Does mobile money services adoption improves tax revenue mobilization in developing countries?

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Abstract:

Mobile money services (MM) have undergone unprecedented development in many developing countries in recent years, offering a large set of payment services and contributing to financial inclusion. Using a propensity score matching methodology and data for 103 developing countries, we study the causal effect of MM P2G's and MPAY's services adoption on respectively direct and indirect tax revenue. We find that the average treatment on the treated (ATT) is positive and significant, meaning that countries that adopted P2G (MPAY) services collect more direct (indirect) tax revenue compared to non-adopters. Considering direct tax revenue composition, we find that the effect of P2G services adoption is positive and significant for both corporate and personal income tax revenue but higher on the latter. For the adoption of MPAY services, we find that the effect is positive and significant on only VAT revenue. The results show that the ATT is positive and significant for low-income and low middle-income countries and countries with a low level of bureaucratic quality, socio-economic conditions, urbanization, and a high level of corruption. The findings highlight the capacity of MM to promote financial inclusion and facilitate transparency and tax compliance in most vulnerable countries, enhancing them to improve their tax revenue collection.

JEL classification:

Keywords: Mobile money; Financial inclusion; Domestic tax revenue; Developing countries; Propensity score matching.

I. Introduction

First adopted in 2002 in Russia, Mobile Money (MM) is a payment service using a cell phone and an associated account. It enables the account holder almost to carry out all the financial transactions offered by a traditional bank, i.e., remittances, transactions or payments on e-commerce sites, transfers from or to a bank card, or withdrawals or deposits of funds or remittances to a public institution. Since its launch, the service has grown considerably. In Kenya[1] For example, there were 13 times more MM agents than ATMs in 2011 (Jack and Suri, 2014). Before 2012, 31 percent of MM account holders in Africa used it at least once a year for bill payment or money transfer (Demirguc-Kunt and Klapper, 2012). In 2019, there were more than 1 billion MM accounts for 290 MM services deployments, nearly 50 percent of which were in sub-Saharan Africa. In the same year, worldwide, there were 228 MM agents on average per 100,000 inhabitants, compared to 11 bank branches and 33 ATMs (GSMA, 2019). This rapid development has made MM an almost inevitable service in adopting countries. For example, Lashitew et al. (2019) explained that MM has become an integral part of the Kenyan economy and is widely used for various purposes such as national and international money transfers, payment of education fees, utility bills, and point-of-sale transactions. However, this is not limited to Kenya but is valid in most countries where MM services have been adopted. Donovan (2012) argued that MM services thus contribute to promoting financial inclusion and financial development, which affect economies. Some studies have shown a positive relationship between financial inclusion and financial development and tax revenue (Maherali, 2017; Oz-Yalaman, 2019; Bayar and Karamelikli, 2017; Nnyanzi et al., 2018).

It is worth noting that domestic tax revenue mobilization constitutes an important challenge in developing countries because they are a more reliable and sustainable source of revenue collection for financing their development goals (De Paepe and Dickinson, 2014; Rodríguez et al., 2016; Moore and Prichard, 2020). However, their constant desire to increase tax revenue makes this exercise particularly difficult (De Paepe and Dickinson, 2014). Moore and Prichard (2020) argue that information communications technology systems can effectively help developing countries collect more tax revenue through more transparency and centralizing the tax compliance process. We thus consider that MM can appear as an important means to improve domestic tax revenue mobilization in developing countries. In this analysis, we are particularly interested in Person to Government (P2G) transfer and Merchant Payment (MPAY) services. P2G payments are transfers of funds from individuals or businesses to governments for public services (for example, to obtain documents such as birth or marriage certificates or business licenses), statutory payments such as

[1] Kenya is the first African country that adopted mobile money services (in 2007).

duties, or tax and payments for public utilities owned by the government (GSMA, 2020). Recipient agencies and institutions may be at the municipal, state, or national level and include, for example, public schools, police forces, and tax authorities. Regarding MPAY, it is a MM service that allows its users to carry out commercial transactions from their account to a physical merchant account (retailer) or on e-commerce platforms. On one side, one can therefore expect that P2G services could improve direct tax revenue by allowing the possibility of settling obligations with the tax administration, facilitating procedures and compliance while reducing corruption. On the other side, MPAY is contributing to increasing indirect tax revenue through increased business transactions and final consumption. Despite all the advantages and opportunities offered by MM services, there are no studies to our knowledge that address the crucial role of MM adoption on tax revenue. We therefore propose to assess in this paper the impact of MM services adoption, specifically P2G and MPAY, on direct and indirect tax revenue, respectively.

This study contributes to the literature on financial inclusion and tax revenue mobilization on many points. First, it differs from Oz-Yalaman's (2019) analysis by considering a large sample of developing countries (103), which have the lowest financial inclusion levels. Second, it only considers financial inclusion through MM, which is more relevant than financial inclusion through the traditional banking system in developing countries (Donovan, 2012; IFC, 2018). Third, compared to other studies, on MM issues, we do not consider MM services as a whole but distinguish them regardless of their intended use. We therefore consider MM P2G and MPAY services assuming that P2G services are affecting direct tax revenue while MPAY is positively affecting indirect tax revenue. Fourth, unlike existing studies on the effect of financial inclusion on tax revenue, we make use of the propensity score matching methodology (PSM), which addresses the self-selectivity bias in MM services adoption by correctly identifying control countries through a set of covariates that are determinants of both MM services adoption and tax revenue. Fifth, we show that several heterogeneities exist depending on some structural factors such as income, corruption, socio-economic conditions, and urbanization.

Our results reveal a positive and significant effect of both P2G and MPAY on direct and indirect tax revenue, respectively. The effect on direct tax revenue is greater than that on indirect tax revenue, for which the significant effect is driven by Value Added Tax (VAT) revenue. Moreover, the results show that the positive and significant effect is observed for low-income and lower-middle-income countries only. We also found that countries with high corruption, bad socio-economic conditions, low bureaucracy quality, and low urbanization exhibit a significant effect on both tax revenue.

The rest of the paper is structured as follows. Section II discusses our theoretical assumptions, and section III presents our data and identification strategy. Section IV presents and discusses the empirical results, while section V curries out further analyses. We finally provide conclusions and policy implications.

II. Theoretical assumptions

In recent years, there have been several studies addressing the role of financial development in tax revenue mobilization (Taha, 2013; Ilievski, 2015; Akçay et al., 2016; Akram, 2016; Bayar et al., 2017; Bayar and Karamelikli, 2017; Ajide and Bankefa, 2017; Ebi, 2018; Nnyanzi et al., 2018). Many of them conclude that financial development positively affects tax revenue. Nevertheless, the financial development concept used in these studies is not very appropriate for developing countries. Because people in developing countries are lagging in terms of financial development, as most of their population is rationed from the conventional banking system. In this case, it is more interesting to talk about financial inclusion rather than financial development. Financial inclusion can be defined as the ability of people who are rationed by the financial system to carry out all or a majority of the services offered by traditional banks at lower costs to everyone, regardless of income levels.

However, there are few studies focused on the effects of financial inclusion on tax revenue mobilization. Maherali (2017) and Oz-Yalaman (2019), using the Global Findex database, found that financial inclusion positively impacts tax revenue considering 140 and 137 countries around the world, respectively. The former estimates the number of people included financially by assuming that 10 percent of those excluded are included each year. This estimate may be biased because, apart from the fact that the method has no theoretical basis in the literature, the inclusion rate is not necessarily linear. The latter uses the percentage of individuals with a bank account and the percentage of individuals with a credit card in the population as measurement variables for financial inclusion. It therefore considers financial inclusion through the traditional banking system, for which the access is still governed by certain conditions that still exclude a large part of developing countries' populations, especially rural ones. Compaore (2020) uses the number of ATMs per 100,000 adults as a proxy for financial inclusion and finds a positive effect of financial inclusion on non-resource tax revenue in 63 developing countries. However, using an ATM requires having access to a traditional bank account. Furthermore, the number of ATMs in a country is more an indicator of financial development than financial inclusion. It is thus necessary to find an alternative measure of financial inclusion adapted to developing countries. Donovan

(2012) and the IFC (2018) argue that MM has been the main driver of financial inclusion in developing countries over the last years.

MM has taken a decisive turn in the lives of developing countries populations, both urban and rural, by offering them a wide range of services such as money transfers, bill payments, international transactions; thus, enhancing financial inclusion (Donovan, 2012; GSMA, 2014; Della Peruta, 2018; Wellalage, 2020; Amoah, 2020; Ahmad, 2020; Cariolle and Carroll, 2020). Therefore, considering financial inclusion through MM appears more relevant than considering financial inclusion through the traditional banking system in developing countries. By facilitating financial inclusion, MM can contribute to improving tax revenue in developing countries in several ways. This contribution includes both direct and indirect tax revenue, respectively, through P2G and MPAY. In figure 1, we can note that about 88 percent (72 percent) of P2G (MPAY) adopter countries experienced an improvement of their direct (indirect) tax revenue after having adopted P2G (MPAY) (i.e., there are located above the first bisector).

Concerning P2G, as seen above, it allows transactions from people and companies to a public administration through a mobile phone. This procedure is a form of payment dematerialization between individuals and enterprises towards public administrations. By making it possible to pay taxes via P2G, the tax authorities lighten the process of collecting direct tax revenue. Indeed, in most developing countries, direct tax revenue collection has remained traditional until recent years. It consists of the taxpayers (persons and businesses) going to the tax authorities to discharge their tax obligations (usually by check or cash). In addition, self-declaration, data entry, and manual collection often take many weeks with high risks of losing declarations and, therefore, losing direct tax revenue. Simplifying the process results in a significant reduction in the taxpayers' compliance costs and collection costs for the tax authorities. Thus, it improves the efficiency and effectiveness of domestic revenue mobilization, which positively influences the collected tax revenue. For countries with a low level of efficiency in domestic revenue mobilization, P2G could thus be an essential factor. Furthermore, the introduction of P2G payment is an effective way to reduce corruption in the tax administration, which mainly affects direct tax revenue. These remote payment methods limit physical interactions so that the high risk of corruption arising from the usage of cash or check payments is eliminated.[2] Moreover, in developing countries, a major obstacle to tax revenue mobilization is the informal sector's strong presence (Besley and Persson, 2014; Joshi et al., 2014). Indeed, some small enterprises, although interested in formalization, face long and complex procedures. Jacolin et al. (2019) found that the adoption of mobile financial services

[2] On the advantages of dematerializing the tax payment, see Brun et al. (2020).

in 101 emerging and developing countries has led to a decline in the informal sector of about 2.4 to 4.3 percentage points of GDP. Besides, requiring these companies to conduct their transactions with the government even if they are small through P2G may help identify these contributors since informal businesses widely use MM payments.

MPAY offers the possibility of carrying out exclusively commercial transactions and facilitating and broadening market access for populations rationed from the traditional bank payments system. It provides a facility of payments, thus increasing the customer base (GSMA, 2020) and stimulating trade (Sawadogo and Wandaogo, 2021), which lead to an increase in consumption (Suri and Jack, 2016). Given that indirect tax revenue (VAT and excises duty) are collected on final consumption, we can expect that MPAY services adoption positively affects indirect tax revenue through trade and consumption.

However, if the effect on VAT and excise revenue indicated above appears indirect, it can also be direct. Indeed, it should be noted that the MM services are not free of charge. The operators market it through transaction fees. Hence, as with most business activities in many countries, VAT applies to the turnover resulting from MM services' marketing. Moreover, in some MPAY adopters' countries, tax authorities have introduced an excise duty on transactions' cost or value. For example, Kenya's finance act for 2013 has introduced an excise tax of 10 percent on the transaction cost, which has increased to 12 percent in the 2018 financial act. In Uganda, a tax of 1 percent of the transaction value has been introduced in 2018's excise duty amendment act. Given the importance of transactions carried out through MM, the mobilized resources can be significant.[3]

Besides the above, it should be added that MM services overall can improve tax revenue in several ways. MM services' introduction has created many new employments in adopting countries, thus increasing individual incomes and improving social inclusion. On the one hand, these incomes are subject to income taxes and, on the other hand, increase consumption and thus enhance direct and indirect tax revenue. Most MM agencies are also usually registered as small businesses. As a result, they pay at least a lump-sum tax and patent. Individually, this may seem very low, but given the number of active agencies per country (11 times more than ATMs for Kenya, for example) aggregated, the tax collected may be substantial. Furthermore, selling MM services increases mobile operators' profits, which are subject to corporate income tax.

[3] Nonetheless, some studies argue that such taxes could negatively affect tax revenue and the financial inclusion process (Ndung'u, 2019; Rota-Graziosi et al., 2021). Besides, this paper's objective is not to evaluate the impact of MM services taxation on domestic tax revenue mobilization.

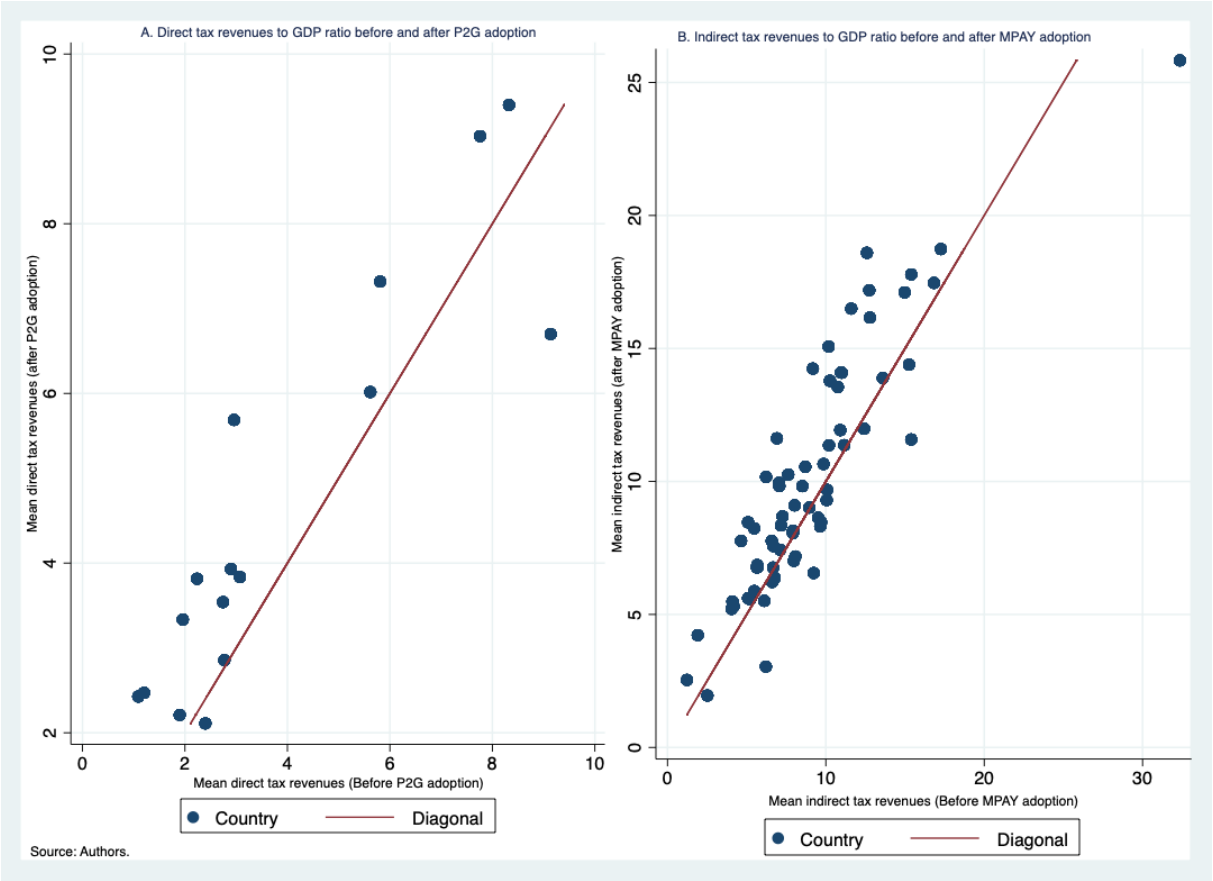

Figure 1: Tax revenue to GDP ratio before and after P2G and MPAY adoptions.

III. Data and methodology

1. Data

In this study, we retain 103 developing countries on the period going from 1994 to 2018.[4] The data on tax revenue are collected from the International Centre for Tax and Development's (ICTD) Government Revenue Dataset (GRD). Our treatment variables, P2G and MPAY, are constructed using the GSMA Mobile Money tracker, which records the year of implementation of mobile financial services for each adopter operator in each country. We then set a value of P2G or MPAY equal to 1 for the first and following years where a mobile network operator proposes a P2G or MPAY service and zero if there is no P2G or MPAY service. The rest of our control variables come from the World Development Indicators (WDI). Concerning the heterogeneity analysis, apart from the urbanization variable which comes from the WDI, the other variables come from the International Country Risk Guide (ICRG).

[4] The country list is provided in Table A.4, while the description of the variables and the data's descriptive statistics are in tables A.5 and A.6, respectively.

2. Methodology

To assess MM services adoption's causal effect on tax revenue mobilization in developing countries, we implement a propensity score matching (PSM). Indeed, in non-randomized or observational studies, individual baseline characteristics generally influence whether or not exposure to a particular treatment occurs. However, the baseline characteristics of individuals exposed or not to treatment are often different. Therefore, it is necessary to take this difference in baseline characteristics into account when assessing the causal effect of treatment exposure on a given outcome. Several strategies are available in the literature to address this issue. However, in recent years there has been increasing interest in PSM in economics (Levchenko et al., 2009; Imai and Azam, 2012; Combes et al., 2019; Sawadogo, 2020), including work addressing tax revenue issues (Lucotte, 2012; Ebeke et al., 2016; Balima et al., 2016). This method is designed to evaluate the effects of a binary variable - which is the case here - on any output, although generalizations have been proposed for continuous or categorical variables. This approach allows us to overcome selection bias (Sawadogo, 2019), but it also has the advantage of reducing the effects of confounding when we work with observational data (Austin, 2014).

To analyze the effect of a treatment using PSM, we use a three-step procedure. The first consists of randomization by estimating the Propensity Score (PS), which is the probability of exposure to the treatment, while the second is focused on creating matched sets of countries that have adopted MM with others that have not, but with similar or close average PS. We therefore estimate the Average Treatment Effect on the Treated (ATT) using various matching methods existing in the literature.

Developed by Rosembaum and Rubin (1983), PS allows considering individuals' basic characteristics by concentrating the information contained in the covariates within a single variable that we called $l(Y_i)$. Considering MM_i the treatment (adopting P2G or MPAY), Y_i a set of covariates that can simultaneously explain the P2G or MPAY adoption and tax revenue, the probability of adopting mobile money (P2G or MPAY) given Y is estimated as follows (PS):

$$l(Y_i) = P(MM_i = 1|Y_i) \qquad (1)$$

With respect to the ATT, it is the average difference between tax revenue mobilized for countries that have adopted P2G/MPAY (MM=1) and those they would have obtained if they had not adopted, respectively referred below as TX^1 and TX^0.

$$ATT = E[(TX_i^1 - TX_i^0)|MM_i = 1] \quad (2)$$

Developing this equation (2), we can rewrite it as follows:

$$ATT = E(TX_i^1 \big| MM_i = 1) - E(TX_i^0 \big| MM_i = 1) \quad (3)$$

In fact, the last term of the previous equation is unobservable. Therefore, it would be more comfortable to replace it with tax revenue in countries that have not adopted MM. Nevertheless, according to Heckman et al. (1998), Dehejia and Wahba (2002), and Lin and Ye (2007), there will be a self-selection problem because MM adoption may not be random but correlated with a set of observable characteristics. Instead, we can replace this second term with tax revenue of non-adapter countries with basic characteristics comparable to their adopted pair. As we have previously concentrated the basic characteristics in a single variable $l(Y_i)$ which is the probability of MM adoption, we can finally write the ATT in the following way:

$$ATT = E\left[TX_i^1 \big| MM_i = 1, l(Y_i)\right] - E[TX_i^0 \big| MM_i = 0, l(Y_i)] \quad (4)$$

We therefore estimate the ATT using various matching methods existing in the literature. We then consider nearest neighbor matching, which consists of matching each P2G/MPAY adopter with the non-adopter with the closest PS (we retain here n=1, 2, and 3). We also consider radius matching (Dehejia and Wahba, 2002), which retain non-adopters with a PS between a radius (we retain r=0.005, r=0.01, and r=0.05). Kernel estimator (Heckman et al., 1997, 1998), which matches each P2G/MPAY adopter with a weighted average of all non-adopters, is also employed to determine the ATT. Finally, we run a local linear regression (Heckman et al.1997, 1998) which improves kernel estimator by adding a linear term in the weighting function (Fan, 1993).[5]

IV. Main results

1. Propensity scores estimation

To estimate the propensity scores, we use a probit model. We then evaluate the probability of mobile money services adoption conditionally to various characteristics based on the existing literature on mobile money services adoption and domestic tax revenue (Khattry and Raos, 2002; Le et al., 2008; Keen and Lockwood, 2010; Imam and Jacobs, 2007, Tanzi, 1977; Ebeke et al., 2016; Gupta et al., 2003; Morrisey et al., 2010). We therefore retain nine covariates in our model specification, i.e., primary sector value-added, GDP growth, natural resource rents, total population, population density, net received ODA (% of GNI), trade openness (% of GDP),

[5] For more details, see Imbens (2004) and Smith and Todd (2005). However, Caliendo & Kopeinig (2008) present the general background, advantages, and weaknesses concerning matching strategies.

private credit, and inflation. The first seven variables are expected to affect P2G (MPAY) adoption positively. First, countries with larger informal sector share measured by the primary sector value-added are more likely to favor financial inclusion through mobile money services. Second, good economic conditions through strong growth would lead to adopting solutions that will include financially excluded populations. In many developing countries, the areas in which are implemented natural resource exploiters are often rural and not covered by traditional banks' presence. The need for workers to conduct day-to-day financial transactions would increase the likelihood of adopting mobile money services. Having an important potential number of users (through total population) for a technology would increase the likelihood of adopting it because of the underlying network effect. Furthermore, population concentration would reduce the cost of deploying mobile money, increasing the probability of adoption. Most of the time, ODAs received by countries are conditional to the application of some policies. As financial inclusion is one of the sustainable development goals, it would enhance mobile money services adoption. Concerning the latter two covariates, we expect private credit and inflation to be negatively correlated to P2G or MPAY services adoption. Countries with a developed traditional banking system may face lower financial exclusion, while worse macroeconomic conditions measured by inflation may discourage the adoption of alternative payment solutions.

Table 1 presents the results. Except private credit (in MPAY adoption likelihood)[6], trade openness and total population, all estimated parameters have the expected sign. Keen and Lockwood (2016) found a similar sign for trade openness when estimating its effect on VAT adoption. However, we could explain this situation by the fact that more opened economies have more developed classical financial systems leading them to have alternative payment solutions. For population, we introduced in a second specification, the interaction term between total population and its density to investigate whether its effect depends on the population concentration. The results in columns 3 and 4 show that its negative effect still holds only in MPAY adoption but becomes positive in more concentrated populations. Furthermore, we find that the primary sector VA coefficient is not significant in P2G and MPAY adoption specifications, while the natural resource rents coefficient significantly affects only MPAY adoption likelihood. We also find that net ODA received negatively affects the adoption of the two mobile money services, meaning that the adoption of mobile money services is not a priority in the use of ODA. In the rest of the paper, we retain propensity score estimations obtained from columns 3 and 4.[7]

[6] The positive coefficient in MPAY specifications could be explained by the fact that higher domestic credit to the private sector is associated with lower demand for goods or services, thus influencing MPAY adoption to diversify payment solutions.

[7] In addition, we consider the estimated propensity score from columns 1 and 2; and the results on the matchings still hold. Tables A.1 and A.2 in the appendices present the matching results.

	[1] P2G	[2] MPAY	[3] P2G	[4] MPAY
Pimary sector VA	0.0031	0.0044	0.0032	0.0039
	(0.0036)	(0.0033)	(0.0036)	(0.0033)
Private credit	-0.0088***	0.0025*	-0.0089***	0.0035**
	(0.0023)	(0.0014)	(0.0023)	(0.0014)
Trade openness	-0.0086***	-0.0045***	-0.0085***	-0.0051***
	(0.0019)	(0.0010)	(0.0019)	(0.0011)
GDP growth	0.0378***	0.0133*	0.0376***	0.0147**
	(0.0110)	(0.0073)	(0.0110)	(0.0073)
Inflation	-0.0125**	-0.0298***	-0.0126**	-0.0296***
	(0.0058)	(0.0050)	(0.0058)	(0.0050)
Natural resources rents	0.0020	0.0120***	0.0021	0.0121***
	(0.0040)	(0.0034)	(0.0040)	(0.0034)
Total population	-8.13e-10***	-4.60e-10**	-5.71e-10	-1.59e-09***
	(1.84e-10)	(1.83e-10)	(5.67e-10)	(3.05e-10)
Population density	0.0010***	0.0006***	0.0011***	0.0003
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Total population*Population density			-7.65e-13	3.91e-12***
			(1.68e-12)	(1.07e-12)
Net ODA received share in GNI	-0.0355***	-0.0108**	-0.0356***	-0.0097*
	(0.0086)	(0.0054)	(0.0086)	(0.0054)
Constant	-0.6778***	-0.4224***	-0.6912***	-0.3732***
	(0.1951)	(0.1235)	(0.1924)	(0.1250)
Observations	1817	1817	1817	1817
Pseudo R2	0.11411	0.03805	0.11422	0.04279

Robust standard errors in brackets. * p<0.10, ** p<0.05, and *** p<0.010.

Table 1: Propensity score estimation results.

2. Matching results

Matching results are presented in tables 2 and 3. To ensure the quality of our matchings, we perform some diagnostic tests. We start with the pseudo-R2, which analyses how well our control variables explain the probability of adopting P2G or MPAY services and thus provide balanced scores (Sianesi, 2004). Caliendo and Kopeinig (2008) argue that a good model performance should be associated with a "fairly low" value. In tables 2 and 3, all pseudo-R2s are lower than 0.03 for P2G and 0.014 for MPAY, respectively. We can then conclude that the matchings provide balanced scores and that our results are robust regarding the common support assumption. Furthermore, we check the conditional independence assumption regarding both observables and unobservables (Rosenbaum, 2002). On the observables side, the standardized bias test, which evaluates the marginal distance distributions of our control variables, provides p-values between 42 and 96 (11 and 92) percent for direct taxes (indirect taxes), revealing the absence of no statistical difference

between P2G (MPAY) adopters' characteristics and non-adopters after matching.[8] Regarding unobservables, we report the Rosembaum (2002) upper bound sensitivity test statistics,[9] which evaluates if there are no unobservables that could affect the effect of P2G or MPAY adoption on tax revenue. We obtain critical values between 1.7 (for 1- nearest neighbor matching) and 3.7 (for local linear regression matching) for direct tax revenue, and 1 (for 1- nearest neighbor matching) and 1.4 (for local linear regression matching) for indirect tax revenue; which are comparable to other studies' (Balima et al., 2016; Caliendo and Kün, 2011), making our results robust to the conditional independence hypothesis.

Table 2 presents the results for P2G adoption on direct taxes. All estimated ATTs are positive and significant at the 1 percent level, meaning that countries that adopted P2G services experience deeper direct tax revenue. The ATT is 0.37 (local linear regression matching), representing 48 percent of log(Direct taxes) standard deviation (corresponding to 0.74); therefore, making this result economically meaningful. Moreover, as the tax structure could differ for different countries, we explore the ATTs by type of direct tax revenue. We then retain Corporate income tax (CIT) and Personal income tax (PIT). The results show that the ATT is higher for PIT, followed by CIT. This could be due to the fact that the service is used by small and medium companies which contribution to CIT is relatively low, while for PIT, it permits individuals to directly pay what they due to the tax authority.

Treatment variable: P2G	**1-Nearest Neighbor Matching**	**2-Nearest Neighbor Matching**	**3-Nearest Neighbor Matching**	**Radius Matching**			**Local Linear Regression Matching**	**Kernel Matching**
				r=0.005	**r=0.01**	**r=0.05**		
				Dependent variable: Log(Direct taxes)				
Average Treatment on the Treated (ATT)	0.2656***	0.3116***	0.3308***	0.3633***	0.3691***	0.3479***	0.3695***	0.3496***
	(0.0864)	(0.0825)	(0.0762)	(0.0638)	(0.0579)	(0.0547)	(0.0534)	(0.0549)
Observations/Treated observations				1431/115				
				Quality of the matching				
Pseudo-R2	0.029	0.021	0.022	0.013	0.015	0.010	0.029	0.009
Rosenbaum bounds sensitivity test	1.7	2.2	2.5	3.3	3.4	3.3	3.7	3.4
Standardized bias (p-value)	0.420	0.653	0.650	0.912	0.847	0.957	0.420	0.964
				ATT by type of direct tax				
Log(Corporate Income Tax)	0.2422***	0.2221***	0.2286***	0.2084***	0.1987***	0.1974***	0.1883***	0.1963***
	(0.0756)	(0.0657)	(0.0597)	(0.0483)	(0.0442)	(0.0373)	(0.0384)	(0.0369)
Log(Personal Income Tax)	0.3415***	0.3660***	0.3979***	0.3469***	0.3665***	0.3340***	0.3037***	0.3388***
	(0.0972)	(0.0886)	(0.0798)	(0.0614)	(0.0590)	(0.0504)	(0.0536)	(0.0521)

Standard errors in brackets. *** significance level at 1%, ** significance level at 5%, and * significance level at 10%. **Bootstrap replications=500**

Table 2: Matching results for the effect of P2G on direct taxes.

The matching results for MPAY adoption are presented in table 3. Except for nearest neighbor matchings and the matching within a 0.005 radius, all ATTs are positive and significant

[8] Rosenbaum and Rubin (1985) proposed a critical value of 20 percent. Furthermore, figure A.1 shows that the distribution of propensity scores after matching is comparable for P2G (MPAY) adopters and non-adopters.
[9] The test is conducted at a 5 percent level.

but have different significance levels. On average, countries that adopted MPAY services experience higher indirect tax revenue (following the local linear regression matching). Exploring the ATT by type of indirect tax revenue reveals that it is positive for Value Added Tax (VAT) revenue and excises, but significant only for the former. We can then conclude that MPAY services adoption positively affects adopters countries' VAT revenue. This could be due to the fact the tax base for VAT within MPAY payable services is more important compared to excises'. In addition, it is worth noting that excise duty revenue are collected at the border or at the point of departure from the producer's premises or from storage point. This could explain the non-significant effect observed for excise duties.

Treatment variable: MPAY	**1-Nearest Neighbor Matching**	**2-Nearest Neighbor Matching**	**3-Nearest Neighbor Matching**	**Radius Matching**			**Local Linear Regression Matching**	**Kernel Matching**
				r=0.005	**r=0.01**	**r=0.05**		
				Dependent variable: Log(Indirect taxes)				
Average Treatment on the Treated (ATT)	0.0284	0.0334	0.0487	0.0437	0.0572**	0.0493**	0.0805***	0.0524*
	(0.0501)	(0.0437)	(0.0430)	(0.0311)	(0.0291)	(0.0251)	(0.0281)	(0.0268)
Observations/Treated observations				1577/386				
				Quality of the matching				
Pseudo-R2	0.013	0.009	0.008	0.005	0.005	0.004	0.013	0.004
Rosenbaum bounds sensitivity test	1	1	1.1	1.1	1.2	1.2	1.4	1.2
Standardized bias (p-value)	0.113	0.394	0.485	0.791	0.836	0.923	0.113	0.876
				ATT by type of indirect tax				
Log(Value Added Tax)	0.2173*	0.1942**	0.1552*	0.1645**	0.1608**	0.1536***	0.1892***	0.1526***
	(0.1114)	(0.0986)	(0.0910)	(0.0665)	(0.0635)	(0.0493)	(0.0509)	(0.0499)
Lag(Excises)	0.0495	0.0323	0.0380	0.0445	0.0313	0.0310	0.0485	0.0310
	(0.0496)	(0.0473)	(0.0413)	(0.0328)	(0.0325)	(0.0312)	(0.0302)	(0.0298)

Standard errors in brackets. *** significance level at 1%, ** significance level at 5%, and * significance level at 10%. **Bootstrap replications=500**

Table 3: Matching results for the effect of MPAY on indirect taxes.

V. Further analysis

1. Heterogeneity

Substantial heterogeneity exists in developing countries in economic development and institutional management (Acemoglu et al., 2019; Easterly, 2002; Lin and Ye, 2009; Balima et al., 2016). As proposed in Lin and Ye (2009), it appears important to explore the heterogeneity features of effective adoption of P2G (or MPAY) on tax revenue mobilization.

As Lin and Ye (2009), we adopt a control function regression methodology to explore these heterogeneity features, starting by investigating if countries that meet the pre-conditions of P2G (or MPAY) adoption perform better in domestic tax revenue collection. In addition, we explore if the experiment in the service (P2G or MPAY) usage, measured by the time length since its adoption, affects tax revenue. Furthermore, we check if the effect of P2G (or MPAY) adoption on tax revenue differs depending on countries income group and financial development level. We end

our heterogeneity analysis by considering countries' socio-economic conditions, corruption, bureaucracy quality, and urbanization.

Table 4 and 5 present the ATTs of MM adoption on the direct and indirect tax revenue, respectively, using the control function approach.[10] We run an OLS regression of log(direct taxes) (log(indirect taxes)) on P2G (MPAY) adoption dummy within the common support. Our estimated coefficients represent the mean difference between adopters and non-adopter countries regarding direct tax (indirect tax) revenue. The P2G coefficient is positive and significant, indicating that P2G adopters' countries mobilize more direct tax revenue than non-adopters countries (column 1 of Table 4). In column 1 of Table 5, the coefficient of MPAY is positive but is not significant. In column 2 of tables 4 and 5, we include the propensity scores estimated from the probit model in table 1 as a control function.[11] The significant coefficient of the propensity scores indicates evidence for the presence of self-selectivity in the models. The estimated coefficient of P2G (MPAY) after controlling for the propensity score remains (becomes) significant at the 1 percent level and is equal to 0.36 (0.07), comparable to the ATTs estimated in table 2 (Table 3).

In the remaining columns of Table 4 (table 5), the heterogeneity features of the treatment effect of P2G (MPAY) is studied. In column 3, we add to the specification in column 2, an interaction of P2G (MPAY) with the difference between the estimated propensity score and its sample average. P2G (MPAY) coefficient, which measures the ATT at the mean propensity score, is significant at the 1 percent level and is equal to 0.19 (0.07). The interaction term with P2G is positive and significant at the 1 percent level, revealing that countries that better meet P2G services adoption's pre-conditions mobilize more direct tax revenue. The interaction term with MPAY is positive but not significant (in column 3 of Table 5), showing no evidence of an additional effect on indirect tax revenue concerning MPAY services adoption pre-conditions meeting. In column 4, we test if the time length since the service has been adopted matters in the ATT estimation. We therefore include the interaction of the P2G (MPAY) dummy and the number of years since the service adoption denoted by the variable time. We find that the interaction term with P2G is positive and significant at the 1 percent level, meaning that there is an evidence of better direct tax revenue mobilization regarding the time length since P2G services adoption. We do not find any evidence of deeper indirect tax revenue regarding the time length since MPAY services adoption.

Furthermore, we explore the heterogeneity in P2G (MPAY) services adoption effect on direct (indirect) tax revenue by countries income group. We therefore run the model, with the specification in column 2, for each income group. The results are presented from columns 5 to 7

[10] See Wooldrige (2002) for details about the function control methodology.
[11] See Lin and Ye (2009) for more details.

of tables 4 and 5. The estimated coefficient of P2G (MPAY) is positive and significant at the 1 percent level in low-income countries (LIC) and lower-middle-income countries (LMIC) only. For direct taxes, we find that the ATT is deeper for LMIC, as P2G services are more developed in these countries, followed by LIC.[12] Concerning indirect tax revenue, we find a deeper ATT for LIC, followed by LMIC, which can be explained by the fact that in the latter group, there are more developed alternative means of payments such as credit cards, related to the traditional banking system.

In addition, we find strong evidence of a significant positive effect of P2G (MPAY) services adoption on direct (indirect) tax revenue only in countries with bad socio-economic conditions, high corruption, and low urbanization rate. We also find that P2G services adoption has a stronger effect in countries with low bureaucracy quality than those with high bureaucracy quality. In contrast, MPAY services adoption effect on indirect tax revenue is positive and significant only in countries with low bureaucracy quality.

2. Endogeneity issue

We are assuming that P2G (or MPAY) services adoption is causing an increase in tax revenue. Nonetheless, the need to expand tax bases could also lead to the need for payment solutions or taxable bases, thus influencing our mobile money services adoption. We therefore consider a panel two-step system GMM[13] estimation (Blundell and Bond, 1998) in order to take into account any potential endogeneity due to simultaneity bias. To overcome the proliferation of instruments, we manage to restrict and collapse the instruments' set to overcome instruments proliferation (Roodman, 2009). In addition, we correct the finite sample bias by using Windmeijer's (2005) standard errors. The p-values of the AR(2) and Hansen tests support the validity of our results. Table 6 presents the results. The estimated coefficients of P2G and MPAY are significant at the 10 percent level and respectively equal to 0.34 and 0.11; they remain comparable to those estimated in tables 2 and 3, respectively.[14]

[12] At the end of 2018, 9 LMIC adopted P2G services, followed by 6 LIC and 3 UMIC.
[13] This also permits us to take into account the panel structure of the data.
[14] We also use the specification in columns 1 and 2 of table 1, and our results remain robust. Table A.3 in appendices presents the results.

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]
Dependent variable: log(Direct taxes)	No Control	Self electivity	Adoption pre-conditions	Experience	LIC	LMIC	UMIC	Bad socio-economic conditions	Good socio-economic conditions	High corruption	Low corruption	Low bureaucracy quality	High bureaucracy quality	Low urbanisation	High urbanisation
P2G	0.0761*	0.3587***	0.1932***	0.0716	0.3187***	0.5032***	0.1412	0.4420***	0.1551	0.3345***	0.1534	0.3284***	0.2527***	0.5155***	0.0571
	(0.0445)	(0.0517)	(0.0600)	(0.0844)	(0.0653)	(0.0617)	(0.2088)	(0.0626)	(0.0945)	(0.0618)	(0.1072)	(0.0729)	(0.0679)	(0.0566)	(0.1029)
PSCORE		-3.8051***	-4.1378***	-3.8386***	-0.4421	-3.9032***	-4.1542***	-3.1347***	-4.2892***	-3.7371***	-3.5279***	-2.9494***	-3.9059***	-3.1517***	-4.6291***
		(0.2166)	(0.2405)	(0.2165)	(0.6008)	(0.1914)	(0.6382)	(0.2774)	(0.3553)	(0.2902)	(0.3668)	(0.4964)	(0.1977)	(0.2128)	(0.6106)
P2G*(PS- $\overline{PS}$)			2.7814***												
			(0.4289)												
P2G*time				0.0536***											
				(0.0108)											
Constant	1.3102***	1.5917***	1.6155***	1.5941***	0.9830***	1.6126***	1.7634***	1.3606***	1.8335***	1.5626***	1.7150***	1.2821***	1.8124***	1.3788***	1.7972***
	(0.0162)	(0.0241)	(0.0252)	(0.0240)	(0.0710)	(0.0361)	(0.0431)	(0.0464)	(0.0335)	(0.0424)	(0.0367)	(0.0633)	(0.0256)	(0.0319)	(0.0425)
Observations	2311	1431	1431	1431	339	500	592	461	580	583	458	383	658	740	682
R2	0.00051	0.17072	0.18027	0.17604	0.03892	0.27444	0.13954	0.22155	0.17728	0.21891	0.17318	0.12953	0.28525	0.21188	0.11764

Robust standard errors in brackets. * p<0.10, ** p<0.05, and *** p<0.010.

Table 4: Heterogeneity analysis of the effect of P2G adoption on direct taxes.

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]
Dependent variable: log(Indirect taxes)	No Control	Self electivity	Adoption pre-conditions	Experience	LIC	LMIC	UMIC	Poor socio-economic conditions	Good socio-economic conditions	High corruption	Low corruption	Low bureaucracy quality	High bureaucracy quality	Low urbanisation	High urbanisation
MPAY	0.0371	0.0748***	0.0735***	0.1093**	0.2377***	0.1751***	0.0041	0.1858***	0.0228	0.1017***	0.0094	0.1830***	0.0117	0.1469***	0.0282
	(0.0262)	(0.0279)	(0.0284)	(0.0464)	(0.0309)	(0.0464)	(0.0531)	(0.0437)	(0.0393)	(0.0390)	(0.0400)	(0.0528)	(0.0312)	(0.0362)	(0.0425)
PSCORE		-0.7206***	-0.7373***	-0.7135***	0.7230***	-1.2080***	-1.1976***	-0.4588*	-0.3475	-0.7477**	0.0915	-0.7055*	-0.3078*	-0.5234***	-1.0787***
		(0.1780)	(0.2198)	(0.1786)	(0.2142)	(0.2304)	(0.3939)	(0.2415)	(0.2672)	(0.3038)	(0.1936)	(0.4269)	(0.1611)	(0.1956)	(0.3387)
MPAY*(PS-$\overline{PS}$)			0.0738												
			(0.3217)												
MPAY*time				-0.0074											
				(0.0070)											
Constant	2.1700***	2.3500***	2.3541***	2.3482***	1.6788***	2.4296***	2.6456***	2.0635***	2.3131***	2.2512***	2.1767***	2.0964***	2.3050***	2.1866***	2.5423***
	(0.0128)	(0.0478)	(0.0576)	(0.0479)	(0.0573)	(0.0660)	(0.0988)	(0.0732)	(0.0697)	(0.0877)	(0.0522)	(0.1154)	(0.0467)	(0.0562)	(0.0850)
Observations	2521	1577	1577	1577	383	579	615	489	651	660	480	413	727	823	745
R2	0.00062	0.01726	0.01729	0.01762	0.15963	0.05833	0.03143	0.03003	0.00545	0.02219	0.00103	0.02682	0.00695	0.02282	0.02633

Robust standard errors in brackets. * p<0.10, ** p<0.05, and *** p<0.010.

Table 5: Heterogeneity analysis of the effect of MPAY adoption on indirect taxes.

	[1] log(Direct taxes)	[2] log(Indirect taxes)
P2G	0.340*	
	(0.2031)	
MPAY		0.113*
		(0.0668)
Pimary sector VA	-0.003	-0.009
	(0.0051)	(0.0061)
Private credit	0.008***	0.002
	(0.0026)	(0.0020)
Trade openness	0.002	0.002
	(0.0016)	(0.0013)
GDP growth	-0.014	0.039
	(0.0222)	(0.0238)
Inflation	0.001	-.0004
	(0.0038)	(0.0017)
Natural resources rents	-0.004	-0.021***
	(0.0066)	(0.0068)
Total population	-7.62e-10**	-3.99e-10
	(3.67e-10)	(3.55e-10)
Population density	-0.001***	-0.001***
	(0.0004)	(0.0002)
Total population*Population density	2.48e-12**	1.02e-12
	(1.09e-12)	(1.06e-12)
Net ODA received share in GNI	-0.021***	-0.007
	(0.0075)	(0.0087)
Constant	1.221***	2.251***
	(0.2150)	(0.2260)
Observations	1362	1538
Groups	95	99
Instruments	24	24
AR1-pvalue	0.21	0.06
AR2-pvalue	0.55	0.17
Hansen-pvalue	0.45	0.66

Robust standard errors in brackets. *** p<0.01, ** p<0.05, and * p<0.1

Table 6: Panel two-step system GMM estimation results.

VI. Conclusion

Several studies had explored the determinants of tax revenue in developing countries. Some of them have focused on the effect of financial development or financial inclusion on tax revenue. However, since most individuals in developing countries are excluded from the traditional financial system, identification variables related to this banking system are not relevant for developing countries. Therefore, we address this issue in this paper in investigating whether the MM's adoption as a financial inclusion factor contributes to improving tax revenue in developing countries.

Using the propensity score matching method, which is an appropriate method, we assess MM services' adoption causal effect (i.e., P2G and MPAY, respectively) on direct and indirect tax revenue, respectively, in developing countries. We find positive and significant ATTs on both direct and indirect taxes. Specifically, we find that the effect of P2G services adoption on direct taxes is stronger than the effect of MPAY adoption on indirect taxes. Our results remain robust to the tests for the quality of the matching and alternative estimation methods, including the function control and the system-GMM. Furthermore, we explore the heterogeneity in our results depending on factors such as the level of income, corruption, bureaucratic quality, and urbanization. We show that the positive and significant ATTs are higher for low-income and low middle-income countries and countries with a low level of bureaucracy, socio-economic condition, urbanization, and high level of corruption.

In light of the results, we recommend developing countries, especially those with low capacities and low financial inclusion, to promote the adoption and use of mobile money services. In addition to impacting the financial inclusion of the most vulnerable populations, reducing the circulation of cash, and facilitating transparency and tax compliance, it would allow countries to collect more tax revenue.

References

Acemoglu, D., Naidu, S., Restrepo, P., & Robinson, J. A. (2019). Democracy does cause growth. *Journal of Political Economy*, *127*(1), 47-100.

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

Ajide, F. M., & Bankefa, O. I., 2017. Does financial system influence tax revenue? The case of Nigeria. *African Journal of Economic Review*, *5*(3), 15-33.

Akçay, S., Sağbaş, İ., & Demirtaş, G., 2016. Financial development and tax revenue nexus in Turkey. *Journal of Economics and Development Studies*, *4*(1), 103-108.

Akram, N. 2016. Do financial sector activities affect tax revenue in Pakistan?. *The Lahore Journal of Economics*, *21*(2), 153.

Amoah, A., Korle, K., & Asiama, R. K., 2020. Mobile money as a financial inclusion instrument: what are the determinants?. *International Journal of Social Economics*.

Austin, P. C., 2014. The use of propensity score methods with survival or time-to-event outcomes: reporting measures of effect similar to those used in randomized experiments. *Statistics in medicine*, *33*(7), 1242-1258.

Balima, W. H., Combes, J. L., & Minea, A., 2016. Bond markets initiation and tax revenue mobilization in developing countries. *Southern Economic Journal*, *83*(2), 550-572.

Bayar, Y., & Karamelikli, H., 2017. Financial development and tax revenue in Turkey: A non-linear cointegration analysis. *The European Journal of Applied Economics*, *14*(2), 31-42.

Bayar, Y., Şaşmaz, M. Ü., & Öztürk, Ö. F., 2017. Financial Development and Tax Revenue: Evidence from OECD Countries. *Eurasian Academy of Sciences Eurasian Business & Economics Journal*, *12*, 51-63.

Besley, T., & Persson, T. (2014). Why do developing countries tax so little?. *Journal of Economic Perspectives, 28*(4), 99-120.

Bird, R. M., Martinez-Vazquez, J., & Torgler, B. (2006). Societal institutions and tax effort in developing countries. *The challenges of tax reform in a global economy*, *283*.

Blundell, R., & Bond, S., 1998. Initial conditions and moment restrictions in dynamic panel data models. *Journal of econometrics*, *87*(1), 115-143.

Brun, J. F., Chambas, G., Tapsoba, J., & Wandaogo, A. A., 2020. Are ICT's boosting tax revenue? Evidence from developing countries.

Caliendo, M., & Kopeinig, S., 2008. Some practical guidance for the implementation of propensity score matching. *Journal of economic surveys*, *22*(1), 31-72.

Caliendo, M., & Künn, S. (2011). Start-up subsidies for the unemployed: Long-term evidence and effect heterogeneity. *Journal of Public Economics*, *95*(3-4), 311-331.

Cariolle, J., & Carroll, D. (2020). The Use of Digital for Public Service Provision in Sub-Saharan Africa (*Doctoral dissertation, FERDI*).

Combes, J. L., Minea, A., & Sawadogo, P. N., 2019. Assessing the effects of combating illicit financial flows on domestic tax revenue mobilization in developing countries.

Compaore, A. (2020). Access-for-all to Financial Services: Non-resources Tax Revenue-harnessing Opportunities in Developing Countries.

De Paepe, G., & Dickinson, B., 2014. Tax revenue as a motor for sustainable development. *Organisation of Economic Co-operation and Development (ed) Development co-operation report*, 91-97.

Dehejia, R. H., & Wahba, S., 2002. Propensity score-matching methods for nonexperimental causal studies. *Review of Economics and statistics*, *84*(1), 151-161.

Della Peruta, M., 2018. Adoption of mobile money and financial inclusion: a macroeconomic approach through cluster analysis. *Economics of Innovation and New Technology*, *27*(2), 154-173.

Demirguc-Kunt, A., & Klapper, L., 2012. *Measuring financial inclusion: The global findex database*. The World Bank.

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

Easterly, W. (2002). Inequality does cause underdevelopment: New evidence. *Center for Global Development working paper*, (1).

Ebeke, C., Mansour, M., & Rota-Graziosi, G., 2016. The Power to Tax in Sub-Saharan Africa: LTUs, VATs, and SARAs.

Ebi, B. O., 2018. Financial sector development and tax revenue in Nigeria. *International Journal of Economics, Commerce and Management*, *6*(6), 93-109.

Rota-Graziosi, G., Sawadogo, F., & Silue, T. (2021). Taxation and innovation diffusion: Evidence from Kenya's mobile money revolution. *Etudes et Documents*, CERDI, à paraître.

GSMA. (2020), Digitalising person-to- government payments Leveraging mobile to improve government revenue and access to public services. https://www.gsma.com/publicpolicy/wp-content/uploads/2020/09/GSMA-Digitalising-person-to-government-payments.pdf.

GSMA. 2014. State of the Industry Mobile Financial Services for the Unbanked. https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2015/03/SOTIR_2014.pdf .

GSMA. 2019. State of the Industry Report on Mobile Money 2019. https://www.gsma.com/sotir/wp-content/uploads/2020/03/GSMA-State-of-the-Industry-Report-on-Mobile-Money-2019-Full-Report.pdf.

Heckman, J. J., Ichimura, H., & Todd, P. E., 1997. Matching as an econometric evaluation estimator: Evidence from evaluating a job training programme. *The review of economic studies*, *64*(4), 605-654.

Heckman, J. J., Ichimura, H., & Todd, P., 1998. Matching as an econometric evaluation estimator. *The review of economic studies*, *65*(2), 261-294.

Ilievski, B., 2015. Stock markets and tax revenue. *Journal of Applied Finance and Banking*, *5*(3), 1.

Imai, K. S., & Azam, M. S., 2012. Does microfinance reduce poverty in Bangladesh? New evidence from household panel data. *Journal of Development studies*, *48*(5), 633-653.

Imam, P. A., & Jacobs, D., 2007. Effect of corruption on tax revenue in the Middle East. *IMF Working Papers*, 1-34.

Imbens, G. W., 2004. Nonparametric estimation of average treatment effects under exogeneity: A review. *Review of Economics and statistics*, *86*(1), 4-29.

IFC (2018). Digital access: the future of financial inclusion in Africa. Available at https://www.ifc.org/wps/wcm/connect/96a4f610-62b1-4830-8516-f11642cfeafd/201805_Digital-Access_The-Future-of-Financial-Inclusion-in-Africa_v1.pdf?MOD=AJPERES&CVID=mdz-QF0 .

Jack, W., & Suri, T., 2014. Risk sharing and transactions costs: Evidence from Kenya's mobile money revolution. *American Economic Review*, *104*(1), 183-223.

Jacolin, L., Massil Joseph, K., & Noah, A. (2019). Informal Sector and Mobile Financial Services in Developing Countries: Does Financial Innovation Matter?.

Joshi, A., Prichard, W., & Heady, C. (2014). Taxing the informal economy: The current state of knowledge and agendas for future research. *The Journal of Development Studies, 50*(10), 1325-1347.

Keen, M., & Lockwood, B., 2010. The value added tax: Its causes and consequences. *Journal of Development Economics*, *92*(2), 138-151.

Khattry, B., & Rao, J. M., 2002. Fiscal faux pas?: an analysis of the revenue implications of trade liberalization. *World Development*, *30*(8), 1431-1444.

Lashitew, A. A., van Tulder, R., & Liasse, Y., 2019. Mobile phones for financial inclusion: What explains the diffusion of mobile money innovations?. *Research Policy*, *48*(5), 1201-1215.

Le, T. M., Le, T. M., Moreno-Dodson, B., & Rojchaichaninthorn, J. (2008). *Expanding taxable capacity and reaching revenue potential: cross-country analysis*. World Bank.

Levchenko, A. A., Ranciere, R., & Thoenig, M., 2009. Growth and risk at the industry level: The real effects of financial liberalization. *Journal of Development Economics*, *89*(2), 210-222.

Lin, S., & Ye, H., 2007. Does inflation targeting really make a difference? Evaluating the treatment effect of inflation targeting in seven industrial countries. *Journal of Monetary Economics*, *54*(8), 2521-2533.

Lin, S., & Ye, H., 2009. Does inflation targeting make a difference in developing countries?. *Journal of Development economics*, *89*(1), 118-123.

Maherali, Alim., 2017. Financial Inclusion, Digital Payments and Their Impact on Income and Tax Revenue Around the World. Master's thesis, Harvard Extension School.

Moore, M., & Prichard, W. (2020). How Can Governments of Low-Income Countries Collect More Tax Revenue?. In *The Politics of Domestic Resource Mobilization for Social Development* (pp. 109-138). Palgrave Macmillan, Cham.

Ndung'u, N. (2019). Taxing Mobile Phone Transactions in Africa: Lessons from Kenya, brookings Institution. *Africa Growth Initiative Policy brief*.

Nnyanzi, J. B., Bbale, J. M., & Sendi, R., 2018. Financial development and tax revenue: How catalytic are political development and corruption. *International Journal of Economics and Finance*, *10*(8), 92-104.

Oz-Yalaman, G., 2019. Financial inclusion and tax revenue. *Central Bank Review*, *19*(3), 107-113.

Rodríguez Bolívar, M. P., Navarro Galera, A., Alcaide Munoz, L., & López Subires, M. D. (2016). Analyzing forces to the financial contribution of local governments to sustainable development. *Sustainability*, *8*(9), 925.

Roodman, D., 2009. How to do xtabond2: An introduction to difference and system GMM in Stata. *The stata journal*, *9*(1), 86-136.

Rosenbaum, P. R., & Rubin, D. B., 1983. The central role of the propensity score in observational studies for causal effects. *Biometrika*, *70*(1), 41-55.

Rosenbaum, P. R., & Rubin, D. B. (1985). Constructing a control group using multivariate matched sampling methods that incorporate the propensity score. *The American Statistician*, *39*(1), 33-38.

Rosenbaum, P. R., 2002. Overt bias in observational studies. In *Observational studies* (pp. 71-104). Springer, New York, NY.

Sawadogo, F., & Wandaogo, A. A., 2021. Does mobile money services adoption foster intra-African goods trade?. *Economics Letters*, *199*, 109681.

Sawadogo, P. N., 2020. Can fiscal rules improve financial market access for developing countries?. *Journal of Macroeconomics*, 103214.

Sianesi, B., 2004. An evaluation of the Swedish system of active labor market programs in the 1990s. *Review of Economics and statistics*, *86*(1), 133-155.

Smith, J. A., & Todd, P. E., 2005. Does matching overcome LaLonde's critique of nonexperimental estimators?. *Journal of econometrics*, *125*(1-2), 305-353.

Taha, R., Colombage, S. R., Maslyuk, S., & Nanthakumar, L., 2013. Does financial system activity affect tax revenue in Malaysia? Bounds testing and causality approach. *Journal of Asian Economics*, *24*, 147-157.

Tanzi, V., 1977. Inflation, lags in collection, and the real value of tax revenue. *Staff Papers*, *24*(1), 154-167.

Wellalage, N. H., Hunjra, A. I., Manita, R., & Locke, S. M., 2020. Information communication technology and financial inclusion of innovative entrepreneurs. *Technological Forecasting and Social Change*, 120416.

Windmeijer, F., 2005. A finite sample correction for the variance of linear efficient two-step GMM estimators. *Journal of econometrics*, *126*(1), 25-51.

Wooldridge, J. M., 2002. Inverse probability weighted M-estimators for sample selection, attrition, and stratification. *Portuguese Economic Journal*, *1*(2), 117-139.

Appendices

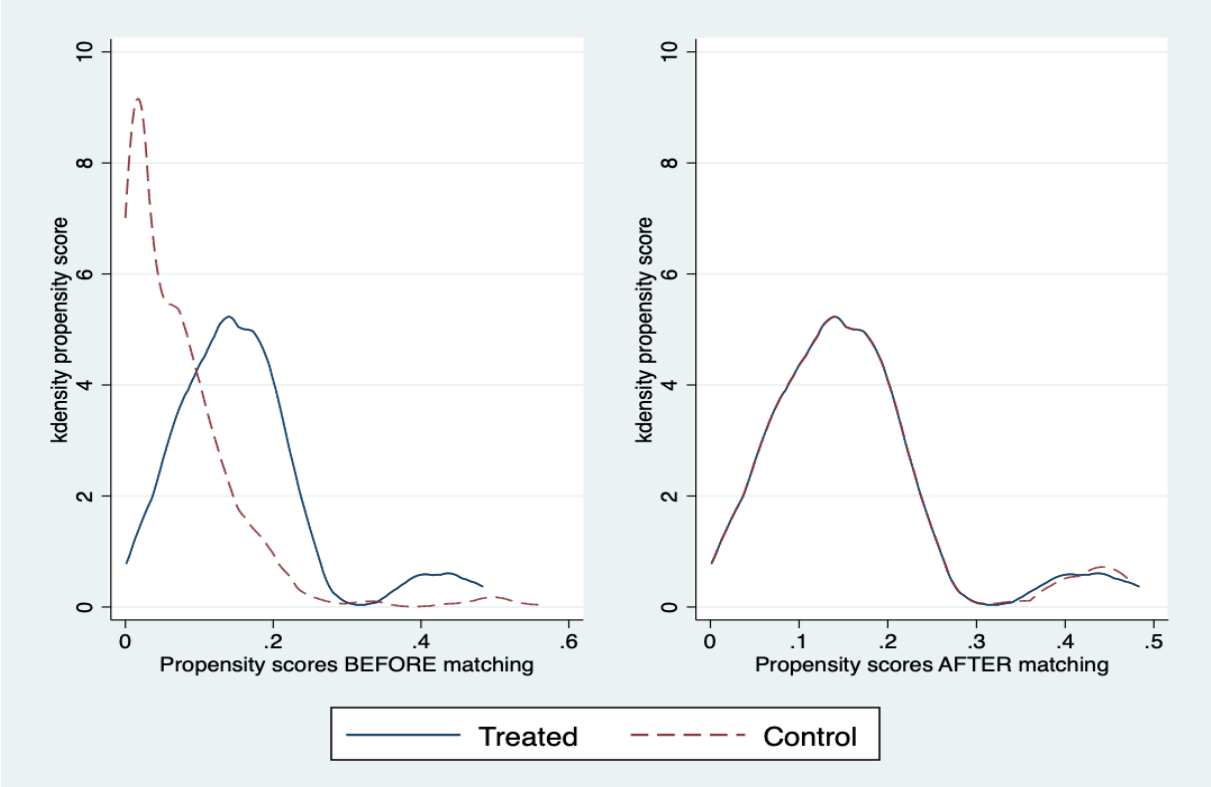

Figure A. 1 : Propensity scores before and after matching for P2G density plot

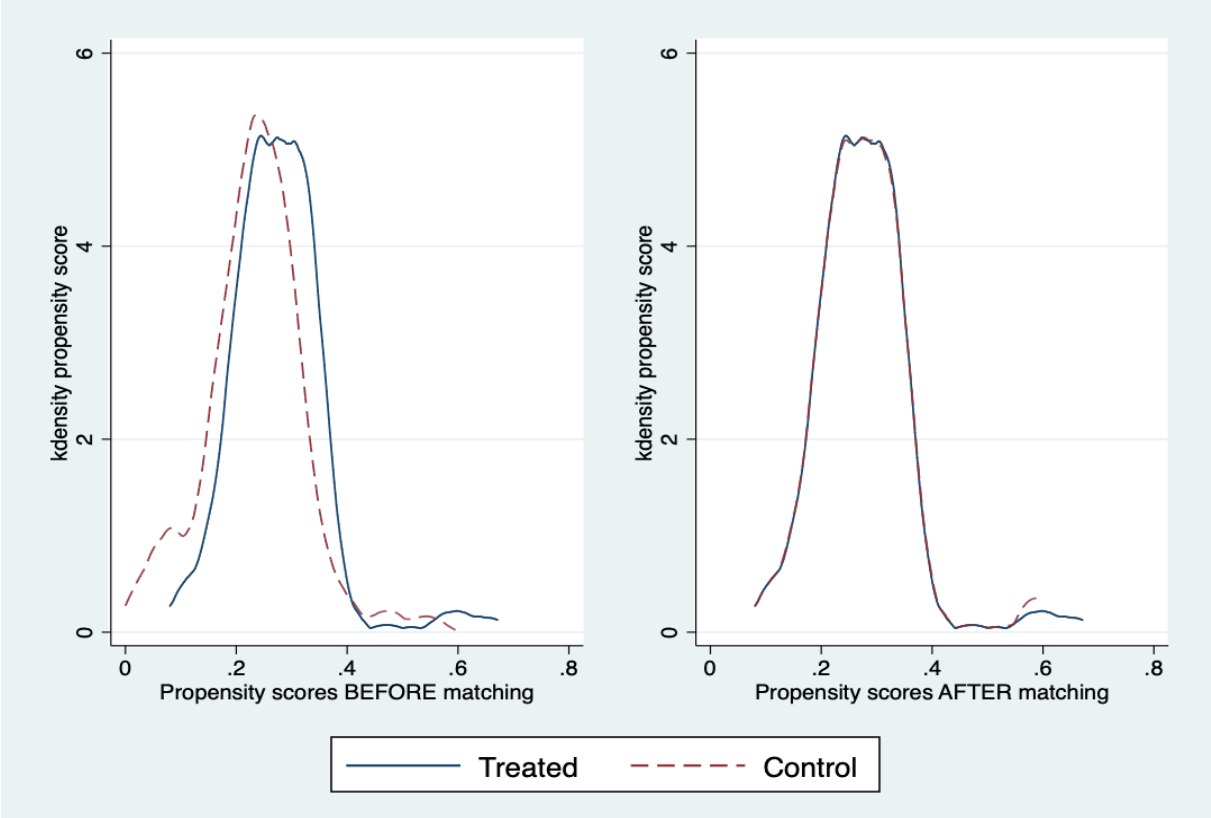

Figure A. 2: Propensity scores before and after matching for MPAY density plot

Treatment variable: P2G	1-Nearest Neighbor Matching	2-Nearest Neighbor Matching	3-Nearest Neighbor Matching	Radius Matching			Local Linear Regression Matching	Kernel Matching
				r=0.005	r=0.01	r=0.05		
Dependent variable: Log(Direct taxes)								
Average Treatment on the Treated (ATT)	0.3604***	0.3827***	0.3544***	0.3654***	0.3652***	0.3516***	0.3715***	0.3545***
	(0.0951)	(0.0860)	(0.0723)	(0.0592)	(0.0574)	(0.0501)	(0.0545)	(0.0549)
Observations/Treated observations	1431/115							
Quality of the matching								
Pseudo-R2	0.058	0.044	0.034	0.017	0.016	0.011	0.058	0.01
Rosenbaum bounds sensitivity test	2.3	3.2	3.1	3.4	3.4	3.4	3.7	3.5
Standardized bias (p-value)	0.03	0.117	0.282	0.816	0.836	0.948	0.03	0.959
ATT by type of direct tax								
Log(Corporate Income Tax)	0.2001***	0.1873***	0.2000***	0.1862***	0.1950***	0.1959***	0.1891***	0.1970***
	(0.0703)	(0.0654)	(0.0634)	(0.0489)	(0.0438)	(0.0378)	(0.0364)	(0.0363)
Log(Personal Income Tax)	0.3190***	0.3459***	0.3345***	0.3912***	0.3650***	0.3441***	0.3122***	0.3483***
	(0.0923)	(0.0753)	(0.0756)	(0.0555)	(0.0530)	(0.0472)	(0.0491)	(0.0473)

Standard errors in brackets. *** significance level at 1%, ** significance level at 5%, * significance level at 10%. **Bootstrap replications=500**

Table A. 1: Matching results for the effect of P2G on direct taxes (alternative specification).

Treatment variable: MPAY	1-Nearest Neighbor Matching	2-Nearest Neighbor Matching	3-Nearest Neighbor Matching	Radius Matching			Local Linear Regression Matching	Kernel Matching
				r=0.005	r=0.01	r=0.05		
Dependent variable: Log(Indirect taxes)								
Average Treatment on the Treated (ATT)	0.0213	0.0347	0.0419	0.0542*	0.0614**	0.0588**	0.0932***	0.0581**
	(0.0493)	(0.0441)	(0.0396)	(0.0291)	(0.0293)	(0.0259)	(0.0276)	(0.0273)
Observations/Treated observations	1577/386							
Quality of the matching								
Pseudo-R2	0.003	0.002	0.002	0.002	0.002	0.002	0.003	0.002
Rosenbaum bounds sensitivity test	1	1	1	1.1	1.2	1.2	1.5	1.2
Standardized bias (p-value)	0.949	0.968	0.976	0.971	0.988	0.97	0.949	0.975
ATT by type of indirect tax								
Log(Value Added Tax)	0.2051*	0.1392	0.1376*	0.1775***	0.1665***	0.1536***	0.1901***	0.1535***
	(0.1226)	(0.1021)	(0.0821)	(0.0676)	(0.0577)	(0.0501)	(0.0532)	(0.0487)
Lag(Excises)	-0.0100	-0.0045	0.0181	0.0405	0.0378	0.0409	0.0614**	0.0410
	(0.0522)	(0.0465)	(0.0445)	(0.0360)	(0.0326)	(0.0306)	(0.0285)	(0.0307)

Standard errors in brackets. *** significance level at 1%, ** significance level at 5%, * significance level at 10%. **Bootstrap replications=500**

Table A. 2: Matching results for the effect of MPAY on indirect taxes (alternative specification).

	[1] log(Direct taxes)	[2] log(Indirect taxes)
P2G	0.345*	
	(0.2079)	
MPAY		0.109*
		(0.0647)
Pimary sector VA	-0.003	-0.009
	(0.0051)	(0.0060)
Private credit	0.008***	0.002
	(0.0025)	(0.0019)
Trade openness	0.002	0.002
	(0.0016)	(0.0013)
GDP growth	-0.015	0.038*
	(0.0217)	(0.0232)
Inflation	0.001	-0.001
	(0.0038)	(0.0020)
Natural resources rents	-0.004	-0.021***
	(0.0066)	(0.0068)
Total population	-1.53e-10	-9.41e-11
	(2.91e-10)	(2.19e-10)
Population density	-0.001**	-0.001***
	(0.0003)	(0.0002)
Net ODA received share	-0.021***	-0.007
	(0.0073)	(0.0085)
Constant	1.212***	2.227***
	(0.2129)	(0.2159)
Observations	1362	1577
Groups	95	99
Instruments	23	23
AR1-pvalue	0.22	0.06
AR2-pvalue	0.55	0.15
Hansen-pvalue	0.41	0.72

Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table A. 3: Panel two-step system GMM estimation results (alternative specification).

N°	Country	Income group	MPAY	P2G	N°	Country	Income group	MPAY	P2G
1	Afghanistan	Low Income	2009		53	Liberia	Low Income	2011	2016
2	Albania	Upper-Middle Income			54	Libya	Upper-Middle Income		
3	Algeria	Upper-Middle Income			55	Macedonia	Upper-Middle Income		
4	Angola	Lower-Middle Income			56	Madagascar	Low Income	2010	2012
5	Armenia	Upper-Middle Income			57	Malawi	Low Income	2012	
6	Azerbaijan	Upper-Middle Income			58	Malaysia	Upper-Middle Income	2018	
7	Bangladesh	Lower-Middle Income	2009	2010	59	Maldives	Upper-Middle Income	2016	
8	Belarus	Upper-Middle Income			60	Mali	Low Income	2010	
9	Benin	Low Income	2010		61	Mauritania	Lower-Middle Income	2013	
10	Bhutan	Lower-Middle Income			62	Mexico	Upper-Middle Income	2012	
11	Bolivia	Lower-Middle Income	2013		63	Moldova	Lower-Middle Income		
12	Bosnia and Herzegovina	Upper-Middle Income			64	Mongolia	Lower-Middle Income	2010	
13	Botswana	Upper-Middle Income	2011		65	Montenegro	Upper-Middle Income		
14	Brazil	Upper-Middle Income	2015	2016	66	Morocco	Lower-Middle Income	2010	
15	Burkina Faso	Low Income	2015		67	Mozambique	Low Income	2011	
16	Burundi	Low Income	2012		68	Myanmar	Lower-Middle Income	2017	2017
17	Cambodia	Lower-Middle Income	2009		69	Namibia	Upper-Middle Income	2015	
18	Cameroon	Lower-Middle Income	2010	2010	70	Nepal	Low Income	2009	
19	Cape Verde	Lower-Middle Income			71	Nicaragua	Lower-Middle Income		
20	Chad	Low Income	2012		72	Niger	Low Income	2010	
21	China	Upper-Middle Income			73	Nigeria	Lower-Middle Income	2011	
22	Colombia	Upper-Middle Income	2011		74	Pakistan	Lower-Middle Income	2009	2012
23	Comoros	Lower-Middle Income			75	Paraguay	Upper-Middle Income	2010	
24	Costa Rica	Upper-Middle Income			76	Peru	Upper-Middle Income	2015	
25	Cote d'Ivoire	Lower-Middle Income	2008	2008	77	Philippines	Lower-Middle Income	2004	2004
26	Djibouti	Lower-Middle Income			78	Rwanda	Low Income	2009	2009
27	Dominica	Upper-Middle Income			79	Samoa	Lower-Middle Income	2011	
28	Dominican Republic	Upper-Middle Income	2015		80	Senegal	Lower-Middle Income	2010	
29	Ecuador	Upper-Middle Income			81	Serbia	Upper-Middle Income		
30	El Salvador	Lower-Middle Income	2011		82	Sierra Leone	Low Income	2017	
31	Equatorial Guinea	Upper-Middle Income			83	Solomon Islands	Lower-Middle Income		
32	Gabon	Upper-Middle Income	2012		84	South Africa	Upper-Middle Income	2015	
33	Gambia, The	Low Income			85	Sri Lanka	Upper-Middle Income	2012	2012
34	Georgia	Upper-Middle Income	2013		86	Suriname	Upper-Middle Income		
35	Ghana	Lower-Middle Income	2009	2009	87	Swaziland	Lower-Middle Income	2011	
36	Grenada	Upper-Middle Income			88	Syrian Arab Republic	Low Income		
37	Guatemala	Upper-Middle Income	2011		89	Tajikistan	Low Income		
38	Guinea	Low Income	2012	2012	90	Tanzania	Low Income	2008	2008
39	Guinea-Bissau	Low Income	2010		91	Thailand	Upper-Middle Income		
40	Guyana	Upper-Middle Income	2013	2013	92	Timor-Leste	Lower-Middle Income	2016	
41	Haiti	Low Income	2010		93	Togo	Low Income	2013	
42	Honduras	Lower-Middle Income	2011		94	Tonga	Upper-Middle Income		
43	India	Lower-Middle Income	2012		95	Tunisia	Lower-Middle Income	2012	
44	Indonesia	Lower-Middle Income	2009		96	Turkey	Upper-Middle Income		
45	Iraq	Upper-Middle Income	2015		97	Uganda	Low Income	2009	2009
46	Jamaica	Upper-Middle Income	2016		98	Ukraine	Lower-Middle Income		
47	Jordan	Upper-Middle Income	2016		99	Vanuatu	Lower-Middle Income		
48	Kazakhstan	Upper-Middle Income			100	Vietnam	Lower-Middle Income	2010	
49	Kenya	Lower-Middle Income	2007	2007	101	West Bank and Gaza	Lower-Middle Income		
50	Kosovo	Upper-Middle Income			102	Zambia	Lower-Middle Income	2009	
51	Lebanon	Upper-Middle Income			103	Zimbabwe	Lower-Middle Income	2011	2011
52	Lesotho	Lower-Middle Income	2012						

Note: In the MPAY/P2G columns, we present the year of adoption. Adoption year is blank for countries that had not yet adopted it at the end of 2018.

Table A. 4: List of countries and adoption years.

Variables	Description	Source
MPAY (Merchant Payments)	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.	Authors construction using informations from Global system for Mobile communication Associations (GSMA)
P2G (Person to government transfers)	These are transfers of funds from individuals or businesses to governments for public services (for example, to obtain documents such as birth or marriage certificates or business licenses), statutory payments such as duties, and payments for public utilities owned by the government. Recipient agencies and institutions may be at the municipal, state or national level, and include, for example, public schools, police forces and tax authorities.	Authors construction using informations from (GSMA)
Direct tax revenues	Total direct tax revenues excluding social contributions and resource revenues	International Centre for Tax and Development (ICTD)
Indirect tax revenues	Total indirect tax revenue	ICTD
Corporate income tax	Corporate and other business tax revenues	ICTD
Personal income tax	Taxe on income, profits and capital gains	ICTD
Value Added Tax	Tax on goods and services, of wich Value add tax	ICTD
Excises	Tax on goods and services, of wich excises	ICTD
Primary sector VA	It includes silviculture, forestry, hunting and fishing, as well as agriculture and breeding. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs.	World Development Indicators (WDI)
Private credit	Domestic credit to the private sector refers to financial resources provided to the private sector by financial companies, such as loans, purchases of non-participating securities, trade credits, and other accounts receivable, which establish a claim for repayment.	WDI
Trade openness	This is the total of exports and imports. It represents the degree of openness of a country.	WDI
GDP growth	Annual percentage growth rate of GDP at market prices based on constant local currency. Aggregates are based on constant 2010 U.S. dollars. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources.	WDI
Inflation	It reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that can be set or changed at annual intervals.	WDI
Natural resources rents	Total natural resource rents are the sum of the rents from oil, natural gas, hard and soft coal, minerals and forests.	WDI
Total population	The total population estimates in mid-year all residents in a country regardless of their legal status or citizenship.	WDI
Population density	Population density is the mid-year population divided by the area in square kilometers. It indicates the number of residents per square kilometer.	WDI
Net ODA received share	Net official development assistance (ODA) consists of disbursements of loans made on concessional terms (net of repayments of principal) and grants by official agencies of the members of the Development Assistance Committee (DAC), by multilateral institutions, and by non-DAC countries to promote economic development and welfare in countries and territories in the DAC list of ODA recipients. It includes loans with a grant element of at least 25 percent (calculated at a rate of discount of 10 percent).	WDI
Corruption	This is an assessment of corruption within the political system. Such corruption is a threat to foreign investment for several reasons: it distorts the economic and financial environment; it reduces the efficiency of government and business by enabling people to assume positions of power through patronage rather than ability; and, last but not least, introduces an inherent instability into the political process.	International Country Risk Guide (ICRG)
Socioeconomic conditions	This is an assessment of the socioeconomic pressures at work in society that could constrain government action or fuel social dissatisfaction. The risk rating assigned is the sum of three subcomponents, each with a maximum score of four points and a minimum score of 0 points. A score of 4 points equates to Very Low Risk and a score of 0 points to Very High Risk.	ICRG
Bureaucracy quality	The institutional strength and quality of the bureaucracy is another shock absorber that tends to minimize revisions of policy when governments change. Therefore, high points are given to countries where the bureaucracy has the strength and expertise to govern without drastic changes in policy or interruptions in government services. In these low-risk countries, the bureaucracy tends to be somewhat autonomous from political pressure and to have an established mechanism for recruitment and training. Countries that lack the cushioning effect of a strong bureaucracy receive low points because a change in government tends to be traumatic in terms of policy formulation and day-to-day administrative functions.	ICRG
Urbanization	Urban population refers to people living in urban areas as defined by national statistical offices. The indicator is calculated using World Bank population estimates and urban ratios from the United Nations World Urbanization Prospects. Percentages urban are the numbers of persons residing in an area defined as "urban" per 100 total population.	WDI

Table A. 5: Variables descriptions.

Variables	Observations	Mean	St. Dev	Min	Max
MPAY	1817	0.2619703	0.4398276	0	1
P2G	1817	0.0781508	0.2684826	0	1
Direct tax revenues	1431	4.552861	2.754095	0.1465192	17.44217
Indirect tax revenues	1577	9.986127	4.653542	0.1521545	47.8479
Corporate income tax	1213	2.293769	1.586587	0	15.29344
Personal income tax	1451	4.696101	2.85449	0.2205394	17.50363
Value Added Tax	1054	4.636709	3.104981	0.787762	18.88621
Excises	1239	1.74742	1.345362	0	8.141266
Primary sector VA	1817	18.09232	12.5085	0.8926961	79.04236
Private credit	1817	33.33606	29.64582	0.4025806	160.1248
Trade openness	1817	75.74713	37.02202	0.1674176	311.3541
GDP growth	1817	4.230042	4.238188	-30.14513	54.15777
Inflation	1817	7.980204	49.29572	-21.53169	2075.888
Natural resources rents	1817	7.651639	9.855866	0	68.79008
Total population	1817	5.93e+07	2.03e+08	69650	1.39e+09
Population density	1817	129.236	179.9646	1.467905	1718.987
ODA net received share	1817	6.202407	8.356912	-0.4752051	92.14146

Table A. 6: Descriptive statistics.