Edoh 2023). It may depend on several factors, such as the level of economic performance, level of development, mobile phone deployment, and access to traditional financial services. These factors can also affect the quality of tax policy and administration, thus making mobile money adoption endogenous (not random), through a selection bias. To address this endogeneity issue, we use the entropy balancing method proposed by Hainmueller (2012) following previous studies (e.g., Basri *et al*. 2021; Apeti 2023a; Apeti and Edoh 2023). Entropy balancing is widely used in the literature, including Neuenkirch and Neumeier (2016), to assess the impact of U.S. sanctions on poverty, Ogrokhina and Rodriguez (2019) to assess the effect of inflation targeting on international debt denomination, Caselli and Wingender (2021) to evaluate the effect of fiscal rules, Apeti (2023b) to examine the effect of sovereign debt default on inequality, Apeti and N'Doua (2023) to analyse the trade effect of timber and timber products regulations.

The approach we use in this study is based on the principle that mobile money adoption is the treatment and the ERM rating is the outcome variable. The units of observation are country–year observations. The observations with mobile money are the treatment group and those without mobile money are the control group. The average treatment effect on the treated (ATT) is written as follows:

$$ATT = E[Y_{(1)}|T = 1] - E[Y_{(0)}|T = 1] \qquad (1)$$

where Y (.) denotes the outcome variable measuring the ERM rating. T indicates whether the observation unit is subject to mobile money adoption ($T = 1$) or not ($T = 0$). $E[Y_{(1)}|T = 1]$ is the ERM rating during the mobile money period, $E[Y_{(0)}|T = 1]$ is the counterfactual result for

countries that did adopt mobile money, i.e., what the ERM rating in countries that did adopt mobile money would have been if they had not done so.

The issue is that $E[Y_{(0)}|T = 1]$ is not observable due to the non-random nature of mobile money adoption. If this were the case, the ATT could easily be identified by comparing the ERM rating in mobile money countries with non-mobile money countries. Identifying ATT then requires a good proxy for $E[Y_{(0)}|T = 1]$. Accordingly, we match mobile money units with non-mobile money units that are as close as possible on observable characteristics that meet two criteria: correlated with mobile money and the ERM rating. Hence, we rewrite equation (1) as follows:

$$ATT = E[Y_{(1)}|T = 1, X = x] - E[Y_{(0)}|T = 0, X = x] \quad (2)$$

where $X = x$ are the observable joint determinants of mobile money adoption and the ERM rating, $E[Y_{(1)}|T = 1, X = x]$ is the ERM rating of mobile money units, and $E[Y_{(0)}|T = 0, X = x]$ is the expected ERM rating for the (synthetic) control units. Estimating the ATT by entropy balancing involves two steps. The first is to compute exact weights (for the non-treated group) such that a set of desired pre-treatment characteristics of the non-treated group match those of the treated group and choose the set of weights that achieves balance that minimally deviates from uniform weights. Specifically, by using entropy balancing, observations are reweighted with respect to the treatment so that all the relevant covariates are balanced (i.e., they have the same mean). In econometric terms, entropy balancing reweights the observations to statistically generate a group of countries where the treated and control groups are comparable on structural covariates. This is possible by directly incorporating covariate balance into the weight function that is applied to the sample units.[9] The second step uses the weights computed in the first step in a regression analysis where the ERM rating is the dependent variable. In the second step, we control for the covariates employed in the first step. This is equivalent to including control variables in a randomised experiment and increases estimation efficiency. In addition, in order to further account for sources of countries' heterogeneity or time-specific effects, we include year and country effects. Hence, by combining both a matching and regression approach, this method offers some advantages over several existing methods (Neuenkirch and Neumeier 2016). A particularly important advantage is that entropy balancing is non-parametric in the sense that no empirical model for either the outcome variable or selection into treatment needs to be specified. Hence, potential types of misspecifications like those, for instance, regarding the functional form of the empirical model, which likely leads to biased estimates, are ruled out. Also, in contrast to regression-based analyses, treatment effects estimates based on entropy balancing do not suffer from multicollinearity, as the reweighting scheme orthogonalises the covariates with respect to the treatment indicator. Relative to other weighting approaches, entropy balancing ensures a high covariate balance between the treatment and control group even in small samples. Specifically, entropy balancing weights minimise the entropy distance metric subject to moments constraints for each covariate and balancing constraints that ensure that all weights are positive and sum up to unity. Accordingly, the control group is comprised of only a subset of the units that are not subject to treatment (Hainmueller 2012; Diamond and Sekhon 2013). In other words, with conventional matching methods, each untreated unit either receives a weight equal to 0, in the event it does not represent the best match for a treated unit, or equal to 1, in the event it does represent the best match for one treated unit. However, when the number of untreated units is limited, and the number of pre-treatment characteristics is large, this procedure does not guarantee a sufficient balance of pre-treatment characteristics across the treatment and control groups. This is a serious

[9] This procedure ensures that once the weights are generated, mobile money and non-mobile money countries exhibit similar trends in their outcome variable over the pre-treatment period (Ogrokhina and Rodriguez 2019). However, later in the paper, we highlight an event study analysis that traces the pre-treatment trend and visualises the pre-treatment situation (section 5.3).

problem, as a low covariate balance may lead to biased treatment effect estimates. In contrast, with entropy balancing, the vector of weights assigned to the units not exposed to treatment is allowed to contain any non-negative values. Thus, a control group is designed that represents a virtually perfect image of the treatment group. Entropy balancing thus can be interpreted as a generalisation of conventional matching approaches.[10] Also, compared to conventional matching where the control units are either discarded or matched, entropy balancing uses more flexible reweighting schemes. Specifically, it reweights units with the goal of achieving a balance between treated and untreated while keeping the weights as close as possible to the base weights to avoid a loss of information. Finally, by combining a reweighting scheme with regression analysis, entropy balancing allows us to properly address the panel structure of our data by including time and country fixed effects.

However, despite the various advantages of this method, it is important to note that this approach may have some limits. Indeed, entropy balancing may fail to control the potential endogeneity biases resulting from unobserved time-varying factors that may affect both mobile money and the ERM rating, and on the other hand, it may fail to successfully deal with the inertia of ERM rating (see Apeti 2023a; Apeti and Edoh 2023). Therefore, we test the robustness of our results, by completing the entropy balancing method by the Ordinary Least Squares (OLS), the two-step system-GMM estimator and an event study approach.

4 Results

4.1 Descriptive statistics and covariate balance

Table 1 computes the mean values of our control variables before and after weighting for country–year observations for the treatment group column 1 and the control group column 2. Column 3 reports the differences across the groups and their statistical significance. As we can see, mobile money units differ significantly from no mobile money units with respect to all pre-treatment characteristics. Compared to the control group, mobile money countries are characterised by i) lower real GDP per capita, ii) higher mobile cellular subscription, iii) higher urban population growth, iv) lower inflation rate, v) lower government effectiveness, and vi) higher level of labour force. These statistics show the importance of selecting an appropriate control group in order to avoid spurious treatment effect estimates.

Columns 4, 5 and 6 present the mean values after weighting between the treatment and the control groups. Comparing the average pre-treatment characteristics of the treatment group to those of the control group reveals the efficacy of entropy balancing as all the covariates are perfectly balanced and the statistically significant difference in mean values between the two groups disappears. Importantly, entropy balancing allows us to construct a perfect control group that is closely similar to mobile money countries in terms of the mean values of the pre-treatment covariates.

Finally, we present a test for comparison of means of the ERM rating between mobile money and non-mobile money groups. For mobile money countries, the average ERM rating is 3.47 and that of the control groups is 3.40 with a difference of 0.07– statistically significant at 5 per cent level. This relationship, while not causal, provides a picture of the treatment effect of mobile money adoption.[11]

[10] Hainmueller (2012), using Monte Carlo simulations as well as empirical applications, demonstrates that entropy balancing outperforms other matching techniques, such as propensity score matching, nearest neighbour matching, and genetic matching, in terms of estimation bias and mean square error.

[11] These results are not reported in the paper but are available on request.

Table 4.1 Descriptive statistics before and after weighting

	[1] Mobile money	[2] No mobile money	[3] Difference
Lag GDP per capita (log)	7.144	7.442	0.298***
Lag mobile cellular	76.34	54.88	-21.46***
Lag urban population growth	3.262	2.632	-0.63***
Lag inflation	5.522	7.507	1.985***
Lag government effectiveness	-0.7369	-0.6711	0.0658*
Lag labour force	67.86	66.33	-1.53**
Observations	522	382	
	[4] Mobile money	[5] No mobile money	[6] Difference
Lag GDP per capita (log)	7.144	7.144	0
Lag mobile cellular	76.34	76.34	0
Lag urban population growth	3.262	3.262	0
Lag inflation	5.522	5.522	0
Lag government effectiveness	-0.736	-0.736	0
Lag labour force	67.86	67.86	0
Observations	522	382	
Total of weights	522	522	

Source: Authors' own from collected data.
Note: *** p<0.01, ** p<0.05, * p<0.1.

4.2 Baseline results

Table 4.2 shows the main results of this analysis. We estimate several models as from equation 2 with weights from entropy balancing using the weighted least squares. In column [1], we show the estimates without controls and country and time fixed effects. Then, in column [2] without controls but with both country and time fixed effects. Finally, in column [3] we show our baseline specification that includes all matching covariates used in the first step as well as country and year fixed effects. Results indicate that the effect of mobile money on ERM rating is positive and statistically significant at just 1 per cent. Specifically, adopting mobile money increases the ERM rating on average by 0.106 in mobile money countries compared to non-mobile money countries. This result is economically meaningful as it represents 21.63 per cent of the standard deviation (0.49) of the ERM rating in our sample.

Table 4.2 Mobile money and ERM: baseline results

	[1] ERM rating	[2] ERM rating	[3] ERM rating
Mobile money	0.169***	0.091***	0.106***
	(0.0503)	(0.0246)	(0.0232)
Control mean	3.41	3.41	3.41
Baseline covariates	No	No	Yes
Year fixed effect	No	Yes	Yes
Country fixed effect	No	Yes	Yes
Observations	816	816	816

Source: Authors' own from collected data.
Note: Unreported constant included. Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

5 Robustness checks

5.1 Alternative specification

This section tests the robustness of our results in several dimensions. First, we tested whether our results remain valid by excluding some periods and countries from our sample. We started by excluding countries that are qualified as tax havens for counterfactual reasons (Apeti and Edoh 2023). These countries, which can be described as non-cooperative, compete internationally through favourable tax legislation. Second, we excluded countries with a colonial history as colonisation may shape fiscal capacity or tax performance (Cogneau, Dupraz and Mesplé-Somps 2021), which could bias our results. Third, we excluded the global financial crisis (GFC) to isolate its potential impact, and resource-rich countries to control the natural resources curse that leads to low tax performance in these countries. Fourth, we made some alterations to our dependent variable, ERM rating, by excluding any major changes in the ERM rating – an increase in ERM above the sample mean value or two standard deviations[12] – the top and the bottom 10 per cent of ERM. Five, we excluded the period after the Addis Ababa conference, i.e., years after 2015,[13] because since this conference many developing countries have implemented tax policy and tax administration reforms that could in turn bias our results. The results are presented in Table A1 (columns 1–9) in the appendix and show that our results remain robust. Second, in order to make sure that our estimates capture the real effect of mobile money, we perform two sets of falsification tests reported in Table A2 in the appendix. First, in column [1], we define placebo or arbitrary dates for mobile money adoption by randomly assigning an adoption date to the countries in our sample.[14] Second, in columns 2–6, we define placebo dates for our mobile money variable by computing a treatment variable that incorrectly assigns the mobile money start date before the actual start date, i.e., one to five years prior to the actual mobile money adoption date of each country in the sample. The intuition is that if our estimates are due to mobile money, the use of these placebo dates should have no statistically significant impact on the ERM rating. Our estimates using these placebo measures are reported in columns 1–6 of Table A2. As expected, we find no statistically

12 The standard deviation approach assumes that a major upward change in the ERM occurs for a given country at a given point in time when the annual change in the ERM rating exceeds by two standard deviations the average annual change over all observations, i.e., exceeds 0.99 (see Furceri and Loungani 2018 for a similar exercise).

13 https://www.oecd.org/dac/financing-sustainable-development/ffdandtheoecd.htm

14 Apeti 2023a; Apeti and Edoh 2023.

significant effect of our placebo measures on the ERM rating. These results suggest that our results are indeed robust, especially regarding measurement error.

As a third robustness exercise, we show that our results are robust when we use a continuous variable for mobile money. Indeed, the use of a dummy variable in a cross-country analysis does not take into account mobile money deployment and the intensity of its use. In order to overcome this issue, we follow Apeti (2023a) and use the number of active mobile money accounts per population from the IMF's FAS. We then re-estimate our effect using the two-step system-GMM (Blundell and Bond 1998) to control for the potential endogeneity problem. Column 2 of Table A3 in the appendix shows that changing the measure of the treatment variable (from binary to continuous) does not alter the direction of our initial results.

Fourth, a possible concern in estimating the effect of mobile money is that the results could be biased due to potential omitted variables affecting the quality of tax policy and administration that is, at the same time, correlated with mobile money. Accordingly, we check the robustness of our results by including a set of additional control variables that can potentially impact both the ERM rating and mobile money. Specifically, we include rule of law, corruption, financial development, foreign direct investment (FDI), remittances, official development assistance (ODA), resource rents, population density, agriculture, internet, economic globalisation, and GDP growth.[15] The results of this exercise are presented in Table A4 (columns 1–13) and support a statistically significant effect of mobile money on ERM rating.

Finally, we control for country-specific time trends. Indeed, controlling for country-specific linear time trends allows us to remove distinctive trends in the ERM in individual countries that might otherwise bias our estimates if they accidentally coincided with other mobile money related changes.[16] Results compiled in column 14 of Table A4 in the appendix show that our baseline result remains robust.

5.2 Alternative estimation methods

To ensure that our findings are independent of the chosen estimator, we further compute the effects of mobile money on ERM rating using panel fixed effects, system-GMM and event study approach.

Table A5 (column 1) in the appendix reports the estimation of panel fixed effects. As can be seen, the results are broadly consistent with the main results presented in the paper. Then, we augment our baseline specification with additional control variables borrowed from the literature.[17] The results are presented in columns 2–14 of Table A5 in the appendix. We find that the effect of mobile money on ERM is still positive and statistically significant.

Second, we use the Blundell and Bond (1998) two-step system-GMM dynamic panel estimator. This method provides us with two major opportunities. First, it allows us to include the lagged ERM in the control variables, which allows us to control the relatively high inertia that can characterise the ERM rating variable. Second, it addresses the lack of valid external instruments for estimating the effect of mobile money on ERM rating while controlling for the Nickell bias (Nickell 1981) that arises when estimating a dynamic panel with fixed effects. Results presented in column 1 of Table A3 in the appendix show that the effect of mobile money on ERM rating is still positive and statistically significant at 10 per cent level, with a coefficient close to our baseline estimate. Concretely, mobile money increases ERM rating by

15 Discussion of additional control variables can be found in the appendix.

16 See Saka, Eichengreen and Aksoy (2022) or Apeti and Edoh (2023) for a similar exercise.

17 These variables are also used in the robustness section of the entropy balancing approach.

0.190. In addition, results show some persistence of ERM rating over time as the lag ERM is positive and statistically significant with a coefficient of 0.67.[18]

5.3 Mobile money and ERM rating: event study approach

Our baseline results show that mobile money adoption improves the quality of tax policy and administration using the entropy balancing method. In this section, we test the robustness of our results using an event study approach. To do this, we combine the entropy balancing approach with an event study specification over a window of five years before mobile money adoption and ten years after it. The event study specification allows us to explore pre-trends and the impact of mobile money over time, rather than looking at an average effect, as shown in the previous studies (Rubolino 2023; Miller 2023). The results are reported in Figure 5.1. Two main findings emerge from the figure. First, we observe that, prior to the adoption date, there is no evidence for a pre-trend.[19] Moreover, a joint exclusion test of the pre-trend coefficients supports this notion for the estimation presented in Figure 5.1, i.e., statistically non-significant coefficients before mobile money adoption.[20] This evidence indicates a parallel trend between the two groups since the effect is statistically non-significant in the pre-adoption episodes.[21] In contrast, after the adoption date, we observe that the effect of mobile money steadily increases over time. This conclusion supports the results previously discussed: the adoption of mobile money improves the quality of tax policy and administration.

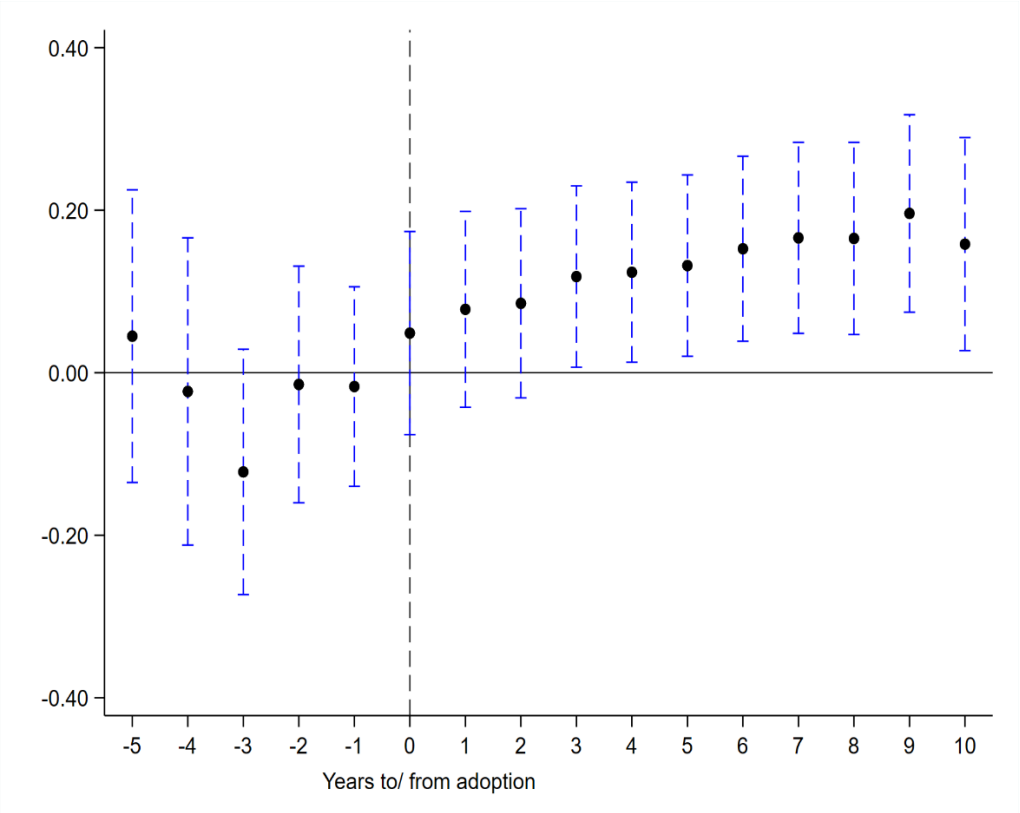
[18] We also use the ordered probit method to test the robustness of our result. Indeed, in the sample, the ERM rating takes on one of six different values, i.e., between 1 and 6, and is technically an ordinal rather than interval measure. Indeed, each half-point increment in value indicates a more efficient tax policy and administration, but an increase from, for example, 3 to 3.5 is not necessarily equivalent in any meaningful sense to an increase from 3.5 to 4. Results not reported but available on request provide similar conclusions to our baseline findings.

[19] This result also supports the findings of the previously reported placebo tests, which highlighted that before mobile money, there was no statistically significant difference in the quality of tax policy and administration between mobile money and non-mobile money countries.

[20] The Fisher test statistics and p-value are 1.10 and 0.357, respectively.

[21] Note that the absence of statistical significance over the pre-treatment period suggests the existence of spurious correlations between our dependent variable and mobile money (Schulz 2022).

Figure 5.1 Mobile money and ERM rating: event study



Source: Authors' own from collected data.

6 Heterogeneity

6.1 The types of mobile money services

In this section, we estimate the effect of different types of mobile money services on ERM rating. We disaggregate the mobile money variable into seven main types of mobile money services, namely: person-to-person (P2P) transfer, person-to-government (P2G) transfer, airtime transaction, merchant payment, international remittances, bill payment, and bulk payment. Given the specificity of each service with respect to transactions, we assume that the effect of mobile money may depend on the type of service. For example, using mobile money instead of cash for P2G transactions has the potential to reduce fraud and increase transparency and revenues for tax authorities. The ability for an official to demand a payment and to dictate that such a transaction take place in cash opens a space for corruption and decreases the likelihood of the official being identified or prosecuted.[22] Bill payment and bulk payment[23] could enable tax authorities to reach a large number of citizens and businesses and thus monitor the taxpayer's tax liability, such as professionals difficult to tax like doctors, lawyers, and architects, among others (Okunogbe and Santoro 2023). However, it is important to stress that the effectiveness of services for tax authorities depends on data sharing between tax officials and mobile money operators, which is a huge challenge in

[22] https://www.gsma.com/mobilefordevelopment/programme/mobile-money/paying-taxes-through-mobile-money-initial-insights-into-p2g-and-b2g-payments/

[23] Bill payment is a payment made by a person from either their mobile money account or over the counter to a biller or billing organisation via a mobile money platform in exchange for services provided, while bulk payment is a payment made by an organisation via a mobile money platform to a person's mobile money account.

developing countries. In addition, international remittances via mobile money services, by easing access to remittances, would help relax financial constraints on households/firms, thereby limiting tax evasion or increasing tax compliance (Alm, Liu and Zhang 2019; Bachas, Jaef and Jensen 2019) and ultimately improving the quality of tax policy and administration. Therefore, we estimate the effect of each type of service on ERM rating using our baseline empirical approach. The results are reported in Table 6.1 (columns 1–7). We find that the effect of mobile money services on ERM rating is positive and statistically significant independent of the type of service. In addition, we observe some relative variations in the coefficients according to the type of mobile money, corroborating our intuition. For example, we find that the effect of merchant payment services is much larger than that of other services. Merchant payments are transactions between merchants, or between merchants and customers, made with the mobile money platform in exchange for goods or services. Bernad *et al*. (2023) note that this type of service is beneficial for tax authorities in fostering tax compliance. Merchant payments provide consumers with access to safer, faster, and more formal payments, which stimulates business growth and leaves a digital record of sales data that can be accessed and used by tax authorities to monitor and enforce tax compliance (Okunogbe and Santoro 2022).

Table 6.1 Mobile money and ERM rating: type of mobile money

ERM rating	[1]	[2]	[3]	[4]	[5]	[6]	[7]
P2P transfer	0.078***						
	(0.0245)						
P2G transaction		0.063*					
		(0.0329)					
Airtime top-up transaction			0.082***				
			(0.0244)				
Merchant payment				0.099***			
				(0.0249)			
International remittances					0.078***		
					(0.0260)		
Bill payment						0.072***	
						(0.0245)	
Bulk payment							0.062**
							(0.0278)
Control mean	3.41	3.41	3.41	3.41	3.41	3.41	3.41
Baseline covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	816	816	816	815	816	816	816

Source: Authors' own from collected data.
Notes: Unreported constant included. Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

6.2 Structural factors

In this section, we explore some potential heterogeneity in the relationship between mobile money and the ERM rating. To ease interpretation, we report all the results in Figure 6.1.

First, we analyse the sensitivity of our results to the level of development. Since emerging countries already have access to a variety of payment methods, we assume that mobile money would be less effective in emerging countries than in developing/low-income countries. Consequently, we interact our binary mobile money variable with countries' level of development measured by real GDP per capita, then we re-estimate the effect of mobile money using the interaction term. We illustrate the result in graph (a) of Figure 6.1. We find that the effect of mobile money decreases with the level of development (i.e., high GDP per capita). Moreover, the effect becomes non-statistically significant when the level of development of countries is high, which supports our hypothesis.

Second, countries with a high level of financial development would be less interested in mobile money because they have extensive formal financial services. Consequently, we assume that mobile money would be less effective in countries characterised by high financial development. We test this hypothesis in graph (b) of Figure 6.1. Indeed, mobile money is less effective in high financial development situations as the effect decreases with the level of financial development and becomes non-statistically significant.

Third, we test the effect of mobile money regarding state legitimacy. Indeed, digital financial services such as mobile money can improve the quality of institutions by reducing corruption, for example. Therefore, the marginal effect of mobile money would be more important in low institutional quality environments (i.e., high state legitimacy index in our case). Graph (c) in Figure 6.1 shows that the effect is greater when the state legitimacy is low.

Fourth, we assess whether our results can be influenced by the fiscal space proxied by public debt.[24] Our hypothesis is that countries with high public debt will have more incentive to mobilise domestic resources to meet their debt or fill the international financial market access gap by improving the quality of their tax policy and administration. Considering that these countries can rely on the use of digital financial services like mobile money, we assume that its effect would be greater when the level of public debt is high. Graph (d) in Figure 6.1 suggests that the effect of mobile money increases with the level of public debt, i.e., when the level of public debt is high, the effect becomes bigger.

Fifth, we consider the number of mobile money company/operators available in each country. Indeed, we assume that when there is a large number of mobile money operators in a country, this indicates the existence of competition that can benefit the consumer and provide broader access to digital payment services to the population, thus amplifying the effect of mobile money on the ERM rating. To test this, we construct a variable that sums up the number of operators available per country–year i.e., the variable takes 0 when there is no mobile money, 1 when the country has one operator, 2 if the country has two operators, and so on. Then, we re-estimate the effect by interacting our mobile money binary variable with the number of operators per country. The result illustrated in graph (e) shows that the effect of mobile money significantly increases with the number of mobile money operators available.

6.3 Sub-Saharan Africa versus the rest of the world

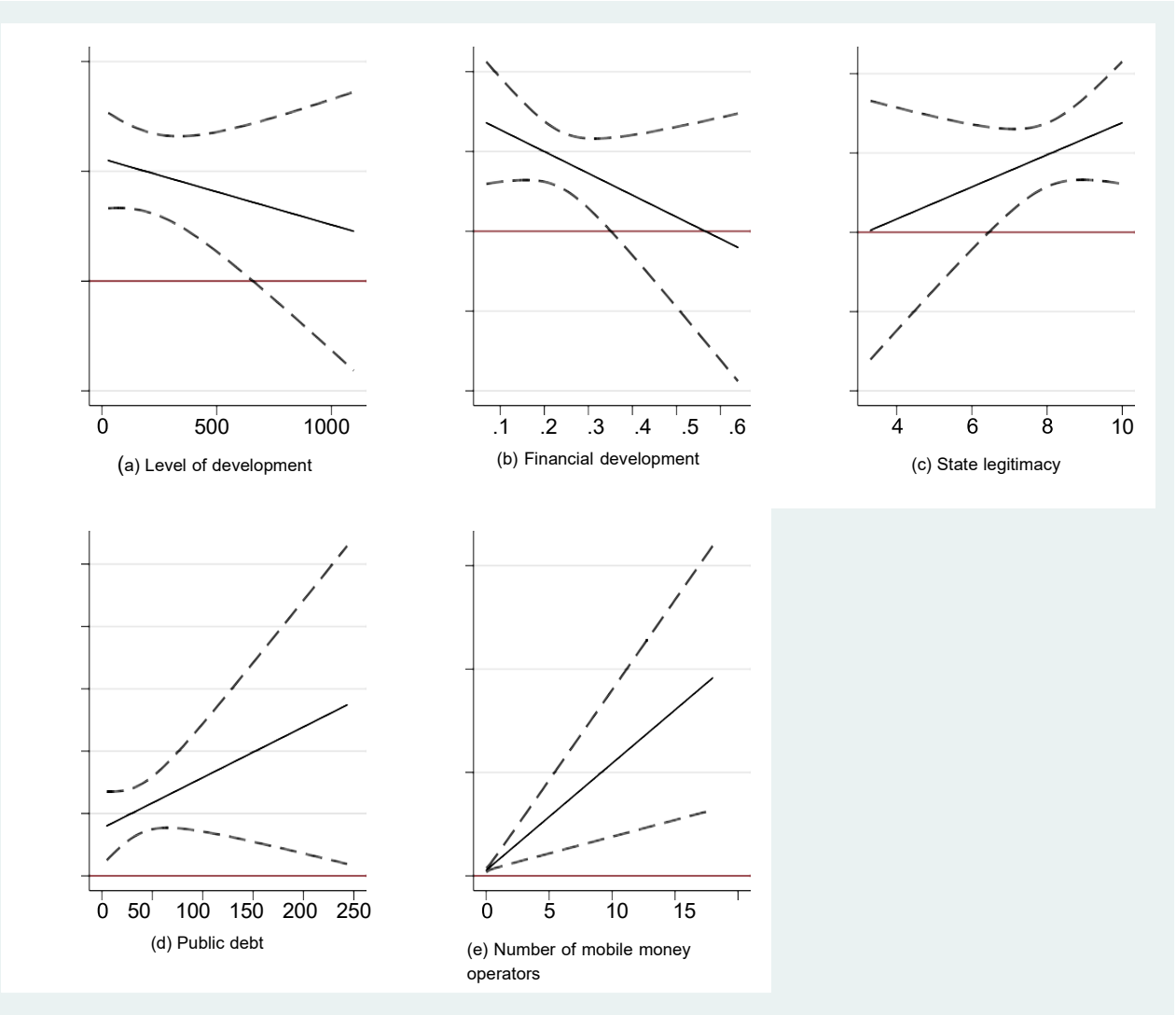
In this section, we analyse whether the effect of mobile money depends on countries' geographical location. To do this, we examine the effect of mobile money according to sub-Saharan African (SSA) countries compared to the other countries in the sample. In other words, we split our sample into two (SSA countries vs. the rest of the world) and re-estimated our effects on each sub-sample.

[24] Apeti *et al*. (2021).

SSA countries are often characterised by weak tax administration and policy. This is particularly due to the predominance of informality in these regions, the strong preference for cash which limits the government's ability to identify transactions/tax base, the low quality of institutions and also the complexity of tax policy, which increases the compliance burden on taxpayers.[25] In addition, mobile money innovations are particular to African countries as Africa is the hotbed for innovation and growth of mobile money. The perfect example is Kenya, where mobile money has been a real success since its launch in 2007.

We assume that mobile money, which can alleviate these burdens that block the efficiency of tax policy and administration, could have a larger effect in SSA regions. We test this hypothesis by comparing the effect of mobile money in SSA to the rest of the countries in our sample. The result of this exercise is compiled in Table 6.2. We find that mobile money increases ERM rating regardless of the region considered. However, the effect is larger for SSA countries compared to the rest of the countries (outside SSA) in our sample, thus supporting our intuitions.[26]

Figure 6.1 Mobile money and ERM rating: structural factors



Source: Authors' own from collected data.

[25] This is particularly relevant for small taxpayers in SSA, who typically face higher compliance costs (Santoro *et al*. 2023).

[26] Note that we do not present the results of this exercise graphically as in the previous exercises because we use a dummy variable that takes 1 when the country is a SSA country and 0 otherwise. In addition, we do not make a more granular breakdown of regions outside of SSA due to data constraints.

Table 6.2 Mobile money and ERM rating: by geographic location

	[1] Outside SSA	[2] SSA
Mobile money	0.094***	0.128***
	(0.0359)	(0.0299)
Control mean	3.51	3.26
Baseline covariates	Yes	Yes
Year fixed effect	Yes	Yes
Country fixed effect	Yes	Yes
Observations	374	442

Source: Authors' own from collected data.
Notes: Unreported constant included. Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

7 Channels

As discussed in section 1, three main channels may drive the positive effect of mobile money on ERM rating: i) lower tax compliance costs that we measure by time to prepare and pay taxes and the number of tax payments, ii) lower informal sector and iii) lower corruption. In this section, we test these channels in Table 7.1. The results suggest that mobile money significantly decreases the tax compliance burden (i.e., time to prepare and pay taxes and the number of tax payments), the informal sector, and corruption. These results thus validate our three main channels and show that the favourable effect of mobile money on the ERM rating can be driven by the reduction of compliance burdens, the reduction of the informal sector, and corruption.[27]

Table 7.1 The effect of mobile money on ERM rating: transmission channels

	[1] Time to prepare and pay taxes	[2] Number of tax payments	[3] Informal sector	[4] Corruption
Mobile money	-19.203***	-2.527***	-0.702***	-0.024**
	(5.4696)	(0.9092)	(0.1808)	(0.0100)
Control mean	273	37.43	37.77	0.67
Baseline covariates	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
Country fixed effect	Yes	Yes	Yes	Yes
Observations	746	818	637	867

Source: Authors' own from collected data.
Notes: Unreported constant included. Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

[27] The corruption used in this paper is the political corruption index from V-Dem dataset. The results presented in Table A6 (columns 1 and 3–6) in the appendix use alternative definitions of corruption namely: public sector corruption, bribe payment, firms visited or required meetings with tax officials ('visit to tax officials'), firms expected to give gifts in meetings with tax officials ('gift to tax officials'), and informal payments to tax officials ('informal payments'). The evidence presented is consistent with that previously established: mobile money reduces corruption. In other words, we find that mobile money decreases bribe payment, public sector corruption, firms visited or required meetings with tax officials, firms expected to give gifts in meetings with tax officials, and informal payments to tax officials. Finally, the informal sector is used as a measure of the size of the tax base. Following Apeti (2023b) and Apeti and Edoh (2023), we use GDP as an alternative measure of tax base. Column 2 of Table A6 shows similar results to the previous ones: mobile money increases GDP and thus broadens the tax base.

8 Conclusion

Digital financial services are increasingly prevalent in developing countries as they have become essential components of broader tax reform, tax administration modernisation, and domestic revenue mobilisation efforts. In this paper, we examine the relationship between mobile money and the quality of tax policy and administration captured by the ERM rating in developing countries using the entropy balancing method. Based on a panel of 82 countries and data covering 2006–2020, we find that mobile money is associated with a statistically significant increase in the quality of tax policy and administration. In particular, we find that, on average, the use of mobile money typically increased the quality of tax policy and administration by 0.106. This effect is economically significant given that ERM rating changes very slowly over time, and it corresponds to 21.63 per cent of the standard deviation of the ERM rating. This finding is robust to several alternative specifications including sample alteration, alternative definitions of the treatment variable, the inclusion of additional control variables, and the use of alternative estimation methods. In addition, our results provide some heterogeneity depending on the level of development, the level of financial development, the legitimacy of the state, fiscal space, i.e., public debt, the type of mobile money services, the number of mobile money products/companies, and the geographical location of countries in our sample. Finally, consistent with the positive impact of mobile money on ERM rating, we provide evidence that lower compliance costs, lower informal sector, and lower corruption are the main channels through which mobile money improves ERM rating.

The above findings shed additional light on the role of digital payments in shaping tax policy and administration in developing countries. At a time when tax authorities in developing countries are increasingly looking to take advantage of digital payment solutions, this paper may have some economic policy implications for their governments or tax authorities. First, digital payments allow developing countries to improve access to or/and usage of taxpayers' data, including data from third parties and transaction data. Consequently, mobile money reduces administrative costs and enhances the efficiency of data management systems and processes. Second, by offering the ability to pay taxes digitally, mobile money simplifies the tax payment process and reduces the tax compliance burden. Thirdly, mobile money can help limit opportunities for corruption and collusion by making data more transparent.

Despite the promise or opportunity, the use of digital payment instruments as tools for developing an effective tax system has certain challenges that policymakers must address. First, data sharing between telecommunication companies and tax administrations has not yet been fully established. Indeed, collaboration between tax authorities and mobile network operators regarding information sharing remains a challenge. Accordingly, collaboration between tax authorities and mobile network operators seems necessary to facilitate data sharing and support tax policy and administration in developing countries. Second, it is also obvious that the lack of appropriate infrastructure can hinder the effective deployment of mobile money. Therefore, this paper calls for governments' support of telecommunication companies to ensure better deployment of mobile money in order to maximise its economic and fiscal effects. Third, as discussed by Okunogbe and Santoro (2022) and Santoro *et al*. (2023), users – taxpayers and tax officials – may avoid the introduction of new technology or actively resist it due to lack of training, high adoption costs, or loss of opportunity for informal behaviour. Accordingly, appropriate communication strategies and regulatory frameworks are needed to facilitate digital and tax literacy and the use of digital payments for tax purposes. Finally, the optimistic view of the impact of digital infrastructure on the quality of tax policy and administration may be less trivial. Indeed, instead of reducing corruption to support an efficient tax system, digital tools may provide corruption opportunities to tax officials. Specifically, digital records and public service systems can be manipulated by corrupt officials with high IT skills (IMF 2019), thus undermining the effect of digital tools like mobile

money on the quality of tax policy and administration. Consequently, policies need to be developed within tax administrations to reduce the use of digital tools as a ‘new’ tool for corruption by (technically skilled) tax officials who have likely lost the opportunity of rent-seeking and corruption involving taxpayers.

Appendices

Appendix 1 Additional tables

Table A1 Mobile money and ERM rating: altering the sample

	[1] Excluding tax haven	[2] Excluding colonial past	[3] Excluding GFC	[4] Excluding resource-rich countries	[5] Excluding high change in ERM (mean)
Mobile money	0.092***	0.136***	0.106***	0.124***	0.093***
	(0.0238)	(0.0303)	(0.0235)	(0.0275)	(0.0228)
Baseline covariates	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes
Country fixed effect	Yes	Yes	Yes	Yes	Yes
Observations	764	447	696	518	776

	[6] Excluding top 10% of ERM	[7] Excluding bottom 10% of ERM	[8] Excluding high change in ERM (standard deviation)	[9] Excluding Addis Ababa conference
Mobile money	0.068***	0.105***	0.101***	0.057**
	(0.0252)	(0.0243)	(0.0236)	(0.0274)
Baseline covariates	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
Country fixed effect	Yes	Yes	Yes	Yes
Observations	598	733	810	491

Source: Authors' own from collected data.
Notes: Unreported constant included. Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table A2 Mobile money and ERM rating: falsification exercise

	[1]	[2]	[3]	[4]	[5]	[6]
Placebo mobile money	0.010					
	(0.0122)					
Placebo mobile money (t-1)		-0.008				
		(0.0131)				
Placebo mobile money (t-2)			0.010			
			(0.0140)			
Placebo mobile money (t-3)				-0.012		
				(0.0141)		
Placebo mobile money (t-4)					-0.014	
					(0.0131)	
Placebo mobile money (t-5)						-0.006
						(0.0132)
Control mean	3.40	3.40	3.40	3.40	3.40	3.40
Baseline covariates	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	815	642	638	640	642	632

Source: Authors' own from collected data.
Notes: Unreported constant included. Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table A3 Mobile money and ERM rating: system-GMM

	[1] System-GMM	[2] System-GMM
Lag efficiency of revenue mobilisation rating	0.677***	0.736***
	(0.1371)	(0.1027)
Mobile money	0.190*	
	(0.0978)	
Log mobile money account (% population)		0.041*
		(0.0240)
Log GDP per capita	-0.061	-0.037
	(0.1097)	(0.0851)
Mobile cellular	0.001	0.001
	(0.0015)	(0.0011)
Urban population growth	-0.018	-0.001
	(0.0210)	(0.0350)
Inflation	0.001	0.002
	(0.0014)	(0.0017)
Government effectiveness	0.240**	0.186*
	(0.1006)	(0.0952)
Labour force	0.005	0.006
	(0.0048)	(0.0053)
Fixed effects	Yes	Yes
AR(1)/AR(2) p-value	0.000/0.406	0.003/0.136
Hansen test p-value	0.827	0.685
Number of instruments/number of countries	38/69	38/60
Observations	812	529

Source: Authors' own from collected data.
Notes: Unreported constant included. Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1, control mean:3.41.

Table A4 Mobile money and ERM rating: additional control

	[1]	[2]	[3]	[4]	[5]	[6]	[7]
	Rule of law	Corruption	Financial development	FDI	Remittances	ODA	Natural resources rents
Mobile money	0.109***	0.105***	0.112***	0.106***	0.105***	0.112***	0.105***
	(0.0230)	(0.0231)	(0.0235)	(0.0234)	(0.0244)	(0.0229)	(0.0234)
Control mean	3.41	3.41	3.41	3.41	3.41	3.41	3.41
Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	816	816	747	815	788	813	807
	[8]	[9]	[10]	[11]	[12]	[13]	[14]
	Population density	Agriculture	Internet	Economic globalisation	Growth	All covariates	Time trend
Mobile money	0.103***	0.109***	0.109***	0.090***	0.102***	0.096***	0.116***
	(0.0235)	(0.0234)	(0.0229)	(0.0236)	(0.0233)	(0.0250)	(0.0235)
Control mean	3.41	3.41	3.41	3.41	3.41	3.41	3.41
Baseline covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	No
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	768	802	789	740	815	663	816

Source: Authors' own from collected data.
Notes: Unreported constant included. Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1. FDI= Foreign direct investment, ODA= official development assistance.

Table A5 Mobile money and ERM rating: additional control (OLS)

ERM rating	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]
Mobile money	0.056**	0.056**	0.056**	0.059**	0.055**	0.057**	0.056**	0.057**	0.056**	0.056**	0.060**	0.045*	0.058**	0.058**
	(0.0259)	(0.0259)	(0.0259)	(0.0253)	(0.0263)	(0.0269)	(0.0256)	(0.0261)	(0.0258)	(0.0265)	(0.0266)	(0.0259)	(0.0257)	(0.0277)
Rule of law		-0.003												-0.083
		(0.0776)												(0.0859)
Corruption			0.029											0.072
			(0.0698)											(0.0806)
Financial development				-0.324										-0.525
				(0.2886)										(0.3230)
FDI					0.000									-0.000
					(0.0006)									(0.0008)
Remittances						0.001								-0.000
						(0.0022)								(0.0028)
ODA							0.001							0.002
							(0.0014)							(0.0018)
Natural resources rents								-0.004***						-0.007***
								(0.0014)						(0.0017)
Population density									-0.000					-0.000
									(0.0003)					(0.0003)
Agriculture										0.001				-0.001
										(0.0026)				(0.0032)
Internet											-0.002			-0.000
											(0.0016)			(0.0017)
Economic globalisation												0.009***		0.012***
												(0.0030)		(0.0030)
Growth													-0.001	-0.000
													(0.0016)	(0.0023)
Control mean	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41
Baseline covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	816	816	816	747	815	788	813	807	768	802	789	740	815	663

Source: Authors' own from collected data.
Notes: Unreported constant included. Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table A6 Mobile money and ERM rating: additional channels

	[1] Bribe	[2] GDP (log)	[3] Public sector corruption	[4] Visit to tax officials	[5] Gift to tax officials	[6] Informal payments
Mobile money	-10.227**	0.016**	-0.021*	-13.813***	-10.382***	-21.806***
	(4.1206)	(0.0061)	(0.0112)	(2.8809)	(3.7705)	(6.9670)
Baseline covariates	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	118	844	867	117	118	118

Source: Authors' own from collected data.
Notes: Unreported constant included. Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table A7 Descriptive statistics of baseline variables

Variable	Obs.	Mean	Std. Dev.	Min	Max
Mobile money	904	0.577	0.494	0	1
ERM rating	816	3.448	0.497	2	4.5
Real GDP per capita (log)	903	7.289	0.807	5.600	9.303
Mobile cellular	898	72.451	35.579	0.499	181.328
Urban population growth	904	2.984	1.622	-3.375	6.252
Inflation	880	6.596	14.015	-8.974	379.999
Government effectiveness	830	-0.710	0.545	-2.353	0.876
Labour force	845	67.136	10.943	38.390	90.340

Source: Authors' own from collected data.

Table A8 Country list

Afghanistan	Eritrea	Malawi*	Sri Lanka*
Albania*	Ethiopia	Maldives	St Lucia
Angola	Fiji*	Mali*	Sudan
Armenia*	Gambia, The*	Mauritania*	Tajikistan*
Azerbaijan	Georgia*	Moldova	Tanzania*
Bangladesh*	Ghana*	Mongolia*	Timor-Leste
Benin*	Grenada	Mozambique*	Togo*
Bhutan	Guinea*	Myanmar*	Tonga
Bolivia*	Guinea-Bissau*	Nepal*	Tuvalu
Burkina Faso*	Guyana*	Nicaragua*	Uganda*
Burundi*	Haiti*	Niger*	Uzbekistan
Cabo Verde	Honduras*	Nigeria*	Vanuatu*
Cambodia*	India*	Pakistan	Vietnam
Cameroon*	Indonesia*	Papua New Guinea*	Yemen, Rep.
Central African Republic*	Kenya*	Rwanda*	Zambia*
Chad*	Kiribati	Samoa	Zimbabwe*
Comoros	Kosovo	Sao Tome and Principe	
Congo, Dem. Rep.	Kyrgyz Republic*	Senegal*	
Congo, Rep.	Lao PDR	Serbia	
Cote d'Ivoire	Lesotho*	Sierra Leone*	
Djibouti	Liberia*	Somalia	
Dominica	Madagascar*	South Sudan	

Source: Authors' own from collected data.
Note: *Mobile money countries.

Appendix 2 Information on methodology

Robustness variables

The level of corruption is included to control its potential effect on the quality of tax policy and administration as well as mobile money adoption. Indeed, corruption tends to penalise the quality of tax administration through its effect on tax compliance (Attila, Chambas and Combes 2009; Baum *et al*. 2017). In addition, high corruption may dampen the population's trust in government and thus reduce the acceptance of or adoption of mobile money. The rule of law is fundamental to the development and administration of tax laws. If the rule of law is weak, taxpayers may be subject to arbitrary tax policies which may increase their compliance costs and thus alter the quality of tax administration. This variable may also impact mobile money adoption as restrictive regulatory environments are negatively correlated with mobile money adoption (Jacolin *et al*. 2021). Financial development promotes third-party development by providing tax authorities with access to taxpayers and use of transaction data (Gordon and Li 2009; Kleven, Kreiner and Saez 2016). Thus, the correlation between financial development and the quality of tax policy and administration may be positive. In addition, the correlation between financial development and mobile money may be ambiguous. Indeed, countries with high financial development would not be interested in adopting mobile money as they have a multitude of formal financial services such as banks. On the other hand, financial development may also be positively correlated to mobile money adoption as less restrictive regulatory environments and investment barriers are important incentives for mobile money adoption (Jacolin *et al*. 2021). The impact of FDI on the quality of tax policy and administration can be positive as FDI promotes economic growth and income levels, which broadens the tax base and thus the quality of tax administration (Mahmood and Chaudhary 2013). Remittances may have a positive impact on the quality of a country's tax policy. Indeed, as theoretical considerations have shown that remittances have a positive effect on tax revenues, policymakers may respond to inflowing remittances by changing tax rates (Asatryan, Bittschi and Doerrenberg 2017). In addition, this variable can also impact mobile money adoption as significant flows of money transfers such as workers' remittances facilitate the spread of mobile money services (Pelletier, Khavul and Estrin 2020). Aid and natural resources rents tend to undermine the quality of tax policy and administration as they undermine domestic revenue strategy by discouraging the government tax effort and the motivation to undertake tax reforms (Pivovarsky *et al*. 2003; Knack 2009). We also include population density since a sparser population may increase the demand for cheap and efficient money transfer services (Pelletier *et al*. 2020). As the agricultural sector is a difficult sector to tax, a large agricultural sector may negatively impact the quality of tax policy and administration. Internet connectivity (proxy of information and communication technology (ICT) adoption) may strengthen tax administration capacities as the use of ICT tends to improve tax payments and the tax strategies of tax administrators (Gnangnon 2020; Adegboye *et al*. 2022). Moreover, the internet can promote information exchange between tax authorities and relevant local and international agencies, which increases the quality of the overall tax policy and administration. However, as Agrawal (2021) stated, higher internet penetration generally results in tax evasion, making the effect of the internet on the quality of tax policy and administration ambiguous. The internet can also promote mobile money adoption as it may facilitate access to international 'best' practices, which could, in turn, promote the widespread adoption of mobile money. Economic globalisation is also included since it promotes economic growth (Dreher 2006) which broadens the tax base. However, economic globalisation may promote capital mobility that leads to tax evasion, thus limiting the tax administration's capacity. Finally, we include growth as better growth provides an opportunity to expand the tax base but is also a sign of sound economic conditions for the success of reforms such as mobile money adoption.

Definition of dependent variable: Efficiency of revenue mobilisation[28]

This variable evaluates the quality of tax policy and administration. The indicator is divided into two sub-indicators rated from 1–6. For the overall assessment, these two dimensions should be given the same weight to produce an overall indicator of the quality of tax policy and tax administration.

Tax administration

Tax administration is extremely weak, with very low collection rates. It is organised by type of tax and business processes have not been reviewed and reformed. Computerisation is limited to very basic functions. Many taxpayers must make several or more personal visits to tax offices. Corruption is endemic among tax and customs officials.

1- Tax administration is weak due to complex laws, poor information systems, corruption, weak capacity and political interference. Collection rates are low. Tax obligations are negotiable rather than rule-based. Appeals and other dispute resolution mechanisms have not been developed.
2- Tax administration is weak, but tax laws are not inordinately complex, and information systems are functioning (e.g., unique taxpayer identification numbers used). Corruption exists, but there are efforts to improve integrity as well as capacity.
3- Tax administration is solid, cost of revenue generation has been reduced and there are relatively few cases of corruption and political interference. Eligibility for preferential rates and exemptions is largely transparent.
4- Tax administration is effective, and entirely rule-based. Administrative and compliance costs are low. A taxpayer service and information programme and an efficient and effective appeals mechanism have been established.
5- There are no warning signs of possible deterioration, and there is widespread expectation of continued strong or improving performance.

Tax policy

1- The bulk of revenues are generated by low-distortion taxes such as sales/VAT, property, etc.
2- Tax base is extremely narrow with many open-ended exemptions. Most tax revenues are collected from foreign trade and other distortionary taxes. There are high, multiple, and widely ranged import tariffs, which change frequently or are applied in a highly discretionary manner. Little is collected from income taxes.
3- Tax system is poorly designed, with a narrow base and many open-ended exemptions. Taxes on foreign trade, turnover taxes and other distortionary taxes are the dominant source of revenue. There are high and multiple import tariffs. Both company and personal income taxes have high rates on a very narrow base and generate little revenue.
4- Taxes on trade are the dominant source of revenue; turnover and other distortionary taxes and levies remain. Consumption based taxes (e.g., VAT) are planned or in limited use. Import tariffs are moderate, but there are too many rates. Income tax base is narrow, and the rate structure is only partly rationalised.
5- A significant amount of revenue is being generated by low-distortion taxes such as retail sales/VAT, property, etc. VAT has not been fully operational to include activities at the retail stage. Non-trivial amounts of revenue are generated from company and personal income taxes. Tax base is broad, and exemptions are moderate and made time-bound, especially for promotion schemes. Trade taxes have few and low rates.
6- There are no warning signs of possible deterioration, and there is widespread expectation of continued strong or improving performance.

[28] Knack 2009; Independent Evaluation Group 2010; World Bank 2021.

Data sources, and definitions

Efficiency of revenue mobilisation: CPIA revenue mobilisation efficiency rating. Source: WDI.
Mobile money: dummy variable taking 1 if a country at date t adopts mobile money and 0 otherwise. Source: authors' calculation based on GSMA Mobile Money Deployment Tracker.
Mobile money account (% of population): number of active mobile money accounts per 1,000 adults. Source: IMF Financial Access Survey (FAS).
P2P transfer: 1 if a country uses P2P service. Person-to-person (P2P) transfers are domestic transfers that are made between two customer accounts, including over the counter (OTC) transactions, off-net/cross-net transfers, bank account-to-mobile money account transfers, and mobile money-to-bank account transfers. Source: authors' calculation based on GSMA Mobile Money Deployment Tracker.
P2G transaction: 1 if a country uses P2G transaction. Person-to-government (P2G) transaction is the transfer of funds from an individual to a government agency to pay for a public good (e.g., school fees), settle an outstanding amount (e.g., a traffic fine), or file taxes (e.g., individual or business tax returns). Source: authors' calculation based on GSMA Mobile Money Deployment Tracker.
Airtime top-up: 1 if a country uses airtime top-up service. Airtime top-up is a purchase of airtime via mobile money, funded from a mobile money account. Source: authors' calculation based on GSMA Mobile Money Deployment Tracker.
Merchant payment: 1 if a country uses merchant payment service. Merchant payment is a payment made from a mobile money account via a mobile money platform to a retail or online merchant in exchange for goods or services. Source: authors' calculation based on GSMA Mobile Money Deployment Tracker.
International remittances: 1 if a country uses international remittances services. An international remittance is a cross-border fund transfer made from one person to another person. This transaction can be a direct mobile money remittance or can be completed using an intermediary organisation, such as Western Union. Source: authors' calculation based on GSMA Mobile Money Deployment Tracker.
Bill payment: 1 if a country uses bill payment services. Bill payment is a payment made by a person from either their mobile money account or over the counter to a biller or billing organisation via a mobile money platform in exchange for services provided. Source: authors' calculation based on GSMA Mobile Money Deployment Tracker.
Bulk payment: 1 if a country uses bulk payment services. Bulk payment is a payment made by an organisation via a mobile money platform to a person's mobile money account. For example, salary payments made by an organisation to an employee's mobile money account, payments made by a government to a recipient's mobile money account, or payments made by development organisations to a recipient's mobile money account. Source: authors' calculation based on GSMA Mobile Money Deployment Tracker.
GDP per capita: real GDP per capita. Source: WDI.
Urban population growth: urban population refers to people living in urban areas. Source: WDI.
Inflation: inflation, average consumer prices (per cent change). Source: WDI.
Mobile cellular: mobile cellular subscriptions (per 100 people). Source: WDI.
Labour force: labour force participation rate is the proportion of the population ages 15 and older that is economically active: all people who supply labour for the production of goods and services during a specified period. Source: WDI.
Government effectiveness: government effectiveness index. Source: Teorell *et al*.(2020).
Rule of law: the rule of law includes several indicators which measure the extent to which agents have confidence in and abide by the rules of society. Source: Teorell *et al*.(2020).
Financial development: financial development index. Source: IMF Financial Development database.

FDI (% GDP): foreign direct investment is the net inflows of investment to acquire a lasting management interest in an enterprise operating in an economy other than that of the investor. Source: WDI.
ODA: net ODA received (% GNI). Source: WDI.
Natural resources (% GDP): total natural resources rents (% GDP). Source: WDI.
Population density: population density (people per sq. km of land area). Source: WDI.
Agriculture (% GDP): agriculture, forestry, and fishing, value added (% GDP). Source: WDI.
Internet: individuals using the internet (% of population). Source: WDI.
Remittances (% GDP): personal remittances comprise personal transfers and compensation of employees. Source: WDI.
Growth: annual percentage growth rate of GDP at market prices based on constant local currency. Source: WDI.
Economic globalisation: KOF economic globalisation index. Source: Dreher (2006).
Time to prepare and pay tax: time to prepare and pay taxes is the time, in hours per year, it takes to prepare, file, and pay (or withhold) three major types of taxes: the corporate income tax, the value-added or sales tax, and labour taxes, including payroll taxes and social security contributions. Source: WDI.
Number of tax payments: total number of taxes paid by businesses, including electronic filing. Source: WDI.
Informal sector: dynamic general equilibrium model-based (DGE) estimate of informal output in a percentage of GDP. Source: Elgin *et al*. (2021).
Public sector corruption index: public sector corruption index. Source: V-Dem dataset.
Corruption: political sector corruption index. Source: V-Dem dataset.
Bribe: bribery incidence (% of firms experiencing at least one bribe payment request). Source: WDI.
Gift to tax officials: firms expected to give gifts in meetings with tax officials (% of firms). Source: WDI.
Visit to tax officials: firms visited or required meetings with tax officials (% of firms). Source: WDI.
Informal payments: informal payments to public officials (% of firms). Source: WDI.
State legitimacy index: state legitimacy index, 0 (high) – 10 (low). Source: Fund for Peace.
Public debt: public debt (%GDP). Source: Kose *et al*. (2022).

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