THE STATE CAPACITY CEILING ON TAX RATES:

EVIDENCE FROM RANDOMIZED TAX ABATEMENTS IN THE DRC

Augustin Bergeron
Gabriel Tourek
Jonathan L. Weigel

November 30, 2023

Abstract

This paper investigates how tax rates and tax enforcement jointly impact fiscal capacity in low-income countries. We study a policy experiment in the D.R. Congo that randomly assigned 38,028 property owners to the status quo tax rate or to a rate reduction. This variation in tax liabilities reveals that the status quo rate lies *above* the revenue-maximizing tax rate (RMTR). Reducing rates by about one-third would maximize government revenue by increasing tax compliance. We then exploit two sources of variation in enforcement — randomized enforcement letters and random assignment of tax collectors — to show that the RMTR increases with enforcement. Including an enforcement message on tax letters or replacing tax collectors in the bottom quartile of enforcement capacity with average collectors would raise the RMTR by about 40%. Tax rates and enforcement are thus complementary levers. Jointly optimizing tax rates and enforcement would lead to 10% higher revenue gains than optimizing them independently. These findings provide experimental evidence that low government enforcement capacity sets a binding ceiling on the revenue-maximizing tax rate in some developing countries, thereby demonstrating the value of increasing tax rates in tandem with enforcement to expand fiscal capacity.

Affiliations: Bergeron — University of Southern California and NBER (augustin.bergeron@usc.edu), Tourek — University of Pittsburgh (gabriel.tourek@pitt.edu), Weigel — U.C. Berkeley and NBER (jweigel@berkeley.edu). We thank Pablo Balán, Jacob Bastian, Pedro Bessone, Michael Best, Emily Breza, Anne Brockmeyer, Raj Chetty, Lucas De Lima, Monica Farid, Edward Glaeser, Blake Heller, Nathan Hendren, Anders Jensen, Larry Katz, Adnan Khan, Henrik Kleven, Wojciech Kopczuk, Asim Khwaja, Gabriel Kreindler, Juliana Londoño-Vélez, Omeed Maghzian, Mateo Montenegro, Joana Naritomi, Nathan Nunn, Dina Pomeranz, Gautam Rao, Tzachi Raz, Juan Carlos Suárez Serrato, Mazhar Waseem, David Yang, Noam Yuchtman as well as participants at the BREAD/NBER Conference 2020, DEVPEC 2020, NEUDC 2019, NTA 2019, PacDev 2020, the 2nd World Bank Tax Conference, and numerous seminars for invaluable suggestions. For outstanding research assistance, we thank Michele Mary Bernadine, Manon Delvaux, Samih Ferrah, Arnaud Fournier, Alix Leroy, Florence Oberholzer, Stephen Mathew and David Mast. For excellent program management we thank Elie Kabue Ngindu and the rest of the Odeka Team. We are grateful for the collaboration with the Provincial Government of Kasaï-Central and the Direction Générale des Recettes du Kasaï-Central (DGRKAC). We gratefully acknowledge funding from the EGAP Metaketa II Taxation Initiative and the J-PAL Governance Initiative. This study has been approved by the Harvard Institutional Review Board: Protocol IRB17-0724. The Pre-Analysis Plan was submitted to the AEA RCT Registry on January 28, 2019: AEARCTR-0003818.

1 Introduction

Governments in the world's poorest countries face severe revenue constraints. They collect only 10% of GDP in taxes compared to 40% in rich countries. This lack of tax revenue is associated with low-quality public services and infrastructures and is thought to undermine economic growth (Besley and Persson, 2013).

To increase revenue, can low-income countries simply raise tax rates? To answer this question, governments must consider behavioral responses — e.g., in labor supply or tax delinquency — which could offset the revenue gains from tax rate increases. In low-income countries with weak states, enforcement is far from perfect (Pomeranz, 2015), and delinquency is the first-order behavioral response governments must contend with when setting tax rates (Besley and Persson, 2014) or choosing the tax base (Best et al., 2015). The magnitude of behavioral responses — and thus the revenue-maximizing tax rate (RMTR) — is likely shaped by government policy and the enforcement environment, as noted in a large theoretical literature (e.g., Slemrod and Kopczuk, 2002; Keen and Slemrod, 2017). Investments in enforcement capacity could, in theory, shift up the RMTR in weak states (Besley and Persson, 2009).

This paper quantifies the impact of tax enforcement activities on the revenue-maximizing tax rate, and in doing so empirically illustrates that low enforcement capacity can set a ceiling on the RMTR. We exploit random variation in the joint distribution of tax rates and tax enforcement in the DRC, a very low capacity state and one of the world's poorest countries. There are two steps to the analysis. First, we analyze (to our knowledge) the first field experiment generating random variation in tax rates. In its 2018 property tax campaign, the Provincial Government of Kasaï-Central randomly assigned tax abatements at the property level. We use this variation to estimate the elasticity of tax compliance and revenue with respect to the tax rate as well as the RMTR. Second, we leverage two exogenous sources of variation in enforcement — randomized enforcement messages on tax notices and random assignment of tax collectors to neighborhoods — to study how the RMTR responds to changes in the enforcement environment.

The field experiment we study was embedded in a 2018 property tax campaign in the city of Kananga, implemented by the Provincial Government of Kasaï-Central. The 38,028 properties in the city were randomly assigned to the status quo annual tax liability (control) or a reduction of 17%, 33%, or 50%. In these three treatment groups, taxpayers were only informed about their liability, printed on a government tax notice, and were not informed about receiving a reduction.

As in other low-income countries, tax compliance is low in Kananga: on average, 8.8% of property owners paid the property tax in 2018. However, lower tax rates substantially increased compliance. Only 5.6% of the owners assigned to the status quo tax rate paid the property tax, compared to 6.7%, 10%, and 13% for owners assigned to reductions of 17%, 33%, and 50%, respectively. Because the property tax in Kananga is a flat fee and partial payments were not permitted, this increase in compliance led to significantly higher revenue at lower rates. The elasticities of tax compliance and revenue with respect to the tax rate are -1.246 and -0.243, respectively. In other words, a 1% increase in the tax rate reduces compliance by 1.246% and revenue by 0.243%. The treatment effects on compliance and revenue and the associated elasticities therefore suggest that the status quo tax rates lie above the RMTR in this setting.

Before estimating the revenue-maximizing tax rate and investigating its interaction with enforcement, we evaluate the validity of our treatment effects and elasticities by considering alternative explanations concerning taxpayer and collector behavior. An important concern is whether property owners' responses could be biased by their information and beliefs about tax rates. Owners' knowledge of others' rates, for instance, could bias our estimated elasticities if owners' behavior in part reflects fairness considerations. However, our estimates are robust to controlling for neighbors' tax rates, or restricting the sample by knowledge of others' rates, as measured in surveys. Our results would also be biased if owners assigned to lower rates were more likely to pay because they anchored on past rates and thus received "transactional utility" — the sense of getting a deal — from rate abatements. Yet by design very few property owners (2.8%) were aware that they received a discount. Another concern is if tax collectors made more frequent visits to households assigned to low rates, the treatment effects could be explained in part by differential enforcement effort across rates. We examine this issue by (*i*) exploiting exogenous variation in collectors' incentives to exert effort differentially by rate, and (*ii*) controlling for the number of times collectors visited households. The treatment effects are essentially unchanged when we take collectors' enforcement effort into account.

In the second part of the paper, we explore how responses to tax rates interact with enforcement. First, we outline a simple theoretical framework focused on how tax rates and tax enforcement jointly impact citizens' decisions to comply or not with the property tax. We use this framework to obtain a formula for the RMTR that we can estimate in the data. The estimated RMTR is 66% of the status quo rate when assuming a linear relationship between tax rates and compliance. In other words, consistent with the estimated treatment effects, in this low-enforcement environment the provincial government would maximize revenue by reducing the statutory property tax rate by 34%.

We then examine the impact of tax enforcement activities on the revenue-maximizing tax rate. According to the theoretical framework, the RMTR should increase with government enforcement capacity. We rely on two sources of variation in enforcement to test this prediction. First, we study messages embedded in government tax letters distributed by collectors to property owners during property registration. Property owners were randomly assigned to receive an enforcement message noting the consequences for tax delinquency or a control message noting that paying taxes is important. The estimated RMTR is 41% higher among owners assigned to the enforcement message.

A second source of variation in enforcement comes from the random assignment of tax collectors to neighborhoods. Tax collectors vary in their enforcement capacity — i.e., their ability to make property owners pay the tax — and we can use their random assignment to neighborhoods to estimate how collector enforcement capacity impacted the RMTR. We use a fixed effects model to estimate each collector's enforcement ability, proxied by the average tax compliance they achieved across all assigned neighborhoods and rates. Additionally, tax collectors vary in their ability to collect at different tax rates, allowing us to estimate the RMTR for each tax collector, again using a fixed effects model. The tax collector approach yields similar results to the tax letter approach: the RMTR increases with enforcement capacity. Specifically, replacing tax collectors in the bottom quartile of enforcement capacity with average collectors would increase the RMTR by 42%.

These results suggest that tax rates and enforcement are complementary levers. Investments in enforcement capacity could allow developing countries to shift up their revenue-maximizing tax rates. To illustrate this idea in revenue terms, we use our estimates to predict the gains that a sophisticated government would realize by anticipating how enforcement investments would increase the RMTR, compared to a naive government that manipulates rates and enforcement independently. A naive government that sequentially implements the RMTR and then increases enforcement — by replacing the bottom quartile of collectors with average collectors — would raise revenue by 61% relative to the status quo. By contrast, a sophisticated government that prospectively chooses the new RMTR corresponding to its higher enforcement capacity — would instead raise revenue by 77%. In short, jointly optimizing tax rates and enforcement would lead to 10% higher revenue gains than optimizing them independently.

This paper contributes to the literature by providing experimental evidence of a state capacity ceiling on the revenue-maximizing tax rate. To our knowledge, this is the first paper to provide a rigorous empirical illustration of this idea, which is how Besley and Persson (2009) conceptualize state capacity in their seminal framework. More generally, a large theoretical literature argues that individuals' responses to tax rates depend on the enforcement environment, and thus that the RTMR is a policy choice not a structural parameter (e.g., Slemrod and Kopczuk, 2002; Keen and Slemrod, 2017). The idea that the RMTR moves in tandem with enforcement capacity is challenging to test because one needs exogenous variation in both tax rates and enforcement.[1] Two related papers are Basri et al. (2019) and Brockmeyer et al. (2023), which compare tax rates and tax enforcement as independent policy levers but do not explore their interaction.[2] The policy experiment we study enables us to make progress on this issue. Consistent with the theoretical literature, tax rates and enforcement appear to be complementary levers in this setting.

We also contribute to a growing empirical literature on optimal tax rates by experimentally illustrating the importance of extensive-margin taxpayer compliance responses in low-income countries. Most of this literature focuses on high-income countries (Saez et al., 2012) and middle-income countries (Basri et al., 2019; Brockmeyer et al., 2023), where tax rates often lie below the RMTR.[3] We contribute evidence from a low-income country with weak enforcement capacity, where tax rates have received less attention.[4] In contrast to most of the literature in high- and middle-income settings, we find that tax rates are *above* the RMTR due to greater extensive-margin noncompliance as rates increase. This is important for policy because tax revenues are sorely needed in fragile state settings (Besley and Persson, 2013), yet we have little evidence of policies capable of boosting compliance in such settings. Moreover, while most past work is quasi-experimental, we use random variation in tax liabilities generated by a policy experiment implemented by the government to

[1] The closest paper might be Mishra et al. (2008), which, while lacking exogenous variation in enforcement, shows that the evasion elasticity with respect to tariff rates in India is more pronounced (*i*) for products where evasion is easier because of differentiation or price variation, and (*ii*) in ports compared to airports, potentially due to less computerization. The interaction between the RMTR and other tax policy parameters, such as the tax base, has also been studied in the context of income (Kopczuk, 2005) and corporate taxation (e.g., Serrato and Zidar, 2018).

[2] Basri et al. (2019) mention the cross-elasticity in passing, but focus instead on comparing how increasing tax rates or staff-to-taxpayer ratios independently impact revenue.

[3] An exception is Bachas and Soto (2019), which finds that the highest tax rates on corporate profits are above the RMTR in a middle-income country (Costa Rica).

[4] Generally, the literature on public finance in developing countries has focused more on enforcement and third-party reporting (Pomeranz, 2015; Naritomi, 2019; Jensen, 2019), tax administration (Khan et al., 2015, 2019; Basri et al., 2019), and tax design (Kleven and Waseem, 2013; Best et al., 2015).

estimate the elasticity of tax compliance and revenue with respect to the tax rate as well as the RMTR. Finally, we leverage rich survey data to explore mechanisms through which rate changes affect compliance.

2 Setting

The DRC is one of the largest and most populous countries in Africa, yet it is also one of the poorest. The average monthly household income in Kananga, the provincial capital of the Kasaï-Central Province, is roughly US$106 (or PPP US$168). Often high on the list of "failed" or "fragile" states, the country has extremely low state capacity, especially in terms of tax enforcement. From 2000-2017, the DRC finished in 188$^{\text{th}}$ place of 200 countries in terms of its tax-GDP ratio.[5]

Kananga, a city with 1 to 2 million inhabitants (the fourth largest in the DRC), is the seat of the Provincial Government of Kasaï-Central. Tax revenues are extremely low: roughly US$0.30 per person per year. The majority of these revenues come from trade taxes, property and rental taxes, and various fees levied on a handful of firms in downtown Kananga, such as mobile-phone companies. Taxes are seldom enforced among private citizens: only 20% of citizens in Kananga reported paying any formal taxes in 2017.

In an effort to raise revenue, the Provincial Government of Kasaï-Central has turned to the property tax, which currently represents about 26 percent of provincial tax revenue.[6] Beginning in 2016, the government has organized a series of door-to-door property tax collection campaigns in Kananga. The first campaign raised property tax compliance from less than 1% to 11% (Weigel, 2020). We study the second property tax campaign run by the government.[7] When the results of the 2016 property tax campaign were presented to the governor, the officials present discussed whether lowering rates could expand the tax net sufficiently to increase revenues. In particular, the governor mentioned a recent voluntary development fund he organized in 2015–2016, which asked citizens to contribute roughly 50% of the modal property tax liability. The perceived success of this initiative led the

[5] See: https://data.worldbank.org/indicator/gc.tax.totl.gd.zs

[6] This decision is consistent with international advice about promising sources of revenue for local governments in Africa because the property tax is thought to be efficient and relatively easy to collect, and urbanization in Africa is driving up property values while fueling demand for urban infrastructure (Franzsen and McCluskey, 2017; Fjeldstad et al., 2017).

[7] Nearly all tax collection was discontinued in 2017 due to a violent conflict in the province between the Kamuina Nsapu militia and the national army. The 2016 and 2018 campaigns were largely coextensive, though only 59% of Kananga's neighborhoods were randomly selected to receive the campaign in 2016, as we discuss in Section 5.3.

government to suspect that marginally lowering rates could increase compliance enough to raise revenue. The potential revenue benefits of lower rates lie at the root of the tax abatement intervention we study and describe in detail in the next section.

In sum, we study a setting of extremely low state capacity in which the government is trying to initiate broad-based compliance with formal taxation. The fact that the government is at this early stage of building tax capacity is likely one reason why it is experimenting with key dimensions of tax policy, such as the use of tax abatements.[8] This presents a rare opportunity to study how the use of key levers — tax rates and tax enforcement, in our case — interact in the context of real-world policy experiments. That said, it also limits the external validity of our results to similar low-capacity and fragile state settings with very little compliance with formal taxes.[9] Although many developing countries do not share these characteristics, fragile states present some of the greatest development and governance challenges today (Collier et al., 2018), and they are in great need of tax revenue (Besley and Persson, 2013). Yet, the literature on the public finance of developing countries has focused more on middle-income countries with higher-capacity states and higher initial levels of tax compliance.[10] Understanding how to extend the tax net and raise revenue at the margin in fragile and weak state settings is thus of great importance.

3 Experimental Design

3.1 Property Tax Campaign

The experiment was embedded in the 2018 property tax campaign in Kananga. In every neighborhood, the campaign had two steps. First, tax collectors, paired in teams of two, went door to door to construct a property register.[11] Because the government did not have an existing cadastre, or property valuation roll, collectors essentially created one in this first step. During the registration visit, tax collectors informed property owners about the property tax, including if their plot is in the low- or high-value band, a distinction based on the building type of the principal construction, as discussed below. They also determined

[8] The willingness to experiment with tax policy is not uncommon in low-capacity settings. Rulers in early modern Europe faced information frictions and other forms of uncertainty over optimal policy such that they frequently engaged in "experimentation" — over tax instruments, rates, and administration policies — in order to learn how best to raise revenue (Kiser, 1994).

[9] The World Bank noted 39 fragile states in 2021: `http://pubdocs.worldbank.org/en/888211594267968803/FCSList-FY21.pdf`.

[10] Important recent exceptions include Okunogbe (2021), Almunia et al. (2019), and Krause (2020).

[11] As discussed in Section B1.3 and Balan et al. (2022), in some (randomly selected) neighborhoods, state agents worked as collectors, while in others, city chiefs worked as collectors. Running the analysis separately in neighborhoods with different collector types does not qualitatively alter our results (Table B7).

exemptions from the property tax during this visit.[12] Next, collectors issued a taxpayer ID (written on the door or wall) and gave the property owner a tax letter, which contained the tax rate (Section 4.1). Collectors also solicited payment of the property tax during this initial registration visit, which lasted 3–4 minutes for the median property.

Upon completion of the property register, collectors made follow-up tax visits throughout the neighborhood. They had one month to complete a neighborhood, after which they would begin work in another. Each collector had a paper copy of the property register, containing taxpayer IDs, names, rates, and exemptions. When a property owner paid the tax, the collector used a handheld receipt printer to issue receipts, with the transaction recorded in the device's memory. Collectors were responsible for discrepancies between the money submitted to the state and the sum recorded by the printer. As in many settings with in-person tax collection, partial payments were not permitted in order to reduce opportunities for collusion between collectors and households (Franzsen and McCluskey, 2017). According to household surveys, the median property owner who paid the tax spent roughly ten more minutes with collectors during this visit. Consistent with standard practices at the tax ministry, collectors received a piece-rate wage for their work on the campaign.[13] The structure and magnitude of the collector wage is analogous to that received by property tax collectors in other developing countries (e.g., Khan et al., 2015).

Property owners who failed to pay the tax during the one-month collection period were considered delinquents and then owed 250% of the original tax liability, due within 30 days. After this, delinquent owners could be summoned to court and face further penalties. In reality, such sanctions were rarely pursued among residential property owners.[14] Nonetheless, there is considerable variation in citizens' beliefs about the probability of sanctions for tax delinquency, and, as we explore in Section 7.2.1, shaping these beliefs is a key source of collectors' enforcement capacity.

[12] Exempt properties — 14.27% of total properties in Kananga — include: (1) properties owned by the state; (2) school, churches, and scientific/philanthropic institutions; (3) properties owned by widows, the disabled, or individuals 55 years or older; and (4) properties with houses under construction.

[13] Specifically, collectors received 30 Congolese Francs (CF) per property registered plus a piece rate corresponding to tax payments. As discussed in Section B1.2, this piece rate varied between 30% of the household liability and a flat 750 CF, randomly assigned at the property level and orthogonal to tax rates.

[14] Although we lack administrative data on sanctions, conversations with tax authority staff make us confident that they did not pursue sanctions against the great majority of delinquent owners in 2018. By contrast, they do impose highly salient sanctions — locking the front door with a sign noting tax delinquency — on stores and large properties rented by NGOs that fail to meet their tax obligations. Such visible enforcement actions likely sustain enforcement beliefs regarding residential property tax delinquents.

3.2 Status Quo Tax Rates

Rather than a schedule of tax rates expressed in percentage of property value, properties in Kananga face a fixed annual tax liability.[15] Before the 2018 campaign, properties in the low-value band (built with non-durable materials, 89% of total properties) faced a tax rate of 3,000 Congolese Francs (CF), or roughly US$2. Properties in the high-value band (built with durable materials, 11% of properties) faced a tax rate of 13,200 CF (US$9).[16]

The use of fixed annual fees for the property tax — rather than applying a rate to property values — reflects the absence of an up-to-date property valuation roll. This is not a problem specific to the DRC.[17] Simplified property tax schedules involving flat fees are common in low-income countries with weak tax enforcement capacity (Franzsen and McCluskey, 2017).[18] Though the tax rates in Kananga might seem low, they are not so different from those in richer countries when expressed as a share of property value. According to machine learning estimates, discussed in Section B7, the average property tax rate in Kananga is 0.34% of the property value, which in fact exceeds the rate in certain U.S. states.[19]

3.3 Tax Abatement Randomization

In the 2018 property tax campaign, randomly selected properties received tax abatements (i.e., tax liability reductions). During property registration, collectors assigned properties sequential taxpayer IDs. They then delivered the corresponding pre-populated tax letter for each ID, which contained the randomly assigned tax liability (inclusive of abatements): either the status quo annual tax rate (3,000 CF for low-value properties and 13,200 CF for high-value properties) or reductions of 17% (2,500 CF and 11,000 CF), 33% (2,000 CF and 8,800 CF), or 50% (1,500 CF and 6,600 CF). Collectors were instructed to read aloud the content of the tax letter, including the tax liability, to property owners and did so in more

[15] Strictly speaking, this property tax therefore does not have *rates* but fixed liabilities. In a slight abuse of terminology, we at times refer to "tax rates" to refer to these fixed liabilities.

[16] There are indeed clear differences in the property values between the low- and high-value bands, according to machine learning estimates (Figure B22) discussed in Section B7, which to some extent validates the use of this building quality 'tag' in setting tax rates. A last category of properties consists of 285 higher-value properties called *villas*. They were not part of the tax campaign and were taxed according to a different tax schedule by different collectors.

[17] Due to the cost of maintaining valuation rolls, only one-third of 159 non-OECD countries in the World Bank's *Doing Business Survey* have registered their largest city's private plots (Lall et al., 2017).

[18] Similar property tax schemes exist in India, Tanzania, Sierra Leone, Liberia, and Malawi (Franzsen and McCluskey, 2017), and were in place in the U.K. from 1989-1993 and Ireland until 2013.

[19] Real-estate property tax rates varied from 0.27% in Hawaii to 2.47% in New Jersey in 2020.

than 95% of cases. Table A1 summarizes the different tax abatement treatment groups by property value band. The randomization of abatements was stratified at the neighborhood level (351 in total).[20]

The randomization of abatements before property registration and pre-population of liabilities on tax letters restricted scope for manipulation. Independent surveyors accompanied collectors during registration to take the GPS coordinates of each property, which allows us to confirm that collectors did not try to game the assignment of tax rates by assigning codes non-sequentially (e.g., Figure B1). We check balance in Section 4.1, including robustness checks for interactions between the assigned tax liability and exemptions or value band designations.

To reduce scope for anchoring or comparisons with other taxpayers, tax letters mentioned the property's annual liability without reference to the status quo rate, tax abatements, or anything about randomization. Figure A1 provides examples of tax letters for each of the rate treatments.[21]

4 Data and Balance

As summarized in Table A2, we use five sources of data.

1. Administrative Data: For the main tax outcomes, we use the universe of payments in the government's tax database. This database was managed by a company, KS InfoSystems, which integrated raw data from tax collectors' receipt printers with bank data. We link the official tax record for the 38,028 properties in our sample to survey data using the unique taxpayer IDs assigned during property registration.[22]

2. Baseline Survey: Baseline survey enumeration occurred between July and December 2017, before the tax campaign. Enumerators randomly sampled compounds following skip patterns while walking down each avenue in a neighborhood: e.g., visit every X^{th} property in the neighborhood, where X was determined by the estimated number of properties and a target of 12 per neighborhood. We primarily use this survey, conducted with 3,358

[20] There are 364 neighborhoods in total. Our analysis excludes 8 neighborhoods that were part of a logistics pilot and 5 neighborhoods randomly selected to have no door-to-door tax collection (the pure control in Balan et al. (2022)). We show robustness to including these neighborhoods in Table A4.

[21] Letters also contained randomized messages as described in Section 7.1.

[22] There are 46,290 registered properties in all of Kananga. For the analysis, we exclude the 1,132 properties located in the neighborhoods where the logistics pilot took place and the 797 properties in the neighborhoods where no door-to-door tax collection took place (the pure control group of Balan et al. (2022)). We also exclude the 6,333 (14%) exempt properties in the remaining neighborhoods. Our final sample size is therefore 38,028 properties. We show robustness of our results to including these excluded neighborhoods and exempt properties in Table A4.

respondents, to examine balance and study heterogeneity in treatment effects.[23]

3. Midline Survey: Enumerators conducted a midline survey in all compounds on average 4-6 weeks after tax collection ended in a given neighborhood. The midline survey measured characteristics of the property and property owner that we use to study heterogeneous treatment effects — as well as secondary outcomes, such as payment of bribes and other taxes. Enumerators sought to conduct this survey with the property owner, who was available in 22,667 cases. Alternatively, enumerators surveyed another adult family member or simply recorded property characteristics — such as wall, roof, and fence quality — in the absence of an available respondent, in an additional 6,967 cases.[24]

4. Endline Survey: Endline survey enumeration occurred between March and September 2019, after tax collection had ended. We draw outcomes from this survey, conducted with 2,760 respondents, such as payment of other taxes, views of the government, and the perceived fairness of the tax system.[25]

5. Property Value: We predicted the market value of the 38,028 properties in our sample using machine learning in order to calculate the effective tax rate as a share of property value, among other analyses. As described in detail in Section B7 (and in Bergeron et al. (2020a)), we trained several algorithms using a sample of 1,654 expert-assessed property values as well as survey and GIS data.

4.1 Balance

In Table A3, we examine balance across treatment groups for a range of property and property owner characteristics. Panel A considers property characteristics, drawing on geographic data, midline survey data on house quality, and property values as estimated using machine learning. Panel B considers property owner characteristics collected at midline

[23] The baseline survey was conducted with a total of 4,331 respondents. But, as noted, in the main analyses we exclude respondents in pilot neighborhoods, pure control neighborhoods of Balan et al. (2022), and exempt properties. Our baseline sample is thus 3,358. Table A4 re-estimates the main analysis in alternate samples that include these excluded sub-groups as a robustness check.

[24] The midline survey was conducted with 36,314 respondents, but after excluding the logistics pilot neighborhoods, the pure control in Balan et al. (2022), and exempt properties, the sample drops by 6,680 (with robustness checks again shown in Table A4). Attrition between registration and the midline survey (22%) is balanced across treatments (Table A3) and appears unrelated to property or owner characteristics (Table B2 and Figure B3).

[25] Enumerators were able to survey 3,887 of the 4,331 baseline respondents at endline. We cannot test whether attrition between baseline and endline (10%) is balanced across treatments because the assignment status and compound code of baseline respondents were recovered at endline and are thus missing for attritors. The sample size after excluding pilot neighborhoods, the pure control in Balan et al. (2022), and exempt properties is 2,760.

that are unlikely to be affected by the treatments. Panel C considers property owner characteristics collected at baseline, including attitudes about the government and tax ministry.

Overall, 2 of the 90 differences reported in Panels A–C of Table A3 are significant at the 5% level, and 3 are significant at the 10% level based on independent t-tests — as one would expect under random assignment. We also test the omnibus null that the treatment effects for the variables in Table A3 are all zero using parametric F-tests (Table B1). We fail to reject this omnibus null for each of these sets of characteristics. Exemption status is also balanced across treatments (Table B3).

5 Treatment Effects on Tax Compliance and Revenue

5.1 Empirical Specifications

We first estimate the effect of assignment to the tax rate abatement treatments using OLS:

$$\begin{aligned} y_{i,n} = \beta_0 + \beta_1 17\%\ Abatement_{i,n} + \beta_2 33\%\ Abatement_{i,n} \\ + \beta_3 50\%\ Abatement_{i,n} + X'_{i,n}\gamma + \delta_n + \epsilon_{i,n} \end{aligned} \tag{1}$$

where $y_{i,n}$ measures the outcome of interest (tax compliance, C, or revenue, R) for individual i living in neighborhood n. The variables $17\%\ Abatement_{i,n}$, $33\%\ Abatement_{i,n}$, and $50\%\ Abatement_{i,n}$ are indicators for being assigned to a rate reduction of 17%, 33%, or 50%. The control group is households assigned to the status quo rate (no reduction). In our main specification $X_{i,n}$ is an indicator for the property value band but we also report results using a broad set of characteristics of the property and owner as controls. δ_n are neighborhood (randomization stratum) fixed effects, and $\epsilon_{i,n}$ is the error term. Exempt properties are excluded from the analysis. Given that the abatement treatments were assigned at the property level, we report robust standard errors.

We then summarize the information contained in the treatment effects by estimating the elasticity of tax compliance and revenue with respect to the tax liability, which we denote $\hat{\varepsilon}_{P,T}$ and $\hat{\varepsilon}_{R,T}$.[26] Because tax compliance and revenue are equal to zero for delinquent properties, we cannot estimate these elasticities using a log-log specification. Instead, we

[26]When the property tax is a fixed fee, the policy-relevant elasticities are the elasticity of tax compliance and revenue with respect to the tax liability — $\varepsilon_{P,T}$ and $\varepsilon_{R,T}$ — because these elasticities determine whether the tax liability is above or below the RMTR (Section 6). These elasticities differ from the standard elasticities used in the optimal taxation literature (e.g., Saez, 2001). For example, if the property tax rate were a percentage of the property value, another key policy-relevant elasticity would be the elasticity of taxable property value with respect to the net-of-tax rate.

adopt the approach of Goldberg (2016) using the following OLS regression:

$$y_{i,n} = \alpha + \beta log(Tax\ Rate_{i,n}) + X'_{i,n}\gamma + \delta_n + \nu_{i,n} \tag{2}$$

with $Tax\ Rate_{i,n} \in \{1500\,CF, 2000\,CF, 2500\,CF, 3000\,CF\}$ for properties in the low-value band, and $Tax\ Rate_{i,n} \in \{6600\,CF, 8800\,CF, 11000\,CF, 13200\,CF\}$ for properties in the high-value band. $X_{i,n}$ and δ_n are defined as before, and $\nu_{i,n}$ is the error term. As above, we report robust standard errors.

The coefficient, $\hat{\beta}$, is the marginal effect of a 1 log-point, or approximately 1%, change in the tax rate on the outcome of interest $y_{i,n}$. This marginal effect can be converted into an elasticity using the standard elasticity formula:

$$\begin{aligned}\hat{\varepsilon}_{y,T} &= \frac{\partial y}{\partial T} \times \frac{T}{y} = \frac{\partial y}{\frac{\partial T}{T}} \times \frac{1}{y} \\ &\approx \hat{\beta}/\overline{y_{i,n}}\end{aligned} \tag{3}$$

where T denotes the property tax rate (in Congolese Francs), y denotes the outcome of interest, and $\overline{y_{i,n}}$ is the mean value of the outcome of interest. Because $\hat{\beta}$ and $\overline{y_{i,n}}$ are estimated separately, we compute bootstrapped standard errors for the elasticity $\hat{\varepsilon}_{y,T}$.[27]

5.2 Results

We first examine the causal effect of rate reductions on tax compliance. As in other low-capacity settings,[28] compliance is low across all treatments: on average, 8.8% of property owners in Kananga paid the property tax in 2018. Nonetheless, rate reductions substantially increased the share of taxpayers (Figure A2, Panel A). Only 5.6% of the property owners assigned to the status quo tax rate paid the property tax, while 6.7%, 10%, and 13% of owners assigned to reductions of 17%, 33%, and 50% paid, respectively (Table 1, Column 1). The results are robust to including neighborhood fixed effects (Table 1, Column 2) — our preferred specification — and to restricting the sample to low- or high-value band properties (Table 1, Columns 3–4). The elasticity of tax compliance with respect to the tax rate is thus large and negative: $\hat{\varepsilon}_{C,T}$ =–1.246 ($SE_{\hat{\varepsilon}_{y,T}}$ =0.062) (Table 1, Column 2). A

[27] Specifically, we construct $1,000$ samples (with replacement) and repeat the estimation procedure for each sample, yielding $SE_{\hat{\varepsilon}_{y,T}}$ as the standard deviation of $\varepsilon_{y,T}$ across these bootstrap iterations.

[28] Recent estimates include 7% in Haiti (Krause, 2020), 8% in Liberia (Okunogbe, 2021), 12% in Senegal (Cogneau et al., 2020), and 25% in Ghana (Dzansi et al., 2022). Moreover, these studies were conducted in national capitals, where property tax compliance is typically higher (Franzsen and McCluskey, 2017).

1% increase in the tax rate is associated with a 1.246% decline in compliance.

Because the property tax is a flat fee with no possibility of partial payments, the treatment effects on compliance lead to higher tax revenue at lower rates. In particular, tax revenue was significantly higher for owners assigned to 50% ($p = 0.04$) and 33% reductions ($p = 0.02$) compared to control (Figure A2 Panel B and Table 1 Column 5).[29] The results hold when we include neighborhood fixed effects (Table 1, Column 6) or estimate the results in the two value band sub-samples separately (Columns 7–8). The elasticity of tax revenue with respect to the property tax rate is thus negative: $\hat{\varepsilon}_{R,T}$ =-0.243 ($SE_{\hat{\varepsilon}_{y,T}}$ =0.081). In this context, status quo tax rates were *above* the revenue-maximizing tax rate.

We explore a range of additional robustness checks in Table A4, including (*i*) controlling for basic covariates (age, age squared, and gender), (*ii*) controlling for roof quality and distance to the nearest market (the imbalanced covariates in Table A3), (*iii*) controlling for further socioeconomic covariates, (*iv*) including neighborhoods where the logistics pilot took place, (*v*) including neighborhoods where no door-to-door tax collection took place (the pure control group in Balan et al. (2022)), and (*vi*) including exempt properties (using the rate they would have been assigned had they not been exempted).

To make the results comparable with settings with a property tax based on underlying property value, we re-estimate the elasticities of compliance and revenue while expressing the property tax rate as a percentage of property value (using our machine learning estimates, cf. Section B7). To quantify the magnitude of the decrease in compliance and revenue as the tax rate increases (Figure B4), we estimate elasticities by instrumenting for the tax rate (as a percentage of property value) using the tax abatement treatment indicators in a standard two-stage least squares set up (Table B4). The elasticities, $\hat{\varepsilon}_{C,\tau}$ =-1.278 ($SE_{\hat{\varepsilon}_{C,\tau}}$=0.062) for compliance and $\hat{\varepsilon}_{R,\tau}$ =-0.253 ($SE_{\hat{\varepsilon}_{R,\tau}}$ =0.079) for revenue, are similar to those reported in Table 1.

What drives the revenue response to lower tax rates? Lowering tax rates increases revenue by bringing more property owners into the tax net — that is, by increasing extensive-margin tax compliance. While the public finance literature has focused on the intensive margin,[30] our paper thus adds to growing evidence that extensive-margin delinquency is a first-order problem in low- and middle-income countries (e.g., Brockmeyer et al., 2023;

[29] The revenue difference between the 17% treatment and control is not statistically significant ($p = 0.16$).

[30] There are exceptions, of course, including work on non-filing "ghosts" in developed countries, such as Meiselman (2018).

Dzansi et al., 2022). We also provide suggestive evidence that property owners with cash-on-hand constraints are more responsive to tax rate reductions (Table A12 and Section B6.3.1). The compliance and revenue responses we observe are thus consistent with liquidity-constrained individuals entering the tax net only when their tax liability is sufficiently low.

Finally, we exploit our survey data to examine whether tax rate reductions adversely impacted other margins of importance to the government: bribe collection, payment of other taxes, and the perceived legitimacy of the government. As we discuss in Section A1, tax rate reductions do not appear to have increased bribe payment, crowded out payment of other taxes, or eroded perceptions of the government, at least according to our survey measures (Table A5). If anything, they may have slightly reduced bribery and led citizens to view property tax rates as more fair.

5.3 Alternative Explanations

Before estimating the revenue-maximizing tax rate in Section 6, we examine whether other components of the experimental design could have influenced taxpayers' responses to treatments in ways that could affect the internal or external validity of our estimates of the causal effect of tax rates on tax compliance — the key policy parameter. We provide evidence that taxpayer behavior does not appear to have been significantly affected by (*i*) knowledge of other property owners' tax rates, (*ii*) anchoring on past tax rates, (*iii*) expectations about future property tax rates, or (*iv*) variation in collectors' enforcement effort across tax rates.

5.3.1 Knowledge of Other Owners' Tax Rates

A first concern is whether property owners were aware that other property owners faced different tax rates, which could introduce fairness considerations into the decision to comply (Besley et al., 2019; Best et al., 2020; Nathan et al., 2020). To investigate this possibility, we re-estimate the treatment effects controlling for the tax rates of each property owner's 5 and 10 closest neighbors, respectively. The estimates are not noticeably affected (Tables 2 and A6, Columns 1–2), and none of the closest neighbors' tax rates appear to impact compliance or revenue (Table A7).

Additionally, knowledge of neighbors' tax rates does not appear to have been affected by tax rate reductions (Table A10, Column 1). Only 14.19% of midline survey respondents reported any knowledge of their neighbors' rates, which likely reflects the fact that financial matters — including taxes — tend to be private in Kananga.[31] The treatment effects are not

[31] For instance, Lowes (2017) notes that adults often avoid discussing financial matters even with their spouse,

statistically different for owners who reported knowing, and not knowing, their neighbors' rates (Tables 2 and A6, Columns 3 and 4 and Table B5, Columns 1 and 5).

Awareness of others' tax rates could also give treated owners "transactional utility" — the sense of getting a good deal — from payment if they were aware of receiving a reduction (Thaler, 1985). However, transactional utility is unlikely in this setting because tax notices only informed owners about their tax liability, without any mention of the status quo liability, others' liability, or a reduction (Figure A1). Moreover, the treatments did not affect citizens' knowledge that the government was issuing abatements (Table A10, Column 2). In fact, only 2.8% of midline survey respondents were aware that the government was issuing abatements. This group of owners may have been somewhat more responsive to treatments, but most differences are not statistically significant (Tables 2 and A6, Columns 5–6, and Table B5, Columns 2 and 6). The low level of awareness of abatements makes this explanation of our main results appear implausible.

5.3.2 Anchoring on Past Tax Rates

Treated owners might have also experienced transactional utility — and thus been more likely to pay — if their tax rate expectations were anchored on past rates. For anchoring to meaningfully impact our estimates, knowledge of status quo property tax rates would need to be widespread. Yet, only 16.23% of baseline survey respondents were able to report the status quo rate corresponding to their property value band. Although citizens are often inattentive to tax rates (Chetty et al., 2009), low knowledge of rates in this context additionally reflects (*i*) the fact that this was only the second-ever citywide property tax campaign in Kananga (and the first covered only 59% of the city), and (*ii*) rapid inflation before the campaign — the value of the Congolese Franc declined by about 80% against the dollar in 2017 and 2018 — and the government's inconsistent updating of tax rates during this time. Moreover, according to our evidence, knowledge of the status quo rate was unaffected by tax rate reductions (Table A10, Column 3), and responses to treatment among those who knew the status quo rate were not statistically different (Table 2 and A6, Columns 7–8, and Table B5, Columns 3 and 7). The results are similar if we count as correct tax rates that are close but not exactly the status quo tax rate (Table B6).

As an additional test, we re-estimate the results in neighborhoods that were randomly assigned to door-to-door tax collection in 2016 compared to neighborhoods where no collection occurred (Weigel, 2020). At baseline, owners were 3.3 percentage points more likely to accurately report the status quo tax rate in neighborhoods that received the 2016

in part due to redistributive pressures.

tax campaign (Table A11, Column 3), and thus should have been more likely to anchor on past rates. However, we find similar responses to tax abatements in both types of neighborhoods (Table 2 and A6, Columns 9–10, and Table B5, Columns 4 and 8). There is thus little evidence that anchoring on past rates influenced taxpayer behavior.

5.3.3 Beliefs about Future Tax Rates

Property owners might have expected tax rate reductions to be temporary, enhancing the perceived benefit of paying in 2018. For example, owners assigned to a rate abatement in 2018 might have been more likely to pay this year because they expected to face the full rate in future arrears. However, less than 3% of citizens even knew of tax abatements, and generally citizens faced a high degree of uncertainty about future tax rates in this setting because citywide collection of the property tax was a new phenomenon. (This was the second such campaign.) If anything, we find suggestive evidence that citizens expect short-term stability in tax rates: owners solicited to pay the property tax in 2016 were more likely to report that the same rate would apply in this tax campaign (Table A11, Columns 3–5). It thus appears implausible that the anticipation of higher future rates would have differentially spurred treated owners to pay.

5.3.4 Tax Collector Effort

The treatment effects might be partly driven by collectors exerting enforcement effort differentially across tax rates. For instance, with a piece-rate wage per collection, collectors might anticipate property owners' higher willingness to pay at lower rates and target their visits accordingly. Such targeting of tax visits — at collectors' discretion — could magnify the treatment effects on compliance and revenue.

Anticipating this possibility, collectors' piece-rate wages were cross-randomized on the property level between a constant amount — 750 CF per collection — and a proportional amount — 30% of the amount collected.[32] This wage structure introduced exogenous variation in collectors' incentives to target by rate. If collectors expected owners who received tax abatements to be more likely to pay, then they would have had an incentive to target treated individuals in the constant wage group. By contrast, this incentive would have been significantly dampened in the proportional wage group because the higher likelihood of collection among lower-rate households was counterbalanced by larger wage payments for collecting from higher-rate households. To test this intuition, we estimate the elasticity of post-registration visits — measured in the midline survey — with respect to rate in

[32] As noted, the property-specific wage was listed on the property register collectors used along with the tax rate and owner information.

both wage groups. Collectors were indeed more likely to visit households assigned to the lowest tax liability in the constant wage group (Table A8, Columns 2 and 5), but not in the proportional wage group (Columns 3 and 6) — though an F-test fails to reject equality of effects (p=0.182).

We investigate if differential targeting by rate in the constant wage groups could influence our treatment effects by re-estimating the main results by wage group (Table A9, Columns 1–2 and 6–7). The elasticities for the constant wage group and the proportional wage group are statistically indistinguishable from each other and from the main results (Table 1).[33] Similarly, including a wage group indicator does not appear to affect responses to tax abatements (Column 3 and 8). Finally, controlling for visits on the extensive and intensive margin does not noticeably change the results (Columns 4–5 and 9–10). Overall, these results suggest that the treatment effects are more likely the result of households' compliance responses than differential collector effort.

A more subtle possibility is that tax collectors might have changed their persuasion tactics among households who received abatements. For instance, they might have been more likely to mention tax abatements to convince owners to pay. Yet we find no evidence that owners assigned to reductions were more likely to know their neighbors' rates or to have heard of abatements (Table A10, Columns 1–3). Alternatively, collectors might have felt emboldened by lower rates to use more forceful messaging to demand tax payment. We examine this possibility using endline survey data about the types of messages owners reported being used by the collectors, such as sanctions, public goods provision, legal obligation, etc. Although this is admittedly challenging to measure, we find little evidence that collectors used different messages across treatments (Table A10, Columns 4–12).

6 The Revenue-Maximizing Tax Rate

Building on the evidence that the status quo tax rate is above the revenue-maximizing tax rate (RMTR) in this setting, we now estimate the RMTR directly. We first outline a simple theoretical framework that illustrates how the levers empirically assessed in this paper — tax rates and tax enforcement — affect citizens' compliance decisions and total revenue.

[33] It may be surprising that tax compliance and revenue do not vary across wage groups given that collectors' visit strategies do appear to vary by wage groups. The likely explanation is that (*i*) given the effect of an additional visit on compliance (0.03), the effect of rate reductions on collector visits is likely too small in magnitude to generate a substantial increase in compliance and revenue; and (*ii*) the effect of rate reductions on visits is likely small in magnitude because collectors target their visits primarily based on other property and owner characteristics that essentially overpower the (weaker) targeting based on tax rates.

We then derive a formula for the RMTR that we take to the data. The framework also clarifies how the government's enforcement capacity shapes the RMTR, a topic we explore empirically in Section 7.

6.1 Theoretical Framework

6.1.1 Property Owners

First, consider the decision to comply or not with the property tax for a representative owner. She faces the choice between paying the fixed annual tax rate, T, or not paying and incurring the expected cost of tax delinquency, $\alpha = p \cdot \pi$ where p is the (perceived) probability of being sanctioned for tax delinquency and π is the associated fine. We refer to α as the government's enforcement capacity because it captures the degree to which citizens believe that tax delinquency will be detected and punished.

The owner also derives utility from tax compliance, denoted by $\Lambda \sim F(.)$, with pdf $f(.)$, which captures "tax morale" motivations to pay, such as intrinsic motivation, reciprocity, or social pressure (Luttmer and Singhal, 2014). The owner's decision is thus:

$$\begin{cases} \text{Compliance if} & \Lambda > T - \alpha \\ \text{Delinquency if} & \Lambda \leq T - \alpha \end{cases}$$

and the fraction of owners who pay the property tax is a differentiable function of T and α:

$$\mathbb{P}(T, \alpha) = 1 - F(T - \alpha) = \int_{T-\alpha}^{\infty} f(\lambda) d\lambda$$

6.1.2 Government Revenue

We follow Besley and Persson (2009) in conceptualizing enforcement capacity as the product of deliberate and costly government investments (e.g., training auditors or accumulating third-party information on taxpayers). The government thus chooses the property tax rate, T, and the level of enforcement capacity, α. Given that the property tax is intended for local public goods provision (rather than redistribution), we assume that the government's goal is to maximize tax revenue:[34,35]

$$\mathbb{R}(T, \alpha) = T \cdot \mathbb{P}(T, \alpha) - \mathbb{C}(\alpha)$$

When choosing the tax rate, the government faces a trade-off because a higher tax rate, T, mechanically increases revenue but also has an indirect negative effect on revenue by reducing compliance, $\mathbb{P}(T, \alpha)$. When deciding how much to invest in enforcement capacity, α, it trades off the higher revenue stemming from increasing compliance, $\mathbb{P}(T, \alpha)$, at rate T and the higher enforcement costs, $\mathbb{C}(\alpha)$.[36]

6.1.3 Revenue-Maximizing Tax Rate (RMTR)

To obtain the revenue-maximizing tax rate, T^*, we consider a small increase, dT, in the fixed annual tax rate. This increase has two effects.

Mechanical effect - The mechanical effect, dM, represents the increase in tax receipts if there were no behavioral (compliance) responses. In the absence of behavioral responses, property owners who comply with the property tax — which we have denoted $\mathbb{P}(T, \alpha)$ — would pay dT additional taxes, making the total mechanical effect:

$$dM = \mathbb{P}(T, \alpha)dT$$

Behavioral effect - The behavioral effect, dB, is the reduction in revenue from owners dropping out of the tax net as the rate increases, $d\mathbb{P}(T, \alpha)$:

$$dB = T\frac{d\mathbb{P}(T, \alpha)}{dT}dT$$

[34] In Section B2.1, we instead assume the government maximizes welfare. The welfare-maximizing (i.e., optimal) tax rate is lower than the revenue-maximizing tax rate as long as the government places positive social welfare weights on taxpayers and the only costs of non-compliance are lost government revenues. When the tax rate decreases by a small amount, taxpayers derive a welfare gain from the lower tax rate, and there is no change in welfare for marginal payers — who pay the tax only if the tax rate decreases — as long as they are optimizing, and thus the envelope theorem holds.

[35] Since fines are rarely implemented in practice, we assume that α captures a utility loss from tax delinquency that does not result in revenue gains from the government. We thus ignore fine revenues, $(1 - \mathbb{P})p\pi$, from the government revenue expression, $\mathbb{R}(T, \alpha)$.

[36] The costs of tax enforcement in Kananga primarily involve personnel costs of hiring and managing collectors and, in extreme cases, pursuing legal action against tax delinquents. As these outlays reflect inputs into the apparatus of tax enforcement as whole — irrespective of the tax rate — we assume that enforcement costs $\mathbb{C}(\alpha)$ do not depend on the tax rate T. Although this assumption could be restrictive in settings in which collector incentives are a function of tax rates, we think it is plausible in our setting given the cross-randomized wage variation and our analysis in Section 5.3.4.

Revenue-Maximizing Tax Rate -To maximize revenue, the government should use the tax rate that maximizes the sum of the mechanical and behavioral effects, i.e, such that $dM + dB = 0$. Substituting in the above expression for dM and dB, and rearranging terms, we obtain an implicit expression for the RMTR, T^*:

$$T^* = \frac{\mathbb{P}(T^*, \alpha)}{-\frac{d\mathbb{P}(T,\alpha)}{dT}\Big|_{T=T^*}} \tag{4}$$

In other words, at the RMTR, the elasticity of tax compliance with respect to the tax rate would be equal to -1 and the elasticity of tax revenue to 0, respectively.[37]

6.1.4 Enforcement Capacity

To obtain the revenue-maximizing level of enforcement capacity, α^*, we similarly consider a small increase $d\alpha$. This increase in α results in an increase in revenues by $T\frac{d\mathbb{P}(T,\alpha)}{d\alpha}d\alpha$, due to increased compliance. But it also increases the cost of enforcement by $\frac{d\mathbb{C}(\alpha)}{d\alpha}d\alpha$. To maximize revenue, the government chooses the level of enforcement capacity to equate its marginal benefit and cost. The revenue-maximizing level of enforcement capacity, α^*, is defined by:

$$T\frac{d\mathbb{P}(T,\alpha)}{d\alpha}\Big|_{\alpha=\alpha^*} = \frac{d\mathbb{C}(\alpha)}{d\alpha}\Big|_{\alpha=\alpha^*}$$

Additionally, the government's enforcement capacity, α, is a determinant of the revenue-maximizing tax rate. By Topkis's monotonicity theorem, if $R(T,\alpha)$ is supermodular in (T,α), then $T^*(\alpha) = \underset{T}{argmax} R(T,\alpha)$ is nondecreasing in α.[38] Thus, if $R(T,\alpha)$ is supermodular in (T,α), the revenue-maximizing tax rate T^* increases with the government's

[37] At the RMTR, $\varepsilon_{P,T}$ and $\varepsilon_{R,T}$ introduced in Section 5.1 are characterized by $\varepsilon_{P,T} = \frac{d\mathbb{P}(T,\alpha)/dT}{\mathbb{P}(T,\alpha)/T} = -1$ or $\varepsilon_{R,T} = \frac{d\mathbb{R}(T,\alpha)/dT}{\mathbb{R}(T,\alpha)/T} = 0$.

[38] Given that $\mathbb{R}(T,\alpha)$ is twice continuously differentiable, a sufficient condition for $\mathbb{R}(T,\alpha)$ to be supermodular in (T,α) is $\frac{\partial^2\mathbb{R}}{\partial T\partial\alpha} \geq 0$. In our framework, $\frac{\partial^2\mathbb{R}}{\partial T\partial\alpha} = \frac{\partial\mathbb{P}(T,\alpha)}{\partial\alpha} + T\frac{\partial}{\partial\alpha}[\frac{\partial\mathbb{P}(T,\alpha)}{\partial T}]$. By definition, tax compliance is increasing in enforcement capacity, α, at all rates: i.e., $\frac{\partial\mathbb{P}(T,\alpha)}{\partial\alpha} = f(T-\alpha) \geq 0$. Additionally, we assume that increasing enforcement capacity weakly attenuates the negative compliance response to tax rate increases — i.e., $\frac{\partial}{\partial\alpha}[\frac{\partial\mathbb{P}(T,\alpha)}{\partial T}] \geq 0$ — which reflects the intuition that enhancing general enforcement capacity should raise compliance equally across rates or differentially more at higher rates (e.g., if fines for non-payment are increasing in liability). This assumption rules out the case where $\frac{\partial}{\partial\alpha}[\frac{\partial\mathbb{P}(T,\alpha)}{\partial T}] < 0$, which could arise if, for instance, enforcement efforts were only effective at lower rates and in fact exacerbated the marginal drop in compliance from tax rate increases. In such a case, the revenue-maximizing tax rate does not necessarily increase with enforcement capacity (if it is also true that $\frac{\partial\mathbb{P}(T,\alpha)}{\partial\alpha} < -T\frac{\partial}{\partial\alpha}[\frac{\partial\mathbb{P}(T,\alpha)}{\partial T}]$).

enforcement capacity, α.

6.2 Estimation

To estimate Equation (4), we first assume that property tax compliance is linear in the property tax rate, i.e., $\mathbb{P}(T, \alpha) = \beta_0(\alpha) + \beta_1(\alpha)T$. Substituting into the expression for revenue and taking the derivative, we find that the revenue-maximizing tax rate is:

$$T^* = \frac{\beta_0(\alpha)}{-2 \times \beta_1(\alpha)} \tag{5}$$

For now, we consider enforcement capacity as constant when estimating $\beta_0(\alpha)$ and $\beta_1(\alpha)$ — though we relax this in Section 7 — and estimate Equation (5) with the regression:

$$Compliance_{i,n} = \beta_0 + \beta_1 Tax\ Rate_{i,n} + \gamma X_{i,n} + \delta_n + \epsilon_{i,n} \tag{6}$$

where $Compliance_{i,n}$ is an indicator for the tax compliance status of property owner i in neighborhood n, and $Tax\ Rate_{i,n}$ is the tax rate expressed as a percentage of the status quo rate. $X_{i,n}$ is an indicator for the property value band, and δ_n are neighborhood fixed effects.[39] We use $\widehat{\beta_0}$ and $\widehat{\beta_1}$ to compute $\widehat{T^*} = \frac{\widehat{\beta_0}}{-2\times\widehat{\beta_1}}$. Since the numerator and denominator are estimated in the same regression, we compute standard errors using the delta method.[40] We also relax the linearity assumption by modeling tax compliance as a quadratic or cubic function of the tax rate (Figure B5).[41]

6.3 Results

Starting with the linear specification, we find that the revenue-maximizing tax rate is about 66% of the status quo rate with or without neighborhood fixed effects (Figure A3 and

[39] The results presented in Figure A3 and Table 3 report results with the property value band indicator and neighborhood fixed effects but the results are reformulated so that the reported intercept is the average of the indicator and fixed effects. Consequently, the results are representative of the average property in Kananga. Results are similar when these fixed effects (Table B10).

[40] We find similar standard errors when computing bootstrapped standard errors instead (Table B11).

[41] When tax compliance is a quadratic function of the tax rate, i.e., $\mathbb{P}(T, \alpha) = \beta_0(\alpha) + \beta_1(\alpha)T + \beta_2(\alpha)T^2$, the revenue-maximizing tax rate is $T^* = (-2\beta_1(\alpha) \pm \sqrt{(2\beta_1(\alpha))^2 - 4 \times \beta_0(\alpha) \times 3\beta_2(\alpha)})/(2 \times 3\beta_2(\alpha))$, which we estimate in the data using the regression $Compliance_{i,n} = \beta_0 + \beta_1 Tax\ Rate_{i,n} + \beta_2 Tax\ Rate^2_{i,n} + \gamma X_{i,n} + \delta_n + \xi_{i,n}$ where $Compliance_{i,n}$, $Tax\ Rate_{i,n}$, $X_{i,n}$, δ_n are defined as above, and $\xi_{i,n}$ is the error term. We use $\widehat{\beta_0}$, $\widehat{\beta_1}$ and $\hat{\beta_2}$ to compute $\widehat{T^*}$ and the delta method to obtain standard errors. To obtain T^*, we ignore the root that corresponds to the part where $\mathbb{P}(T, \alpha)$ implausibly increases with T. We also consider the case where tax compliance is a cubic function of the tax rate and solve for the revenue-maximizing tax rate numerically and similarly ignore the non-sensical roots.

Table 3, Columns 1–2). In other words, a 34% tax cut would maximize revenue. With the quadratic and cubic specifications, the RMTR is even lower: 55% (Figure A3 and Table 3, Columns 3–4) and 61% of the status quo rate (Figure B7 and Table B13), respectively. In the rest of the analysis, we only report results from the linear and quadratic specification because likelihood ratio tests find improvements in fit from the quadratic ($p = 0.007$) but not the cubic model ($p = 0.137$). We repeat the robustness checks considered in Section 5.3 and find similar results (Table B14).

The RMTR is well below the status quo tax rate in both value bands (Figure B6 and Table B12) and at all levels of liquidity, income, and property value (Tables B15 and B16). However, the RMTR is higher for households with more liquidity and higher value property: 75% of the status quo rate in the top decile v. 63% in the bottom decile (Table B16, Columns 1 and 10).[42] Such heterogeneity suggests that, separate from fairness or redistributive concerns, a progressive rate schedule would maximize revenue — though all rates would still lie below the status quo rate. Given that status quo tax rates exceed the RMTR, the abatements we study represent a Pareto improvement. In this context, implementing the RMTR would increase welfare (see Section B2.1).

7 Does Enforcement Increase the RMTR?

At current levels of enforcement capacity, a revenue-maximizing government in Kananga would cut property tax rates. But a large theoretical literature emphasizes that the magnitude of behavioral responses — and thus the RMTR — is a function of government enforcement efforts (e.g., Slemrod and Kopczuk, 2002; Keen and Slemrod, 2017). As suggested in our theoretical framework, could the government invest in its enforcement capacity to shift up the RMTR? This section explores this question empirically by quantifying the impact of tax enforcement activities on the RMTR. We use two sources of exogenous variation in enforcement: random assignment of enforcement messages embedded in tax letters and random assignment of tax collectors to neighborhoods.

7.1 Randomized Enforcement Letters

We first examine how randomly assigned enforcement letters impacted the RMTR.[43] As noted in Section 3, during property registration, owners received a tax letter with infor-

[42] This echoes the mechanism discussed in Section B6.3.1.

[43] A large literature finds that enforcement letters from tax authorities can marginally increase compliance (e.g., Blumenthal et al., 2001; Pomeranz, 2015).

mation about the property tax and rate. A subset of these tax letters contained randomly assigned messages, which collectors were instructed to read aloud to property owners and did so in over 95% of cases.[44] The first enforcement message, *central enforcement*, stated "refusal to pay the property tax entails the possibility of audit and investigation by the provincial tax ministry" (Figure B8, Panel A). A second message, *local enforcement*, was identical except "provincial tax ministry" was replaced by "chef de quartier" (Panel B), a city authority who oversees local governance.[45] We compare these enforcement messages to an active *control* message: "paying the property tax is important" (Panel C). To maximize power, we pool the enforcement message treatments. The random assignment of messages achieved balance across property and owner characteristics (Table B18).[46]

Compared to the control message, enforcement messages increased tax compliance by 1.6 percentage points and tax revenues by 36 CF per property (Table A13). We find suggestive evidence that the increases in tax payments stems from higher perceived probability of sanctions for tax delinquency. In response to a midline survey question asking households to estimate this probability, the *central enforcement* messages caused a roughly 6 percentage point increase in the frequency with which households said sanctions were "likely" or "very likely" (Table A14, Columns 1–3).[47] We can therefore leverage the random assignment of enforcement messages to test if raising perceptions of government enforcement capacity shifts up the RMTR.

The results are consistent with this prediction. According to the linear specification, the RMTR is 55.4% of the status quo rate among properties assigned to the control message

[44] For this analysis, we restrict the sample to the 2,665 properties subject to one of the three randomized messages of interest (*central enforcement*, *local enforcement*, *control*) on their tax letter. There were also trust and public goods messages, which we do not examine here but describe in Section B1.4. The message randomization was introduced in the last phase of the tax campaign, which had two consequences: *(i)* a smaller sample size, *(ii)* lower levels of tax compliance and revenue, due to a secular decline in compliance over the course of the study, as described in Balan et al. (2022).

[45] In some randomly selected neighborhoods, similar chiefs were responsible for tax collection, as noted above and analyzed in Balan et al. (2022).

[46] Overall, 3 of the 58 differences reported in Table B18 are significant at the 1% level, 5 are significant at the 5% level, and 6 are significant at the 10% level based on t-tests. Moreover, we show in Table B20 that the results are unaffected by controlling for the property and property owner characteristics that are imbalanced in Table B18.

[47] That said, the effect of the *local enforcement* message on beliefs about sanctions is not significant. When we pool the enforcement messages the point estimate is positive but not statistically significant at conventional levels (p=0.109). For completeness, Table B19 shows results separately for each message. Table A14 also clarifies that enforcement messages are not associated with improved beliefs about overall state capacity (Columns 4–6) and that tax collectors do not target their visits towards owners who received an enforcement message (Columns 7–9).

compared to 77.9% among properties assigned to enforcement messages (Panel A of Figure 1 and Columns 1–2 and 5–6 of Table A15). Using the quadratic specification (Panel B of Figure 1 and Columns 3–4 and 7–8 of Table A15) suggests an even larger difference in RMTR for properties assigned to the control (35.4% of the status quo rate) and enforcement messages (77.2%). The estimated RMTR is consistent with the treatment effects in Figure B9, which show that tax revenue is maximized by the 50% tax abatement for the control message and by the 17% tax abatement for the enforcement messages. These results suggest that tax enforcement activities, such as reminding taxpayers about the consequences of delinquency, can raise the RMTR. Tax rates and enforcement thus appear to be complementary levers for raising government revenue.

7.2 Random Assignment of Tax Collectors

A second source of variation in tax enforcement capacity stems from the random assignment of tax collectors to neighborhoods. In low-capacity settings, the degree to which taxpayers view tax delinquency as likely to be sanctioned is shaped by the specific tax collectors who arrive at their doorstep, inform them of their annual liability, and demand payment. Indeed, tax collectors explain 21% of the variation in tax compliance across neighborhoods (Bergeron et al., 2020b). Because collectors vary in their enforcement capacity — i.e., their ability to make property owners pay the tax — overall and by tax rate, we can use their random assignment to study if higher enforcement capacity raises the RMTR.

During the 2018 tax campaign, state tax collectors were assigned to team up with another collector every month at random. Each pair of collectors was then randomly assigned to two neighborhoods, where they were in charge of tax collection for the month. In total, 44 state tax collectors worked in 233 neighborhoods of Kananga spanning 23,777 properties.[48] The median collector worked with 6 teammates in 12 neighborhoods. Random assignment of collectors achieved balance across property and owner characteristics (Fig-

[48]The tax campaign was active in 363 neighborhoods. We only consider the 190 neighborhoods where teams of two state tax collectors worked in pairs (the 110 "Central" and 80 "Central + Local information" neighborhoods in Balan et al. (2022)) and 43 neighborhoods where state tax collectors teamed up with city chiefs to collect taxes ("Central X Local" neighborhoods in Balan et al. (2022)). More specifically, we exclude from the analysis (*i*) 8 neighborhoods where a logistics pilot took place, (*ii*) 5 neighborhoods with no door-to-door collection (pure control neighborhoods in Balan et al. (2022)), (*iii*) 110 neighborhoods where city chiefs collected taxes — chiefs are not randomly assigned to neighborhoods preventing us from obtaining an unbiased estimate of their enforcement capacity — ("Local" neighborhoods in Balan et al. (2022)), (iv) 7 "Central + Local Information" neighborhoods where state tax collectors never worked in other neighborhoods, preventing us from obtaining an unbiased estimate of their enforcement capacity.

ure B10).

7.2.1 Collector-Specific Enforcement Capacity

We proxy tax collectors' enforcement capacity, E_c, by the average level of compliance they achieved across randomly assigned neighborhoods using a fixed effects specification:

$$y_{i,n} = \sum_c E_c 1[c(n) = c] + X_{i,n}' \gamma + \epsilon_{i,n} \tag{7}$$

where $y_{i,n}$ is an indicator for tax compliance of property owner i living in neighborhood n, $c(n)$ denotes the tax collectors assigned to neighborhood n, $X_{i,n}$ is a vector containing an indicator for the property value band and indicators for the neighborhood-level interventions described in Balan et al. (2022), and $\epsilon_{i,n}$ denotes the error term. Due to random assignment, $\hat{E}_c$ are unbiased estimates of collectors' enforcement capacities. Because randomization occurred at the collector pair level, we cluster standard errors by collector pair. We describe the estimation procedure in more detail in Section B3, and we report the distribution of the estimated $\widehat{E}_c$ in Panel A of Figure B13.[49]

Why do some collectors have greater enforcement capacity than others? We provide evidence of two (related) mechanisms: more frequent tax visits and the ability to shape beliefs about the probability of sanctions for tax delinquency.

Collectors with high enforcement capacity appear to conduct more visits on the extensive and intensive margin (Figure A4, Panels A and B). Extensive margin visits mechanically raise compliance by allowing more property owners to pay. Intensive margin visits could increase compliance by relaxing time-varying cash-on-hand constraints — because the collector is present at different points in time[50] — or by having a causal effect on beliefs about enforcement — because, with each visit, the owners might update their belief about the necessity of payment. We find evidence consistent with the later explanation: the number of visits reported by households is positively correlated with their perceptions of the probability of sanctions for delinquency ($\rho = 0.101$, $p < 0.001$).

Relatedly, collectors with high enforcement capacity appear to be more persuasive in

[49] This estimation procedure imposes an additional linear restriction that the average collector effect is zero. E_c should thus be interpreted with reference to the average collector, and some of the estimated $\widehat{E_c}$ are negative (Figure B13, Panel A) for collectors with low enforcement capacity. By contrast, enforcement capacity at the collector-pair level, $E_{(c_1,c_2)}$, captures the compliance associated with the pair (c_1, c_2) when randomly assigned to a neighborhood, and the estimates, $\widehat{E}_{(c_1,c_2)}$, are always positive (Figure B18, Panel A).

[50] We, unfortunately, cannot test this first mechanism because we lack data on the exact timing of cash-on-hand constraints and collector visits.

convincing owners that payment is mandatory as collector enforcement capacity is positively correlated with owners' perceived probability of sanctions for tax delinquency, measured in the midline survey (Figure A4, Panel C). This relationship holds even when controlling for collector visits (Panel D), suggesting that high enforcers raise compliance partly by persuading owners that payment is necessary.

7.2.2 Collector-Specific RMTRs

Because we have random variation in tax rates within each collector's set of assigned neighborhoods, we can estimate the collector specific treatment effects (Figures B11 and B12) and revenue-maximizing tax rate, T_c^*. We begin with the linear specification:

$$y_{i,n} = \sum_c \beta_c^0 1[c(n) = c] + \sum_c \beta_c^1 1[c(n) = c] \times Tax\ Rate_{i,n} + X_{i,n}'\gamma + \epsilon_{i,n} \tag{8}$$

where $TaxRate_{i,n}$ is the tax rate assigned to property owner i, expressed as a percentage of the status quo tax rate, and $y_{i,n}$, $X_{i,n}$, and $\epsilon_{i,n}$ are the same as in Equation (7). Owing to random assignment of tax liabilities and tax collectors, the estimates of β_c^0 and β_c^1 are unbiased and can be used to construct an informative estimate of collector c's RMTR, $T_c^* = \frac{\beta_c^0}{-2\times\beta_c^1}$. We cluster the standard errors of β_c^0 and β_c^1 at the collector pair level, and we obtain standard errors for $\widehat{T}_c^*$ using the delta method. We also estimate an analogous quadratic specification. We describe the estimation procedure in more detail in Section B3 and we report the distribution of the estimated $\widehat{T_c^*}$ in Panels B and C of Figure B13.

The fixed effects estimates $\widehat{E}_c$, $\widehat{\beta_c^0}$, and $\widehat{\beta_c^1}$ provide unbiased but noisy estimates of collectors' performance. We show robustness to shrinking $\widehat{E}_c$ and $\widehat{T_c^*} = \frac{\widehat{\beta_c^0}}{-2\times\widehat{\beta_c^1}}$ towards the mean of the true underlying distribution using a multivariable empirical Bayes (EB) model. We describe the EB adjustment in Section B4, and show the distribution of the EB estimates of collectors' enforcement capacity and RMTR in Figure B14.

7.2.3 Raising the (Collector-Specific) RMTR

Consistent with our theoretical prediction, we find a positive and statistically significant relationship between tax collectors' enforcement capacity, E_c, and their RMTR, T_c^*, regardless of whether we assume that tax compliance is linear in the tax rate (Figure 1, Panel C) or quadratic in the tax rate (Figure 1, Panel D). A 1% increase in collector enforcement capacity is associated with a 0.623% increase in the RMTR using the linear specification, and a 0.347% increase using the quadratic specification (Table A16). The positive relationship between E_c and T_c^* suggests that the RMTR is well below the status quo rate for "low enforcers," while the RMTR is closer to the status quo rate for "high enforcers."[51]

The results are analogous when using the empirical Bayes estimates of collectors' enforcement capacity and RMTR (Figure B15). They are also robust to splitting the sample in two and estimating E_c on the first sample split and T_c^* on the second split and are therefore unlikely to be driven by positively correlated measurement error in E_c and T_c^* (Figure B16, Panels A and B). They are also robust to controlling for characteristics of the properties and their owner and are thus unlikely to be driven by differences in the characteristics of the neighborhoods the tax collectors are assigned to (Figure B17). Finally, the results are similar when estimated at the collector pair level, which suggests that they are unlikely to be affected by violations of the linearity assumption implicit in equations (7) and (8) and by potential complementarities between collectors in each pair (Figure B19).[52]

Section 5.3.4 presented evidence that the effects of tax abatements on compliance and revenue did not stem from collectors exerting effort or deploying persuasion techniques differentially across rates. This section shows that collectors who have a high enforcement capacity have a higher RMTR. Although these two findings might at first appear contradictory, they can be reconciled by the fact that collectors appear to raise the RTMR by increasing compliance across all rates — i.e., by increasing the intercept in Equation (5) — rather than by moderating how household compliance responds to lower tax rates — i.e., changing the slope in Equation (5). Consistent with this interpretation, we find that there is more variation in collectors' intercepts than slopes (Figure A5),[53] and that high-enforcement collectors have larger intercepts but similar slopes compared to low-enforcement collectors (Table A17).[54] Moreover, the elasticities of collectors' visits and persuasion tactics with respect to rate are essentially flat across collector enforcement capacity (Figure A6,

[51] Anticipating the positive relationship between collectors' enforcement capacity and RMTR, governments would ideally recruit high enforcers ex ante. Section B5 shows that collectors' enforcement capacity is positively correlated with their socio-economic status and their intrinsic motivation to work in the public sector. That said, less than 10% of collectors have an RMTR that exceeds the status quo tax rate, which makes it unlikely that even the optimal recruitment policy could maximize revenue without corresponding reductions to tax rates.

[52] Given the small number of neighborhoods randomly assigned to each collector pair, these results could be influenced by differences in neighborhood characteristics. But in fact the relationship between the RMTR and enforcement capacity is more pronounced when controlling for property characteristics (Figure B20).

[53] Using regression specification (8), collector-level intercepts — i.e., β_c^0 — have higher variance ($Var(\beta_c^0) = 0.011$) than the collector-level slopes — i.e., β_c^1 — ($Var(\beta_c^1) = 0.008$).

[54] We estimate the regression specification $y_{i,n} = \beta_1 1[c_1(n) = H \text{ } or \text{ } c_2(n) = H] + \beta_2 Tax\ Rate_{i,n} + \beta_3 1[c_1(n) = H \text{ } or \text{ } c_2(n) = H] \times Tax\ Rate_{i,n} + X'_{i,n}\gamma + \epsilon_{i,n}$, where $1[c_1(n) = H \text{ } or \text{ } c_2(n) = H]$ is an indicator for either or both of the collectors' fixed effects — estimated in Equation (7) — being above median, and everything else is defined as above. Table A17 summarizes the results.

Panels A–B and Figure A7).[55] In other words, according to our evidence, collectors with high enforcement capacity are not differentially targeting visits or using more persuasive tactics for households with rate reductions relative to collectors with low enforcement capacity. Instead, high-enforcement collectors appear to shift the RMTR by raising average compliance across all tax rates.

7.3 Rates and Enforcement as Complements: Revenue Implications

The positive impact of tax enforcement activities on the RMTR implies that governments should treat tax rates and enforcement as complementary policy levers. To illustrate this point, we predict the revenue gains that a sophisticated government would achieve by anticipating that investments in its enforcement capacity will increase the RMTR, compared to a naive government that manipulates rates and enforcement independently.

To do so, we estimate tax revenue by tax rates ("Laffer curves") at different levels of enforcement capacity. Specifically, we predict tax revenues, $T \cdot \widehat{\mathbb{P}(T, \alpha)}$, at different tax rates, T, using Equation (6) to estimate $\widehat{\mathbb{P}(T, \alpha)}$.[56,57] The resulting graph shows the familiar hump-shaped relationship between tax rates and total revenue (Figure 2, Panel A).

We then consider a hypothetical policy in which the government increases its enforcement capacity by replacing collectors in the bottom quartile of the enforcement capacity distribution with average collectors. The estimated revenue curve shifts up and to the right at this higher level of enforcement capacity (Figure 2, Panel B), echoing the positive impact of tax enforcement activities on the RMTR discussed in Sections 7.1 and 7.2. Specifically, while the RMTR is 67% of the status quo tax rate in the baseline enforcement scenario, it rises to 95% of the status quo rate after the hypothetical enforcement policy. Thus, replacing tax collectors in the bottom quartile of enforcement capacity by average collectors would raise the RMTR by 42%.

Imagine that the naive government sequentially implements the RMTR and then increases enforcement. Implementing the RMTR would raise revenue by 32% (Figure 2, Panel A), and additionally replacing the bottom quartile of collectors with average collec-

[55] Furthermore, if we re-estimate the relationship between collector enforcement capacity and collector-level RMTRs controlling for the number of visits households received from collectors, we find a similar positive slope (Figure A6, Panels C–F).

[56] Figure A8 shows the fit of the predicted tax revenue by tax rate and the treatment effects on tax revenue described in Section 5.

[57] We use the same sample restriction as in Section 7.2 given that we consider the increase in enforcement capacity associated with replacing collectors in the bottom quartile of the enforcement capacity distribution with average collectors. This explains the difference in tax compliance levels in Figure A2 and A8.

tors would result in a total revenue increase of 61% (Figure 2, Panel B). By contrast, a sophisticated government could increase enforcement and prospectively choose the new RMTR corresponding to its higher enforcement capacity, which would raise revenue by 77% (Figure 2, Panel B).[58] Jointly optimizing tax rates and enforcement would therefore lead to 10% higher revenue gains than adjusting these levers independently.[59] In short, governments are leaving tax dollars on the table if they fail to exploit the complementarities between enforcement and tax rates as policy tools.

8 Conclusion

Using random variation in property tax rates and enforcement in the DRC, this paper provides evidence that the revenue-maximizing tax rate increases with government enforcement capacity. The paper thus highlights the importance of endogenizing government enforcement activities as well as taxpayer compliance decisions (on the intensive and extensive margin) when conceptualizing the revenue-maximizing tax rate. Governments in low-capacity settings can exploit the complementarity between tax rates and enforcement to counter the revenue deficits they face. Compared to independently implementing the RMTR and increasing enforcement, prospectively implementing the post-enforcement RMTR would lead to 10% higher revenue gains.

In light of the observed complementarities between tax rates and enforcement, it is puzzling that many low-capacity governments adopt tax rates on par with high-capacity countries (Besley and Persson, 2013). Tax rates in some of these countries could be above the RMTR, as we found to be the case in the DRC, given their low enforcement capacities. One plausible explanation is that low-capacity governments simply lack information about the RMTR and set rates by mimicking those in other countries. Alternatively, forward-looking governments may strategically set tax rates above the RMTR if they anticipate making investments in enforcement capacity — and thus shifting up the RMTR — in the future and if they knowing that tax rate increases are unpopular. Still another possibility is that officials choose higher-than-optimal tax rates to signal effort in raising revenues when other tax policy levers are less observable to their principals (e.g., politicians, voters, international donors). Adjudicating between these (and other) explanations would be fertile ground for future research.

[58] These revenue predictions are similar when using the tax letter variation in enforcement instead of the collector-level variation (Figure A9).

[59] Independently optimizing rates and enforcement leads to 1.61 times more revenue than the status quo, while jointly optimizing rates and enforcement leads to 1.77 times, i.e., 10% ($1.77/1.61 = 1.10$), more revenue.

References

Almunia, Miguel, Jonas Hjort, Justine Knebelmann, and Lin Tian, "Strategic or Confused Firms? Evidence from Missing Transactions in Uganda," *Working Paper, Mimeo, Columbia University*, 2019.

Bachas, Pierre and Mauricio Soto, "Not(ch) your Average Tax System: Corporate Taxation under Week Enforcement," *Working Paper*, 2019.

Balan, Pablo, Augustin Bergeron, Gabriel Tourek, and Jonathan Weigel, "Local Elites as State Capacity: How City Chiefs Use Local Information to Increase Tax Compliance in the DR Congo," *American Economic Review*, 2022, *112* (3), 762–797.

Basri, Chatib M., Mayara Felix, Rema Hanna, and Benjamin Olken, "Tax Administration vs. Tax Rates: Evidence from Corporate Taxation in Indonesia," *NBER Working Paper 26150*, 2019.

Bergeron, Augustin, Arnaud Fournier, Gabriel Tourek, and Jonathan Weigel, "Using Machine Learning to Increase Property Tax Collection in the D.R. Congo," *Working Paper*, 2020.

_ , Pedro Bessone, John Kabeya Kabeya, Gabriel Tourek, and Jonathan Weigel, "Optimal Assignment of Bureaucrats: Evidence from Randomly Assigned Tax Collectors in the DRC," *Working Paper*, 2020.

Besley, Timothy and Torsten Persson, "The Origins of State Capacity: Property Rights, Taxation and Politics," *American Economic Review*, 2009, *99* (4), 1218–1244.

_ and _ , "Taxation and Development," *Handbook of Public Economics*, 2013, *5*, 51–110.

_ and _ , "Why Do Developing Countries Tax So Little?," *Journal of Economic Perspectives*, 2014, *28* (4), 99–120.

_ , Anders Jensen, and Torsten Persson, "Norms, Enforcement, and Tax Evasion," *NBER Working Paper 25575*, 2019.

Best, Michael Carlos, Anne Brockmeyer, Henrik Jacobsen Kleven, Johannes Spinnewijn, and Mazhar Waseem, "Production versus Revenue Efficiency with Limited Tax Capacity: Theory and Evidence from Pakistan," *Journal of political Economy*, 2015, *123* (6), 1311–1355.

Best, Michael, Francois Gerard, Evan Kresch, Joana Naritomi, and Laura Zoratto, "Greener on the Other Side? Spatial Discontinuities in Property Tax Rates and their Effects on Tax Morale," *Working Paper*, 2020.

Blumenthal, Marsha, Charles Christian, Joel Slemrod, and Matthew G Smith, "Do Normative Appeals Affect Tax Compliance? Evidence From a Controlled Experiment in Minnesota," *National Tax Journal*, 2001, pp. 125–138.

Brockmeyer, Anne, Alejandro Estefan, Juan Carlos Suàrez Serrato, and Karina Ramirez, "Taxing Property in Developing Countries: Theory and Evidence from Mexico," *Working Paper*, 2023.

Chetty, Raj, Adam Looney, and Kory Kroft, "Salience and taxation: Theory and evidence," *American economic review*, 2009, *99* (4), 1145–77.

Cogneau, Denis, Marc Gurgand, Justine Knebelmann, Victor Pouliquen, and Bassirou Sarr, "Bringing property owners into the tax net: avenues of fiscal capacity and local accountability. Evidence from Dakar, Senegal," *Working Paper*, 2020.

Collier, Paul, Timothy Besley, and Adnan Khan, "Escaping the Fragility Trap," *Report of the Commission on State Fragility, Growth and Development*, 2018.

Dzansi, James, Anders Jensen, David Lagakos, and Henry Telli, "Technology and Tax Capacity: Evidence from Local Governments in Ghana," *NBER Working Paper No. 29923*, 2022.

Fjeldstad, Odd-Helge, Merima Ali, and Tom Goodfellow, "Taxing the Urban Boom: Property Taxation in Africa," *Chr. Michelsen Institute (CMI) Insight*, 2017.

Franzsen, Riel and William McCluskey, *Property Tax in Africa: Status, Challenge, and Prospects*, Lincoln Institute of Land Policy, 2017.

Goldberg, Jessica, "Kwacha Gonna Do? Experimental Evidence about Labor Supply in Rural Malawi," *American Economic Journal: Applied Economics*, 2016, *8* (1), 129–149.

Jensen, Anders, "Employment Structure and the Rise of the Modern Tax system," *Working Paper*, 2019.

Keen, Michael and Joel Slemrod, "Optimal Tax Administration," *Journal of Public Economics*, 2017, *152*, 133–142.

Khan, Adnan Q, Asim I Khwaja, and Benjamin A Olken, "Tax Farming Redux: Experimental Evidence on Performance Pay for Tax Collectors," *The Quarterly Journal of Economics*, 2015, *131* (1), 219–271.

__ , Asim Ijaz Khwaja, and Benjamin A Olken, "Making moves matter: Experimental evidence on incentivizing bureaucrats through performance-based postings," *American Economic Review*, 2019, *109* (1), 237–70.

Kiser, Edgar, "Markets and Hierarchies in Early Modern Tax Systems: A Principal-Agent Analysis," *Politics & Society*, 1994, *22* (3), 284–315.

Kleven, Henrik J and Mazhar Waseem, "Using Notches to Uncover Optimization Frictions and Structural Elasticities: Theory and Evidence From Pakistan," *The Quarterly Journal of Economics*, 2013, *128* (2), 669–723.

Kopczuk, Wojciech, "Tax Bases, Tax Rates and the Elasticity of Reported Income," *Journal of Public Economics*, 2005, *89* (1), 2093–2119.

Krause, Benjamin, "Taxation Toward Representation: Public Goods, Tax Collection, Social Norms, and Democratic Accountability," *Working Paper*, 2020.

Lall, Somik, Vinay Vernon Henderson, and Anthony Venables, *Africa's Cities: Opening Doors to the World*, Washington DC: World Bank, 2017.

Lowes, Sara, "Matrilineal kinship and spousal cooperation: Evidence from the matrilineal belt," *Harvard University Working Paper*, 2017.

Luttmer, Erzo and Monica Singhal, "Tax Morale," *The Journal of Economic Perspectives*, 2014, *28* (4), 149–168.

Meiselman, Ben S, "Ghostbusting in Detroit: Evidence on nonfilers from a controlled field experiment," *Journal of Public Economics*, 2018, *158*, 180–193.

Mishra, Prachi, Arvind Subramanian, and Petia Topalova, "Tariffs, enforcement, and customs evasion: Evidence from India," *Journal of public Economics*, 2008, *92* (10-11), 1907–1925.

Naritomi, Joana, "Consumers as Tax Auditors," *American Economic Review*, 2019.

Nathan, Brad C., Perez-Truglia Ricardo, and Alejandro Zentner, "My Taxes are Too Darn High: Tax Protests as Revealed Preferences for Redistribution," *NBER WP 27816*, 2020.

Okunogbe, Oyebola Olabisi, "Becoming Legible to the State: The Role of Detection and Enforcement on Tax Compliance," *World Bank Policy Research Working Paper 9852*, 2021.

Pomeranz, Dina, "No Taxation Without Information: Deterrence and Self-Enforcement in the Value Added Tax," *The American Economic Review*, 2015, *105* (8), 2539–2569.

Saez, Emmanuel, "Using Elasticities to Derive Optimal Income Tax Rates," *Review of Economic Studies*, 2001, *68* (1), 205–229.

__ , Joel Slemrod, and Seth H. Giertz, "The Elasticity of Taxable Income with Respect to Marginal

Tax Rates: A Critical Review," *Journal of Economic Literature*, 2012, *50*, 3–50.

Serrato, Juan Carlos Suárez and Owen Zidar, "The structure of state corporate taxation and its impact on state tax revenues and economic activity," *Journal of Public Economics*, 2018, *167*, 158–176.

Slemrod, Joel and Wojciech Kopczuk, "The Optimal Elasticity of Taxable Income," *Journal of Public Economics*, 2002, *84* (1), 91–112.

Thaler, Richard, "Mental accounting and consumer choice," *Marketing science*, 1985, *4* (3), 199–214.

Weigel, Jonathan, "The Participation Dividend of Taxation: How Citizens in Congo Engage More with the State when it Tries to Tax Them," *Quarterly Journal of Economics*, 2020.

Wong, Francis, "Mad as Hell: Property Taxes and Financial Distress," *Working Paper*, 2020.

9 Figures and Tables

TABLE 1: TREATMENT EFFECTS ON TAX COMPLIANCE AND REVENUE

	Outcome: Tax Compliance (Indicator)				Outcome: Tax Revenue (in CF)			
	All properties		Low-value properties	High-value properties	All properties		Low-value properties	High-value properties
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Treatment Effects								
50% Reduction	0.074***	0.073***	0.076***	0.050***	28.675**	24.711*	28.270**	16.743
	(0.004)	(0.004)	(0.004)	(0.012)	(14.145)	(13.828)	(9.201)	(109.071)
33% Reduction	0.044***	0.044***	0.046***	0.026**	35.616**	34.069**	35.327***	17.659
	(0.004)	(0.004)	(0.004)	(0.010)	(15.316)	(14.937)	(9.837)	(113.175)
17% Reduction	0.011**	0.011***	0.014***	-0.013	-20.518	-20.202	6.404	-253.891**
	(0.003)	(0.003)	(0.004)	(0.009)	(14.750)	(14.420)	(10.034)	(109.150)
Mean (control)	0.056	0.056	0.057	0.046	216.903	216.903	170.611	611.74
Panel B: Marginal Effects								
ln(Tax Rate in CF)	-0.112***	-0.110***	-0.114***	-0.085***	-62.089***	-55.870**	-47.027***	-170.321
	(0.006)	(0.006)	(0.006)	(0.016)	(18.669)	(18.274)	(12.267)	(142.544)
Mean (sample)	0.088	0.088	0.092	0.062	229.662	229.662	188.888	560.547
Panel C: Elasticities								
Elasticity	-1.266	-1.246	-1.241	-1.37	-0.270	-0.243	-0.249	-0.304
	(0.064)	(0.062)	(0.064)	(0.245)	(0.083)	(0.081)	(0.067)	(0.259)
p-value (elasticity=0)					0.0011	0.0026	0.0002	0.2405
Observations	38028	38028	33856	4172	38028	38028	33856	4172
Sample	All properties	All properties	Low-value properties	High-value properties	All properties	All properties	Low-value properties	High-value properties
FE: Property Value Band	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FE: Neighborhood	No	Yes	Yes	Yes	No	Yes	Yes	Yes

Notes: This table reports estimates from Equations (1), (2), and (3). The dependent variable is an indicator for compliance in Columns 1–4 and tax revenues (in Congolese Francs) in Columns 5–8. Panel A reports treatment effects from Equation (1), comparing property tax compliance and revenue for the tax abatement treatment groups relative to the status quo property tax rate (the excluded category). Panel B reports the mean tax compliance and revenue as well as the marginal effect of changes in tax rates (in CF) on tax compliance and revenue from Equation (2). These two estimates are used in Panel C to compute the elasticities of tax compliance and revenue with respect to the tax rate following Equation (3) and to calculate the p-value associated with the elasticity of tax revenue. All regressions include an indicator for the property value band, and Columns 2–4 and 6–8 include randomization stratum (neighborhood) fixed effects. Panels A and B report robust standard errors. Standard errors in Panel C are bootstrapped (with 1,000 iterations). Results are reported for all properties in Columns 1–2 and 5–6. Results for properties in the low (high) value band are reported in Columns 3 and 7 (Columns 4 and 8). The data include all non-exempt properties registered by tax collectors merged with the government's property tax database.

TABLE 2: TREATMENT EFFECTS ON COMPLIANCE — ROBUSTNESS: ACCOUNTING FOR KNOWLEDGE OF OTHERS' RATES, PAST RATES, AND PAST TAX COLLECTION

	Outcome: Tax Compliance (Indicator)									
	Neighbors' rate		Neighbors' rate		Discounts		Past rates		Past tax campaign	
	Ctrl for 5	Ctrl for 10	Doesn't Know	Knows	Doesn't Know	Knows	Doesn't Know	Knows	No	Yes
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A: Treatment Effects										
50% Reduction	0.073***	0.073***	0.084***	0.093***	0.062***	0.241	0.113***	0.159*	0.081***	0.069***
	(0.004)	(0.004)	(0.008)	(0.022)	(0.012)	(0.221)	(0.023)	(0.085)	(0.007)	(0.005)
33% Reduction	0.044***	0.044***	0.055***	0.067**	0.043***	0.094	0.046**	0.084	0.042***	0.045***
	(0.004)	(0.004)	(0.007)	(0.022)	(0.011)	(0.195)	(0.022)	(0.089)	(0.006)	(0.005)
17% Reduction	0.011**	0.011**	0.006	-0.002	0.002	-0.013	-0.016	0.027	0.008	0.013**
	(0.003)	(0.003)	(0.006)	(0.020)	(0.010)	(0.161)	(0.019)	(0.088)	(0.005)	(0.004)
Mean (control)	0.056	0.056	0.071	0.104	0.064	0.114	0.079	0.143	0.055	0.056
Tests of coef. equality:										
50% Reduction			$p_{50\%}$ =0.687		$p_{50\%}$ =0.617		$p_{50\%}$ =0.455		$p_{50\%}$ =0.102	
33% Reduction			$p_{33\%}$ =0.562		$p_{33\%}$ =0.565		$p_{33\%}$ =0.551		$p_{33\%}$ =0.855	
17% Reduction			$p_{17\%}$ =0.679		$p_{17\%}$ =0.769		$p_{17\%}$ =0.487		$p_{17\%}$ =0.768	
All Reductions			$p_{All\%}$ =0.780		$p_{All\%}$ =0.785		$p_{All\%}$ =0.873		$p_{All\%}$ =0.265	
Panel B: Marginal Effects										
ln(Tax Rate in CF)	-0.110***	-0.110***	-0.132***	-0.152***	-0.099***	-0.358	-0.184***	-0.237**	-0.122***	-0.103***
	(0.006)	(0.006)	(0.010)	(0.030)	(0.016)	(0.282)	(0.032)	(0.114)	(0.009)	(0.007)
Mean (sample)	0.088	0.088	0.110	0.136	0.089	0.156	0.125	0.157	0.089	0.088
Panel C: Elasticities										
Elasticity	-1.247	-1.247	-1.202	-1.117	-1.111	-2.286	-1.471	-1.507	-1.369	-1.176
	(0.061)	(0.061)	(0.139)	(1.890)	(0.171)	(1.958)	(0.263)	(0.726)	(0.093)	(0.077)
Observations	38028	38028	13046	2158	5098	147	2069	401	14590	23296
Sample	All properties	All properties	Midline Sample	Midline Sample	Midline Sample	Midline Sample	Baseline Sample	Baseline Sample	All properties	All properties
FE: Property Value Band	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FE: Neighborhood	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Neighbor Rate Controls	Yes	Yes	No	No	No	No	No	No	No	No

Notes: This table explores whether other components of the experimental design could have influenced taxpayers' responses to tax abatements. It reports estimates from Equations (1), (2), and (3). The dependent variable is an indicator for tax compliance. Panel A reports treatment effects from Equation (1) comparing property tax compliance for the tax abatement treatment groups relative to the status quo property tax rate (the excluded category). It also reports the p-values associated with F-tests for equality of the treatment effects when considering heterogeneity by knowledge of others' rates (Columns 3–4), tax reduction (Columns 5–6), past rates (Columns 7–8), and by past exposure to tax collection (Columns 9–10). Panel B reports the mean tax compliance as well as the marginal effect of property tax rates (in Congolese Francs) on tax compliance from Equation (2). These two estimates are used in Panel C to compute the elasticity of tax compliance with respect to the tax rate following Equation (3). All regressions include an indicator for the property value band and for randomization stratum (neighborhood). Panels A and B report robust standard errors. Standard errors in Panel C are bootstrapped (with 1,000 iterations). Columns 1 and 2 control for the property tax rate assigned to the nearest 5 and nearest 10 properties (using the GPS location of all properties in Kananga), respectively. The effects are reported for: owners who reported not knowing or knowing their neighbors' rate in Columns 3–4; owners who reported knowing or not knowing about the existence of tax abatements in Kananga in Columns 5–6; and owners who accurately reported the status quo rate or not in Columns 7–8. The variables that define these subsamples come from the baseline and midline survey and are described in Section B8. Columns 9–10 estimate treatment effects in neighborhoods where door-to-door tax collection took place during the previous property tax campaign and in neighborhoods where no door-to-door collection took place, using the treatment assignment from Weigel (2020). The sample in Columns 3–6 is smaller than the total midline sample because these questions were introduced after midline enumeration began, and the question about knowledge of discounts randomly appeared for a subset of respondents (to increase the pace of survey administration). Table A6 provides analogous results with revenue as the outcome.

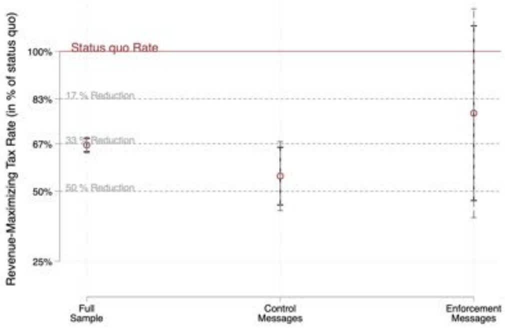
TABLE 3: THE REVENUE-MAXIMIZING TAX RATE

	Linear Specification (1)	(2)	Quadratic Specification (3)	(4)
Panel A: Effect of Tax Rates on Tax Compliance				
Tax Rate (in % of status quo)	-0.154***	-0.152***	-0.410***	-0.391***
	(0.008)	(0.008)	(0.080)	(0.077)
Tax Rate Squared (in % of status quo)			0.171***	0.160**
			(0.052)	(0.050)
Constant	0.203***	0.202***	0.293***	0.286***
	(0.006)	(0.006)	(0.029)	(0.028)
Panel B: Revenue-Maximizing Tax Rate (RMTR)				
RMTR (in % of status quo rate)	0.661	0.665	0.541	0.553
	(0.014)	(0.014)	(0.045)	(0.046)
Implied Reduction in Tax Rate	33.93%	33.50%	45.95%	44.71%
Observations	38028	38026	38028	38026
Sample	All properties	All properties	All properties	All properties
FE: Property Value Band	Yes	Yes	Yes	Yes
FE: Neighborhood	No	Yes	No	Yes
Quadratic Tax Rate Term	No	No	Yes	Yes

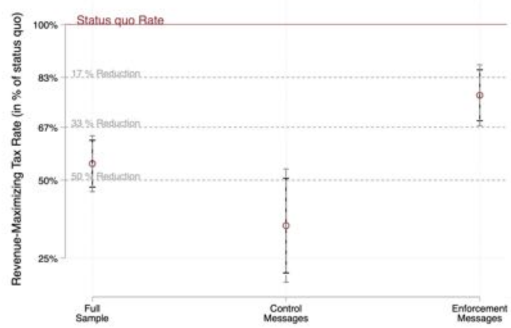
Notes: This table reports estimates of the revenue-maximizing tax rate (RMTR) using the expression in Equation (4). Columns 1 and 2 assume linearity of tax compliance with respect to the tax rate. Panel A reports estimates from regression specification (6), and Panel B the corresponding RMTR estimates from Equation (5). Columns 3 and 4 assume a quadratic relationship between tax compliance and tax rate. Panel A reports estimates from a quadratic regression specification, and Panel B reports the corresponding RMTR estimates. All estimates in Panels A and B are expressed as a percentage of the status quo tax rate. All regressions include an indicator for the property value band, and Columns 2 and 4 also include randomization stratum (neighborhood) fixed effects. In Panel A, we report robust standard errors. Standard errors in Panel B are computed using the delta method. In this and all subsequent Tables in Sections 6.3 and 7.1 that report the RMTR, we use the Stata command *reghdfe*, which allows several levels of fixed effects and reformulates the output so that the reported intercept, which is used to compute the RMTR, is the average value of the fixed effects. The command *reghdfe* drops singleton observations, resulting in two observations being dropped when including property value band and neighborhood fixed effects in Columns 2 and 4. The data include all non-exempt properties registered by tax collectors merged with the government's property tax database.

Figure 1: Revenue-Maximizing Tax Rate by Enforcement Capacity

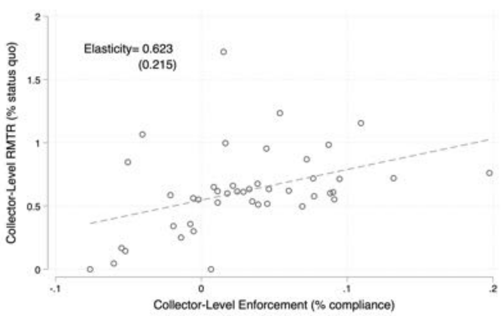
A: Tax Letter Variation (Linear Specification)



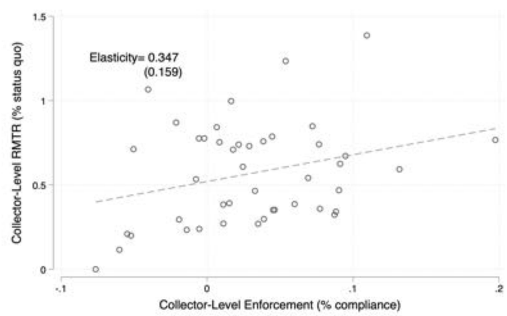
B: Tax Letter Variation (Quadratic Specification)



C: Collector Variation (Linear Specification)



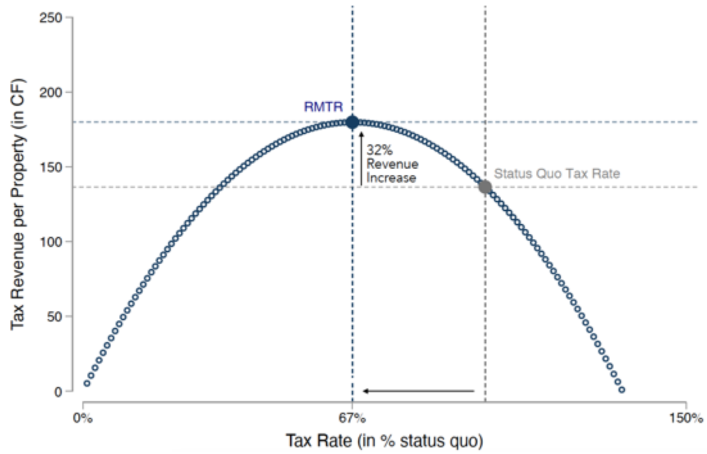
D: Collector Variation (Quadratic Specification)



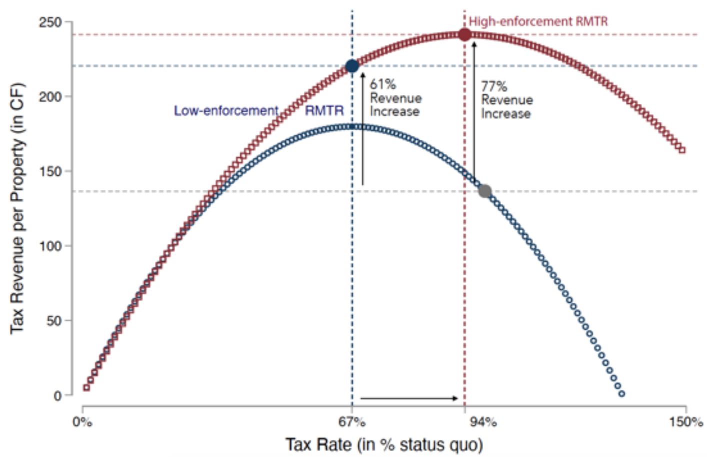
Notes: This figure examines how the revenue-maximizing tax rate (RMTR) varies by enforcement capacity. Panel A and B use the variation in the messages embedded in the tax letters. Panel A assumes that tax compliance is linear with respect to the tax rate so the RMTR is given by Equation (5) and estimated using regression specification (6). The quadratic analog is shown in Panel B. All estimates of the RMTR are expressed as a percentage of the status quo tax rate. All regressions include an indicator for the property value band and for randomization stratum (neighborhood). The black lines show the 90% confidence interval and the gray lines the 95% confidence interval for each estimate using the standard errors obtained from the delta method. The coefficients and confidence intervals correspond to the point estimates and standard errors reported in Table A15 (Panel B). The first point estimate corresponds to the full sample, the second to owners who received the *control* message, and the third to owners who received an enforcement message (*central enforcement* or *local enforcement*). For the second and third point estimates, the sample is restricted to the 2,665 properties exposed to randomized messages on tax letters. In this and all subsequent Figures in Sections 6.3 and 7.1 that report the RMTR, we use the Stata command *reghdfe*, which allows several levels of fixed effects and reformulates the output so that the reported intercept, which is used to compute the RMTR, is the average value of the fixed effects. Panel C and D uses variation in collector enforcement capacity. The x-axis contains estimates of collector enforcement capacity from Equation (7). In Panel C, the y-axis reports the collector-specific RMTR assuming that tax compliance is linear with respect to the tax rate so the RMTR is obtained from estimating Equation (8). In Panel D, the y-axis reports the quadratic analog collector-specific RMTR. Estimates of enforcement capacity are expressed as the percentage of owners who pay the property tax. Estimates of the RMTR are expressed as a percentage of the status quo tax rate. The best-fit line and the regression coefficient of the log of the x-axis on the log of the y-axis are reported with the corresponding robust standard errors. These estimates correspond to those in Table A16.

FIGURE 2: RATES AND ENFORCEMENT AS COMPLEMENTS REVENUE IMPLICATIONS (COLLECTOR VARIATION)

A: Setting Tax Rates at the Revenue-Maximizing Rate



B: Increasing Enforcement Capacity
Naive vs Sophisticated Government

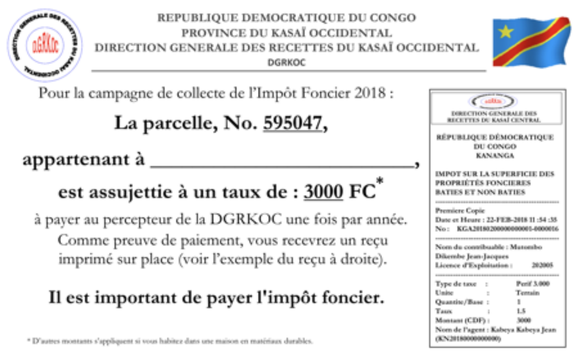


Notes: This figure reports estimates of the relationship between tax rates (x-axis) and tax revenue per property owner (y-axis). We predict tax revenue $T \cdot \widehat{\mathbb{P}(T,\alpha)}$ by predicting $\mathbb{P}(T,\alpha)$ at every tax rate T using Equation (6). Panel A estimates this relationship in the current enforcement environment in Kananga. Panel B then compares the predicted relationship between tax rates and tax revenues in the current enforcement environment (blue dotted curve) and after the government increases its enforcement capacity by replacing collectors in the bottom quartile of enforcement capacity with average tax collectors (red dotted curve). In both panels, vertical lines indicate different potential tax rates, while horizontal lines indicate the corresponding revenue levels. In our example, a naive government would sequentially increase rates and increase enforcement, increasing total revenue by 61%, while a sophisticated government would prospectively choose the post-enforcement revenue-maximizing tax rate (RMTR) and increase revenue by 77%. We restrict the data to the properties subject to tax collection by teams of two state tax collectors. Figure A9 conducts the analogous analysis using the tax letter enforcement variation.

Supplementary Data and Appendix
For Online Publication

FIGURE A1: TAX LETTERS: EXAMPLES BY TREATMENT GROUP

A: Status Quo Tax Rate



REPUBLIQUE DEMOCRATIQUE DU CONGO
PROVINCE DU KASAÏ OCCIDENTAL
DIRECTION GENERALE DES RECETTES DU KASAÏ OCCIDENTAL
DGRKOC

Pour la campagne de collecte de l'Impôt Foncier 2018 :

La parcelle, No. 595047,

appartenant à ____________________,

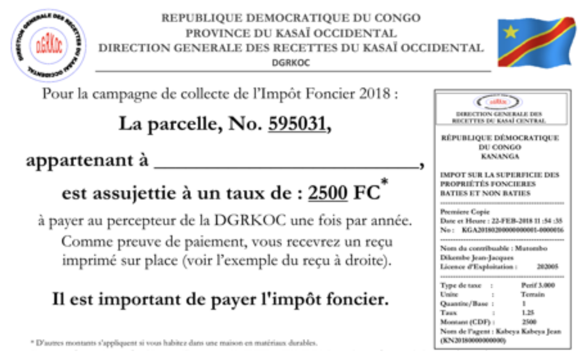
est assujettie à un taux de : 3000 FC*

à payer au percepteur de la DGRKOC une fois par année. Comme preuve de paiement, vous recevrez un reçu imprimé sur place (voir l'exemple du reçu à droite).

Il est important de payer l'impôt foncier.

* D'autres montants s'appliquent si vous habitez dans une maison en matériaux durables.

B:17% Reduction in the Status Quo Rate



REPUBLIQUE DEMOCRATIQUE DU CONGO
PROVINCE DU KASAÏ OCCIDENTAL
DIRECTION GENERALE DES RECETTES DU KASAÏ OCCIDENTAL
DGRKOC

Pour la campagne de collecte de l'Impôt Foncier 2018 :

La parcelle, No. 595031,

appartenant à ____________________,

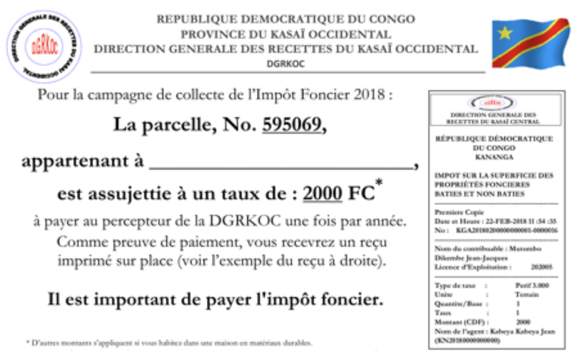
est assujettie à un taux de : 2500 FC*

à payer au percepteur de la DGRKOC une fois par année. Comme preuve de paiement, vous recevrez un reçu imprimé sur place (voir l'exemple du reçu à droite).

Il est important de payer l'impôt foncier.

* D'autres montants s'appliquent si vous habitez dans une maison en matériaux durables.

C: 33% Reduction in the Status Quo Rate



REPUBLIQUE DEMOCRATIQUE DU CONGO
PROVINCE DU KASAÏ OCCIDENTAL
DIRECTION GENERALE DES RECETTES DU KASAÏ OCCIDENTAL
DGRKOC

Pour la campagne de collecte de l'Impôt Foncier 2018 :

La parcelle, No. 595069,

appartenant à ____________________,

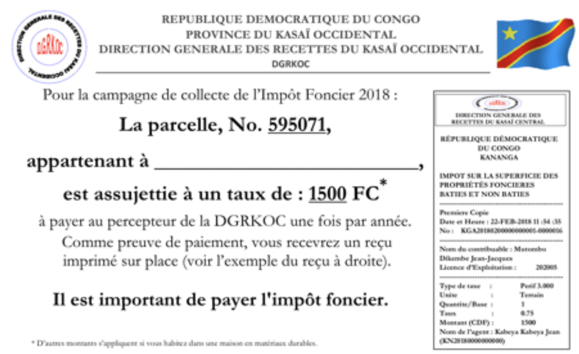
est assujettie à un taux de : 2000 FC*

à payer au percepteur de la DGRKOC une fois par année. Comme preuve de paiement, vous recevrez un reçu imprimé sur place (voir l'exemple du reçu à droite).

Il est important de payer l'impôt foncier.

* D'autres montants s'appliquent si vous habitez dans une maison en matériaux durables.

D: 50% Reduction in the Status Quo Rate



REPUBLIQUE DEMOCRATIQUE DU CONGO
PROVINCE DU KASAÏ OCCIDENTAL
DIRECTION GENERALE DES RECETTES DU KASAÏ OCCIDENTAL
DGRKOC

Pour la campagne de collecte de l'Impôt Foncier 2018 :

La parcelle, No. 595071,

appartenant à ____________________,

est assujettie à un taux de : 1500 FC*

à payer au percepteur de la DGRKOC une fois par année. Comme preuve de paiement, vous recevrez un reçu imprimé sur place (voir l'exemple du reçu à droite).

Il est important de payer l'impôt foncier.

* D'autres montants s'appliquent si vous habitez dans une maison en matériaux durables.

Notes: This figure shows examples of tax letters for owners of properties in the low-value band for each of the tax abatement treatment groups. Panel A shows a picture of a letter for a property owner assigned to the status-quo annual tax rate (control), and Panels B, C, and D show the letter for a property owner assigned to a 17%, 33%, and 50% tax abatement, respectively. The main text of the fliers (from *"Pour la campagne* ..." to "... *droite)*.") translates in English as: "For the 2018 property tax collection campaign, the property Number [Property ID] belonging to [Property Owner Name] is subject to a tax rate of [Tax Rate] CF to pay to the DGRKOC collector once a year. As proof of payment, you will receive a printed receipt on the spot (see the example of the receipt at right)." The footnote indicated by an asterisk reads: "Other amounts apply if you live in a house made of durable materials." The randomization of property tax abatements is discussed in Section 3.

TABLE A1: TAX ABATEMENT TREATMENT ALLOCATION

Tax Rate Abatement Treatment Groups	Tax Rates by Type of Property			
	Low-value band properties		High-value band properties	
	Rate	N	Rate	N
Status Quo Tax Rate	3,000 CF	8,282	13,200 CF	971
17% Reduction in Tax Rate	2,500 CF	8,569	11,000 CF	1,047
33% Reduction in Tax Rate	2,000 CF	8,372	8,800 CF	1,113
50% Reduction in Tax Rate	1,500 CF	8,633	6,600 CF	1,041

Notes: This table shows the number of properties assigned to each tax abatement treatment. Property owners in the low-value band were randomly assigned to an annual status quo property tax rate of 3,000 CF or to tax abatements of 17% (2,500 CF), 33% (2,000 CF), or 50% (1,500 CF). Similarly, property owners in the high-value band were randomly assigned to an annual status quo property tax rate of 13,200 CF or to tax abatements of 17% (11,000 CF), 33% (8,800 CF), or 50% (6,600 CF). We discuss these treatments in Section 3.3.

TABLE A2: ACTIVITIES OF COLLECTORS, ENUMERATORS AND LAND SURVEYORS

Activity	Timing	Observations	Neighborhoods
Tax Campaign - Collectors			
Property registration	May-Dec 2018	44,361	351
Tax collection	May-Dec 2018	38,028	351
Household Surveys - Enumerators			
Baseline survey	Jul-Dec 2017	3,358	351
Midline survey	Jun '18-Feb '19	29,634	351
Endline survey	Mar-Sep 2019	2,760	351
Collector Surveys - Enumerators			
Baseline survey	Jan-Apr 2018	44	NA
Endline survey	Feb-Apr 2019	33	NA
Other Data - Land Surveyors			
Property value estimation	Aug-Dec 2019	1,654	364

Notes: This table reports the components of the 2018 property tax campaign and its evaluation. The tax campaign was implemented by tax collectors, the household and collector surveys by enumerators, and the property value estimation by land surveyors. The numbers of observations and neighborhoods in this table reflect the sample used in the main analysis, in which we exclude the 8 neighborhoods where the logistics pilot took place, the 5 pure control neighborhoods in Balan et al. (2022) where no door-to-door collection took place, and exempted households (with robustness to alternative samples shown in Table A4). Thus, of the 44,361 properties registered (Row 1), only 38,028 properties were non-exempt. As explained in detail in Section 4, the midline sample consists of 29,634 (77.93%) of the 38,028 non-exempted households that the enumerators managed to survey at midline. Attrition from baseline and endline was roughly 10% and is uncorrelated with predicted property value and household income. Enumerators conducted pre-campaign surveys with the 44 tax collectors studied in Section 7.2, and again with 33 of them at endline. Finally, the property value estimation was conducted with 1,654 randomly chosen property owners from the 364 total neighborhoods of Kananga (including those chosen for the logistics pilot and the pure control group in Balan et al. (2022)). These data sources are discussed in Section 4.

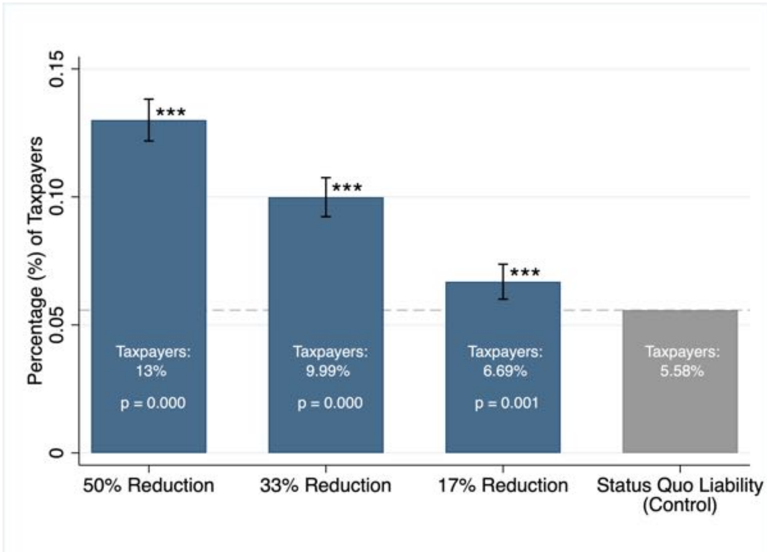
Table A3: Randomization Balance

	Sample	Obs.	Mean status quo	Rate Reductions 17%	33%	50 %
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Property Characteristics						
Distance to city center (in km)	Registration	37,790	3.204	0.000	-0.002	0.001
				(0.002)	(0.002)	(0.002)
Distance to market (in km)	Registration	37,790	0.809	-0.002	-0.004*	-0.002
				(0.002)	(0.002)	(0.002)
Distance to gas station (in km)	Registration	37,790	1.924	0.001	-0.001	0.004
				(0.002)	(0.002)	(0.002)
Distance to health center (in km)	Registration	37,790	0.350	0.002	0.001	0.003
				(0.002)	(0.002)	(0.002)
Distance to government building (in km)	Registration	37,790	0.998	-0.000	-0.001	0.003
				(0.002)	(0.002)	(0.002)
Distance to police station (in km)	Registration	37,790	0.801	-0.000	-0.001	0.001
				(0.002)	(0.002)	(0.002)
Distance to private school (in km)	Registration	37,790	0.322	-0.001	0.002	0.002
				(0.002)	(0.002)	(0.002)
Distance to public school (in km)	Registration	37,790	0.425	0.001	0.001	0.001
				(0.002)	(0.002)	(0.002)
Distance to university (in km)	Registration	37,790	1.314	0.001	- 0.001	0.001
				(0.002)	(0.002)	(0.002)
Distance to road (in km)	Registration	37,237	0.427	0.001	0.001	0.002
				(0.002)	(0.002)	(0.002)
Distance to major erosion (in km)	Registration	37,237	0.128	0.000	0.000	-0.001
				(0.001)	(0.001)	(0.001)
Roof Quality	Midline	29,740	0.970	-0.004	-0.006**	-0.006**
				(0.003)	(0.003)	(0.003)
Walls Quality	Midline	29,413	1.163	-0.005	-0.006	-0.004
				(0.005)	(0.005)	(0.005)
Fence Quality	Midline	27,071	1.391	-0.003	-0.006	-0.011
				(0.007)	(0.007)	(0.007)
Erosion Threat	Midline	29,634	0.402	-0.002	-0.007	0.004
				(0.008)	(0.008)	(0.008)
Property value (in USD)	Registration	38,028	1338	-6.304	3.094	-34.503
Machine Learning estimate				(23.484)	(23.918)	(23.409)
Panel B: Property Owner Characteristics						
Employed Indicator	Midline	20,441	0.793	0.006	-0.000	0.013
				(0.008)	(0.008)	(0.008)
Salaried Indicator	Midline	20,441	0.265	0.003	-0.006	-0.003
				(0.009)	(0.009)	(0.009)
Work for Government Indicator	Midline	20,441	0.157	0.006	-0.002	0.004
				(0.007)	(0.007)	(0.007)
Relative Work for Government Indicator	Midline	22,667	0.229	0.008	-0.004	0.012
				(0.008)	(0.008)	(0.008)
Panel C: Property Owner Characteristics						
Gender	Baseline	2,760	1.339	-0.013	-0.022	-0.001
				(0.027)	(0.027)	(0.027)
Age	Baseline	2,753	47.763	-1.158	0.232	-0.138
				(0.880)	(0.854)	(0.872)
Main Tribe Indicator	Baseline	2,760	0.750	0.023	0.022	0.014
				(0.024)	(0.024)	(0.025)
Years of Education	Baseline	2,751	10.745	-0.112	-0.055	-0.085
				(0.239)	(0.240)	(0.244)
Has Electricity	Baseline	2,760	0.152	-0.016	-0.005	-0.017
				(0.020)	(0.021)	(0.020)
Log Monthly Income (CF)	Baseline	2,735	10.687	-0.006	-0.005	-0.209
				(0.133)	(0.133)	(0.148)
Trust Chief	Baseline	2,749	3.151	-0.013	-0.014	-0.031
				(0.059)	(0.060)	(0.060)
Trust National Government	Baseline	2,611	2.569	-0.036	-0.095	0.013
				(0.073)	(0.075)	(0.074)
Trust Provincial Government	Baseline	2,628	2.493	-0.060	-0.030	-0.026
				(0.071)	(0.073)	(0.072)
Trust Tax Ministry	Baseline	2,600	2.353	0.040	0.011	0.044
				(0.070)	(0.072)	(0.071)
Panel D: Attrition						
Registration to Midline	Registration	38,028	0.213	-0.001	-0.002	-0.003
				(0.004)	(0.004)	(0.004)

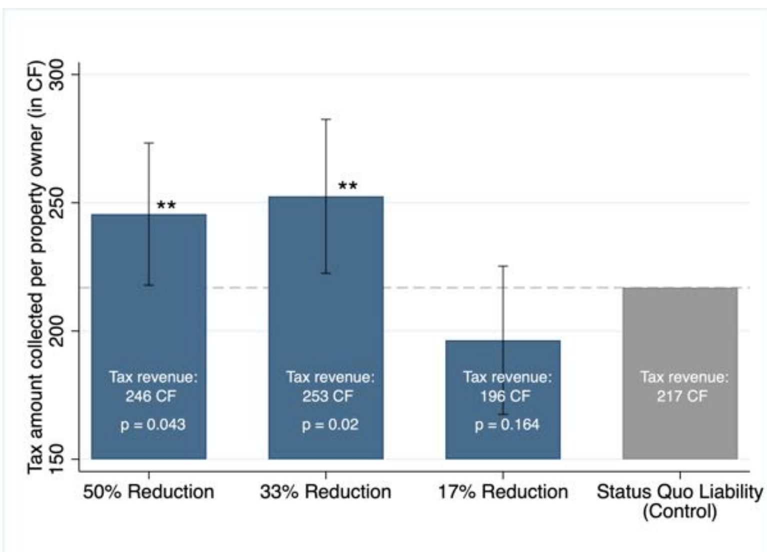
Notes: This table reports coefficients from balance tests conducted by regressing baseline and midline characteristics for properties (Panel A) and property owners (Panels B and C) or an indicator for attrition (Panel D) on treatment indicators, with an indicator for the property value band and randomization stratum (neighborhood) fixed effects. Robust standard errors are reported. All balance checks are conducted in the same samples of the primary analysis, which excludes neighborhoods from the logistics pilot, pure control group of Balan et al. (2022) in which no door-to-door collection took place, and exempted households (with robustness to alternative samples shown in Table A4). Specifically, Panel A considers the sample of 38,028 non-exempt properties. Rows 1–11 exclude 238 properties with missing GPS information; Rows 12–15 use midline surveys conducted with 29,634 property owners; and Row 16 uses the predicted property value for the 38,028 non-exempt properties. Panels B and C use 22,667 midline surveys and 2,760 baseline surveys with property owners, respectively. Missing values in Panels B–C reflect non-response to individual survey questions. Panel D contains an indicator for attrition between registration and the midline survey. We cannot test whether attrition between the baseline and endline survey is balanced across treatments since information on treatment assignment for baseline respondents was recovered at endline, and is therefore missing for attritors. The results are summarized in Section 4.1. The variables are described in detail in Section B8.

FIGURE A2: TREATMENT EFFECTS ON TAX COMPLIANCE AND REVENUE

A: Tax Compliance



B: Tax Revenue



Notes: This figure reports estimates from Equation (1), comparing property tax compliance and revenue in the tax abatement treatment groups (in blue) relative to the status quo property tax rate (the control group, in gray). Panel A uses an indicator for tax compliance as the dependent variable while Panel B uses tax revenue (in Congolese Francs). All estimations include an indicator for the property value band. Panel A corresponds to the results in Column 1 of Table 1, while Panel B corresponds to the results in Column 5 of Table 1. The black lines show the 95% confidence interval for each of the estimates using robust standard errors. The horizontal dashed gray line corresponds to the control group's mean. The Figure also reports the average tax compliance (Panel A) and revenue (Panel B) for the tax abatement treatment groups and the status quo rate group, and the p-values for non-zero treatment effects. The data include all non-exempt properties registered by tax collectors merged with the government's property tax database. We discuss these results in Section 5.2.

Table A4: Robustness — Including Controls, Pilot Neighborhoods, Pure Control Neighborhoods, and exempt properties

	Outcome: Tax Compliance (Indicator)						Outcome: Tax Revenue (in CF)					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Panel A: Treatment Effects												
50% Reduction	0.073***	0.073***	0.073***	0.075***	0.072***	0.064***	24.769*	24.565*	23.652*	27.975**	24.809*	24.876**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(13.819)	(13.841)	(13.817)	(13.568)	(13.589)	(11.970)
33% Reduction	0.044***	0.044***	0.043***	0.045***	0.043***	0.038***	33.328**	33.807**	32.934**	36.914**	33.417**	28.958**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)	(14.936)	(14.953)	(14.935)	(14.690)	(14.646)	(12.874)
17% Reduction	0.011***	0.011***	0.011***	0.012***	0.011***	0.010**	-20.795	-20.311	-20.517	-18.161	-20.037	-16.924
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(14.418)	(14.423)	(14.410)	(14.171)	(14.156)	(12.453)
Mean (control)	0.056	0.056	0.056	0.055	0.055	0.048	216.903	216.903	216.903	214.874	212.696	186.066
Panel B: Marginal Effects												
ln(Tax Rate in CF)	-0.110***	-0.110***	-0.109***	-0.113***	-0.108***	-0.097***	-56.040**	-55.642**	-54.205**	-60.187***	-55.712**	-52.779***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)	(18.256)	(18.294)	(18.249)	(17.936)	(17.966)	(15.837)
Mean (sample)	0.088	0.088	0.088	0.089	0.087	0.076	229.662	229.662	229.662	229.515	225.588	198.548
Panel C: Elasticities												
Elasticity	-1.247	-1.245	-1.238	-1.267	-1.248	-1.263	-0.244	-0.242	-0.236	-0.262	-0.247	-0.266
	(0.061)	(0.061)	(0.060)	(0.060)	(0.061)	(0.062)	(0.079)	(0.079)	(0.079)	(0.078)	(0.079)	(0.080)
p-value (elasticity=0)							0.0021	0.0022	0.0029	0.0008	0.0018	0.0009
Controls:												
Age, Age-squared, Gender	Yes	No	Yes	No	No	No	Yes	No	Yes	No	No	No
Roof Quality, Distance to Market (Imbalanced)	No	Yes	Yes	No	No	No	No	Yes	Yes	No	No	No
Employed, Salaried	No	No	Yes	No	No	No	No	No	Yes	No	No	No
Government Job (Self & Fam.)	No	No	Yes	No	No	No	No	No	Yes	No	No	No
Adjustments:												
Includes Pilot Nbdhs.	No	No	No	Yes	No	No	No	No	No	Yes	No	No
Includes Pure Control Nbdhs.	No	No	No	No	Yes	No	No	No	No	No	Yes	No
Includes Exempted Properties	No	No	No	No	No	Yes	No	No	No	No	No	Yes
Observations	38028	38028	38028	38899	38744	44361	38028	38028	38028	38899	38744	44361
Sample	Midline sample	Midline sample	Midline sample	All properties	All properties	All properties	Midline sample	Midline sample	Midline sample	All properties	All properties	All properties
FE: Property Value Band	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FE: Neighborhood	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table explores a series of robustness checks concerning the main treatment effects on compliance and revenue. It reports estimates from Equations (1), (2), and (3). In Columns 1–6, the dependent variable is an indicator for compliance, while in Columns 7–12, the dependent variable is tax revenue (in Congolese Francs). Panel A reports treatment effects from Equation (1) comparing property tax compliance and property tax revenue for the tax abatement treatment groups relative to the status quo property tax rate (the excluded category). Panel B reports the mean tax compliance and revenue as well as the marginal effect of property tax rates (in CF) on tax compliance and revenue from Equation (2). These two estimates are used in Panel C to compute the elasticity of tax compliance and revenue with respect to the tax rate following Equation (3) and to calculate the p-value associated with the elasticity of tax revenue. All regressions include an indicator for the property value band and randomization stratum (neighborhood) fixed effects. Panels A and B report robust standard errors. Standard errors in Panel C are bootstrapped (with 1,000 iterations). Columns 1 and 7 control for basic covariates (age, age squared, and gender), measured at baseline; Columns 2 and 8 add controls for roof quality and distance to the nearest market (the imbalanced covariates in Table A3); Columns 3 and 9 add controls for having any job, a salaried job, and a government job, and a family member with a government job. When including controls, we replace missing values in control variables with the mean for the entire sample and include a separate dummy (for each control variable) for the value being missing. Columns 4 and 10 include pilot neighborhoods; Columns 5 and 11 include pure control neighborhoods; and Columns 6 and 12 include exempt properties. The data include all properties registered by tax collectors merged with the government's property tax database. We discuss these results in Section 5.2.

A1 Treatment Effects on Secondary Outcomes

This section explores if lowering tax rates had adverse outcomes from the perspective of the government by fueling bribe payments, crowding out other tax payments, or eroding the perceived legitimacy of the government.

A1.1 Bribe Payments

Lowering tax rates could potentially backfire by leading tax collectors to extract more bribes.[60] For instance, collectors might have asked property owners in the tax abatement treatment groups to pay part of the difference between the status quo rate and the reduced rate as a bribe in order to receive a tax receipt.

We test this possibility using survey data on bribe payments to property tax collectors in the midline survey. Enumerators asked respondents if they paid the "transport" of the collectors — a colloquial expression for bribes — and if so, the amount of the payment. While these measures of bribe payments are self-reported and should therefore be interpreted with caution, reporting petty bribes is not taboo in Kananga.[61] According to these measures, we find no evidence that lowering tax rates increased bribe payments. If anything, lower tax rates are associated with fewer bribe payments on the extensive margin (Table A5, Panel A, Row 1). Although the negative effects on bribe payments are only statistically significant when analyzing the 50% reduction treatment, the elasticity of bribe payments with respect to the tax rate, and bootstrapped standard error, is $\hat{\varepsilon}_{B,T} = 0.706$ (0.180). On the intensive margin, the magnitude of the equilibrium bribe also appears to decrease among households assigned to the 50% and 33% rate reduction treatments (Table A5, Panel A, Row 2), yielding an elasticity of $\hat{\varepsilon}_{B,T} = 1.604$ (0.210).

Although we prefer the midline bribe measures because of the large sample, we also explore alternative measures of bribes and other informal payments to tax collectors collected in the endline survey, including (*i*) the gap between self-reported payments and payment according to the administrative data (Table A5, Panel A, Row 3), and (*ii*) self-reported bribe payments (Table A5, Panel A, Rows 4–6). Re-estimating treatment effects and elasticities using these measures, the results are qualitatively similar though not statistically significant. Thus, although there is some evidence that property owners switched from bribes to tax payments when the rate was sufficiently low, this conclusion is suggestive at best.

A1.2 Payment of Other Taxes

Lowering property tax rates could also backfire, from the government's point of view, if it crowds out payment of other taxes. For example, higher tax compliance in response to lower property tax rates could reduce payment of other taxes if citizens have a fixed budget or a mental model in which enforcement risk declines sharply for the partially compliant.[62]

[60] Khan et al. (2015) demonstrate the importance of examining how bribes respond to tax policy changes.

[61] For instance, Reid and Weigel (2019) find that nearly half of motorcycle taxi drivers openly admitted to paying bribes at Kananga's roadway tolls using similar local codes for bribes. The authors also show a high correlation between more and less overt bribe elicitation mechanisms.

[62] This section builds on the literature on fiscal externalities across tax instruments (Waseem, 2018).

In Kananga, the most common "tax" to which citizens contribute is actually an informal labor levy called *salongo*. *Salongo* is organized on a weekly basis by neighborhood chiefs and involves citizens contributing labor (or occasionally cash or in-kind contributions) to local public good projects, such as road repair and trash collection. In our midline data, 37.6% of citizens reported participating in *salongo* in the past two weeks, with those participating contributing 4.2 hours on average over this period. We estimate treatment effects of property tax rate reductions on reported *salongo* participation in (Table A5, Panel B, Rows 1–2). There are no significant effects on the extensive or intensive margin.

Other formal taxes paid by citizens in Kananga include the vehicle tax (3.6% of endline respondents reported paying), market vendor fees (18.5%), the business tax (5.3%), and the income tax (11.5%). Although these measures are self-reported, our questionnaire included an obsolete poll tax included to gauge possible reporting bias. Estimating treatment effects in the familiar specification, we find no evidence that property tax rate reductions crowded out payment of other formal taxes (Table A5, Panel B, Rows 3–7).

A1.3 Views of the Government

Finally, tax rate reductions could backfire if they cause citizens to update negatively about the government. This could be the case if lowering tax rates were perceived by citizens as signaling that property tax payment is less important or obligatory than they had previously thought, or if it signals a lack of state capacity to enforce compliance at higher rates.[63]

We investigate this possibility using endline survey data on citizens' trust in the provincial government, perceptions of the performance of the government, and perceptions of government corruption — as well as corresponding measures for the provincial tax ministry. As shown in Panel C of Table A5, we find no evidence that reductions in tax rates affected views of the provincial government (Rows 1–3) or of the provincial tax ministry (Rows 5–7). Distributing property tax abatements does not appear to have eroded citizens' attitudes about the government.

Finally, we examine citizens' perceptions of the fairness of the property tax, an important component of tax morale (Luttmer and Singhal, 2014; Best et al., 2020). The endline survey included questions about citizens' perceptions of the fairness of property tax collection, property tax rates, and tax collectors. Lower rates do not appear to have affected respondents' perception of the fairness of the property tax (Table A5, Panel C, Row 7) or of the property tax collectors (Row 9). They did, however, increase how fair citizens viewed property tax rates, with a sizable elasticity of –0.100 (0.048) (Row 8).

[63] This vein of analysis is motivated by recent work documenting how tax collection shapes citizens' views of the legitimacy and capacity of the government (Jibao et al., 2017; Weigel, 2020).

Table A5: Treatment Effects on Secondary Outcomes: Bribe Payments, Payment of Other Taxes, Views of the Government

	Treatment Effects							Marginal Effects			Elasticity		Sample	
	50% Reduction		33% Reduction		17% Reduction		Status Quo	ln(Tax Rate in CF)			Elasticity			
Dependent variable	$\hat{\beta}$	SE	$\hat{\beta}$	SE	$\hat{\beta}$	SE	$\bar{y}$	$\hat{\beta}$	SE	$\bar{y}$	$\hat{\beta}$	SE	Obs.	Sample
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Panel A: Bribes														
Paid Bribe	-0.007***	0.002	-0.002	0.002	0.001	0.002	0.019	0.012***	0.003	0.017	0.706	0.172	25,558	Midline
Bribe Amount	-28.209***	5.182	-17.455***	5.820	-8.232	6.438	39.467	40.553***	6.480	25.286	1.604	0.209	25,558	Midline
Gap Self v. Admin	-0.005	0.006	-0.010*	0.006	-0.003	0.006	0.103	0.008	0.008	0.098	0.082	0.081	19,146	Midline
Paid Bribe	0.000	0.020	-0.015	0.018	-0.004	0.022	0.027	0.002	0.027	0.034	0.059	0.878	951	Endline
Bribe Amount	-0.538	22.376	-27.530	19.693	-8.189	22.339	27.232	4.000	31.355	29.715	0.135	1.162	949	Endline
Other Payments	-0.019	0.019	-0.038**	0.018	-0.018	0.019	0.136	0.029	0.026	0.118	0.246	0.221	2753	Endline
Panel B: Payments of Other Taxes														
Participation to Salongo	0.009	0.009	0.007	0.009	0.007	0.009	0.374	-0.012	0.013	0.376	-0.032	0.034	18,924	Midline
Hours of Salongo	0.145	0.142	0.077	0.099	-0.033	0.085	1.510	-0.245	0.196	1.539	-0.159	0.129	18,426	Midline
Paid Vehicle Tax	0.005	0.011	-0.005	0.010	-0.003	0.011	0.038	-0.008	0.014	0.036	-0.222	0.403	2,752	Endline
Paid Market Vendor Fee	-0.031	0.022	-0.033	0.022	-0.007	0.022	0.208	0.049	0.030	0.185	0.265	0.166	2,757	Endline
Paid Business Tax	-0.009	0.013	-0.018	0.013	-0.015	0.013	0.067	0.010	0.018	0.053	0.189	0.337	2,753	Endline
Paid Income Tax	0.002	0.018	0.009	0.019	0.000	0.018	0.116	-0.006	0.025	0.115	-0.052	0.219	2,751	Endline
Paid Obsolete Tax	0.002	0.007	0.002	0.007	0.013	0.008	0.013	0.003	0.010	0.017	0.176	0.605	2,725	Endline
Panel C: Views of the Government														
Trust in Provincial Government	-0.069	0.049	-0.033	0.051	-0.013	0.050	1.770	0.100	0.066	1.761	0.057	0.038	2,739	Endline
Provincial Government Performance	0.028	0.067	0.043	0.068	0.074	0.067	3.878	-0.010	0.089	3.924	-0.003	0.023	2,687	Endline
Provincial Government Corruption	3.212	20.012	18.631	19.989	1.080	19.668	567.274	-9.591	27.225	572.370	-0.017	0.048	2,760	Endline
Trust in Tax Ministry	-0.027	0.055	-0.003	0.056	0.026	0.055	2.038	0.055	0.074	2.035	0.027	0.036	2,743	Endline
Tax Ministry Performance	-0.120*	0.070	-0.064	0.071	-0.019	0.071	4.138	0.178*	0.097	4.080	0.044	0.025	2,691	Endline
Tax Ministry Corruption	34.549*	18.617	20.410	18.473	34.927*	18.598	399.903	-35.066	25.367	422.366	-0.083	0.060	2,743	Endline
Fairness Prop. Tax	-0.021	0.033	-0.010	0.032	0.021	0.034	2.021	0.044	0.045	2.008	0.022	0.024	2,745	Endline
Fairness Tax Rates	0.121**	0.049	0.121**	0.049	0.123**	0.048	1.293	-0.138**	0.066	1.384	-0.100	0.049	2,513	Endline
Fairness Tax Coll.	0.005	0.042	-0.027	0.042	0.005	0.041	1.687	0.004	0.057	1.688	0.002	0.034	2,466	Endline

Notes: Each row summarizes the estimation of Equations (1), (2), and (3). Columns 1–7 summarize the OLS estimation of Equations (1). All regressions include an indicator for the property value band and randomization stratum. The $\hat{\beta}$ are the coefficients on the treatment indicators (in Columns 1, 3, and 5 for the 50%, 33%, and 17% tax abatements, respectively) followed by robust standard errors (in Columns 2, 4, and 6). $\bar{y}$ indicates the mean outcome in the control — status quo tax rate — group (Column 7). Columns 8–10 summarize the OLS estimation of Equation (2). $\hat{\beta}$ is the marginal effect of property tax rates (in CF) on the outcome of interest (Column 8), followed by the robust standard error (Column 9) and $\bar{y}$, the mean outcome in the sample (Column 10). Columns 11–12 summarize the estimation of Equation (3) and present the elasticity of the outcome of interest with respect to the tax rate (Column 11) and the bootstrapped standard errors (Column 12), using the standard deviation across 1,000 bootstrap samples with replacement. Finally, the last two columns provide the number of observations (Column 13) and the sample used, midline or endline (Column 14). In Panel A, the outcome in Rows 1 and 4 are indicators for self-reported bribe payment in the midline and endline surveys, respectively. Rows 2 and 5 report results for the corresponding amount of bribe paid. The outcome in Row 3 indicates property owners who reported paying the tax during the midline survey but who were not recorded as having paid in the administrative data. The outcome in Row 6 is self-reported payment of any informal fee at endline. In Panel B, the outcome in Rows 1 and 2 are indicators for participation in *salongo* and the number of hours devoted to *salongo* at midline, respectively. The outcome in Rows 3–7 are indicators from the endline survey for the payment of the vehicle tax (Row 3), the market vendor fee (Row 4), the business tax (Row 5), the income tax (Row 6), or a fake tax (Row 7). In Panel C, the outcomes are standardized indices measuring trust, perceived performance, and corruption of the provincial government (Rows 1–3) and of the provincial tax ministry (Rows 4–6), followed by the perceived fairness of property tax collection (Row 7), tax rates (Row 8), and tax collectors (Column 9). The number of observations varies across variables in the same survey due to nonresponse. Additionally, analysis of the gap between self-reported and administratively verified tax payments (Row 3) restricts the sample to households deemed non-compliant in the admin data, while analysis of endline bribe measures (Rows 4–5) restricts to the set of households reporting any post-registration visits from collectors (who had opportunities to pay bribes). Midline and endline survey data collection is described in Section 4, and the variables used in this table are described in Section B8. We discuss these results in Section A1.

TABLE A6: TREATMENT EFFECTS ON REVENUE — ROBUSTNESS: ACCOUNTING FOR KNOWLEDGE OF OTHERS' RATES, PAST RATES, EXPECTATIONS OF FUTURE RATES, AND PAST EXPOSURE TO TAX COLLECTION

	Outcome: Tax Revenue (in CF)									
	Neighbors' rate		Neighbors' rate		Discounts		Past rates		Past tax campaign	
	Ctrl for 5	Ctrl for 10	Doesn't Know	Knows	Doesn't Know	Knows	Doesn't Know	Knows	No	Yes
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A: Treatment Effects										
50% Reduction	24.829*	24.603*	31.000	2.066	-2.676	-64.522	51.831	133.677	39.711	15.271
	(13.829)	(13.843)	(24.196)	(63.235)	(35.987)	(680.464)	(77.198)	(176.085)	(24.254)	(16.647)
33% Reduction	33.947**	34.167**	42.073	42.736	71.435*	-621.510	-32.192	72.279	23.625	40.434**
	(14.933)	(14.931)	(25.663)	(61.768)	(39.649)	(1129.941)	(80.482)	(211.148)	(25.358)	(18.432)
17% Reduction	-20.193	-20.023	-38.543	-28.680	-42.812	-372.198	-97.065	27.455	-28.553	-16.780
	(14.421)	(14.422)	(24.935)	(66.992)	(37.663)	(642.694)	(81.063)	(207.580)	(24.764)	(17.602)
Mean (control)	216.903	216.903	258.357	330.055	227.411	634.286	301.250	428.571	225.726	211.524
Tests of coef. equality:										
50% Reduction			$p_{50\%}=0.647$		$p_{50\%}=0.459$		$p_{50\%}=0.555$		$p_{50\%}=0.343$	
33% Reduction			$p_{33\%}=0.992$		$p_{33\%}=0.499$		$p_{33\%}=0.516$		$p_{33\%}=0.675$	
17% Reduction			$p_{17\%}=0.883$		$p_{17\%}=0.399$		$p_{17\%}=0.433$		$p_{17\%}=0.765$	
All Reductions			$p_{All\%}=0.925$		$p_{All\%}=0.865$		$p_{All\%}=0.882$		$p_{All\%}=0.353$	
Panel B: Marginal Effects										
ln(Tax Rate in CF)	-55.992**	-55.651**	-76.148**	-30.241	-41.952	294.168	-119.342	-195.964	-78.392**	-42.766*
	(18.274)	(18.305)	(32.165)	(87.645)	(46.021)	(1174.460)	(107.128)	(232.279)	(31.950)	(22.013)
Mean (sample)	229.662	229.662	272.444	317.748	225.010	399.320	328.565	329.177	239.047	223.150
Panel C: Elasticities										
Elasticity	-0.244	-0.242	-0.280	-0.095	-0.186	0.737	-0.363	-0.595	-0.328	-0.192
	(0.082)	(0.082)	(0.174)	(2.529)	(0.194)	(2.978)	(0.350)	(0.733)	(0.140)	(0.103)
p-value (elasticity=0)	0.0030	0.0032	0.1073	0.9700	0.3371	0.8056	0.2998	0.4176	0.0188	0.0630
Observations	38028	38028	13046	2158	5098	147	2069	401	14590	23296
Sample	All properties	All properties	Midline Sample	Midline Sample	Midline Sample	Midline Sample	Baseline Sample	Baseline Sample	All properties	All properties
FE: Property Value Band	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FE: Neighborhood	Yes	Yes	No	No	No	No	No	No	No	No
Neighbor Rate Controls	Yes	Yes	No	No	No	No	No	No	No	No

Notes: This table explores whether other components of the experimental design could have influenced taxpayers' responses to tax abatements. It reports estimates from Equations (1), (2), and (3). The dependent variable is tax revenues (in Congolese Francs). Panel A reports treatment effects from Equation (1) comparing property tax revenue for the tax abatement treatment groups relative to the status quo property tax rate (the excluded category). It also reports the p-values associated with F-tests for equality of the treatment effects when considering heterogeneity by knowledge of others' rates (Columns 3–4), tax reduction (Columns 5–6), past rates (Columns 7–8), and by past exposure to tax collection (Columns 9–10). Panel B reports the mean tax revenue in the sample as well as the marginal effect of property tax rates (in CF) on tax revenue from Equation (2). These two estimates are used in Panel C to compute the elasticity of tax revenue with respect to the tax rate following Equation (3) and to calculate the p-value associated with the elasticity of tax revenue. All regressions include an indicator for the property value band and for randomization stratum (neighborhood). Panels A and B report robust standard errors. Standard errors in Panel C are bootstrapped (with 1,000 iterations). The effects are reported for: owners who reported not knowing or knowing their neighbors' rate in Columns 3–4; owners who reported knowing or not knowing about the existence of tax abatements in Kananga in Columns 5–6; and owners who accurately reported the status quo rate or not in Columns 7–8. The variables that define these subsamples come from the baseline and midline survey (indicated in the bottom panel of the table) and are described in Section B8. Columns 9 and 10 estimate treatment effects for neighborhoods where door-to-door tax collection took place during the previous (2016) property tax campaign and neighborhoods where no door-to-door collection took place, using the treatment assignment from Weigel (2020). The sample in Columns 3–6 is smaller than the total midline sample because these questions were introduced after midline enumeration began, and the question about knowledge of discounts randomly appeared for a subset of respondents (to increase the pace of survey administration). We discuss these results in Section 5.3.

Table A7: Robustness — Accounting for Neighbors' Tax Rates

	Outcome: Tax Compliance (Indicator)			Outcome: Tax Revenue (in CF)		
	Neighbors' Rate Controls			Neighbors' Rate Controls		
	No	Closest 5	Closest 10	No	Closest 5	Closest 10
	(1)	(2)	(3)	(4)	(5)	(6)
50% Reduction	0.073150***	0.073183***	0.073185***	24.710779*	24.828665*	24.602730*
	(0.004057)	(0.004058)	(0.004058)	(13.828226)	(13.829044)	(13.842639)
33% Reduction	0.043992***	0.043958***	0.044011***	34.069000**	33.946848**	34.166802**
	(0.003790)	(0.003789)	(0.003789)	(14.937406)	(14.933235)	(14.930843)
17% Reduction	0.011407***	0.011395***	0.011418***	-20.202272	-20.192966	-20.023098
	(0.003415)	(0.003416)	(0.003415)	(14.420118)	(14.420714)	(14.421936)
1st Neighbor Rate		-0.000000	-0.000001		-0.001699	-0.002459
		(0.000001)	(0.000001)		(0.003547)	(0.003577)
2nd Neighbor Rate		0.000001	0.000001		0.002359	0.001639
		(0.000001)	(0.000001)		(0.003799)	(0.003811)
3rd Neighbor Rate		0.000001	0.000001		0.005773	0.005070
		(0.000001)	(0.000001)		(0.003811)	(0.003842)
4th Neighbor Rate		0.000000	0.000000		0.000953	0.000093
		(0.000001)	(0.000001)		(0.003733)	(0.003753)
5th Neighbor Rate		0.000001	0.000001		0.000917	0.000069
		(0.000001)	(0.000001)		(0.003500)	(0.003524)
6th Neighbor Rate			0.000000			0.001143
			(0.000001)			(0.003505)
7th Neighbor Rate			0.000001			0.003014
			(0.000001)			(0.003708)
8th Neighbor Rate			0.000000			0.004828
			(0.000001)			(0.003887)
9th Neighbor Rate			-0.000001			-0.003529
			(0.000001)			(0.003357)
10th Neighbor Rate			0.000002**			0.005235
			(0.000001)			(0.003549)
Mean (control)	0.056	0.056	0.056	216.903	216.903	216.903
Observations	38028	38028	38028	38028	38028	38028
Sample	All properties	All properties	All properties	All properties	All properties	All properties
FE: Property Value Band	Yes	Yes	Yes	Yes	Yes	Yes
FE: Neighborhood	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table examines treatment effects on tax compliance and tax revenue (in Congolese Francs). It reports treatment effects from Equation (1) comparing property tax revenue for the tax abatement treatment groups relative to the status quo property tax rate (the excluded category). All regressions include an indicator for the property value band and for randomization stratum (neighborhood). We report robust standard errors. The dependent variable is tax compliance in Columns 1–3 and tax revenue in Columns 4–6. Columns 2 and 5 control for the property tax rate assigned to the nearest 5 properties (using the GPS location of all properties in Kananga). Columns 3 and 6 control for the property tax rate assigned to the nearest 10 properties. The effects of the nearest properties' tax rate on tax compliance and tax revenue are reported. We discuss these results in Section 5.3.

TABLE A8: ROBUSTNESS — ACCOUNTING FOR DIFFERENTIAL TAX COLLECTOR ENFORCEMENT EFFORT BY RATE

	Outcome: Visit Indicator			Outcome: Number of Visits		
	All	Constant Wage	Proportional Wage	All	Constant Wage	Proportional Wage
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Treatment Effects						
50% Reduction	0.026**	0.038**	0.015	0.027*	0.043**	0.015
	(0.009)	(0.012)	(0.012)	(0.014)	(0.022)	(0.020)
33% Reduction	0.016*	0.015	0.016	0.001	-0.012	0.014
	(0.009)	(0.012)	(0.012)	(0.014)	(0.021)	(0.020)
17% Reduction	0.013	0.016	0.011	0.014	-0.001	0.025
	(0.009)	(0.012)	(0.012)	(0.015)	(0.021)	(0.022)
Mean (control)	0.407	0.409	0.404	0.560	0.579	0.541
Tests of coef. equality:						
50% Reduction		$p_{50\%}$ =0.182			$p_{50\%}$ =0.336	
33% Reduction		$p_{33\%}$ =0.934			$p_{33\%}$ =0.366	
17% Reduction		$p_{17\%}$ =0.782			$p_{17\%}$ =0.377	
All Reductions		$p_{All\%}$ =0.463			$p_{All\%}$ =0.183	
Panel B: Marginal Effects						
ln(Tax Rate in CF)	-0.034**	-0.049**	-0.020	-0.031	-0.056*	-0.012
	(0.012)	(0.017)	(0.016)	(0.020)	(0.029)	(0.027)
Mean (sample)	0.422	0.429	0.416	0.570	0.586	0.554
Panel C: Elasticities						
Elasticity	-0.081	-0.114	-0.049	-0.055	-0.095	-0.021
	(0.027)	(0.039)	(0.040)	(0.034)	(0.048)	(0.049)
Observations	23054	11411	11643	22893	11335	11558
Sample	Midline Sample	Midline Sample	Midline Sample	Midline Sample	Midline Sample	Midline Sample
FE: Property Value Band	Yes	Yes	Yes	Yes	Yes	Yes
FE: Neighborhood	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table explores the possibility that collectors exerted enforcement effort differentially across rates, which could magnify the estimated responses to rate reductions. It reports estimates from Equations (1), (2), and (3). In Columns 1–3, the dependent variable is an indicator for the property owner reporting any visits by tax collectors after property registration. Panel A reports treatment effects from Equation (1) comparing visits for the tax abatement treatment groups relative to the status quo property tax rate (the excluded category). It also reports the p-values associated with F-tests for equality of the treatment effects when considering heterogeneity by wage group (Columns 2–3 and 5–6). Panel B reports the mean visits as well as the marginal effect of property tax rates (in CF) on visits from Equation (2). These two estimates are used in Panel C to compute the elasticity of visits with respect to the tax rate following Equation (3). In Columns 4–6, the dependent variable is the number of visits by tax collectors after property registration reported by property owners. Columns 1 and 4 consider all properties. Columns 2 and 5 restrict the sample to properties randomly assigned to the constant tax collector wage group (750 FC per collection), while Columns 3 and 6 restrict to properties assigned to the proportional collector wage group (30% of the amount collected). Collectors' wage is discussed in Section B1.2. The data include all non-exempt properties registered by tax collectors merged with the government's property tax database. We discuss these results in Section 5.3.4.

TABLE A9: ROBUSTNESS — ACCOUNTING FOR THE EFFECTS OF DIFFERENTIAL TAX COLLECTOR ENFORCEMENT EFFORT BY RATE ON COMPLIANCE AND REVENUE

	Outcome: Tax Compliance (Indicator)					Outcome: Tax Revenue (in CF)				
	Constant Wage (1)	Proportional Wage (2)	Wage FEs (3)	Visit Ind. Ctrl (4)	Nb of Visits Ctrl (5)	Constant Wage (6)	Proportional Wage (7)	Wage FEs (8)	Visit Ind. Ctrl (9)	Nb of Visits Ctrl (10)
Panel A: Treatment Effects										
50% Reduction	0.076***	0.078***	0.076***	0.081***	0.082***	27.805**	32.103**	28.267**	17.611	18.872
	(0.006)	(0.006)	(0.004)	(0.006)	(0.006)	(13.125)	(13.049)	(9.201)	(11.953)	(12.030)
33% Reduction	0.046***	0.048***	0.046***	0.049***	0.051***	34.540**	39.966**	35.431***	30.898**	33.397**
	(0.006)	(0.006)	(0.004)	(0.005)	(0.005)	(14.003)	(13.948)	(9.837)	(12.740)	(12.833)
17% Reduction	0.011**	0.018***	0.014***	0.011**	0.011**	-1.087	16.983	6.431	-6.041	-6.106
	(0.005)	(0.005)	(0.004)	(0.005)	(0.005)	(14.154)	(14.311)	(10.034)	(13.004)	(13.088)
Mean (control)	0.057	0.057	0.057	0.067	0.068	170.13	171.081	170.611	202.205	203.545
Tests of coef. equality:										
50% Reduction	$p_{50\%}$ =0.783					$p_{50\%}$ =0.815				
33% Reduction	$p_{33\%}$ =0.736					$p_{33\%}$ =0.782				
17% Reduction	$p_{17\%}$ =0.338					$p_{17\%}$ =0.364				
All Reductions	$p_{All\%}$ =0.817					$p_{All\%}$ =0.802				
Panel B: Marginal Effects										
ln(Tax Rate in CF)	-0.115***	-0.115***	-0.114***	-0.123***	-0.124***	-50.296**	-48.060**	-47.038***	-37.292**	-39.874**
	(0.009)	(0.009)	(0.006)	(0.008)	(0.008)	(17.495)	(17.400)	(12.267)	(15.871)	(15.967)
Mean (sample)	0.090	0.093	0.092	0.105	0.105	185.536	192.217	188.888	216.405	217.119
Panel C: Elasticities										
Elasticity	-1.271	-1.235	-1.241	-1.171	-1.183	-0.271	-0.250	-0.249	-0.172	-0.184
	(0.093)	(0.089)	(0.063)	(0.071)	(0.072)	(0.097)	(0.091)	(0.065)	(0.074)	(0.075)
p-value (elasticity=0)						0.0053	0.0063	0.0001	0.0199	0.0137
Observations	16870	16986	33856	23054	22893	16870	16986	33856	23054	22893
Sample	All Properties	All Properties	All Properties	Midline Sample	Midline Sample	All Properties	All Properties	All Properties	Midline Sample	Midline Sample
FE: Property Value Band	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FE: Neighborhood	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FE: Wage Group	No	No	Yes	No	No	No	No	Yes	No	No
Visit Controls	No	No	No	Yes	Yes	No	No	No	Yes	Yes

Notes: This table explores the effects of collectors potentially exerting enforcement effort differentially across rates on the estimated responses to rate reductions. It reports estimates from Equations (1), (2), and (3). In Columns 1–5, the dependent variable is an indicator for property tax compliance. In Columns 6–10, the dependent variable is tax revenues (in Congolese Francs). Panel A reports treatment effects from Equation (1) comparing property tax compliance or revenue for the tax abatement treatment groups relative to the status quo property tax rate (the excluded category). It also reports the p-values associated with F-tests for equality of the treatment effects when considering heterogeneity by wage group (Columns 1–2 and 6–7). Panel B reports the mean property tax compliance or revenue as well as the marginal effect of property tax rates (in CF) on property tax compliance or revenue from Equation (2). These two estimates are used in Panel C to compute the elasticity of tax compliance or revenue with respect to the tax rate following Equation (3) and to calculate the p-value associated with the elasticity of tax revenue. Columns 1 and 6 restrict the sample to properties randomly assigned to the constant tax collector wage group (750 FC per collection). Columns 2 and 7 restrict to properties assigned to the proportional collector wage group (30% of the amount collected). Collectors' wage is discussed in Section B1.2. In Columns 3–5 and 8–10, all cases of tax compliance are considered, and we control for a collector wage (constant or proportional) indicator (Columns 3 and 8), a visit indicator (Columns 4 and 9) and for the number of visits (Columns 5 and 10). The data include all non-exempt properties registered by tax collectors merged with the government's property tax database. We discuss these results in Section 5.3.4.

TABLE A10: TREATMENT EFFECTS ON OWNERS' KNOWLEDGE AND COLLECTORS' STRATEGIES

	Knowledge			Collector Messages								
	Knows	Knows	Knows	Sanctions		Public goods		Show Trust	It's Important	Legal Obligation	Avoid Social	Other
	Nb Rate	Reductions	Past Rate	Chief	Tax Ministry	Neighborhood	Kananga	in Gov			Embarrassment	Threat
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
50% Reduction	-0.011	-0.004	-0.019	0.008	-0.003	-0.003	0.018	-0.014	-0.064**	-0.003	0.008	-0.005
	(0.008)	(0.007)	(0.025)	(0.025)	(0.026)	(0.025)	(0.025)	(0.026)	(0.026)	(0.025)	(0.023)	(0.022)
33% Reduction	-0.014*	0.003	-0.000	0.029	0.030	0.051*	0.035	-0.006	-0.022	0.008	0.015	0.022
	(0.008)	(0.007)	(0.025)	(0.024)	(0.026)	(0.026)	(0.025)	(0.026)	(0.026)	(0.025)	(0.023)	(0.023)
17% Reduction	-0.005	0.002	-0.030	-0.033	-0.021	0.014	0.037	-0.012	-0.036	-0.009	-0.015	-0.007
	(0.008)	(0.007)	(0.024)	(0.024)	(0.025)	(0.025)	(0.025)	(0.025)	(0.026)	(0.025)	(0.022)	(0.023)
Mean (control)	0.149	0.029	0.167	0.256	0.278	0.263	0.232	0.324	0.452	0.383	0.203	0.230
Observations	15072	5245	2209	2743	2743	2743	2743	2743	2743	2743	2743	2743
Sample	Midline Sample	Midline Sample	Midline Sample	Endline Sample	Endline Sample	Endline Sample	Endline Sample	Endline Sample	Endline Sample	Endline Sample	Endline Sample	Endline Sample
FE: Property Value Band	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FE: Neighborhood	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table examines treatment effects on owners' knowledge of tax rates, tax abatements, and past tax rates as well as the different possible messages used by collectors when demanding payment, as measured in the midline and endline surveys. It reports the treatment effects from Equation (1) comparing the outcome of interest for the tax abatement treatment groups relative to the status quo property tax rate (the excluded category). The dependent variable in Column 1 is an indicator for knowing the neighbors' property tax rate. In Column 2 it is an indicator for knowing about the existence of tax abatements. In Column 3 it is an indicator for knowing the status quo tax rate. In Columns 4–12 the outcomes are indicators for the different messages used by the property tax collectors during tax collection: sanctions by the chief (Column 4), sanctions by the tax ministry (Column 5), provision of public goods in the neighborhood (Column 6) or in Kananga (Column 7), showing trust in the government (in Column 8), the importance of paying the property tax (Column 9), tax compliance as a legal obligation (Column 10), social embarrassment associated with tax delinquency (Column 11), and any other threats in the case of tax delinquency (Column 12). All regressions include an indicator for the property value band and for randomization stratum (neighborhood). We report robust standard errors. The variables are described in Section B8. We discuss these results in Section 5.3.

TABLE A11: KNOWLEDGE OF STATUS QUO TAX RATE BY PAST ASSIGNMENT TO DOOR-TO-DOOR PROPERTY TAX COLLECTION

Outcome:	Has Heard of Tax Ministry	Has Heard of Property Tax	Accurately reported status quo tax rate		
Sample:	2016 Treatment Vs Control	2016 Treatment Vs Control	2016 Treatment Vs Control	Paid in 2016 Treatment Vs Control – self reported	Paid in 2016 Treatment Vs Control – administrative data
	(1)	(2)	(3)	(4)	(5)
Past door-to-door collection	0.070***	0.058*	0.033**	0.078***	0.134***
	(0.021)	(0.034)	(0.016)	(0.023)	(0.040)
Control Mean	0.833	0.492	0.142	0.142	0.142
Observations	1607	2426	2423	1465	1101
Sample	Baseline Sample	Baseline Sample	Baseline Sample	Baseline Sample	Baseline Sample
FE: Property Value Band	Yes	Yes	Yes	Yes	Yes
FE: Neighborhood	Yes	Yes	Yes	Yes	Yes

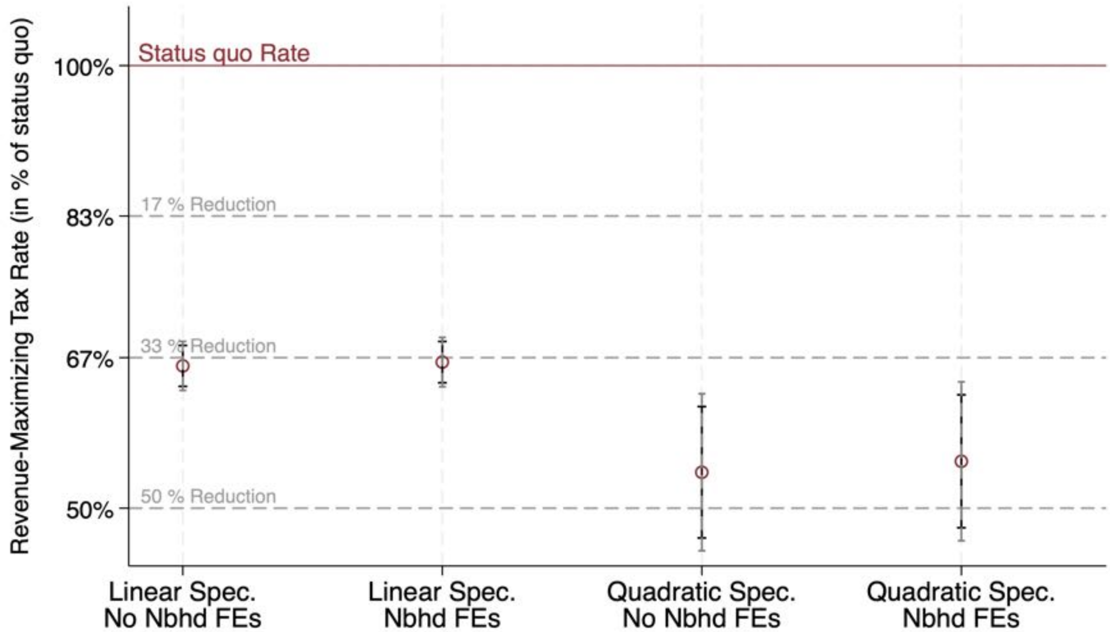
Notes: This table examines the treatment effects of assignment to door-to-door tax collection in the 2016 property tax campaign, using the treatment assignment from Weigel (2020), on knowledge of the tax ministry (Column 1), knowledge of the property tax (Column 2), and an indicator for the property owner accurately reporting the status quo tax rate at baseline in 2017 (Columns 3–5). Columns 1–3 report the results when considering all baseline respondents. Columns 4–5 include everyone in the control group from Weigel (2020), where no door-to-door tax collection took place in 2016, compared to tax-compliant households in the treatment group from Weigel (2020), where tax collection did occur in 2016. In Column 4, tax compliance status is self-reported, while in Column 5 it is measured using administrative data. All regressions include an indicator for the property value band and the randomization strata from Weigel (2020). Standard errors are clustered at the neighborhood level, the unit of randomization in Weigel (2020). The data include all property owners surveyed at baseline merged with the government's property tax databases. We discuss these results in Section 5.3.

TABLE A12: HETEROGENEOUS TREATMENT EFFECTS ON COMPLIANCE BY PROXIES FOR LIQUIDITY

	Outcome: Tax Compliance (Indicator)											
	Monthly Income		Weekly Transport		Number of Possessions		Went to Bed Hungry – Past Month		Can find 3,000 CF – Next Four Days		Nb of days w/o 3,000 CF – Past Month	
	$\leq$ median	$>$ median	$\leq$ median	$>$ median	$\leq$ median	$>$ median	Yes	No	No	Yes	$>$ median	$\leq$ median
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Panel A: Treatment Effects												
50% Reduction	0.141***	0.070**	0.131***	0.072**	0.124***	0.052	0.076**	0.119***	0.127***	0.069*	0.119***	0.102**
	(0.031)	(0.030)	(0.032)	(0.029)	(0.022)	(0.045)	(0.031)	(0.031)	(0.025)	(0.038)	(0.027)	(0.038)
33% Reduction	0.066**	0.022	0.058**	0.007	0.056**	-0.020	0.080**	0.011	0.065**	0.011	0.062**	-0.009
	(0.028)	(0.029)	(0.029)	(0.026)	(0.021)	(0.045)	(0.030)	(0.027)	(0.023)	(0.037)	(0.025)	(0.035)
17% Reduction	0.037	-0.043	0.007	-0.044*	0.016	-0.109**	0.009	-0.033	0.010	-0.024	-0.016	-0.014
	(0.026)	(0.027)	(0.027)	(0.025)	(0.019)	(0.040)	(0.025)	(0.026)	(0.021)	(0.034)	(0.022)	(0.033)
Mean (control)	0.069	0.104	0.069	0.102	0.066	0.150	0.065	0.108	0.076	0.113	0.085	0.096
Tests of coef. equality:												
50% Reduction	$p_{50\%}$ =0.058		$p_{50\%}$ =0.117		$p_{50\%}$ =0.263		$p_{50\%}$ =0.259		$p_{50\%}$ =0.128		$p_{50\%}$ =0.664	
33% Reduction	$p_{33\%}$ =0.197		$p_{33\%}$ =0.138		$p_{33\%}$ =0.149		$p_{33\%}$ =0.048		$p_{33\%}$ =0.140		$p_{33\%}$ =0.053	
17% Reduction	$p_{17\%}$ =0.012		$p_{17\%}$ =0.113		$p_{17\%}$ =0.006		$p_{17\%}$ =0.187		$p_{17\%}$ =0.295		$p_{17\%}$ =0.966	
All Reductions	$p_{All\%}$ =0.072		$p_{All\%}$ =0.291		$p_{All\%}$ =0.055		$p_{All\%}$ =0.018		$p_{All\%}$ =0.368		$p_{All\%}$ =0.145	
Panel B: Marginal Effects												
ln(Tax Rate in CF)	-0.198***	-0.130**	-0.202***	-0.127**	-0.183***	-0.132**	-0.129**	-0.184***	-0.192***	-0.115**	-0.198***	-0.153**
	(0.042)	(0.041)	(0.045)	(0.040)	(0.031)	(0.064)	(0.042)	(0.042)	(0.034)	(0.052)	(0.037)	(0.053)
Mean (sample)	0.138	0.125	0.132	0.130	0.124	0.151	0.123	0.139	0.129	0.136	0.137	0.121
Panel C: Elasticities												
Elasticity	-1.438	-1.041	-1.526	-0.977	-1.482	-0.875	-1.05	-1.323	-1.492	-0.850	-1.446	-1.264
	(0.334)	(0.343)	(0.368)	(0.329)	(0.270)	(0.451)	(0.369)	(0.323)	(0.276)	(0.391)	(0.278)	(0.473)
Observations	1348	1405	1317	1436	1983	777	1346	1414	1816	944	1769	991
Sample	Baseline Sample	Baseline Sample	Baseline Sample	Baseline Sample	Baseline Sample	Baseline Sample	Endline Sample	Endline Sample	Endline Sample	Endline Sample	Endline Sample	Endline Sample
FE: Property Value Band	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FE: Neighborhood	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table investigates how the effect of tax abatements on compliance varies by household liquidity. It reports estimates from Equations (1), (2), and (3). The dependent variable is an indicator for tax compliance. Panel A reports treatment effects from Equation (1) comparing property tax compliance for the tax abatement treatment groups relative to the status quo property tax rate (the excluded category). It also reports the p-values associated with F-tests for equality of the treatment effects when considering heterogeneity by monthly income (Columns 1–2), weekly transport expenditures (Columns 3–4), number of possessions (Columns 5–6), going to bed hungry in the past 30 days (Columns 7–8), being able to find 3,000 CF in the next four days (Columns 9–10), number of days the respondent did not have 3,000 CF in the past 30 days (Columns 11–12). Panel B reports the mean tax compliance as well as the marginal effect of property tax rates (in Congolese Francs) on tax compliance from Equation (2). These two estimates are used in Panel C to compute the elasticity of tax compliance with respect to the tax rate following Equation (3). All regressions include an indicator for the property value band and for randomization stratum (neighborhood). Panels A and B report robust standard errors. Standard errors in Panel C are bootstrapped (with 1,000 iterations). Columns 1, 3, and 5 restrict the baseline sample to respondents with below-median monthly household income, weekly transport expenditures, and number of possessions, respectively. Columns 2, 4, and 6 restrict the baseline sample to respondents with above-median monthly household income, weekly transport expenditures, and number of possessions, respectively. Columns 7–8 report results by whether endline respondents declared that they went to bed hungry in the past 30 days. Columns 9 and 10 report results by whether respondents declare being able to find 3,000 CF in the next four days. Columns 11–12 report results by whether the number of days the respondent reported not having 3,000 CF in the past month at endline is above or below the median. The variables come from the baseline and endline surveys and are described in Section B8. We discuss these results in Section B6.3.1.

FIGURE A3: THE REVENUE-MAXIMIZING TAX RATE



Notes: This figure reports estimates of the revenue-maximizing tax rate (RMTR) using the expression in Equation (4). The first two estimates assume linearity of tax compliance with respect to the tax rate and correspond to the estimation of Equation (5) using regression specification (6), while the following two estimates assume a quadratic relationship between tax compliance and tax rate. All estimates of the RMTR are expressed as a percentage of the status quo tax rate. All regressions include an indicator for the property value band, and the second and fourth point estimates also include randomization stratum (i.e., neighborhood, or "Nbhd") fixed effects. The black lines show the 90% confidence interval and the gray lines the 95% confidence interval for each estimate using the standard errors obtained from the delta method. The coefficients and confidence intervals correspond to the point estimates and standard errors reported in Table 3 (Panel B). The data include all non-exempt properties registered by tax collectors merged with the government's property tax database. We discuss these results in Section 6.3.

TABLE A13: EFFECTS OF TAX LETTER MESSAGES ON TAX COMPLIANCE AND REVENUE

	Tax Compliance			Tax Revenue (in CF)		
	(1)	(2)	(3)	(4)	(5)	(6)
Central Enforcement	0.014	0.016*		32.837*	36.510**	
	(0.009)	(0.009)		(18.610)	(18.453)	
Local Enforcement	0.014	0.016*		31.244*	35.545*	
	(0.009)	(0.009)		(18.723)	(18.783)	
Pooled Enforcement			0.016**			36.038**
			(0.007)			(15.589)
Observations	2665	2665	2665	2665	2665	2665
Mean	0.029	0.029	0.029	57.671	57.671	57.671
Sample	Tax Message Sample	Tax Message Sample	Tax Message Sample	Tax Message Sample	Tax Message Sample	Tax Message Sample
FE: Property Value Band	Yes	Yes	Yes	Yes	Yes	Yes
FE: Neighborhood	No	Yes	Yes	No	Yes	Yes

Notes: This table examines the treatment effects of randomized tax letter enforcement messages on compliance, revenues, and perceived sanctions for tax delinquents. It reports estimates from a regression of tax compliance (Columns 1–3) and tax revenue (Columns 4–6) on treatment dummies for households assigned to enforcement messages on tax letters distributed during property registration. Sections 7.1 and B1.4 describe these tax letters and the message randomization. The excluded category is the control message in all regressions. Columns 2–3 and 5–6 introduce randomization stratum (neighborhood) fixed effects. Columns 3 and 6 pool households assigned to the *central enforcement* message and the *local enforcement* message. The data are restricted to the sample of 2,665 properties subject to randomized messages on tax letters, which were introduced toward the end of the tax campaign. We discuss these results in Section 7.1.

TABLE A14: EFFECTS OF TAX LETTER MESSAGES ON PERCEIVED SANCTIONS AND STATE CAPACITY

	Likelihood of Sanctions			Perceived State Capacity			Number of Visits		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Central Enforcement	0.064**	0.058**		0.077	0.011		0.037	0.055	
	(0.031)	(0.029)		(0.089)	(0.107)		(0.042)	(0.040)	
Local Enforcement	0.019	0.022		0.001	-0.052		-0.027	0.003	
	(0.032)	(0.030)		(0.089)	(0.100)		(0.039)	(0.036)	
Pooled Enforcement			0.041			-0.021			0.030
			(0.025)			(0.091)			(0.033)
Observations	1553	1553	1553	193	193	193	1859	1859	1859
Mean	0.478	0.478	0.478	0.492	0.492	0.492	0.434	0.434	0.434
Sample	Tax Message & Midline Sample	Tax Message & Midline Sample	Tax Message & Midline Sample	Tax Message & Baseline Sample	Tax Message & Baseline Sample	Tax Message & Baseline Sample	Tax Message & Midline Sample	Tax Message & Midline Sample	Tax Message & Midline Sample
FE: Property Value Band	v	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FE: Neighborhood	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes

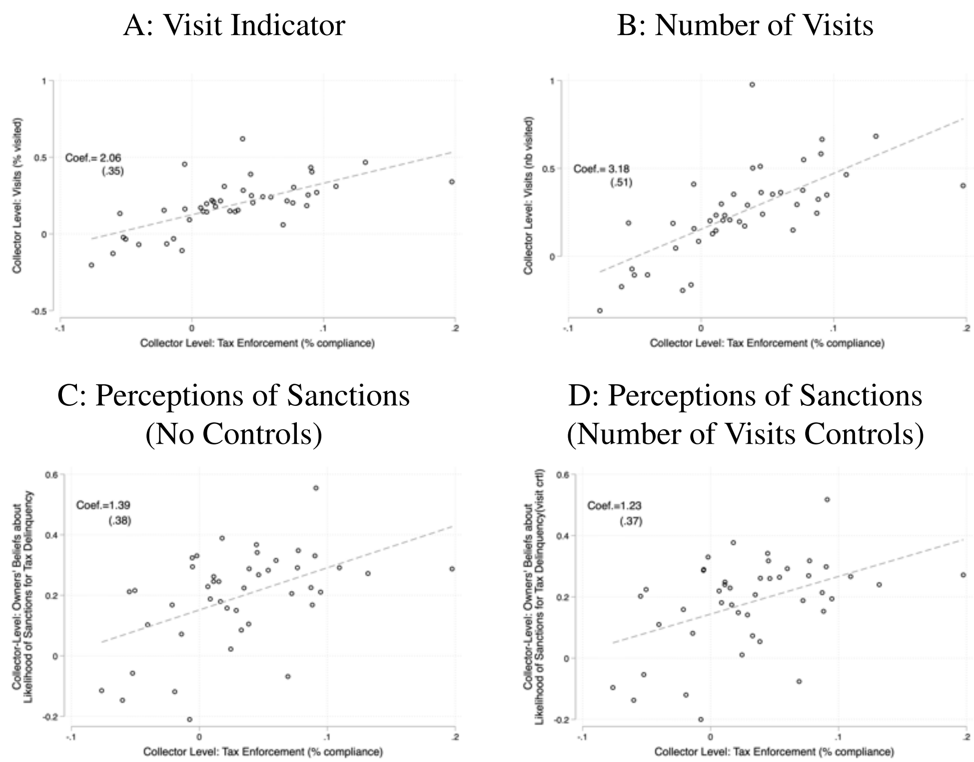
Notes: This table examines the treatment effects of randomized tax letter enforcement messages on perceived sanctions for tax delinquency, perceived state capacity, and visits by tax collectors. It reports estimates from a regression of an indicator for households reporting that sanctions for tax delinquency are "likely" or "very likely" (Columns 1–3), an indicator for respondents reporting that the provincial government would be able to repair the main roads in Kananga within 3 months if they had been badly damaged due to bad weather (Columns 4–6), and the number of tax collectors' visits after property registration reported by the respondent (Columns 7–9) on treatment dummies for households assigned to enforcement messages on tax letters distributed during property registration. Sections 7.1 and B1.4 describe these tax letters and the message randomization. The excluded category is the control message in all regressions. Columns 2–3, 5–6, and 8–9 introduce randomization stratum (neighborhood) fixed effects. Columns 3, 6, and 9 pool households assigned to the *central enforcement* message and the *local enforcement* message. The data are restricted to the sample of 2,665 properties subject to randomized messages on tax letters, which were introduced toward the end of the tax campaign, but the sample size is smaller in all columns because the outcomes come from the midline survey (Columns 1–3 and 7–9) and the baseline survey (Columns 4–6), rather than the administrative data. We discuss these results in Section 7.1.

TABLE A15: REVENUE-MAXIMIZING TAX RATE BY ENFORCEMENT CAPACITY (TAX LETTER VARIATION)

	Control Message				Enforcement Message			
	Linear Specification		Quadratic Specification		Linear Specification		Quadratic Specification	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Effect of Tax Rates on Tax Compliance								
Tax Rate (in % of status quo)	-0.082**	-0.083**	-0.379	-0.399	-0.061**	-0.053**	0.192	0.210
	(0.032)	(0.033)	(0.336)	(0.327)	(0.025)	(0.025)	(0.266)	(0.261)
Tax Rate Squared (in % of status quo)			0.196	0.210			-0.169	-0.175
			(0.211)	(0.209)			(0.172)	(0.170)
Constant	0.091***	0.092***	0.197	0.203*	0.088***	0.082***	-0.001	-0.010
	(0.028)	(0.028)	(0.128)	(0.123)	(0.020)	(0.021)	(0.097)	(0.096)
Panel B: Revenue-Maximizing Tax Rate (RMTR)								
RMTR (in % of status quo rate)	0.557	0.554	0.361	0.354	0.724	0.779	0.756	0.772
	(0.061)	(0.063)	(0.101)	(0.093)	(0.138)	(0.190)	(0.052)	(0.050)
Implied Reduction in Tax Rate	44.32%	44.57%	63.91%	64.57%	27.63%	22.12%	24.35%	22.75%
Observations	893	893	893	893	1772	1772	1772	1772
Sample	Tax Message Sample	Tax Message Sample	Tax Message Sample	Tax Message Sample	Tax Message Sample	Tax Message Sample	Tax Message Sample	Tax Message Sample
FE: Property Value Band	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FE: Neighborhood	No	Yes	No	Yes	No	Yes	No	Yes
Quadratic Tax Rate Term	No	No	Yes	Yes	No	No	Yes	Yes

Notes: This table examines how the revenue-maximizing tax rate (RMTR), given by Equation (4), varies by enforcement capacity using the variation in messages embedded in tax letters. Columns 1–2 and 5–6 assume linearity of tax compliance with respect to the tax rate. Panel A reports results from estimating Equation (6), and Panel B reports the corresponding RMTR from Equation (5). Columns 3–4 and 7–8 assume a quadratic relationship between tax compliance and tax rate. Panel A reports the regression results, and Panel B reports the RMTR. All estimates in Panels A and B are expressed as a percentage of the status quo tax rate. All regressions include an indicator for the property value band, and Columns 2, 4, 6, and 8 also include randomization stratum (neighborhood) fixed effects. In Panel A, we report robust standard errors. In Panel B, we reported standard errors computed using the delta method. The data are restricted to the sample of 2,665 properties exposed to randomized messages on tax letters. Columns 1–4 further restrict the sample to owners who received the *control* message and Columns 5–8 to owners who received an enforcement message (*central enforcement* or *local enforcement*). We discuss these results in Section 7.1.

FIGURE A4: COLLECTOR ENFORCEMENT CAPACITIES VS. FREQUENCY OF COLLECTOR VISITS AND PERCEPTIONS OF SANCTIONS



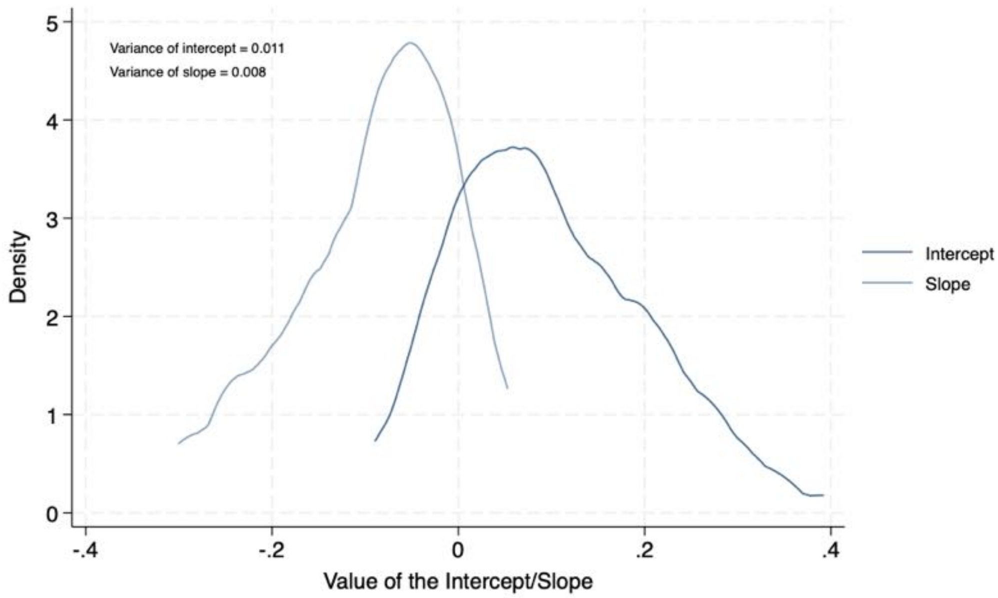
Notes: This figure shows correlations between the collector-specific enforcement capacities and average reported visits and beliefs about the probability of sanctions for tax delinquents in neighborhoods to which collectors were randomly assigned. The x-axis reports estimates of tax collector enforcement capacity using regression specification (7), expressed as the percentage of owners who pay the property tax in all neighborhoods to which a collector was randomly assigned. In Panels A and B, the y-axis reports the collector-level visits on the extensive and intensive margins as reported by households in the midline survey. In Panels C and D, the y-axis reports property owners' midline perception of sanctions for tax delinquency at the collector level. This variable is measured as an indicator for households reporting that sanctions for tax delinquency are "likely" or "very likely". All y-axis estimates are from empirical specification (7). We discuss these results in Section 7.2.

TABLE A16: COLLECTOR ENFORCEMENT CAPACITIES AND REVENUE-MAXIMIZING TAX RATES

	Level-Level		Log-Log	
	OLS	Empirical Bayes	OLS	Empirical Bayes
	(1)	(2)	(3)	(4)
Panel A: RMTR from Linear Specification				
Enforcement Capacity	2.421**	2.797***		
	(0.819)	(0.666)		
ln(Enforcement Capacity)			0.623**	0.465***
			(0.215)	(0.108)
Observations	44	44	42	41
Panel B: RMTR from Quadratic Specification				
Enforcement Capacity	1.587*	1.597**		
	(0.831)	(0.755)		
ln(Enforcement Capacity)			0.347**	0.112**
			(0.159)	(0.050)
Observations	44	44	43	43
Sample	All state tax collectors	All state tax collectors	All state tax collectors	All state tax collectors

Notes: This table examines the relationship between tax collectors' revenue-maximizing tax rates (RMTR) and their enforcement capacities. Collector-specific enforcement capacities are estimated using regression specification (7). In Columns 1–4, the collector-specific RMTR assumes linearity of tax compliance with respect to the tax rate and is obtained from estimating Equation (8). In Columns 5–8, the collector-specific RMTR assumes a quadratic relationship between tax compliance and the tax rate. Columns 1, 3, 5, and 7 report the fixed effects estimates, while Columns 2, 4, 6, and 8 report the empirical Bayes estimates described in Section B4. Columns 1–2 and 5–6 report the results of a level-level regression, while Columns 3–4 and 7–8 use the log-log specification $ln(\widehat{T_c^*}) = \alpha + \beta ln(\widehat{E}_c) + \nu_c$ and can be interpreted as an elasticity. We discuss these results in Section 7.2.

FIGURE A5: DISTRIBUTION OF COLLECTOR SLOPES AND INTERCEPTS



Notes: This figure reports the distribution of the coefficients estimated from regression specification (8). Specifically, it reports the Kernel Density of the collector-level intercepts (β_c^0 in Equation (8)) in dark blue and of the collector-level slopes (β_c^1 in Equation (8)) in light blue. The Kernel densities use the default (Epanechnikov) Kernel function and bandwidth. To document whether the differences in the RMTR across collectors is generated by differences in their intercepts or slopes, the figure also reports the variance of the collector-level intercepts ($Var(\beta_c^0) = 0.011$) and the variance of the collector-level slopes ($Var(\beta_c^1) = 0.008$). We discuss these results in Section 7.2.

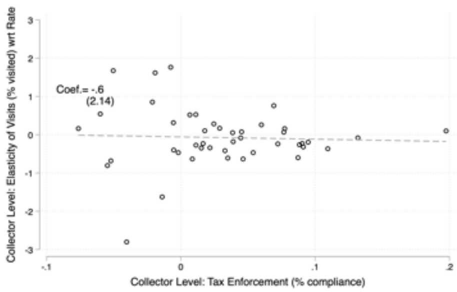
TABLE A17: EFFECT OF COLLECTOR ENFORCEMENT CAPACITY ON INTERCEPT AND SLOPE

	Outcome: Tax Compliance (Indicator)		Outcome: Tax Revenue (in CF)	
	(1)	(2)	(3)	(4)
High-Ability Collector	0.066**	0.098***	107.792*	158.119**
	(0.031)	(0.028)	(57.547)	(59.571)
Tax Rate (in % of status quo)	-0.115***	-0.115***	-79.122	-77.694
	(0.022)	(0.022)	(54.389)	(54.362)
High-Ability Collector × Tax Rate (in % of status quo)	-0.043	-0.043	-12.954	-14.668
	(0.027)	(0.027)	(64.808)	(64.737)
Constant	0.146***	0.114***	162.135**	121.651**
	(0.025)	(0.022)	(49.302)	(52.638)
Observations	23777	23777	23777	23777
Sample	Collector Sample	Collector Sample	Collector Sample	Collector Sample
FE: Property Value Band	Yes	Yes	Yes	Yes
FE: Treatment from Balan et al.	No	Yes	No	Yes

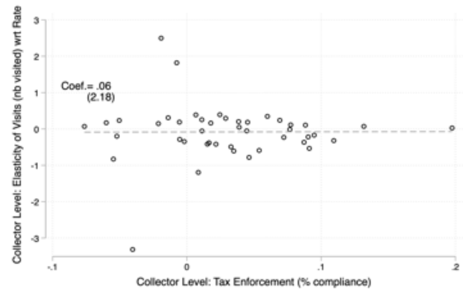
Notes: This table examines whether tax collectors with above median enforcement capacity are characterized by higher tax compliance across all rates (i.e., β_0 in Equation (6)) or differentially affect tax compliance by tax rates (i.e., β_1 in Equation (6)). We estimate the following regression specification: $y_{i,n} = \beta_0 1[c_1(n) = H \textit{ or } c_2(n) = H] + \beta_2 Tax\ Rate_{i,n} + \beta_3 1[c_1(n) = H \textit{ or } c_2(n) = H] \times Tax\ Rate_{i,n} + X'_{i,n}\gamma + \epsilon_{i,n}$, where $y_{i,n}$ measures the outcome of interest (tax compliance or revenue) for individual i living in neighborhood n. $c_1(n)$ and $c_2(n)$ are the two collectors assigned to collect in neighborhood n and $1[c_1(n) = H \textit{ or } c_2(n) = H]$ is an indicator for either or both of the collectors' fixed effects — estimated in Equation (7) — being above median. $Tax\ Rate_{i,n}$ is the tax rate expressed as a percentage of the status quo rate. In Columns 1–4, $X_{i,n}$ contains an indicator for properties in the high-value band. In Columns 2 and 4, it also includes an indicators for the neighborhood-level interventions described in Balan et al. (2022). The dependent variable is an indicator for compliance in Columns 1–2 and tax revenues (in Congolese Francs) in Columns 3–4. We discuss these results in Section 7.2.

FIGURE A6: COLLECTOR ENFORCEMENT CAPACITIES AND VISITS BY RATE

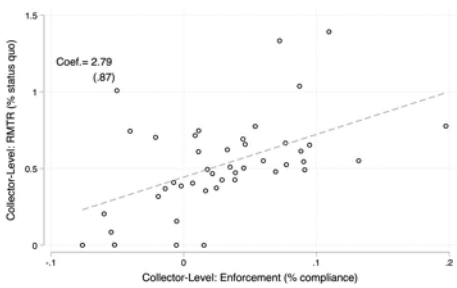
A: Elasticity of Visit Indicator
wrt Tax Rates v. Enforcement Capacity



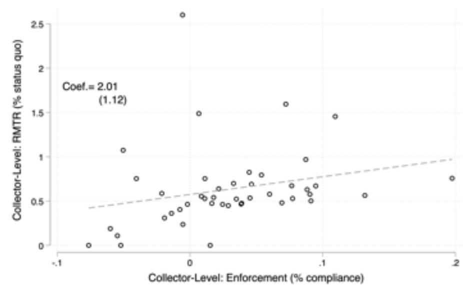
B: Elasticity of Number of Visits
wrt Tax Rates v. Enforcement Capacity



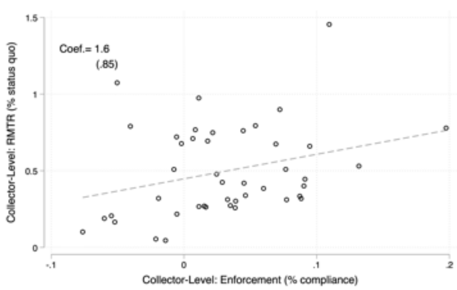
C: Enforcement Capacity v. RMTR
Controlling for Visit Indicator
(linear spec.)



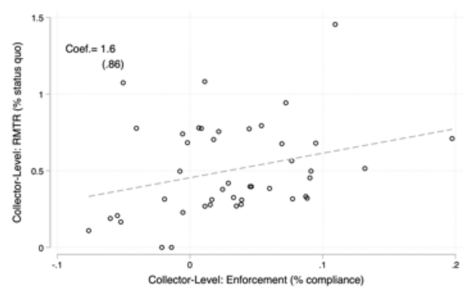
D: Enforcement Capacity v. RMTR
Controlling for Number of Visits
(linear spec.)



E: Enforcement Capacity v. RMTR
Controlling for Visit Indicator
(quadratic spec.)



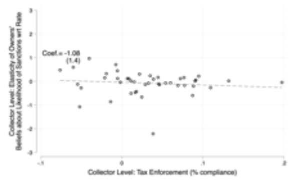
F: Enforcement Capacity v. RMTR
Controlling for Number of Visits
(quadratic spec.)



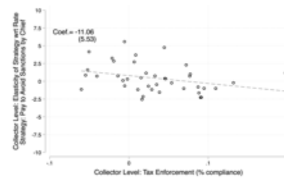
Notes: This figure examines whether high-enforcement collectors exhibit differential elasticity of tax visits by rate and whether controlling for tax visits impacts the observed relationship between collector enforcement capacities and revenue-maximizing tax rates (RMTR). The x-axis of this figure always reports estimates of tax collector enforcement capacity using regression specification (7), expressed as the percentage of owners who pay the property tax. In Panels A and B, the y-axis reports the collector-level elasticity of visits on the extensive (Panel A) and the intensive margin (Panel B) with respect to tax rates. In Panels C–F, the y-axis reports the collector-specific RMTR in Equation (4) controlling for visits on the extensive margin (Panels C and D) and extensive margin (Panels E and F). When estimating the collector-specific RMTR, we assume linearity in Panels C and D and estimate Equation (8), while in Panels E and F we assume a quadratic relationship between tax compliance and tax rate. We discuss these results in Section 7.2.

FIGURE A7: COLLECTOR ENFORCEMENT CAPACITIES AND PERCEIVED LIKELIHOOD OF SANCTIONS OR COLLECTOR MESSAGE BY RATE

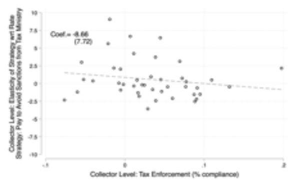
A: Elasticity of Perceived Sanctions
wrt Tax Rates v. Enforcement Capacity



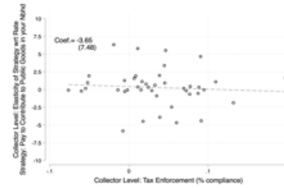
B: Elasticity of 'Chief Sanctions' Message
wrt Tax Rates v. Enforcement Capacity



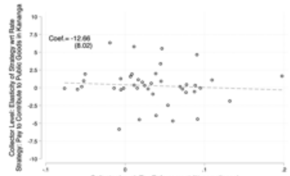
C: Elasticity of 'Tax Ministry Sanctions' Message
wrt Tax Rates v. Enforcement Capacity



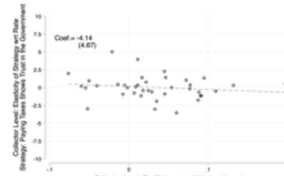
D: Elasticity of 'Public Goods in Nbhd' Message
wrt Tax Rates v. Enforcement Capacity



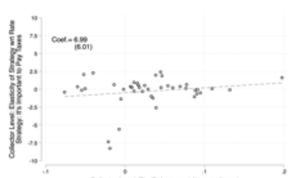
E: Elasticity of 'Public Goods in Kananga' Message
wrt Tax Rates v. Enforcement Capacity



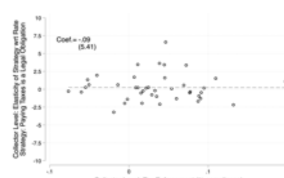
F: Elasticity of 'Show Trust in Gov' Message
wrt Tax Rates v. Enforcement Capacity



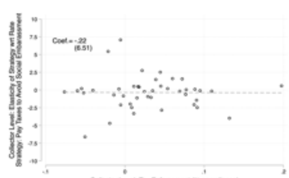
G: Elasticity of 'It's Important' Message
wrt Tax Rates v. Enforcement Capacity



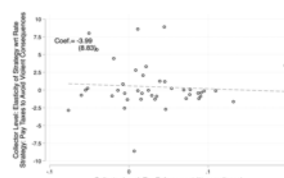
H: Elasticity of ' Legal Obligation' Message
wrt Tax Rates v. Enforcement Capacity



I: Elasticity of 'Avoid Social Embarrassment'
Message wrt Tax Rates v. Enforcement Capacity

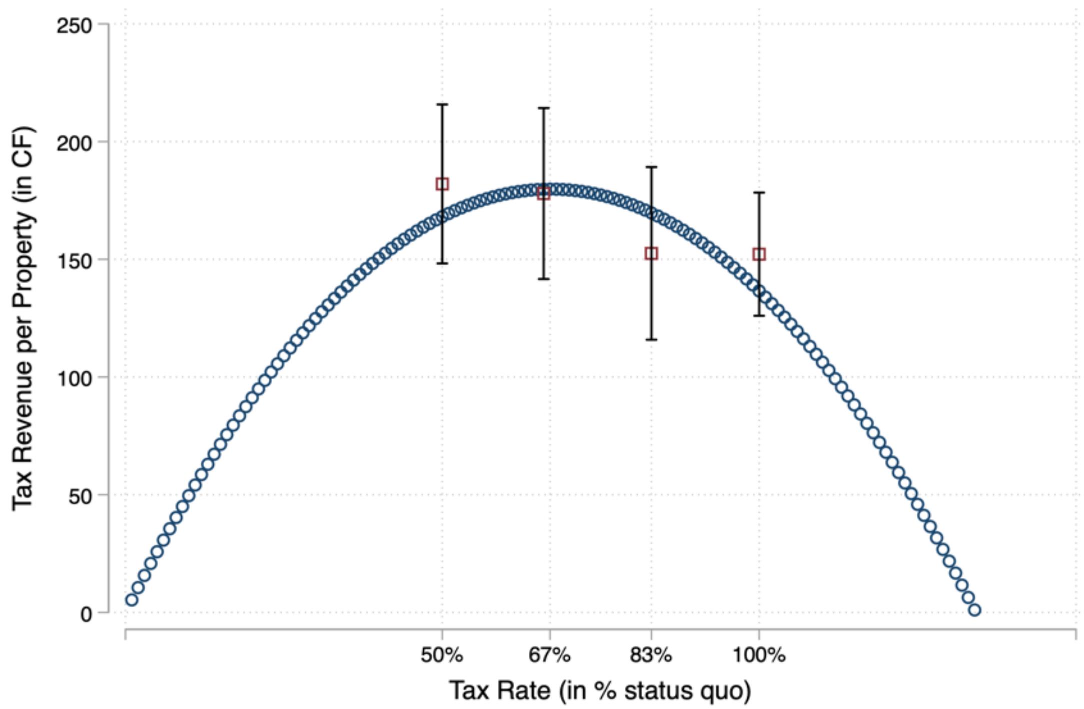


J: Elasticity of 'Other Threats' Message
wrt Tax Rates v. Enforcement Capacity



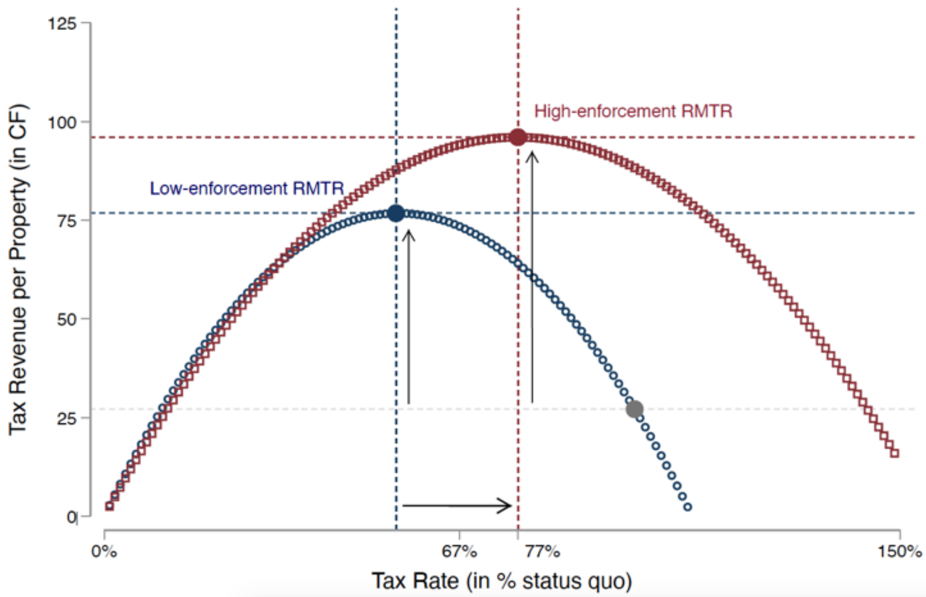
Notes: This figure examines whether high-enforcement collectors result in a different elasticity of owner's beliefs about the likelihood of sanction for tax delinquency wrt rate (Panel A) and a different elasticity of collector messages by rate (Panels B–J). The x-axis of this figure always reports estimates of tax collector enforcement capacity using regression specification (7), expressed as the percentage of owners who pay the property tax. In Panels A the y-axis reports the collector-level elasticity of owner's beliefs about the likelihood of sanctions for tax delinquency with respect to tax rates. Owner's beliefs about the likelihood of sanctions for delinquency is measured in the midline survey. In Panels B–J, the y-axis reports the collector-level elasticity of the message used by the tax collector with respect to the tax rate: sanctions by the chief (Panel B), sanctions by the tax ministry (Panel C), provision of public goods in the neighborhood (Panel D) or in Kananga (Panel E), showing trust in the government (Panel F), the importance of paying the property tax (Panel G), tax compliance as a legal obligation (Panel H), social embarrassment associated with tax delinquency (Panel I), and any other threats in the case of tax delinquency (Panel J). We discuss these results in Section 7.2.

FIGURE A8: RATES AND ENFORCEMENT AS COMPLEMENTS – FIT OF THE TAX REVENUE VS. TAX RATES RELATIONSHIP



Notes: This figure reports estimates of the relationship between tax rates (x-axis) and tax revenue per property owner (y-axis). The red point estimates are from Equation (1), comparing property tax revenue in the tax abatement treatment groups relative to the status quo property tax rate. The black lines show the 95% confidence interval for each of the estimates using robust standard errors. The blue point estimates are the predicted tax revenue, $T \cdot \widehat{\mathbb{P}(T, \alpha)}$, which we obtain by predicting $\mathbb{P}(T, \alpha)$ at every tax rate T using Equation (6). As described in Section 7.2, we restrict the data to the 23,777 properties subject to tax collection by state tax collectors. We discuss these results in Section 7.3.

FIGURE A9: RATES AND ENFORCEMENT AS COMPLEMENTS – REVENUE IMPLICATIONS (TAX LETTERS)



Notes: This figure reports estimates of the relationship between tax rates (x-axis) and tax revenue per property owner (y-axis). We predict tax revenues at different hypothetical tax rates using the regression coefficients obtained when estimating Equation (6). We compare the estimated relationship among households assigned to the *control* message on their tax letter (blue dotted curve) to households assigned to an enforcement message (red dotted curve). For the latter, we pool the *central enforcement* and *local enforcement* messages. Vertical lines indicate different potential tax rates, while horizontal lines indicate the corresponding revenue levels. The data are restricted to the sample of 2,665 properties that were subject to randomized messages on tax letters. We discuss these results in Section 7.3

Secondary Supplement
Not For Online Publication

B1 Additional Campaign Details 67
- B1.1 Logistics Pilot . . . 67
- B1.2 Collector Wage . . . 67
- B1.3 Types of Tax Collector . . . 67
- B1.4 Tax Letter Messages . . . 69

B2 Welfare Implications 69
- B2.1 Optimal Tax Rate . . . 69
- B2.2 Marginal Value of Public Funds (MVPF) . . . 71

B3 Estimation of Collector-Lever Enforcement Capacity and RMTR 71

B4 Empirical Bayes Adjustment 72

B5 Collector Characteristics and Enforcement Capacity 74

B6 Additional Tables and Figures 75
- B6.1 Additional Exhibits for Paper Section 3 — Setting . . . 75
- B6.2 Additional Exhibits for Paper Section 4 — Data and Balance . . . 77
- B6.3 Additional Exhibits for Paper Section 5 — Treatment Effects on Tax Compliance and Revenue . . . 81
  - B6.3.1 Mechanisms: the role of liquidity constraints . . . 86
- B6.4 Additional Exhibits for Paper Section 6 — The Revenue-Maximizing Tax Rate . . . 89
- B6.5 Additional Exhibits for Paper Section 7 — Can Enforcement Increase the Revenue-Maximizing Tax Rate? . . . 100

B7 Predicting Property Value with Machine Learning 118
- B7.1 Data Collection . . . 118
  - B7.1.1 Training Sample . . . 118
  - B7.1.2 Feature Vector . . . 118
- B7.2 Machine Learning Predictions . . . 119
  - B7.2.1 Algorithms . . . 119
  - B7.2.2 Results . . . 120

B8 Detailed Survey-Based Variable Descriptions 126
- B8.1 Property and Property Owner Surveys . . . 126
- B8.2 Tax Collectors Surveys . . . 133

B1 Additional Campaign Details

B1.1 Logistics Pilot

Before the tax campaign, a logistics pilot took place in March-April 2018. During the pilot, collectors tested the receipt printers for the different tax abatement treatments. They also piloted the protocols for property registration and the delivery of tax letters that were used in the campaign. The pilot took place in eight neighborhoods of Kamilabi, in northwest Kananga. Kamilabi is isolated from the rest of Kananga by a series of steep ravines. This area was selected strategically due to its remote location to minimize potential informational spillovers. We exclude the pilot neighborhoods from our main estimations. But in Table A4, we show that the main results are robust to including these pilot neighborhoods

B1.2 Collector Wage

Consistent with standard practices at the tax ministry, all tax collectors received piece-rate compensation for their work on the campaign. Tax collectors received 30 Congolese Francs per property in the register plus a piece rate for each instance of tax collection. The compensation for tax payments was randomly assigned at the property level, orthogonal to tax rates, between a proportional wage of 30% of the tax rate and a constant wage of 750 CF.[64] The size of the piece-rate wage in this context is analogous to incentives paid to property tax collectors in other low-income countries (Khan et al., 2015; Amodio et al., 2018).

> **B1. Proportional Wage.** Half of the properties in the low-value band were randomly assigned to the proportional wage group equal to 30% of the amount of property tax collected. Thus, compensation is 900 CF for taxed properties assigned to the status quo tax rate, 750 CF for properties in the 17% tax abatement treatment, 600 CF for the properties in the 33% tax abatement treatment, and 450 CF for properties in the 50% tax abatement treatment.
>
> **B2. Constant Wage.** Half of the properties in the properties in the low-value band were randomly assigned to a constant piece-rate wage of 750 CF per taxed property.

The treatment effects on tax compliance and revenue as well as the elasticities of tax compliance and revenue with respect to the tax rate are very similar across collector wage groups (Table A8).

B1.3 Types of Tax Collector

During the 2018 property tax campaign, the provincial government simultaneously randomized different types of tax collector at the neighborhood level. We provide more details

[64]One exception is for properties in the high-value band, which were all assigned to a fixed collector wage of 2,000 CF per taxed property.

about these tax collector types and analyze their effects on tax compliance and tax revenue in a companion paper (Balan et al., 2022), but here we provide a brief summary.

1. State Collectors (Central). In 110 "Central" neighborhoods, agents of the provincial tax ministry were charged with all campaign responsibilities. Central collectors were unsalaried contractors who frequently undertake work for the tax ministry and other parts of the provincial government. Some of these agents had worked on the 2016 property tax campaign; others had prior experience collecting firm taxes. The most productive collectors could expect to be competitive for full-time (salaried) positions at the tax ministry.

2. Chief Collectors (Local). In 111 "Local" neighborhoods, city chiefs were charged with campaign responsibilities. These chiefs are locally embedded elite leaders whose main responsibilities include: (*i*) mediating local disputes, especially over property; (*ii*) acting as an intermediary between citizens in the neighborhood and the authorities; and (*iii*) organizing a weekly informal labor tax in which citizens undertake local public good provision (*salongo*). The position is technically approved by city government authorities, but chiefs have indefinite and often lifelong tenure, which at times passes through families. Although they share many characteristics with customary chiefs — including land dispute mediation, informal labor tax administration, and long-lasting, sometimes heritable tenure — city chiefs are a distinct institution that is common across Francophone Africa. Known as *chefs d'avenue* or *chefs de localité*, such chiefs frequently play a role in property tax collection.

3. Central + Local Information (CLI). In 80 "Central + Local Information" neighborhoods, after completing the registry, but before follow-up tax visits, state collectors met with the neighborhood chief for a consultation about potential taxpayers. During this meeting, the chief and central collectors went line-by-line through the property register with accompanying photos of each compound (shown on a tablet) taken during registration. For each property, the chief indicated the household's ability and willingness to pay.

4. Central X Local (CXL). In 50 "Central X Local" neighborhoods, one state and one chief collector worked together on the campaign. The other rules and procedures of tax collection remained as above.

5. Pure Control. 5 "Pure Control" neighborhoods kept the old "declarative" system (the status quo until 2016), in which individuals were supposed to pay themselves at the tax ministry. In this arm, two agents from the tax ministry conducted the property register, assigned tax IDs, and distributed tax letters as in other neighborhoods. The exception was that property owners were informed that they could only pay at the tax ministry rather than paying field-based collectors.

Because the tax rate abatements were randomized at the household level (stratifying on the neighborhood level), we pool neighborhoods assigned to these different tax collector treatments in most of the analysis in this paper. However, we show in Table B7 that the treatment effects in terms of tax compliance and tax revenue as well as the elasticities of tax compliance and revenue with respect to the tax rate are similar across types of tax collector.

B1.4 Tax Letter Messages

Tax letters contained six cross-randomized messages read out loud by collectors during taxpayer registration:

> **M1. Central enforcement.** This message says that refusal to pay the property tax entails the possibility of audit and investigation by the provincial tax ministry.
>
> **M2. Local enforcement.** The local version of the deterrence message says that refusal to pay the property tax entails the possibility of audit and investigation by the quartier chief.[65]
>
> **M3. Central public goods.** This message says that the provincial government will be able to improve infrastructure in the city of Kananga only if citizens pay the property tax.
>
> **M4. Local public goods.** The local version of this message is exactly the same, expect that it mentions each citizen's locality instead of Kananga.[66]
>
> **M5. Trust.** The trust message reminds citizens that paying the property tax is a way of showing that they trust the state and its agents.
>
> **M6. Control.** Control letters say "It is important to pay the property tax."

Figure shows examples of the messages written on the tax letters. We show in Table B18 that the random assignment of these letters achieved balance across property and property owner characteristics. Table A13 shows that compared to the control message, the enforcement messages (M1 or M2) increased tax compliance and revenue. Finally, Panel A of Figure 1 and Table A15 show that the RMTR is lower among property owners assigned to the control message than among those assigned to enforcement messages. Table B20 shows that this is true when controlling for characteristics of the property and of the property owner that appear to be imbalanced across tax messages in Table B18.

B2 Welfare Implications

B2.1 Optimal Tax Rate

In this section, we consider the case where the government maximizes social welfare. To define the welfare-maximizing rate, consider a small increase, dT, in the fixed annual tax rate. This change in the tax rate has three effects:

[65] This is a higher-rank chief than the chiefs who are collecting taxes in Local neighborhoods.

[66] Localities are the smallest administrative unit in Kananga. The neighborhoods (polygons on a satellite map of the city) used for randomization are roughly analogous to localities.

1. **Mechanical effect**: The mechanical effect, dM, represents the mechanical increase in tax revenue.

$$dM = \mathbb{P}(T, \alpha)dT$$

2. **Welfare effect**: The welfare effect, dW, represents the social welfare loss due to the additional taxes paid.

$$dW = -\bar{g}\mathbb{P}(T, \alpha)dT$$

   where $\bar{g}$ is the average social welfare weights for tax compliers and so $\bar{g} \in [0, 1]$. There is no change in welfare for marginal payers — who pay the tax only if the tax rate decreases — assuming they are optimizing and the envelope theorem holds.

3. **Behavioral effect**: The behavioral effect, dB, represents the fiscal externality due to behavioral responses.

$$dB = T\ d\mathbb{P}(T, \alpha) = T\frac{d\mathbb{P}(T, \alpha)}{dT}dT$$

The optimal tax rate is characterized by $dM + dW + dB = 0$ and is therefore

$$\mathbb{P}(T, \alpha)dT - \bar{g}\mathbb{P}(T, \alpha)dT + T\frac{d\mathbb{P}(T, \alpha)}{dT}dT = 0$$
$$\Rightarrow T^{Optimal} = \frac{(1-\bar{g})\mathbb{P}(T^{Optimal}, \alpha)}{-\frac{d\mathbb{P}(T,\alpha)}{dT}\Big|_{T=T^{Optimal}}}$$

The optimal tax rate decreases with $\bar{g}$, the average social welfare weight attributed to taxpayers. Moreover, for any $\bar{g} > 0$, the welfare-maximizing tax rate is strictly lower than the revenue-maximizing tax rate.

The easiest way to see this is to consider the case where the relationship between tax compliance and the tax rate is linear. In this case, the welfare-maximizing tax rate is

$$T^{Optimal} = \frac{1-\bar{g}}{2-\bar{g}} \times \frac{\beta_0(\alpha)}{-2\beta_1(\alpha)}$$

while the revenue-maximizing tax rate is

$$T^{*} = \frac{\beta_0(\alpha)}{-2\beta_1(\alpha)}$$

for $\bar{g} \in [0, 1]$, $\frac{1-\bar{g}}{2-\bar{g}} < 1$. As a consequence, the welfare-maximizing tax rate is always strictly lower than the revenue-maximizing tax rate:

$$T^{Optimal} = \frac{1-\bar{g}}{2-\bar{g}} \times \frac{\beta_0(\alpha)}{-2\beta_1(\alpha)} < \frac{\beta_0(\alpha)}{-2\beta_1(\alpha)} = T^*$$

B2.2 Marginal Value of Public Funds (MVPF)

For policy changes that are not budget neutral, the marginal value of public funds can be defined following Hendren (2016) and Hendren and Sprung-Keyser (2020) as a simple "benefit/cost" ratio equal to the marginal social welfare impact of the policy per unit of government revenue expended:

$$MVPF = \frac{WTP}{\max\{0, Net\ Cost\}}$$

where WTP is the willingness to pay (in local monetary units) of the policy recipients and $Net\ Cost$ is the policy's net cost to the government.

- **Willingness to Pay (WTP):** Based on the results with respect to tax revenue presented in Figure A2 and Table 1, taxpayers would be willing to pay $WTP_{17\%} = 0.17 \times 216.9 = 37$ Congolese Francs (CF) for a 17% reduction, $WTP_{33\%} = 0.33 \times 216.9 = 72$ CF for a 33% reduction, and $WTP_{50\%} = 0.50 \times 216.9 = 108$ CF for a 50% reduction in the status quo tax rate. Behavioral responses to marginal policy changes do not affect utility directly by the envelope theorem and so marginal payers — who pay the tax when the tax rate decreases — do not enter into the expression of the willingness to pay.

- **Net Cost:** Based on the results with respect to tax revenue presented in Figure A2 and Table 1, the net cost associated with the 50% and the 33% reduction — $Net\ Cost_{50\%}$ and $Net\ Cost_{33\%}$ — is 0 (it is, in fact, negative since the 50% and the 33% tax reductions increase tax revenues) while $Net\ Cost_{17\%} = 216.9 - 196.70 = 20.2$ CF for the 17% reduction.

Table B17 summarizes this information and reports the willingness to pay, net cost, and marginal value of public funds associated with each tax reduction.

B3 Estimation of Collector-Lever Enforcement Capacity and RMTR

To estimate E_c, the enforcement capacity of collector c, we use OLS and regress an indicator for tax compliance of property owner i living in neighborhood n, denoted $y_{i,n}$, on a matrix G that consists of indicators for the tax collector working in neighborhood n, and on $X_{i,n}$, which is a vector containing an indicator for properties in the high-value band and indicators for the neighborhood-level interventions described in Balan et al. (2022):

$$y_{i,n} = G\vec{E} + X'_{i,n}\delta + \eta_{i,n}$$

The matrix G is constructed as follows: for each property owner i, living in neighborhood n, the column corresponding to collector c is assigned a value of +1 if this collector worked as a tax collector in the neighborhood and a value of 0 otherwise. Tax collectors work in pairs so for each row — which represents a property owner — two of the columns — corresponding to the two tax collectors working in neighborhood n — take the value of +1 and the other columns take the value of 0.

Consider an example where collectors c_1 and c_3 are assigned to collect in neighborhood $n = 1$ (which has a population of n_1 property owners) and collectors c_1 and c_2 are assign to collect taxes in neighborhood $n = 2$ (which has a population of n_2 property owners). In this example, the matrix G has the following form:

$$G = \begin{array}{cc} & \begin{array}{ccccc} c1 & c2 & c3 & c4 & c5 \end{array} \\ \begin{array}{c} y_{1,1} \\ \vdots \\ y_{n_1,1} \\ y_{1,2} \\ \vdots \\ y_{n_2,2} \end{array} & \begin{bmatrix} +1 & 0 & +1 & 0 & 0 \\ +1 & 0 & +1 & 0 & 0 \\ +1 & 0 & +1 & 0 & 0 \\ +1 & +1 & 0 & 0 & 0 \\ +1 & +1 & 0 & 0 & 0 \\ +1 & +1 & 0 & 0 & 0 \end{bmatrix} \end{array}$$

The approach is similar when estimating T_c^*. For the specification that assumes that tax compliance is linear with respect to the tax rate, we use OLS and regress $y_{i,n}$ on the matrix G as well as the interaction of matrix G with the property tax rate faced by property owner i living in neighborhood n, $Tax\ Rate_{i,n}$:

$$y_{i,n} = G\vec{\beta_0} + Tax\ Rate' \times G \times \vec{\beta_1} + X'_{i,n}\delta + \mu_{i,n}$$

For the specification that assumes that tax compliance is quadratic with respect to the tax rate, we add the interaction of matrix G and the property tax rate squared, $Tax\ Rate^2_{i,n}$:

$$y_{i,n} = G\vec{\beta_0} + Tax\ Rate' \times G \times \vec{\beta_1} + Tax\ Rate^{2'} \times G \times \vec{\gamma} + X'_{i,n}\delta + \nu_{i,n}$$

B4 Empirical Bayes Adjustment

The fixed effects estimates $\widehat{E}_c$, $\widehat{\beta_c^0}$, and $\widehat{\beta_c^1}$ provide unbiased but noisy estimates of collectors' performance. To improve precision, we use a multivariable empirical Bayes model (Gelman et al., 2013) and shrink $\widehat{E}_c$ and $\widehat{T_c^*} = \frac{\widehat{\beta_c^0}}{-2\times\widehat{\beta_c^1}}$ towards the mean of the true underlying distribution to reduce prediction errors.[67,68] Consider q_c, the true performance vector of tax collector c, which is given by $q_c = (E_c, T_c^*)'$, and $\widehat{q}_c$, the estimated performance of collector c, which equals true performance plus an error vector η_c:

$$\underbrace{\begin{pmatrix} \widehat{E}_c \\ \widehat{T_c^*} \end{pmatrix}}_{\widehat{q}_c} = \underbrace{\begin{pmatrix} E_c \\ T_c^* \end{pmatrix}}_{q_c} + \underbrace{\begin{pmatrix} \eta_{E_c} \\ \eta_{T_c^*} \end{pmatrix}}_{\eta_c}$$

Suppose that the estimated performance is independently distributed around the true performance, q_c, following a bivariate normal distribution $\widehat{q}_c | q_c, \Lambda \sim \mathcal{N}(q_c, \Lambda_c)$ and that the true performance of collector c is independently bivariate normal with mean $\bar{q}$ and covariance matrix Ω. The prior distribution of collector c's performance is the bivariate normal distribution:

$$q_c | \bar{q}, \Omega \sim \mathcal{N}(\bar{q}, \Omega)$$

and the posterior distribution for q_c is

$$q_c | \hat{q}_c, \bar{q}, \Omega, \Lambda \sim \mathcal{N}(Q_c, \Omega_c)$$

where Q_c and Λ_c are defined as

$$\begin{aligned} Q_c &= (\Omega^{-1} + \Lambda_c^{-1})^{-1}(\Omega^{-1}\bar{q} + \Lambda_c^{-1}\hat{q}) \\ \Omega_c^{-1} &= \Omega^{-1} + \Lambda_c^{-1} \end{aligned}$$

[67] The empirical Bayes approach was introduced by Morris (1983) and has been used in economics to estimate the causal effects of: teachers on students test scores (Gordon et al., 2006), hospitals on patients' health (Chandra et al., 2006), and neighborhoods on intergenerational mobility (Chetty and Hendren, 2018).

[68] We use a multivariate empirical Bayes model rather than the more standard univariate empirical Bayes model since Section 7.2.3 focuses on the relationship between collectors' enforcement capacity, E_c, and collectors' RMTR, T_c^*.

which we can estimate in the data after first estimating the covariance matrices Ω and Λ_c:[69]

$$\widehat{\Omega} = \frac{1}{C}\sum_{i=1}^{c=C}(\hat{q}_c - \bar{q}_c)(\hat{q}_c - \bar{q}_c)^T - \widehat{\Lambda}$$

$$\widehat{\Lambda} = \frac{1}{C}\sum_{i=1}^{c=C}\hat{\Lambda}_c$$

$$\hat{\Lambda}_c = \begin{bmatrix} SE^2_{\widehat{E_c}} & Cov(\widehat{E_c}, \widehat{T^*_c}) \\ Cov(\widehat{E_c}, \widehat{T^*_c}) & SE^2_{\widehat{T^*_c}} \end{bmatrix}$$

The interpretation of the multivariate empirical Bayes model (Gelman et al., 2013) is analogous to the interpretation of the univariate normal model (Morris, 1983): the posterior mean is a weighted average of the prior mean and the data, and the weights are equal to corresponding precision matrices, Λ_c^{-1} and Ω^{-1}, respectively. The precision of the posterior is equal to the sum of the prior and data precisions. We report the distribution of the empirical Bayes estimates of collectors' enforcement capacity, E_c^{EB}, and of the RMTR, ${T^*}_c^{EB}$, in Figure B14.

B5 Collector Characteristics and Enforcement Capacity

As a policy-relevant extension, we explore if governments might be able to identify "high enforcer" tax collectors — capable of raising more revenue and of sustaining higher tax rates — ex ante. We examine which collector characteristics, measured in a survey with collectors before the tax campaign, are positively associated with higher enforcement capacity and a higher RMTR.[70]

Collectors with more education, income, and wealth appear to have higher enforcement capacity (Table B21). Perhaps more interestingly, collectors with higher tax morale and stronger preferences for redistribution appear to have a higher enforcement capacity.[71] Although these correlations do not imply a causal relationship between these collector characteristics and enforcement capacity, they provide suggestive evidence that a sophisticated government could potentially both increase revenue and raise the revenue-maximizing tax rate by recruiting tax collectors with higher socio-economic status and more intrinsic motivation to work in the public sector.[72] That said, less than 10% of the collectors in the 2018

[69] When estimating the covariance matrix Λ_c, $SE_{\widehat{E_c}}$ comes from estimating Equation (7) and computing the standard errors of each coefficient using the delta method. $SE_{\widehat{T^*_c}}$ comes from estimating (8) and computing the standard errors of each coefficient using the delta method, and $Cov(\widehat{E_c}, \widehat{T^*_c})$ is estimated by computing the covariance between $\widehat{E_c}$ and $\widehat{T^*_c}$ across $1,000$ bootstrap samples with replacement at the collector pair level.

[70] This analysis builds on recent work studying how bureaucrat characteristics impact policy outcomes (Xu, 2018; Callen et al., 2018; Ashraf et al., 2020; Best et al., 2019).

[71] These characteristics are also associated with a higher RMTR, but most correlation coefficients are not statistically significant (Table B22).

[72] Selection of tax collectors with high intrinsic motivation to work in the public sector has long been recog-

campaign had an RMTR greater than the status quo tax rate. So, to maximize revenue, the government would still likely need to lower tax rates even if it recruited new collectors with higher enforcement capacity.

B6 Additional Tables and Figures

B6.1 Additional Exhibits for Paper Section 3 — Setting

FIGURE B1: COLLECTORS' ROUTES DURING PROPERTY REGISTRATION.

Notes: This map shows the linear, property-by-property route taken by collectors in a sample neighborhood in the Quartier of Malanji. Due to the imprecision of the GPS measures, some points appear outside of the neighborhood (across the street). These points would have been, in fact, within the neighborhood boundary. We discuss this figure in Section 3.1.

nized as optimal for states. In Tunisia under Ottoman rule, for instance, tax collectors were selected from "preachers of the faith" to ensure individuals of high integrity and dedication (Khaldun, 1978).

FIGURE B2: LOW- AND HIGH-VALUE PROPERTY BANDS — EXAMPLES

A: Low-value band property

B: High-value band property

Notes: This figure shows pictures of a property in the low-value band (Panel A) and of a property in the high-value band (Panel B). The distinction is based on whether the main building on the property is constructed with non-durable materials, such as mudbricks (low-value band), or is built in cement or other durable materials (high-value band). Further details about the property value bands and their importance in the tax campaign are discussed in Section 3.

B6.2 Additional Exhibits for Paper Section 4 — Data and Balance

TABLE B1: F-TEST OF THE OMNIBUS NULL

Sample and Test	F-test	p-value
Panel A: Property Characteristics (Registration, Midline)		
Status quo rate vs 17% reduction	0.370	0.989
Status quo rate vs 33% reduction	0.981	0.474
Status quo rate vs 50% reduction	0.883	0.590
Panel B: Property Owner Characteristics (Midline)		
Status quo rate vs 17% reduction	0.535	0.710
Status quo rate vs 33% reduction	0.161	0.958
Status quo rate vs 50% reduction	1.728	0.141
Panel C: Property Owner Characteristics (Baseline)		
Status quo rate vs 17% reduction	1.273	0.241
Status quo rate vs 33% reduction	0.537	0.865
Status quo rate vs 50% reduction	0.668	0.755

Notes: This table tests the omnibus null hypothesis that the treatment effects for the variables listed in Table A3 are all zero using parametric F-tests. Panel A reports the omnibus null hypothesis for each tax abatement treatment against the status quo treatment for property characteristics from the registration and midline sample. Panels B and C repeat this exercise using characteristics from the midline and endline surveys, respectively. The results are summarized in Section 4.1.

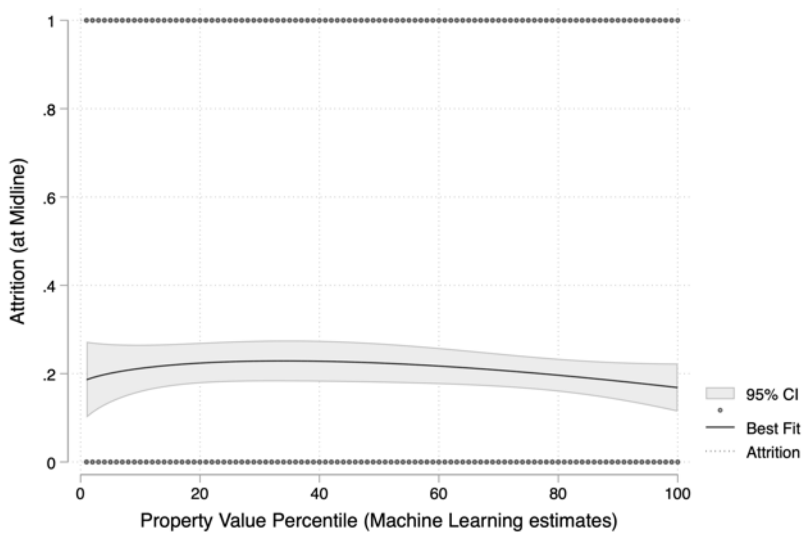
TABLE B2: MIDLINE ATTRITION BALANCE

	Sample (1)	Obs. (2)	Mean (3)	Attrition
Panel A: Property Characteristics				
Distance to city center (in km)	Registration	44,102	3.188	0.002
				(0.002)
Distance to market (in km)	Registration	44,102	0.823	0.003
				(0.002)
Distance to gas station (in km)	Registration	44,102	1.920	-0.000
				(0.002)
Distance to health center (in km)	Registration	44,102	0.345	0.001
				(0.002)
Distance to government building (in km)	Registration	44,102	1.000	-0.000
				(0.002)
Distance to police station (in km)	Registration	44,102	0.817	-0.002
				(0.002)
Distance to private school (in km)	Registration	44,102	0.319	-0.002
				(0.002)
Distance to public school (in km)	Registration	44,102	0.421	0.002
				(0.002)
Distance to university (in km)	Registration	44,102	1.315	0.005**
				(0.002)
Distance to road (in km)	Registration	43,483	0.425	-0.001
				(0.002)
Distance to major erosion (in km)	Registration	43,483	0.130	-0.001
				(0.001)
Property value (in USD)	Registration	44,361	1,359.149	25.258
Machine Learning estimate				(27.956)
Panel B: Property Owner Characteristics				
Gender	Baseline	3,629	1.343	-0.006
				(0.028)
Age	Baseline	3,619	50.970	0.238
				(1.015)
Main Tribe Indicator	Baseline	3,629	0.746	-0.017
				(0.026)
Years of Education	Baseline	3,616	10.456	-0.160
				(0.262)
Has Electricity	Baseline	3,629	0.130	-0.010
				(0.022)
Log Monthly Income (CF)	Baseline	3,596	10.529	-0.109
				(0.153)
Trust Chief	Baseline	3,615	3.155	-0.005
				(0.060)
Trust National Government	Baseline	3,438	2.521	0.070
				(0.078)
Trust Provincial Government	Baseline	3,461	2.442	0.062
				(0.076)
Trust Tax Ministry	Baseline	3,425	2.357	-0.023
				(0.075)

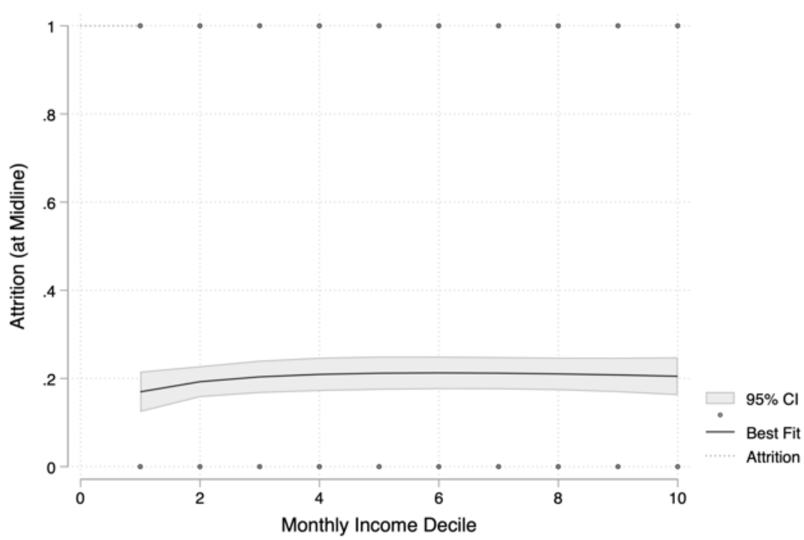
Notes: This table reports coefficients from balance tests conducted by regressing baseline and midline characteristics for properties (Panel A) and property owners (Panels B and C) on an indicator for attrition between the initial property registration and the midline survey, with an indicator for the property value band and randomization stratum (neighborhood) fixed effects. Robust standard errors are reported. All balance checks are conducted in the full sample, which includes neighborhoods from the logistics pilot, pure control group of Balan et al. (2022) in which no door-to-door collection took place, and exempted households. Specifically, Panel A considers the full sample of 44,361 properties. Rows 1–11 exclude 259 properties with missing GPS information, and Row 12 uses the predicted property value in USD for the 44,361 non-exempt properties. Panel B uses 3,629 baseline surveys with property owners. Missing values in Panels B–C reflect non-response to individual survey questions. We discuss the results in Section 4.

FIGURE B3: ATTRITION AT MIDLINE BY PROPERTY VALUE AND INCOME

A: Attrition at Midline by Property Value



B: Attrition at Midline by Monthly Income



Notes: This figure shows how attrition between the initial property registration and the midline survey varies with the percentile of the predicted property values in USD (Panel A) and with the decile of the baseline measure of household monthly income (Panel B). Property values were estimated using the best-performing machine learning algorithm as described in Section B7. These relationships are estimated using a fractional polynomial regression of degree 2 and the best-fit curve is displayed in dark gray. Standard errors are clustered at the neighborhood level, and the 95% confidence interval is displayed in light gray. We discuss the results in Section 4.

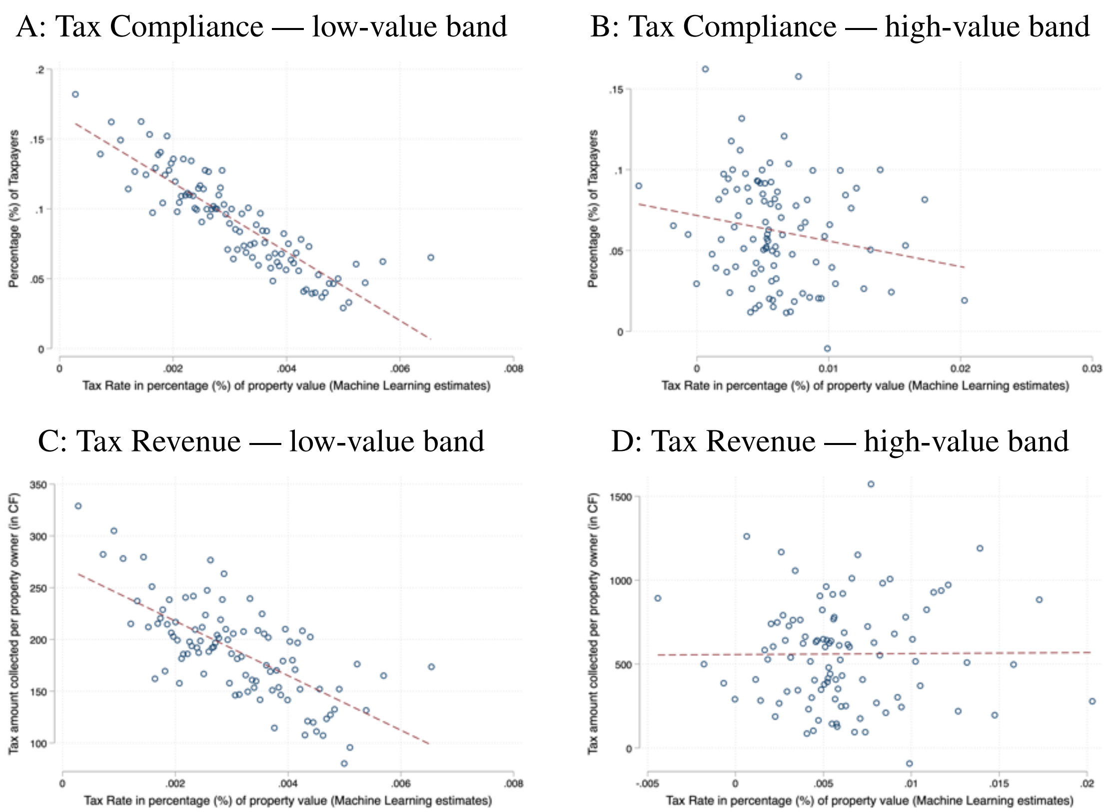
TABLE B3: RANDOMIZATION BALANCE - EXEMPTION STATUS

	Sample (1)	Obs. (2)	Status quo Mean (3)	17% Reduction (4)	33% Reduction (5)	50% Reduction (6)
Exempted	Registration	44,361	0.147	-0.007	0.001	-0.009
				(0.005)	(0.005)	(0.005)
Senior	Registration	44,361	0.071	-0.002	0.002	-0.002
				(0.003)	(0.003)	(0.003)
Widow	Registration	44,361	0.062	-0.005	-0.001	-0.006**
				(0.003)	(0.003)	(0.003)
Government Pension	Registration	44,361	0.007	0.000	-0.000	-0.000
				(0.001)	(0.001)	(0.001)
Handicap	Registration	44,361	0.002	0.000	0.001	0.000
				(0.001)	(0.001)	(0.001)
Other	Registration	44,361	0.005	-0.000	-0.001	-0.000
				(0.001)	(0.001)	(0.001)

Notes: This table reports results from estimating Equation (1) using different official exemption categories as the outcome. This table uses the final registration sample that consists of 44,361 properties. The status quo tax rate is the excluded category. Row 1 examines the balance of any official exemption status by tax abatement treatments. Rows 2–6 report balance by categories of exemption. The results are discussed in Sections 4.1 and 5.2. The variables come from property registration and are described in Section B8.

B6.3 Additional Exhibits for Paper Section 5 — Treatment Effects on Tax Compliance and Revenue

FIGURE B4: TAX COMPLIANCE AND REVENUE BY TAX RATE (IN % OF PROPERTY VALUE)



Notes: This table reports binned scatterplots of the relationship between tax rates, expressed as a percentage of property value, and tax compliance (Panels A and B) or tax revenue (Panels C and D). All binned scatterplots include randomization stratum (neighborhood) fixed effects. The data include all non-exempt properties registered by tax collectors merged with the government's property tax database. Panels A and C restrict the sample to properties in the low-value band, while Panels B and D restrict the sample to properties in the high-value band. The prediction of property values in Kananga using machine learning is described briefly in Section 4 and in more detail in Section B7. We discuss these results in Section 5.2.

TABLE B4: EFFECTS OF TAX RATES (IN % OF PROPERTY VALUE) ON TAX COMPLIANCE AND REVENUE

	Outcome: Tax Compliance (Indicator)				Outcome: Tax Revenue (in CF)			
	All properties		Low-value properties	High-value properties	All properties		Low-value properties	High-value properties
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: IV Specification - First Stage								
50% Reduction	-0.658***	-0.674***	-0.667***	-0.708***	-0.658***	-0.674***	-0.667***	-0.708***
	(0.013)	(0.009)	(0.008)	(0.040)	(0.013)	(0.009)	(0.008)	(0.040)
33% Reduction	-0.397***	-0.408***	-0.404***	-0.442***	-0.397***	-0.408***	-0.404***	-0.442***
	(0.013)	(0.009)	(0.009)	(0.039)	(0.013)	(0.009)	(0.009)	(0.039)
17% Reduction	-0.181***	-0.180***	-0.173***	-0.237***	-0.181***	-0.180***	-0.173***	-0.237***
	(0.013)	(0.009)	(0.008)	(0.039)	(0.013)	(0.009)	(0.008)	(0.039)
Mean (control)	-5.995	-5.995	-6.021	-5.777	-5.995	-5.995	-6.021	-5.777
F-Test	961	2287	2418	116	961	2287	2418	116
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00 0
Panel B: IV Specification - Second Stage								
ln(Tax Rate in % property value)	-0.118***	-0.113***	-0.118***	-0.081***	-65.576***	-58.035**	-49.395***	-141.088
	(0.006)	(0.006)	(0.006)	(0.016)	(19.763)	(18.796)	(12.709)	(144.781)
Mean (sample)	0.088	0.088	0.092	0.062	229.662	229.662	188.888	560.547
Panel C: Elasticities								
Elasticity	-1.332	-1.278	-1.284	-1.311	-0.286	-0.253	-0.262	-0.252
	(0.067)	(0.062)	(0.065)	(0.244)	(0.083)	(0.079)	(0.067)	(0.256)
p-value (elasticity=0)					0.0006	0.0013	0.0001	0.3261
Observations	38028	38028	33856	4172	38028	38028	33856	4172
Sample	All properties	All properties	Low-value properties	High-value properties	All properties	All properties	Low-value properties	High-value properties
FE: Property Value Band	Yes	Yes	No	No	Yes	Yes	No	No
FE: Neighborhood	No	Yes	Yes	Yes	No	Yes	Yes	Yes

Notes: This table reports estimates from the instrumental variable approach described in Section 5.2. The dependent variable is an indicator for tax compliance in Columns 1–4 and tax revenue (in Congolese Francs) in Columns 5–8. Panel A reports the first stage of the instrumental variable model ($log(\tau_{i,n}) = \beta_0 + \beta_1 17\%\ Abatement_{i,n} + \beta_2 33\%\ Abatement_{i,n} + \beta_3 50\%\ Abatement_{i,n} + \gamma X_{i,n} + \delta_n + \epsilon_{i,n}$) and the corresponding F-test and p-value. The first stage consists in regressing the tax rate expressed in percentage of the property value on the treatment dummies and is therefore identical for tax compliance (i.e., Columns 1 and 5, 2 and 6, 3 and 7, 4 and 8 are identical). Panel B reports the second stage of the instrumental variable model ($y_{i,n} = \alpha + \beta log(\tau_{i,n}) + \gamma X_{i,n} + \delta_n + \nu_{i,n}$). Panel C reports the corresponding elasticity of tax compliance and revenue with respect to the tax rate from Equation (3). All regressions include an indicator for the property value band and Columns 2–4 and 6–8 include randomization stratum (neighborhood) fixed effects. Panels A and B report robust standard errors, while Panel C reports bootstrapped standard errors (with 1,000 iterations). Results are reported for all properties in Columns 1–2 and 5–6, while Columns 3 and 7 restrict the sample to low-value properties, and Columns 4 and 8 restrict to high-value properties. The data include all non-exempt properties registered by tax collectors merged with the government's property tax database. We discuss these results in Section 5.2.

Table B5: Heterogeneous Treatment Effects by Knowledge of Neighbors' Tax Rates, Status Quo Tax Rates, Tax Reductions, and Exposure to Past Tax Collection

	Outcome: Tax Compliance (Indicator)				Outcome: Tax Revenue (in CF)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ln(Tax Rate in CF)	-0.130***	-0.100***	-0.185***	-0.119***	-62.430*	-32.563	-124.156	-72.196**
	(0.010)	(0.016)	(0.032)	(0.007)	(33.459)	(45.883)	(103.334)	(32.174)
ln(Tax Rate in CF) x Knows Neighbors' Rate	-0.022				-28.878			
	(0.015)				(104.330)			
Knows Neighbors' Rate	0.193				273.372			
	(0.122)				(798.787)			
ln(Tax Rate in CF) x Knows About Reductions		-0.077*				-36.410		
		(0.046)				(394.187)		
Knows About Reductions		0.673*				419.863		
		(0.373)				(3036.938)		
ln(Tax Rate in CF) x Knows Status Quo Rate			0.072				254.871	
			(0.081)				(194.257)	
Knows Status Quo Rate			-0.529				-1875.112	
			(0.627)				(1485.650)	
ln(Tax Rate in CF) x Exposure to 2016 Collection				0.015**				25.556
				(0.007)				(40.345)
Exposure to 2016 Collection				-0.008				-17.213
				(0.058)				(315.733)
Constant	1.016***	0.767***	1.427***	0.931***	524.885**	239.794	940.023	586.081**
	(0.079)	(0.122)	(0.246)	(0.055)	(260.462)	(354.332)	(799.083)	(248.235)
Observations	15072	5245	2470	37886	15072	5245	2470	37886
FE: Property Value Band	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FE: Neighborhood	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table examines how the effect of tax liabilities varies by owners' knowledge of neighbors' tax rates, status quo tax rates (at baseline), the existence of property tax abatements in Kananga, and the exposure to past door-to-door tax collection in 2016. It reports the marginal effect of property tax rates (in Congolese Francs) on tax compliance (in Columns 1–4) and tax revenue in CF (in Columns 5–8). The property tax rate (in Congolese Francs) is interacted with an index for knowledge of the neighbors' tax rates in Columns 1 and 5, with an index for knowledge of tax reductions in Kananga in Columns 2 and 6, with an indicator for accurately reporting the status quo property tax rate at baseline in Columns 3 and 7, and with an indicator for assignment to door-to-door tax collection during the 2016 property tax campaign (studied in Weigel (2020)) in Columns 4 and 8. All regressions include an indicator for the property value band and for randomization stratum (neighborhood). We report robust standard errors. The variables coming from the baseline and midline survey used in Columns 1–3 and 5–7 are described in Section B8. We discuss these results in Section 5.3.

Table B6: Robustness — Accounting for Imperfect Recall of Past Tax Rates

	Outcome: Tax Compliance (Indicator)								Outcome: Tax Revenue (in CF)							
	Past Rate +/- 250 CF Error		Past Rate +/- 500 CF Error		Past Rate +/- 750 CF Error		Past Rate +/- 1000 CF Error		Past Rate +/- 250 CF Error		Past Rate +/- 500 CF Error		Past Rate +/- 750 CF Error		Past Rate +/- 1000 CF Error	
	Doesn't Know	Knows	Doesn't Know	Knows	Doesn't Know	Knows	Doesn't Know	Knows	Doesn't Know	Knows	Doesn't Know	Knows	Doesn't Know	Knows	Doesn't Know	Knows
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Panel A: Treatment Effects																
50% Reduction	0.116***	0.159*	0.117***	0.118	0.102***	0.131**	0.103***	0.143**	82.514	133.677	85.054	54.606	43.721	-1.983	47.007	28.521
	(0.023)	(0.085)	(0.024)	(0.073)	(0.024)	(0.060)	(0.024)	(0.059)	(72.350)	(176.961)	(73.817)	(153.999)	(76.956)	(157.406)	(77.700)	(152.462)
33% Reduction	0.049**	0.084	0.054**	0.048	0.047**	0.062	0.046*	0.085	10.076	72.279	19.540	-0.905	12.042	-1.029	13.816	47.771
	(0.022)	(0.089)	(0.022)	(0.076)	(0.023)	(0.062)	(0.023)	(0.060)	(70.596)	(212.199)	(72.344)	(182.136)	(75.823)	(151.928)	(76.279)	(148.030)
17% Reduction	-0.014	0.027	-0.009	-0.011	-0.022	0.021	-0.020	0.029	-67.188	27.455	-59.399	-76.497	-95.959	-28.252	-91.034	-10.704
	(0.019)	(0.089)	(0.019)	(0.078)	(0.020)	(0.064)	(0.020)	(0.062)	(76.359)	(208.612)	(78.400)	(189.439)	(81.448)	(163.072)	(82.078)	(157.976)
Mean (control)	0.077	0.151	0.079	0.139	0.083	0.111	0.084	0.109	274.895	561.29	279.574	516.832	295.281	414.286	297.285	404.651
Tests of coef. equality:																
50% Reduction	$p_{50\%}$ =0.480		$p_{50\%}$ =0.984		$p_{50\%}$ =0.555		$p_{50\%}$ =0.405		$p_{50\%}$ =0.707		$p_{50\%}$ =0.809		$p_{50\%}$ =0.731		$p_{50\%}$ =0.888	
33% Reduction	$p_{33\%}$ =0.586		$p_{33\%}$ =0.911		$p_{33\%}$ =0.750		$p_{33\%}$ =0.414		$p_{33\%}$ =0.692		$p_{33\%}$ =0.886		$p_{33\%}$ =0.919		$p_{33\%}$ =0.790	
17% Reduction	$p_{17\%}$ =0.509		$p_{17\%}$ =0.968		$p_{17\%}$ =0.378		$p_{17\%}$ =0.309		$p_{17\%}$ =0.546		$p_{17\%}$ =0.909		$p_{17\%}$ =0.625		$p_{17\%}$ =0.555	
All Reductions	$p_{All\%}$ =0.891		$p_{All\%}$ =0.999		$p_{All\%}$ =0.825		$p_{All\%}$ =0.737		$p_{All\%}$ =0.947		$p_{All\%}$ =0.996		$p_{All\%}$ =0.840		$p_{All\%}$ =0.874	
Panel B: Marginal Effects																
ln(Tax Rate in CF)	-0.188***	-0.237**	-0.187***	-0.191*	-0.172***	-0.191**	-0.171***	-0.212**	-158.794	-195.964	-160.368	-127.775	-121.252	-14.628	-123.297	-66.512
	(0.032)	(0.115)	(0.033)	(0.098)	(0.034)	(0.085)	(0.034)	(0.083)	(101.276)	(233.435)	(102.901)	(200.045)	(106.786)	(208.608)	(107.662)	(202.587)
Mean (sample)	0.125	0.158	0.127	0.147	0.123	0.154	0.123	0.154	322.809	358.519	328.912	327.571	324.621	342.549	325.342	339.685
Panel C: Elasticities																
Elasticity	-1.502	-1.499	-1.48	-1.301	-1.392	-1.236	-1.388	-1.379	-0.492	-0.547	-0.488	-0.39	-0.374	-0.043	-0.379	-0.196
	(0.269)	(0.769)	(0.270)	(0.716)	(0.288)	(0.578)	(0.290)	(0.571)	(0.343)	(0.709)	(0.344)	(0.669)	(0.363)	(0.652)	(0.368)	(0.648)
p-value (elasticity=0)									0.1516	0.4419	0.1562	0.5605	0.3037	0.9478	0.3036	0.7629
Observations	2065	405	2013	457	1913	557	1898	572	2065	405	2013	457	1913	557	1898	572
Sample	Baseline Sample	Baseline Sample	Baseline Sample	Baseline Sample	Baseline Sample	Baseline Sample	Baseline Sample	Baseline Sample	Baseline Sample	Baseline Sample	Baseline Sample	Baseline Sample	Baseline Sample	Baseline Sample	Baseline Sample	Baseline Sample
FE: Property Value Band	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FE: Neighborhood	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table explores whether other components of the experimental design could have influenced taxpayers' responses to tax abatements. It reports estimates from Equations (1), (2), and (3). The dependent variable is tax compliance in Columns 1–5 and tax revenue (in Congolese Francs) in Columns 6–10. Panel A reports treatment effects from Equation (1) comparing property tax revenue for the tax abatement treatment groups relative to the status quo property tax rate (the excluded category). It also reports the p-values associated with F-tests for equality of the treatment effects when considering heterogeneity by knowledge of past rates. Panel B reports the mean tax revenue in the sample as well as the marginal effect of property tax rates (in CF) on tax revenue from Equation (2). These two estimates are used in Panel C to compute the elasticity of tax revenue with respect to the tax rate following Equation (3) and to calculate the p-value associated with the elasticity of tax revenue. All regressions include an indicator for the property value band and for randomization stratum (neighborhood). Panels A and B report robust standard errors. Standard errors in Panel C are bootstrapped (with 1,000 iterations). The effects are reported for owners who inaccurately reported the status quo rate in Columns 1, 3, 5, 7, 9, 11, 13, and 15, and for owners who accurately reported the status quo rate in Columns 2, 4, 6, 8, 10, 12, 14, 16. The variable that is used to define these subsamples comes from the baseline survey and is described in Section B8. The definition of accurately reporting the status quo rate allows respondents to incorrectly recall the past tax rate: by 250 CF (Columns 1–2 and 9–10), 500 CF (Columns 1–2 and 9–10), 750 CF (Columns 1–2 and 9–10), and 1000 CF (Columns 1–2 and 9–10). We discuss these results in Section 5.3.

TABLE B7: HETEROGENEOUS TREATMENT EFFECTS ON COMPLIANCE AND REVENUE BY COLLECTOR TYPE

	Central Collectors		Local Collectors		Central Collectors (+ Local Info)		Central x Local Collectors	
	Tax Compliance	Tax Revenue	Tax Compliance	Tax Revenue	Tax Compliance	Tax Revenue	Tax Compliance	Tax Revenue
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Treatment Effects								
50% Reduction	0.057***	4.195	0.085***	8.573	0.079***	68.986***	0.077***	43.062
	(0.007)	(25.365)	(0.008)	(28.422)	(0.008)	(19.856)	(0.011)	(32.428)
33% Reduction	0.035***	11.777	0.057***	47.506	0.037***	46.232**	0.048***	37.073
	(0.006)	(27.552)	(0.007)	(31.265)	(0.007)	(20.972)	(0.010)	(33.723)
17% Reduction	0.009	-24.676	0.012*	-59.054**	0.013*	38.155*	0.015*	-16.143
	(0.006)	(27.187)	(0.007)	(28.567)	(0.007)	(22.754)	(0.009)	(32.173)
Mean (control)	0.052	219.31	0.069	282.721	0.048	142.786	0.047	173.226
Panel B: Marginal Effects								
ln(Tax Rate in CF)	-0.086***	-22.664	-0.130***	-57.658	-0.115***	-90.529**	-0.115***	-80.133*
	(0.009)	(33.298)	(0.011)	(37.139)	(0.012)	(27.926)	(0.015)	(42.766)
Mean (sample)	0.078	220.921	0.107	285.889	0.081	182.62	0.081	188.84
Panel C: Elasticities								
Elasticity	-1.096	-0.103	-1.216	-0.202	-1.422	-0.496	-1.424	-0.424
	(0.113)	(0.147)	(0.097)	(0.131)	(0.136)	(0.151)	(0.176)	(0.233)
p-value (elasticity=0)		0.4859		0.1242		0.0011		0.0688
Observations	12514	12514	12232	12232	8251	8251	5018	5018
Sample	All properties	All properties	All properties	All properties	All properties	All properties	All properties	All properties
FE: Property Value Band	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FE: Neighborhood	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table examines heterogeneity in the main treatment effects by the cross-randomized tax collector treatments, assigned at the neighborhood level, examined in Balan et al. (2022). It reports estimates from Equations (1), (2), and (3). In Columns 1, 3, 5, and 7 the dependent variable is an indicator for compliance, while in Columns 2, 4, 6, and 8 the dependent variable is tax revenues (in Congolese Francs). Panel A reports treatment effects from Equation (1) comparing property tax compliance and property tax revenue for the tax abatement treatment groups relative to the status quo property tax rate (the excluded category). Panel B reports the mean tax compliance and revenue as well as the marginal effect of property tax rates (in CF) on tax compliance and revenue from Equation (2). These two estimates are used in Panel C to compute the elasticity of tax compliance and revenue with respect to the tax rate following Equation (3) and to calculate the p-value associated with the elasticity of tax revenue. All regressions include an indicator for the property value band and Columns 2–4 and 6–8 include randomization stratum (neighborhood) fixed effects. Panels A and B report robust standard errors. Standard errors in Panel C are bootstrapped (with 1,000 iterations). Results are reported for neighborhoods assigned to "Central" tax collection in Columns 1–2, "Local" tax collection in Columns 3–4, "Central + Local Information" tax collection in Columns 5–6, and "Central x Local" tax collection in Columns 7–8. The treatment groups are described in Section B1.3 and in further detail in Balan et al. (2022). The data include all non-exempt properties registered by tax collectors merged with the government's property tax database. We discuss these results in Section 3.1.

B6.3.1 Mechanisms: the role of liquidity constraints

As noted in the paper, reducing tax rates raises revenue in this setting by bringing more property owners into the tax net — that is, by boosting extensive margin tax compliance. To explore this compliance response further, Tables A12 and B8 estimate heterogeneity in treatment effects and elasticities by proxies for socioeconomic status and liquidity. The elasticities of tax compliance and revenue are larger in absolute value among property owners with lower incomes (Columns 1–2), lower transport expenditures (Columns 3–4), fewer possessions (Columns 5–6), and less liquidity (Columns 9–12). They are smaller, by contrast, when we proxy liquidity as reporting not having gone to bed hungry in the past 30 days (Columns 7–8).[73] Overall, the compliance and revenue responses we observe are consistent with liquidity-constrained individuals entering the tax net only when their tax liability is sufficiently low.

One may wonder if the importance of liquidity constraints in shaping the compliance response to rate changes is specific to the door-to-door nature of tax collection in our setting. Property owners might have been less responsive to changes in tax liability if they could pay whenever they had cash on hand. However, after registration, tax collectors made appointments with property owners at times of their choosing (within the one-month window), allowing them time to find the money to pay the tax. The tax campaign procedures were thus designed to lessen the impact of time-varying cash-on-hand constraints.[74] Moreover, we can directly test whether the unexpected nature of collector visits is driving our results by re-estimating the main results while excluding tax payments during property registration. Registration visits were indeed likely unexpected, in contrast to scheduled follow-up tax visits. But the elasticities of compliance and revenue are similar (Table B9).

Our results are therefore consistent with cash-on-hand constraints partly explaining the large delinquency responses to higher tax rates in our context, and the results do not appear to be specific to the door-to-door nature of tax collection in our setting. Indeed, researchers have also noted the importance of liquidity constraints in property tax compliance in middle- (Brockmeyer et al., 2023) and high-income countries (Wong, 2020).

[73] One possible explanation is that many households obtain food on credit and pay back the vendors when their monthly pay arrives.

[74] Additionally, property owners were informed that they could pay at the tax ministry. In total, 38 owners — about 1% of taxpayers — paid at the ministry, though it likely increased the transaction costs of compliance.

TABLE B8: HETEROGENEOUS TREATMENT EFFECTS ON REVENUE BY PROXIES FOR LIQUIDITY

	Outcome: Tax Revenues (in CF)											
	Monthly Income		Weekly Transport		Number of Possessions		Went to Bed Hungry – Past Month		Can find 3,000 CF – Next Four Days		Nb of days w/o 3,000 CF – Past Month	
	≤ median	> median	≤ median	> median	≤ median	> median	Yes	No	No	Yes	> median	≤ median
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Panel A: Treatment Effects												
50% Reduction	71.688	-17.295	111.085	-10.727	107.622*	-179.680	-1.655	-6.888	110.943	-105.025	51.432	30.188
	(87.999)	(101.176)	(79.620)	(101.232)	(59.968)	(171.012)	(85.537)	(104.889)	(67.707)	(164.700)	(75.855)	(137.123)
33% Reduction	-6.071	-11.822	43.882	-72.015	26.562	-289.514	90.575	-105.228	65.845	-120.566	31.664	-124.863
	(80.965)	(115.151)	(78.531)	(112.048)	(59.771)	(244.765)	(82.332)	(112.557)	(64.647)	(193.147)	(75.655)	(167.034)
17% Reduction	15.657	-130.759	56.875	-215.247**	38.655	-462.189**	44.868	-225.579**	25.427	-184.973	-44.960	-177.611
	(100.635)	(103.686)	(78.872)	(106.033)	(71.263)	(164.277)	(88.859)	(108.021)	(75.991)	(146.793)	(77.765)	(134.503)
Mean (control)	275.248	343.119	205.776	392.635	218.777	568.786	194.245	409.632	252.323	429.730	304.478	332.751
Tests of coef. equality:												
50% Reduction	$p_{50\%}$ =0.445		$p_{50\%}$ =0.276		$p_{50\%}$ =0.161		$p_{50\%}$ =0.965		$p_{50\%}$ =0.142		$p_{50\%}$ =0.873	
33% Reduction	$p_{33\%}$ =0.963		$p_{33\%}$ =0.329		$p_{33\%}$ =0.236		$p_{33\%}$ =0.106		$p_{33\%}$ =0.266		$p_{33\%}$ =0.311	
17% Reduction	$p_{17\%}$ =0.243		$p_{17\%}$ =0.018		$p_{17\%}$ =0.009		$p_{17\%}$ =0.026		$p_{17\%}$ =0.126		$p_{17\%}$ =0.314	
All Reductions	$p_{All\%}$ =0.565		$p_{All\%}$ =0.120		$p_{All\%}$ =0.051		$p_{All\%}$ =0.055		$p_{All\%}$ =0.403		$p_{All\%}$ =0.615	
Panel B: Marginal Effects												
ln(Tax Rate in CF)	-90.641	-45.273	-136.409	-80.317	-138.205*	68.807	0.324	-71.523	-162.423*	79.912	-109.667	-114.052
	(118.118)	(136.437)	(114.727)	(134.535)	(83.024)	(250.078)	(123.826)	(141.395)	(95.774)	(228.604)	(105.246)	(187.235)
Mean (sample)	326.113	334.804	301.139	357.521	294.705	422.909	306.984	353.465	312.004	366.949	333.861	325.328
Panel C: Elasticities												
Elasticity	-0.278	-0.135	-0.453	-0.225	-0.469	0.163	0.001	-0.202	-0.521	0.218	-0.328	-0.351
	(0.393)	(0.424)	(0.430)	(0.404)	(0.315)	(0.617)	(0.430)	(0.440)	(0.332)	(0.621)	(0.343)	(0.626)
Observations	1348	1405	1317	1436	1983	777	1346	1414	1816	944	1769	991
Sample	Baseline Sample	Baseline Sample	Baseline Sample	Baseline Sample	Baseline Sample	Baseline Sample	Endline Sample	Endline Sample	Endline Sample	Endline Sample	Endline Sample	Endline Sample
FE: Property Value Band	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FE: Neighborhood	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table investigates how the effect of tax abatements on revenue varies by household liquidity. It reports estimates from Equations (1), (2), and (3). The dependent variable is tax revenues (in Congolese Francs). Panel A reports treatment effects from Equation (1) comparing property tax revenues for the tax abatement treatment groups relative to the status quo property tax rate (the excluded category). It also reports the p-values associated with F-tests for equality of the treatment effects when considering heterogeneity by monthly income (Columns 1–2), weekly transport expenditures (Columns 3–4), number of possessions (Columns 5–6), going to bed hungry in the past month (Columns 7–8), being able to find 3,000 CF in the next four days (Columns 9–10), number of days the respondent did not have 3,000 CF in the past month (Columns 11–12). Panel B reports the mean tax revenue as well as the marginal effect of property tax rates (in Congolese Francs) on tax revenue from Equation (2). These two estimates are used in Panel C to compute the elasticity of tax revenue with respect to the tax rate following Equation (3). All regressions include an indicator for the property value band and randomization stratum (neighborhood) fixed effects. Panels A and B report robust standard errors. Standard errors in Panel C are bootstrapped (with 1,000 iterations). Columns 1, 3, and 5 restrict the baseline sample to respondents with below-median monthly household income, weekly transport expenditures, and number of possessions, respectively. Columns 2, 4, and 6 restrict the baseline sample to respondents with above-median monthly household income, weekly transport expenditures, and number of possessions, respectively. Columns 7–8 report results by whether endline respondents declared that they went to bed hungry in the past month. Columns 9 and 10 report results by whether endline respondents declare being able to find 3,000 CF in the next four days. Columns 11–12 report results by whether the number of days the respondent reported not having 3,000 CF in the past month at endline is above or below the median. The variables come from the baseline and endline surveys and are described in Section B8. We discuss these results in Section B6.3.1.

Table B9: Heterogeneous Treatment Effects on Compliance and Revenue by Campaign Timing

	Outcome: Tax Compliance (Indicator)			Outcome: Tax Revenue (in CF)		
	Full period of tax collection	Excluding day 1 of tax collection	Excluding day 1-3 of tax collection	Full period of tax collection	Excluding day 1 of tax collection	Excluding day 1-3 of tax collection
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Treatment Effects						
50% Reduction	0.073***	0.069***	0.066***	24.711*	20.940	19.840
	(0.004)	(0.004)	(0.004)	(13.828)	(13.593)	(13.454)
33% Reduction	0.044***	0.042***	0.041***	34.069**	33.385**	34.270**
	(0.004)	(0.004)	(0.004)	(14.937)	(14.788)	(14.662)
17% Reduction	0.011***	0.012***	0.011***	-20.202	-18.141	-16.428
	(0.003)	(0.003)	(0.003)	(14.420)	(14.213)	(14.028)
Mean (control)	0.056	0.053	0.051	216.903	206.744	199.261
Panel B: Marginal Effects						
ln(Tax Rate in CF)	-0.110***	-0.103***	-0.099***	-55.870**	-49.297**	-47.144**
	(0.006)	(0.006)	(0.005)	(18.274)	(17.973)	(17.826)
Mean (sample)	0.088	0.084	0.080	229.662	218.853	211.388
Panel C: Elasticities						
Elasticity	-1.246	-1.238	-1.234	-0.243	-0.225	-0.223
	(0.062)	(0.064)	(0.066)	(0.077)	(0.079)	(0.081)
p-value (elasticity=0)				0.0015	0.0044	0.0058
Observations	38028	37830	37689	38028	37830	37689
Sample	All properties	All properties	All properties	All properties	All properties	All properties
FE: Property Value Band	Yes	Yes	Yes	Yes	Yes	Yes
FE: Neighborhood	Yes	Yes	Yes	Yes	Yes	Yes
Neighbor Rate Controls	No	No	No	No	No	No

Notes: This table explores whether households' responses to rate reductions vary by different time periods during the month in which tax collectors worked in each neighborhood. It reports estimates from Equations (1), (2), and (3). In Columns 1–3 the dependent variable is an indicator for compliance, while in Columns 4–6 the dependent variable is tax revenue (in Congolese Francs). Panel A reports treatment effects from Equation (1) comparing property tax compliance and property tax revenue for the tax abatement treatment groups relative to the status quo property tax rate (the excluded category). Panel B reports the mean tax compliance and revenue as well as the marginal effect of property tax rates (in CF) on tax compliance and revenue from Equation (2). These two estimates are used in Panel C to compute the elasticity of tax compliance and revenue with respect to the tax rate following Equation (3) and to calculate the p-value associated with the elasticity of tax revenue. All regressions include an indicator for the property value band, and Columns 2–4 and 6–8 include randomization stratum (neighborhood) fixed effects. Panels A and B report robust standard errors. Standard errors in Panel C are bootstrapped (with 1,000 iterations). Results are reported for the full month-long period of tax collection for each neighborhood in Columns 1 and 4, while Columns 2 and 5 exclude payments made on the first day of the month, and Columns 3 and 6 exclude the first three days. Collectors' visits to households would have been unexpected during the initial days of the campaign in each neighborhood, while subsequent visits were typically made by appointment. The data include all non-exempt properties registered by tax collectors merged with the government's property tax database. We discuss these results in Section B6.3.1.

B6.4 Additional Exhibits for Paper Section 6 — The Revenue-Maximizing Tax Rate

TABLE B10: REVENUE-MAXIMIZING TAX RATE — WITH VS. WITHOUT VALUE BAND INDICATOR AND NEIGHBORHOOD FIXED EFFECTS

	Linear Specification				Quadratic Specification			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Tax Rate (in % of status quo)	-0.154***	-0.154***	-0.151***	-0.152***	-0.415***	-0.410***	-0.395***	-0.391***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.080)	(0.080)	(0.077)	(0.077)
Tax Rate Squared (in % of status quo)					0.175***	0.171***	0.163**	0.160**
					(0.052)	(0.052)	(0.050)	(0.050)
Constant	0.203***	0.203***	0.201***	0.202***	0.295***	0.293***	0.287***	0.286***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.029)	(0.029)	(0.028)	(0.028)
Panel B: Revenue-Maximizing Tax Rate (RMTR)								
RMTR (in % of status quo rate)	0.661	0.661	0.666	0.665	0.538	0.541	0.551	0.553
	(0.014)	(0.014)	(0.014)	(0.014)	(0.045)	(0.045)	(0.046)	(0.046)
Implied Reduction in Tax Rate	33.88	33.93	33.38	33.5	46.21	45.95	44.91	44.71
Observations	38028	38028	38026	38026	38028	38028	38026	38026
FE: Property Value Band	No	Yes	No	Yes	No	Yes	No	Yes
FE: Neighborhood	No	No	Yes	Yes	No	No	Yes	Yes
Quadratic Tax Rate Term	No	No	No	No	Yes	Yes	Yes	Yes

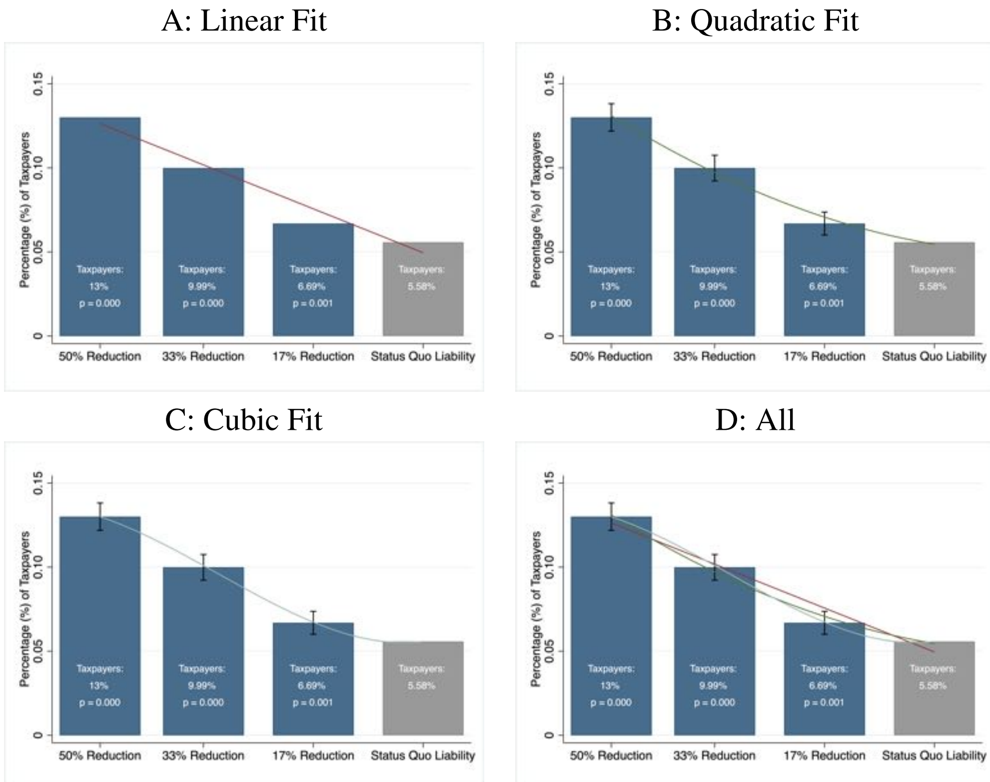
Notes: This table reports estimates of the revenue-maximizing tax rate (RMTR) using the expression in Equation (4). Columns 1–4 assume linearity of tax compliance with respect to the tax rate. Panel A reports estimates from regression specification (6), and Panel B the corresponding RMTR estimates from Equation (5). Columns 5–8 assume a quadratic relationship between tax compliance and tax rate. Panel A reports estimates from a quadratic regression specification, and Panel B reports the corresponding RMTR estimates. All estimates in Panels A and B are expressed as a percentage of the status quo tax rate. The regression results reported in Columns 1 and 5 do not include any controls. The results reported in Columns 2 and 6 correspond to regressions that include an indicator for the property value band. The regression results in Columns 3 and 7 include neighborhood fixed effects. Lastly, the regression results in Columns 4 and 8 include an indicator for the property value band and neighborhood fixed effects. In Panel A, we report robust standard errors. Standard errors in Panel B are computed using the delta method. The data include all non-exempt properties registered by tax collectors merged with the government's property tax database. We discuss these results in Section 6.3.

TABLE B11: THE REVENUE-MAXIMIZING TAX RATE — STANDARD ERRORS USING THE DELTA METHOD VS. BOOTSTRAPPED STANDARD ERRORS

	Linear Specification		Quadratic Specification	
	(1)	(2)	(3)	(4)
Panel A: Effect of Tax Rates on Tax Compliance				
Tax Rate (in % of status quo)	-0.154***	-0.152***	-0.410***	-0.391***
	(0.008)	(0.008)	(0.080)	(0.077)
Tax Rate Squared (in % of status quo)			0.171***	0.160**
			(0.052)	(0.050)
Constant	0.203***	0.202***	0.293***	0.286***
	(0.006)	(0.006)	(0.029)	(0.028)
Panel B: Revenue-Maximizing Tax Rate (RMTR)				
RMTR (in % of status quo rate)	0.661	0.665	0.541	0.553
	(0.014)	(0.014)	(0.045)	(0.046)
	{0.014}	{0.014}	{0.043}	{0.044}
Implied Reduction in Tax Rate	33.93%	33.50%	45.95%	44.71%
Observations	38028	38026	38028	38026
Sample	All properties	All properties	All properties	All properties
FE: Property Value Band	Yes	Yes	Yes	Yes
FE: Neighborhood	No	Yes	No	Yes
Quadratic Tax Rate Term	No	No	Yes	Yes

Notes: This table reports estimates of the revenue-maximizing tax rate (RMTR). The results are identical to those reported in Table 3 with the addition of bootstrapped standard errors for the RMTR in Panel B. Columns 1 and 2 assume linearity of tax compliance with respect to the tax rate. Panel A reports estimates from regression specification (6), and Panel B the corresponding RMTR estimates from Equation (5). Columns 3 and 4 assume a quadratic relationship between tax compliance and tax rate. Panel A reports estimates from a quadratic regression specification, and Panel B reports the corresponding RMTR estimates using the expression in Equation (4). All estimates in Panels A and B are expressed as a percentage of the status quo tax rate. All regressions include an indicator for the property value band, and Columns 2 and 4 also include randomization stratum (neighborhood) fixed effects. In Panel A, we report robust standard errors. In Panel B, the standard errors in brackets are computed using the delta method and the standard errors in curly braces are bootstrapped (with 1,000 iterations). The data include all non-exempt properties registered by tax collectors merged with the government's property tax database. We discuss these results in Section 6.3.

FIGURE B5: TREATMENT EFFECTS ON TAX COMPLIANCE — LINEAR, QUADRATIC AND CUBIC FITS

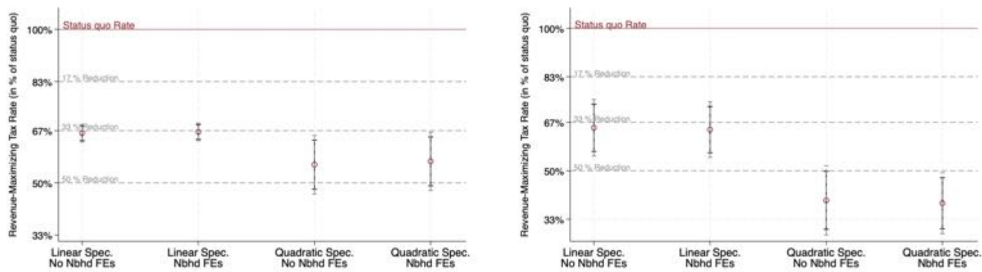


Notes: This figure reports estimates from Equation (1) comparing property tax compliance for the tax abatement treatment groups relative to the status quo property tax rate (the excluded category). Panel A displays the best linear fit, Panel B the best quadratic fit, Panel C the best cubic fit, and Panel D all fits. All panels report results including an indicator for the property value band and randomization stratum (neighborhood) fixed effects. The black lines show the 95% confidence interval for each of the estimates using robust standard errors. The treatment effects correspond to the results in Figure A2 and Table 1. The Figure also reports the average tax compliance for the tax abatement treatment groups and the status quo rate group and the p-values for non-zero treatment effects. The data include all non-exempt properties registered by tax collectors merged with the government's property tax database. We discuss these results in Section 6.3.

FIGURE B6: REVENUE-MAXIMIZING TAX RATE BY PROPERTY VALUE BAND

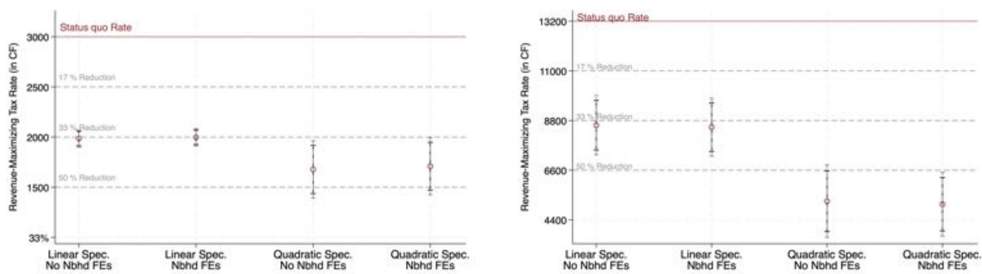
A: Low-value band properties (RMTR in % of status quo rate)

B: High-value band properties (RMTR in % of status quo rate)



C: Low-value band properties (RMTR in Congolese Francs)

D: High-value band properties (RMTR in Congolese Francs)



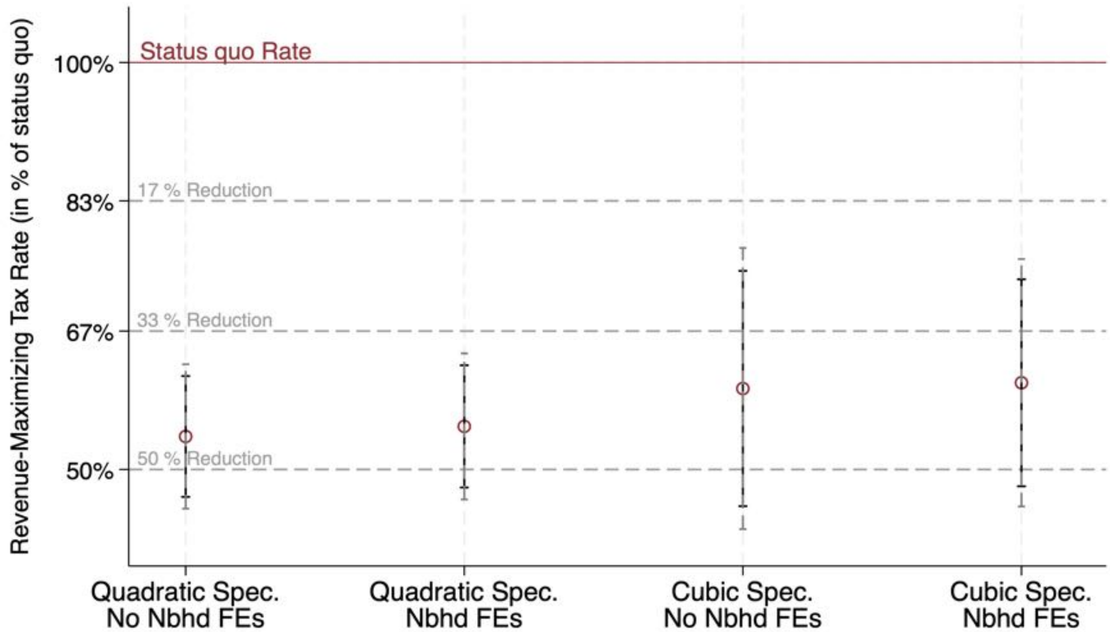
Notes: This figure reports estimates of the revenue-maximizing tax rate (RMTR) in Equation (4) in different property value bands. Panels A and C restrict the sample to properties in the low-value band, and Panels B and D to properties in the high-value band. In Panels A and B, we estimate the RMTR as a percentage of the status quo tax rate, while in Panels C and D we estimate it in tax amounts expressed in Congolese Francs. In each panel, the first two estimates assume linearity of tax compliance with respect to the tax rate and correspond to the estimation of Equation 5 using regression specification (6) while the following two estimates assume a quadratic relationship between tax compliance and rates. All regressions include an indicator for the property value band, and the second and fourth point estimates in each figure also include randomization stratum (neighborhood) fixed effects. 95% confidence intervals are reported for each estimate using the standard errors obtained from the delta method. The coefficients and confidence intervals in Panels A and B of Figure B6 correspond to the point estimates and standard errors reported in Panel B of Table B12. The data include all non-exempt properties registered by tax collectors merged with the government's property tax database. We discuss these results in Section 6.3.

Table B12: Revenue-Maximizing Tax Rate by Property Value Band

	Low-value band properties				High-value band properties			
	Linear Specification		Quadratic Specification		Linear Specification		Quadratic Specification	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Effect of Tax Rates on Tax Compliance								
Tax Rate (in % of status quo)	-0.159***	-0.157***	-0.391***	-0.375***	-0.111***	-0.114***	-0.561**	-0.600**
	(0.008)	(0.008)	(0.086)	(0.083)	(0.021)	(0.022)	(0.206)	(0.208)
Tax Rate Squared (in % of status quo)			0.155**	0.146**			0.300**	0.324**
			(0.056)	(0.054)			(0.134)	(0.135)
Constant	0.210***	0.209***	0.292***	0.286***	0.145***	0.147***	0.303***	0.318***
	(0.007)	(0.007)	(0.032)	(0.031)	(0.017)	(0.017)	(0.076)	(0.076)
Panel B: Revenue-Maximizing Tax Rate (RMTR)								
RMTR (in % of status quo rate)	0.662	0.666	0.559	0.570	0.651	0.645	0.396	0.386
	(0.015)	(0.015)	(0.049)	(0.048)	(0.051)	(0.050)	(0.062)	(0.055)
Implied Reduction in Tax Rate	33.82%	33.40%	44.10%	43.01%	34.90%	35.55%	60.37%	61.40%
Observations	33856	33852	33856	33852	4172	4147	4172	4147
Sample	low-value band properties	low-value band properties	low-value band properties	low-value band properties	high-value band properties	high-value band properties	high-value band properties	high-value band properties
FE: Property Value Band	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FE: Neighborhood	No	Yes	No	Yes	No	Yes	No	Yes
Quadratic Tax Rate Term	No	No	Yes	Yes	No	No	Yes	Yes

Notes: This table reports estimates of the revenue-maximizing tax rate (RMTR) in Equation (4). Columns 1–2 and 5–6 assume linearity of tax compliance with respect to the tax rate. For these columns, Panel A contains estimates of regression specification (6), and Panel B reports the corresponding RMTR from Equation (5). Columns 2–3 and 7–8 assume a quadratic relationship between tax compliance and tax rate. For these columns, Panel A estimates a quadratic regression specification, and Panel B reports the RMTR. All estimates in Panels A and B are expressed as a percentage of the status quo tax rate. All regressions include an indicator for the property value band and Columns 2, 4, 6, and 8 also include randomization stratum (neighborhood) fixed effects. In Panel A, we report robust standard errors. Standard errors in Panel B are computed using the delta method. Columns 1–4 restrict the sample to properties in the low-value band, while Columns 5–8 restrict the sample to properties in the high-value band. We discuss these results in Section 6.3.

FIGURE B7: REVENUE-MAXIMIZING TAX RATE — QUADRATIC AND CUBIC SPECIFICATION



Notes: This figure reports estimates of the revenue-maximizing tax rate (RMTR) in Equation (4). The first two estimates assume linearity of tax compliance with respect to the tax rate and correspond to the estimation of Equation (5) using regression specification (6), while the following two coefficients assume a quadratic relationship between tax compliance and tax rates. All estimates of the RMTR are expressed as a percentage of the status quo tax rate. All regressions include an indicator for the property value band, and the second and fourth also include randomization stratum (neighborhood) fixed effects. The black lines show the 90% confidence interval and the gray line the 95% confidence interval for each estimate. For the quadratic specification, the confidence intervals are estimated using the standard errors from the delta method. For the cubic specification, the standard errors are bootstrapped (with 1,000 iterations). The coefficients and confidence intervals correspond to the point estimates and standard errors reported in Table 3, Panel B. The data include all non-exempt properties registered by tax collectors merged with the government's property tax database. We discuss these results in Section 6.3.

TABLE B13: REVENUE-MAXIMIZING TAX RATE — QUADRATIC AND CUBIC SPECIFICATION

	Quadratic Specification		Cubic Specification	
	(1)	(2)	(3)	(4)
Panel A: Effect of Tax Rates on Tax Compliance				
Tax Rate (in % of status quo)	-0.410***	-0.391***	1.045	1.054
	(0.080)	(0.077)	(0.764)	(0.739)
Tax Rate Squared (in % of status quo)	0.171***	0.160**	-1.837*	-1.833*
	(0.052)	(0.050)	(1.038)	(1.004)
Tax Rate Cubed (in % of status quo)			0.893*	0.886**
			(0.456)	(0.441)
Constant	0.293***	0.286***	-0.045	-0.050
	(0.029)	(0.028)	(0.181)	(0.175)
Panel B: Revenue-Maximizing Tax Rate (RMTR)				
RMTR (in % of status quo rate)	0.541	0.553	0.599	0.606
	(0.045)	(0.046)	(0.088)	(0.078)
Implied Reduction in Tax Rate	45.95%	44.71%	40.06%	39.35%
Observations	38028	38028	38028	38028
Sample	All properties	All properties	All properties	All properties
FE: Property Value Band	Yes	Yes	Yes	Yes
FE: Neighborhood	No	Yes	No	Yes
Quadratic Tax Rate Term	Yes	Yes	Yes	Yes
Cubic Tax Rate Term	No	Yes	No	Yes

Notes: This table reports estimates of the revenue-maximizing tax rate (RMTR) in Equation (4). Columns 1 and 2 assume linearity of tax compliance with respect to the tax rate. Panel A contains estimates of regression specification (6), and Panel B reports the corresponding RMTR from Equation (5). Columns 3 and 4 assume a quadratic relationship between tax compliance and tax rate. Panel A contains estimates from a quadratic regression specification, and Panel B reports the RMTR. All estimates in Panels A and B are expressed as a percentage of the status quo tax rate. All regressions include an indicator for the property value band, and Columns 2 and 4 also include randomization stratum (neighborhood) fixed effects. In Panel A, we report robust standard errors. Standard errors in Panel B are computed using the delta method applied to the quadratic specification. For the cubic specification, the standard errors are bootstrapped (with 1,000 iterations). The data include all non-exempt properties registered by tax collectors merged with the government's property tax database. We discuss these results in Section 6.3.

TABLE B14: REVENUE-MAXIMIZING TAX RATE ROBUSTNESS: ACCOUNTING FOR KNOWLEDGE OF OTHERS' RATES, PAST RATES, EXPECTATIONS OF FUTURE RATES, AND PAST EXPOSURE TO TAX COLLECTION

	Controls for 5 neighbors' rate (1)	Controls for 10 neighbors' rate (2)	Doesn't know neighbors' rate (3)	Knows neighbors' rate (4)	Doesn't know discounts (5)	Knows discounts (6)	Doesn't Know past rates (7)	Knows past rates (8)	No 2016 door-to-door tax campaign (9)	Door-to-door 2016 tax campaign (10)
Panel A: Effect of Tax Rates on Tax Compliance										
Tax Rate (in % of status quo)	-0.151***	-0.151***	-0.182***	-0.209***	-0.137***	-0.466	-0.246***	-0.326**	-0.167***	-0.143***
	(0.008)	(0.008)	(0.014)	(0.042)	(0.022)	(0.296)	(0.045)	(0.138)	(0.013)	(0.010)
Constant	0.193***	0.188***	0.245***	0.292***	0.191***	0.503**	0.309***	0.390***	0.214***	0.195***
	(0.007)	(0.008)	(0.012)	(0.033)	(0.018)	(0.225)	(0.035)	(0.105)	(0.010)	(0.008)
Panel B: Revenue-Maximizing Tax Rate (RMTR)										
RMTR (in % of status quo rate)	0.640	0.626	0.674	0.700	0.698	0.539	0.628	0.599	0.640	0.681
	(0.019)	(0.021)	(0.023)	(0.064)	(0.051)	(0.112)	(0.045)	(0.100)	(0.019)	(0.020)
Implied Reduction in Tax Rate	36.05%	37.45%	32.55%	29.97%	30.24%	46.05%	37.23%	40.09%	35.96%	31.90%
Observations	37209	37209	13042	2126	5093	87	2066	300	14589	23295
Sample	All properties	All properties	Midline Sample	Midline Sample	Midline Sample	Midline Sample	Baseline Sample	Baseline Sample	All properties	All properties
FE: Property Value Band	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FE: Neighborhood	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Neighbor Rate Controls	Yes	Yes	No	No	No	No	No	No	No	No

Notes: This table examines whether the revenue-maximizing tax rate (RMTR) could be biased by owners' knowledge of others' rates, past rates, expectations of future rates, or past exposure to tax collection. It reports estimates of the RMTR in Equation (4), assuming linearity of tax compliance with respect to the tax rate. Panel A contains estimates of regression specification (6), and Panel B reports the corresponding RMTR from Equation (5). All estimates in Panels A and B are expressed as a percentage of the status quo tax rate. All regressions include an indicator for the property value band and randomization stratum (neighborhood) fixed effects. In Panel A, we report robust standard errors. Standard errors in Panel B are computed using the delta method. Columns 1 and 2 control for the property tax rate assigned to the nearest 5 and nearest 10 properties (using the GPS location of all properties in Kananga), respectively. Columns 3 and 4 restrict the sample to owners who reported not knowing or knowing their neighbors' rates. Columns 5 and 6 then restrict the sample to owners who reported knowing or not knowing about the existence of tax abatements in Kananga. Columns 7 and 8 restrict the sample to owners who accurately reported the status quo rate or not. The variables that define these subsamples come from the baseline and midline survey (indicated in the bottom panel of the table) and are described in Section B8. Columns 9 and 10 estimate treatment effects for neighborhoods where door-to-door tax collection took place during the previous (2016) property tax campaign and neighborhoods where no door-to-door collection took place, using the treatment assignment from Weigel (2020). We discuss these results in Section 6.3.

TABLE B15: REVENUE-MAXIMIZING TAX RATE BY PROXIES FOR LIQUIDITY

	Monthly Income		Weekly Transport		Number of Possessions		Went to Bed Hungry – Past Month		Can find 3,000 CF – Next Four Days		Nb of days w/o 3,000 CF – Past Month	
	≤ median	> median	≤ median	> median	≤ median	> median	Yes	No	No	Yes	> median	≤ median
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Panel A: Effect of Tax Rates on Tax Compliance												
Tax Rate (in % of status quo)	-0.273***	-0.169**	-0.274***	-0.162**	-0.249***	-0.159*	-0.183**	-0.237***	-0.261***	-0.150**	-0.267***	-0.195**
	(0.057)	(0.056)	(0.061)	(0.055)	(0.042)	(0.084)	(0.058)	(0.057)	(0.047)	(0.069)	(0.051)	(0.071)
Constant	0.343***	0.252***	0.335***	0.251***	0.309***	0.257***	0.258***	0.315***	0.324***	0.243***	0.337***	0.267***
	(0.046)	(0.044)	(0.048)	(0.043)	(0.034)	(0.065)	(0.045)	(0.045)	(0.037)	(0.053)	(0.040)	(0.055)
Panel B: Revenue-Maximizing Tax Rate (RMTR)												
RMTR (in % of status quo rate)	0.629	0.746	0.611	0.776	0.621	0.811	0.704	0.665	0.619	0.807	0.630	0.685
	(0.053)	(0.124)	(0.052)	(0.137)	(0.041)	(0.232)	(0.106)	(0.069)	(0.044)	(0.199)	(0.048)	(0.115)
Implied Reduction in Tax Rate	37.09%	25.35%	38.94%	22.42%	37.93%	18.92%	29.57%	33.49%	38.08%	19.28%	37.01%	31.47%
Observations	1316	1374	1286	1411	1976	696	1309	1391	1808	882	1735	930
Sample	Baseline Sample	Baseline Sample	Baseline Sample	Baseline Sample	Baseline Sample	Baseline Sample	Endline Sample	Endline Sample	Endline Sample	Endline Sample	Endline Sample	Endline Sample
FE: Property Value Band	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FE: Neighborhood	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table explores how the revenue-maximizing tax rate (RMTR) tax rate varies by several proxies of household liquidity. It reports estimates of the RMTR in Equation (4), assuming linearity of tax compliance with respect to the tax rate. Panel A contains estimates of regression specification (6), and Panel B reports the corresponding RMTR from Equation (5). All estimates in Panels A and B are expressed as a percentage of the status quo tax rate. All regressions include an indicator for the property value band and randomization stratum (neighborhood) fixed effects. In Panel A, we report robust standard errors. Standard errors in Panel B are computed using the delta method. Columns 1, 3, and 5 restrict the baseline sample to respondents with below-median monthly household income, weekly transport expenditures, and number of possessions, respectively. Columns 2, 4, and 6 restrict the baseline sample to respondents with above-median monthly household income, weekly transport expenditures, and number of possessions, respectively. Columns 7–8 report results by whether endline respondents declared that they went to bed hungry in the past month. Columns 9 and 10 report results by whether endline respondents declare being able to find 3,000 CF in the next four days. Columns 11–12 report results by whether the number of days the respondent reported not having 3,000 CF in the past month at endline is above or below the median. The variables come from the baseline and endline surveys and are described in Section B8. We discuss these results in Section 6.3.

Table B16: Revenue-Maximizing Tax Rate by Decile of Estimated Property Value

	Property Value (in 2018 USD)									
	1^{st} Decile	2^{nd} Decile	3^{rd} Decile	4^{th} Decile	5^{th} Decile	6^{th} Decile	7^{th} Decile	8^{th} Decile	9^{th} Decile	10^{th} Decile
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A: Effect of Tax Rates on Tax Compliance										
Tax Rate (in % of status quo)	-0.160***	-0.166***	-0.168***	-0.195***	-0.144***	-0.155***	-0.109***	-0.190***	-0.127***	-0.111***
	(0.024)	(0.025)	(0.026)	(0.025)	(0.025)	(0.024)	(0.023)	(0.025)	(0.026)	(0.025)
Constant	0.201***	0.221***	0.222***	0.233***	0.196***	0.196***	0.159***	0.237***	0.189***	0.167***
	(0.019)	(0.020)	(0.021)	(0.020)	(0.020)	(0.019)	(0.019)	(0.021)	(0.021)	(0.020)
Panel B: Revenue-Maximizing Tax Rate (RMTR)										
RMTR (in % of status quo rate)	0.628	0.665	0.663	0.597	0.677	0.630	0.731	0.625	0.746	0.748
	(0.036)	(0.043)	(0.042)	(0.028)	(0.050)	(0.038)	(0.074)	(0.032)	(0.074)	(0.080)
Implied Reduction in Tax Rate	37.19%	33.53%	33.71%	40.31%	32.29%	37.04%	26.95%	37.53%	25.41%	25.17%
Observations	3777	3788	3791	3778	3787	3780	3771	3750	3767	3788
Sample	All properties	All properties	All properties	All properties	All properties	All properties	All properties	All properties	All properties	All properties
FE: Property Value Band	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FE: Neighborhood	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table explores how the revenue-maximizing tax rate (RMTR) varies as a function of predicted property value. It reports estimates of the RMTR in Equation (4), assuming linearity of tax compliance with respect to the tax rate. Panel A contains estimates of regression specification (6), and Panel B reports the corresponding RMTR from Equation (5). All estimates in Panels A and B are expressed as a percentage of the status quo tax rate. All regressions include an indicator for the property value band and randomization stratum (neighborhood) fixed effects. In Panel A, we report robust standard errors. Standard errors in Panel B are computed using the delta method. Each column restricts the sample to one of the deciles of property value in Kananga, as estimated using machine learning and described in Section 4 as well as in Bergeron et al. (2020a). We discuss these results in Section 6.3.

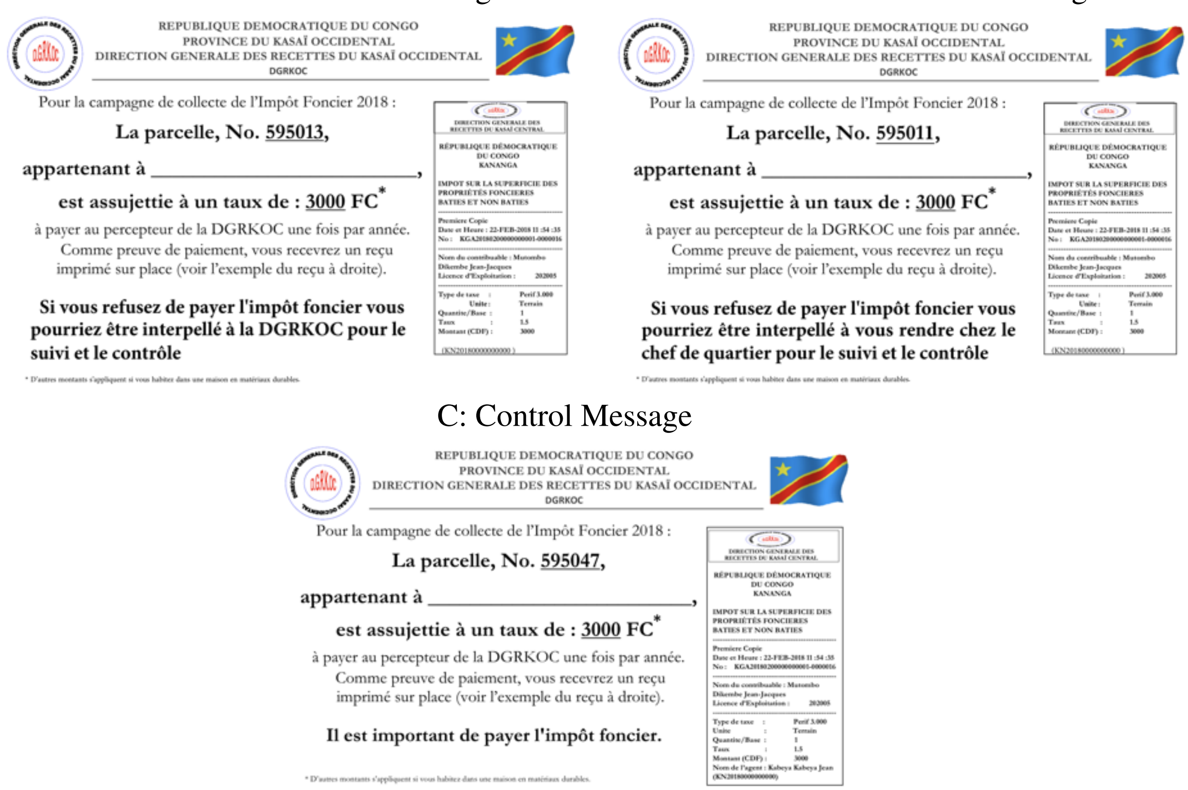
TABLE B17: MARGINAL VALUE OF PUBLIC FUNDS (MVPF)

Policy	WTP	Net Cost	MVPF
17% reduction	CF 37	CF 20.2	1.84
33% reduction	CF 72	CF 0 (<0)	∞
50% reduction	CF 108	CF 0 (<0)	∞

Notes: This table reports the willingness to pay, net cost, and the marginal value of public funds associated with each tax reduction using the results with respect to tax revenue presented in Figure A2 and Table 1. The results are discussed in Section B2.

B6.5 Additional Exhibits for Paper Section 7 — Can Enforcement Increase the Revenue-Maximizing Tax Rate?

FIGURE B8: TAX LETTER MESSAGES — ENFORCEMENT AND CONTROL



A: Central Enforcement Message

REPUBLIQUE DEMOCRATIQUE DU CONGO
PROVINCE DU KASAÏ OCCIDENTAL
DIRECTION GENERALE DES RECETTES DU KASAÏ OCCIDENTAL
DGRKOC

Pour la campagne de collecte de l'Impôt Foncier 2018 :

La parcelle, No. 595013,

appartenant à ______________________,

est assujettie à un taux de : 3000 FC*

à payer au percepteur de la DGRKOC une fois par année. Comme preuve de paiement, vous recevrez un reçu imprimé sur place (voir l'exemple du reçu à droite).

Si vous refusez de payer l'impôt foncier vous pourriez être interpellé à la DGRKOC pour le suivi et le contrôle

* D'autres montants s'appliquent si vous habitez dans une maison en matériaux durables.

B: Local Enforcement Message

REPUBLIQUE DEMOCRATIQUE DU CONGO
PROVINCE DU KASAÏ OCCIDENTAL
DIRECTION GENERALE DES RECETTES DU KASAÏ OCCIDENTAL
DGRKOC

Pour la campagne de collecte de l'Impôt Foncier 2018 :

La parcelle, No. 595011,

appartenant à ______________________,

est assujettie à un taux de : 3000 FC*

à payer au percepteur de la DGRKOC une fois par année. Comme preuve de paiement, vous recevrez un reçu imprimé sur place (voir l'exemple du reçu à droite).

Si vous refusez de payer l'impôt foncier vous pourriez être interpellé à vous rendre chez le chef de quartier pour le suivi et le contrôle

* D'autres montants s'appliquent si vous habitez dans une maison en matériaux durables.

C: Control Message

REPUBLIQUE DEMOCRATIQUE DU CONGO
PROVINCE DU KASAÏ OCCIDENTAL
DIRECTION GENERALE DES RECETTES DU KASAÏ OCCIDENTAL
DGRKOC

Pour la campagne de collecte de l'Impôt Foncier 2018 :

La parcelle, No. 595047,

appartenant à ______________________,

est assujettie à un taux de : 3000 FC*

à payer au percepteur de la DGRKOC une fois par année. Comme preuve de paiement, vous recevrez un reçu imprimé sur place (voir l'exemple du reçu à droite).

Il est important de payer l'impôt foncier.

* D'autres montants s'appliquent si vous habitez dans une maison en matériaux durables.

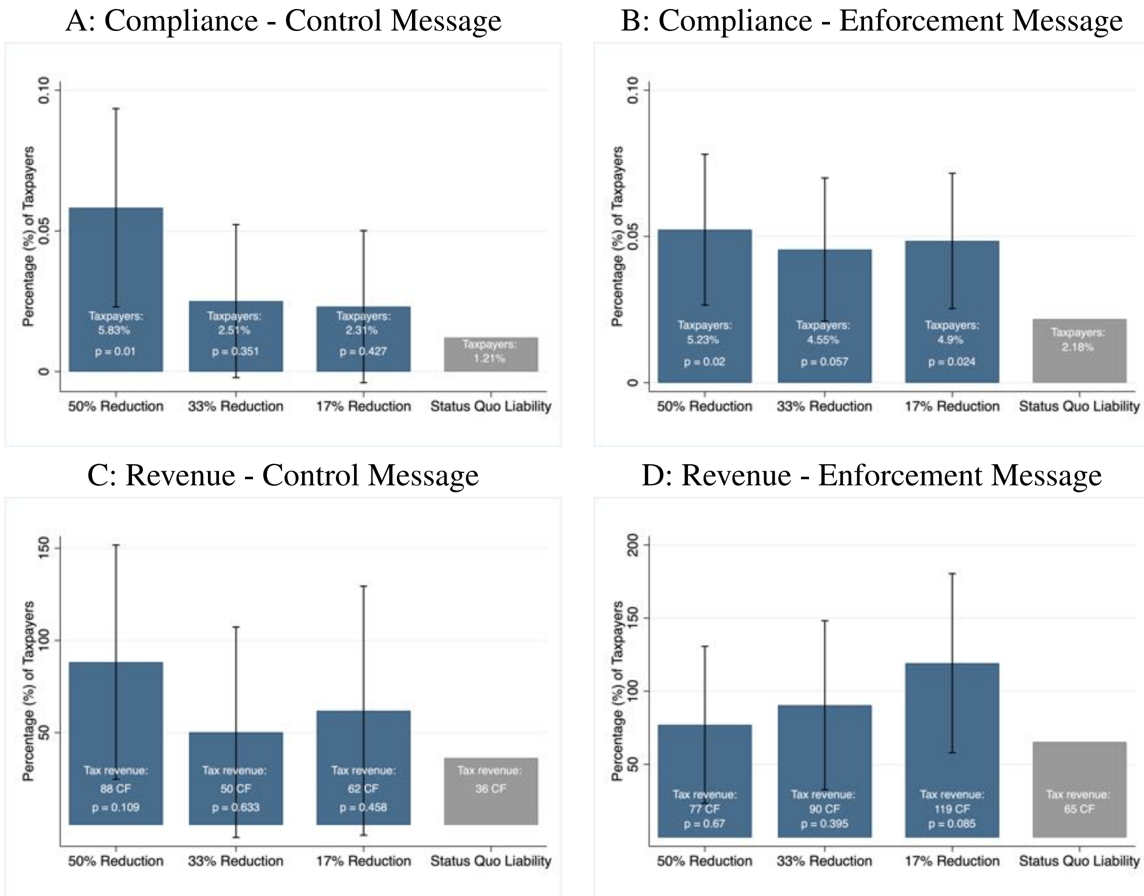
Notes: This figure shows examples of tax letters for owners of properties in the low-value band. The main text of the fliers (from *"Pour la campagne ..."* to *"... droite)."*) translates in English as: "For the 2018 property tax collection campaign, the property Number [Property ID] belonging to [Property Owner Name] is subject to a tax rate of 3000 CF to pay to the DGRKOC collector once a year. As proof of payment, you will receive a printed receipt on the spot (see the example of the receipt at right)." The footnote indicated by an asterisk reads: "Other amounts apply if you live in a house made of durable materials." Examples of the message treatments examined in the paper appear in the last large-font, bolded sentence in each letter. Panel A shows a letter with the *control* message, Panel B the *central enforcement* message, and Panel C the *local enforcement* message. The English translation of these messages and the details of their randomization on tax letters is discussed in Section 7.1.

TABLE B18: RANDOMIZATION BALANCE OF TAX LETTER MESSAGES

	Sample	Obs.	Mean control	Local Enforcement	Central Enforcement	Any Enforcement
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Property Characteristics						
Distance to city center (in km)	All Properties	2,665	2.878	0.008	0.001	0.005
				(0.007)	(0.006)	(0.006)
Distance to market (in km)	All Properties	2,665	0.638	-0.001	-0.007	-0.004
				(0.006)	(0.006)	(0.005)
Distance to gas station (in km)	All Properties	2,665	1.855	0.008	-0.003	0.002
				(0.006)	(0.006)	(0.005)
Distance to health center (in km)	All Properties	2,665	0.356	-0.000	-0.005	-0.003
				(0.006)	(0.005)	(0.005)
Distance to government building (in km)	All Properties	2,665	0.874	-0.003	-0.015**	-0.009*
				(0.006)	(0.006)	(0.005)
Distance to police station (in km)	All Properties	2,665	0.884	-0.004	-0.011*	-0.007
				(0.007)	(0.006)	(0.006)
Distance to private school (in km)	All Properties	2,665	0.313	0.006	0.003	0.004
				(0.006)	(0.005)	(0.005)
Distance to public school (in km)	All Properties	2,665	0.420	0.001	-0.002	-0.000
				(0.005)	(0.005)	(0.004)
Distance to university (in km)	All Properties	2,665	1.302	0.006	-0.008	-0.001
				(0.007)	(0.006)	(0.006)
Distance to road (in km)	All Properties	2,664	0.371	0.004	0.005	0.004
				(0.006)	(0.005)	(0.005)
Distance to major erosion (in km)	All Properties	2,664	0.154	-0.003	-0.002	-0.002
				(0.003)	(0.003)	(0.003)
Roof Quality	Midline Sample	1,634	0.961	-0.010	-0.003	-0.006
				(0.011)	(0.011)	(0.009)
Walls Quality	Midline Sample	1,628	1.145	0.016	0.011	0.014
				(0.018)	(0.017)	(0.015)
Fence Quality	Midline Sample	1,641	1.308	0.026	0.024	0.025
				(0.024)	(0.022)	(0.020)
Erosion Threat	Midline Sample	2,106	0.392	-0.006	-0.006	-0.006
				(0.028)	(0.027)	(0.024)
Property value (in USD)	All Properties	2,665	1230	10.929	-5.329	2.628
Machine Learning estimate				(68.748)	(65.513)	(56.312)
Panel B: Property Owner Characteristics						
Employed Indicator	Midline Sample	1,627	0.712	0.073***	0.058**	0.065***
				(0.025)	(0.025)	(0.022)
Salaried Indicator	Midline Sample	1,627	0.222	0.073***	0.051*	0.062***
				(0.027)	(0.026)	(0.023)
Work for Government Indicator	Midline Sample	1,627	0.147	0.013	0.032	0.023
				(0.022)	(0.022)	(0.019)
Relative Work for Government. Indicator	Midline Sample	1,780	0.235	-0.002	0.026	0.012
				(0.025)	(0.025)	(0.022)
Panel C: Property Owner Characteristics						
Gender	Midline Sample	193	1.250	0.071	0.056	0.064
				(0.087)	(0.091)	(0.076)
Age	Midline Sample	193	49.697	-1.082	0.441	-0.328
				(3.096)	(2.734)	(2.592)
Main Tribe Indicator	Midline Sample	193	0.842	-0.220***	-0.072	-0.147**
				(0.085)	(0.086)	(0.074)
Years of Education	Baseline Sample	193	11.211	-0.099	0.552	0.223
				(0.838)	(0.763)	(0.689)
Has Electricity	Baseline Sample	193	0.263	-0.106	-0.069	-0.088
				(0.087)	(0.098)	(0.082)
Log Monthly Income (CF)	Baseline Sample	193	11.366	-0.275	-0.277	-0.276
				(0.392)	(0.260)	(0.252)
Trust Chief	Baseline Sample	193	2.961	0.113	-0.250	-0.067
				(0.248)	(0.257)	(0.222)
Trust National Government.	Baseline Sample	183	2.521	-0.112	-0.028	-0.071
				(0.271)	(0.265)	(0.228)
Trust Provincial Government	Baseline Sample	183	2.357	0.210	0.390	0.297
				(0.261)	(0.259)	(0.222)
Trust Tax Ministry	Baseline Sample	183	2.282	0.139	0.085	0.112
				(0.252)	(0.249)	(0.216)
Panel D: Attrition						
Registration to Midline	Registration	2,665	0.385	0.05	0.018	0.012
				(0.013)	(0.013)	(0.011)

Notes: This table reports the coefficients regressing baseline and midline characteristics for properties (Panel A) and property owners (Panels B and C) or an indicator for attrition (Panel D) on treatment indicators and also including an indicator for the property value band and randomization stratum (neighborhood) fixed effects. Columns 4 and 5 correspond to separately estimating the effects of the Central enforcement message and the Local enforcement message while Column 6 reports the effects when both enforcement messages are pooled. The control message is the excluded category. We report robust standard errors. The results are discussed in Section 7.1. The variables come from the baseline, registration, and midline surveys and are described in Section B8.

FIGURE B9: TREATMENT EFFECTS ON TAX COMPLIANCE AND REVENUE — CONTROL AND ENFORCEMENT MESSAGE GROUP



Notes: This figure examines treatment effects on tax compliance and revenue among households randomly assigned to the control tax letter message (Panel A and C) or to the enforcement tax letter message (Panel B and D). The figure reports estimates from Equation (1), comparing property tax compliance and revenue in the tax abatement treatment groups (in blue) relative to the status quo property tax rate (the control group, in gray). In Panels A and B, the dependent variable is an indicator for property tax compliance. In Panel C and D, the dependent variable is tax revenues (in Congolese Francs). All estimations include an indicator for the property value band randomization stratum (neighborhood) fixed effects. The black lines show the 95% confidence interval for each of the estimates using robust standard errors. The data include all non-exempt properties registered by tax collectors merged with the government's property tax database. We discuss these results in Section 7.1.

TABLE B19: REVENUE-MAXIMIZING TAX RATE BY ENFORCEMENT CAPACITY (TAX LETTER VARIATION — CENTRAL V. LOCAL ENFORCEMENT MESSAGES)

	Central Enforcement Message				Local Enforcement Message			
	Linear Specification		Quadratic Specification		Linear Specification		Quadratic Specification	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Effect of Tax Rates on Tax Compliance								
Tax Rate (in % of status quo)	-0.061*	-0.049	0.297	0.282	-0.061*	-0.058	0.084	0.189
	(0.034)	(0.037)	(0.374)	(0.387)	(0.036)	(0.036)	(0.379)	(0.359)
Tax Rate Squared (in % of status quo)			-0.239	-0.221			-0.097	-0.165
			(0.242)	(0.250)			(0.247)	(0.235)
Constant	0.089**	0.080**	-0.037	-0.037	0.088**	0.086**	0.037	-0.002
	(0.028)	(0.030)	(0.137)	(0.142)	(0.030)	(0.029)	(0.138)	(0.131)
Panel B: Revenue-Maximizing Tax Rate (RMTR)								
RMTR (in % of status quo rate)	0.728	0.814	0.761	0.780	0.718	0.738	0.748	0.761
	(0.191)	(0.326)	(0.055)	(0.061)	(0.200)	(0.218)	(0.112)	(0.074)
Implied Reduction in Tax Rate	27.18%	18.61%	23.90%	21.99%	28.15%	26.24%	25.25%	23.94%
Observations	906	904	906	904	866	866	866	866
Sample	Tax Message Sample	Tax Message Sample	Tax Message Sample	Tax Message Sample	Tax Message Sample	Tax Message Sample	Tax Message Sample	Tax Message Sample
FE: Property Value Band	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FE: Neighborhood	No	Yes	No	Yes	No	Yes	No	Yes
Quadratic Tax Rate Term	No	No	Yes	Yes	No	No	Yes	Yes

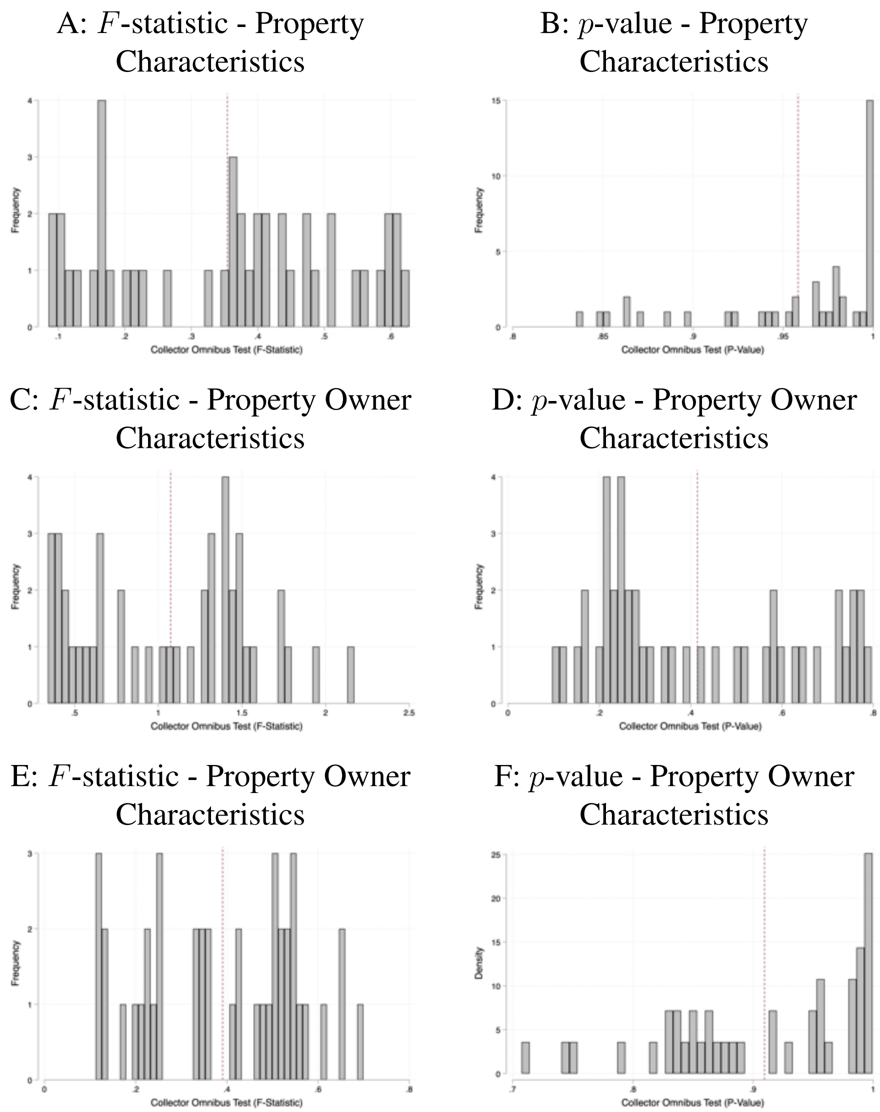
Notes: This table examines how the revenue-maximizing tax rate (RMTR), from Equation (4), varies among households randomly assigned to tax letter enforcement messages. Columns 1–2 and 5–6 assume linearity of tax compliance with respect to the tax rate. For these columns, Panel A contains estimates of regression specification (6), and Panel B reports the corresponding RMTR from Equation (5). Columns 3–4 and 7–8 assume a quadratic relationship between tax compliance and tax rate. For these columns, Panel A reports estimates of a quadratic regression specification and Panel B reports the RMTR. All estimates in Panels A and B are expressed as a percentage of the status quo tax rate. All regressions include an indicator for the property value band and Columns 2, 4, 6, and 8 also include randomization stratum (neighborhood) fixed effects. In Panel A, we report robust standard errors. Standard errors in Panel B are computed using the delta method. The data are restricted to the sample of 2,665 properties exposed to randomized messages on tax letters. Columns 1–4 further restrict the sample to owners who received the *central enforcement* message, and Columns 5–8 to owners who received the *local enforcement* message. We discuss these results in Section 7.1.

TABLE B20: REVENUE-MAXIMIZING TAX RATE BY ENFORCEMENT CAPACITY (TAX LETTER VARIATION — INCLUDING IMBALANCED COVARIATES)

	Control Message				Enforcement Message			
	Linear Specification		Quadratic Specification		Linear Specification		Quadratic Specification	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Effect of Tax Rates on Tax Compliance								
Tax Rate (in % of status quo)	-0.081**	-0.088**	-0.424	-0.444	-0.058**	-0.050**	0.243	0.225
	(0.032)	(0.033)	(0.346)	(0.328)	(0.025)	(0.025)	(0.268)	(0.263)
Tax Rate Squared (in % of status quo)			0.227	0.237			-0.201	-0.184
			(0.218)	(0.210)			(0.174)	(0.171)
Constant	0.079**	-0.013	0.200	0.109	0.099***	0.064	-0.008	-0.033
	(0.032)	(0.042)	(0.129)	(0.127)	(0.026)	(0.040)	(0.101)	(0.102)
Panel B: Revenue-Maximizing Tax Rate (RMTR)								
RMTR (in % of status quo rate)	0.489	0.076	0.315	0.138	0.849	0.634	0.791	0.734
	(0.111)	(0.254)	(0.078)	(0.083)	(0.237)	(0.362)	(0.054)	(0.114)
Implied Reduction in Tax Rate	51.09%	92.44%	68.50%	86.23%	15.07%	36.59%	20.93%	26.64%
Controls:								
Dist. state building (imbalanced)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dist. police station (imbalanced)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Employed (imbalanced)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Salaried (imbalanced)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	893	892	893	892	1772	1772	1772	1772
Sample	Tax Message Sample	Tax Message Sample	Tax Message Sample	Tax Message Sample	Tax Message Sample	Tax Message Sample	Tax Message Sample	Tax Message Sample
FE: Property Value Band	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FE: Neighborhood	No	Yes	No	Yes	No	Yes	No	Yes
Quadratic Tax Rate Term	No	No	Yes	Yes	No	No	Yes	Yes

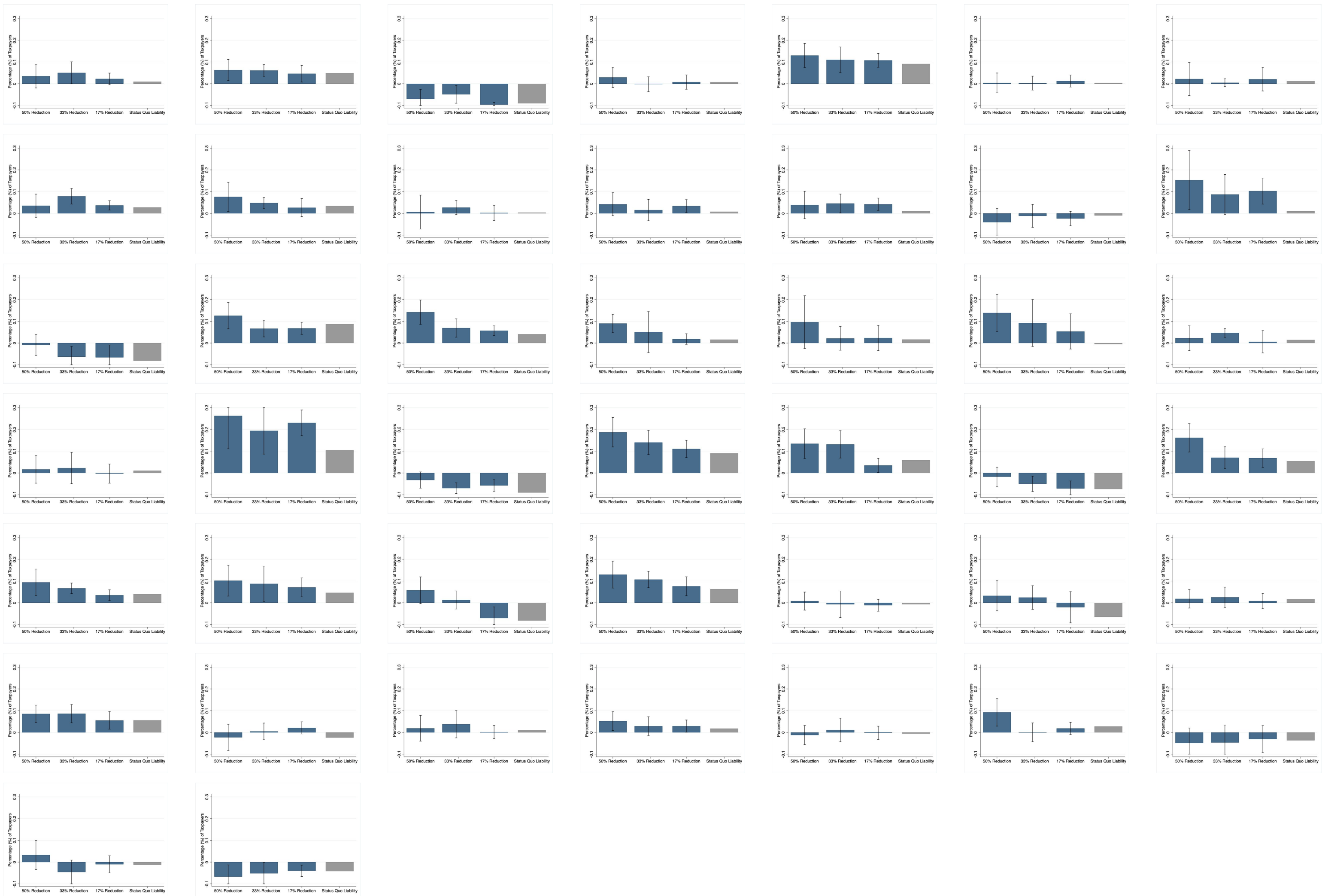
Notes: This table reports estimates of the revenue-maximizing tax rate (RMTR) in Equation (4). Columns 1–2 and 5–6 assume linearity of tax compliance with respect to the tax rate. For these columns, Panel A contains estimates of regression specification (6), and Panel B reports the corresponding RMTR from Equation (5). Columns 3–4 and 7–8 assume a quadratic relationship between tax compliance and tax rate. For these columns, Panel A reports estimates of a quadratic regression specification, and Panel B reports the RMTR. All estimates in Panels A and B are expressed as a percentage of the status quo tax rate. All regressions include an indicator for the property value band and Columns 2, 4, 6, and 8 also include randomization stratum (neighborhood) fixed effects. In Panel A, we report robust standard errors. Standard errors in Panel B are computed using the delta method. In all specifications, we add controls for distance to the nearest state building and police stations as well as indicators for having any job and a salaried job (the imbalanced covariates in Table B18). When including controls, we replace missing values in control variables with the mean for the entire sample and include a separate dummy (for each control variable) for the value being missing. The data are restricted to the sample of 2,665 properties exposed to randomized messages on tax letters. Columns 1–4 further restrict the sample to owners who received the *control* message, and Columns 5–8 to owners who received the *central enforcement* or *local enforcement* message. We discuss these results in Section 7.1.

FIGURE B10: TAX COLLECTOR ASSIGNMENT — OMNIBUS BALANCE TESTS



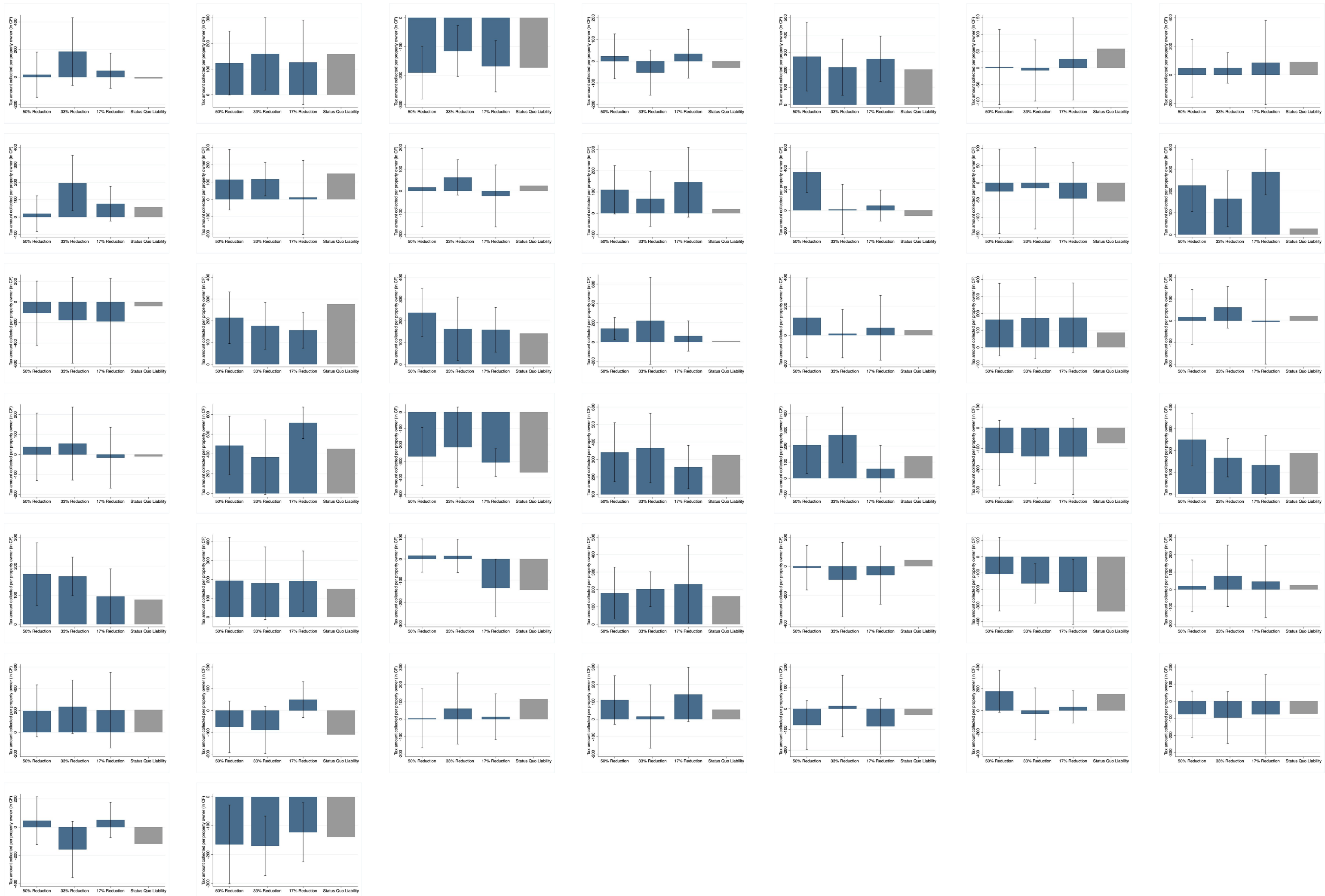
Notes: In this figure, we test the omnibus null hypothesis that the treatment effect associated with each tax collector is zero when the outcomes are the variables used to assess balance in Table A3. For each collector, we test the omnibus null hypothesis for the property characteristics collected during registration (Panels A and B, which use the variables from Panel A of Table A3 as the outcomes), for property owners' characteristics recorded in the midline survey (Panels C and D, which use the variables from Panel B of Table A3 as the outcomes), and for the property owners' characteristics recorded in the endline survey (Panels E and F, which use the variables from Panel C of Table A3 as the outcomes). Panels A, C, and E report the distribution of omnibus null test F-statistics across collectors and the mean F-statistic across collectors. Panels B, D, and F report the distribution of omnibus null test p-values across collectors and the mean p-value across collectors. We discuss these results in Section 7.2.

FIGURE B11: TREATMENT EFFECTS ON TAX COMPLIANCE — HETEROGENEITY BY TAX COLLECTOR



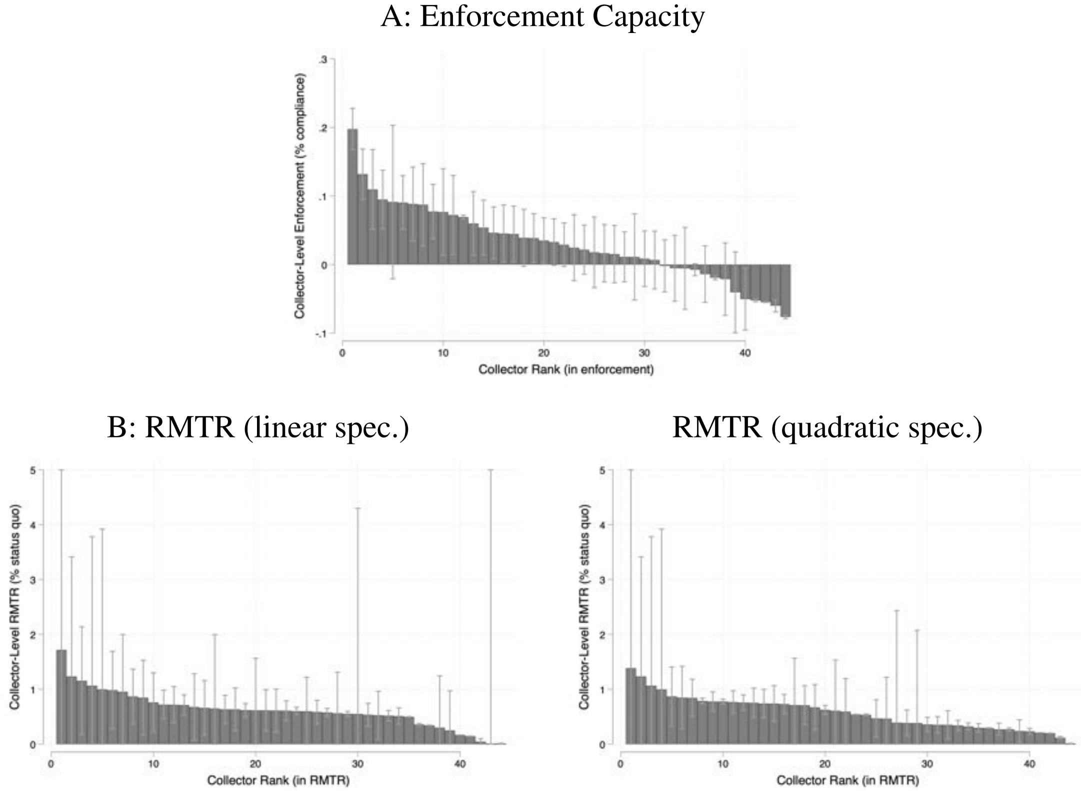
Notes: This figure reports estimates from equation $y_{i,n} = \sum_c \alpha_c^0 1[c(n) = c] + \sum_c \alpha_c^1 1[c(n) = c] Reduction17\%_{i,n} + \sum_c \alpha_c^2 1[c(n) = c] Reduction33\%_{i,n} + \sum_c \alpha_c^3 1[c(n) = c] Reduction50\%_{i,n} + \beta X_{i,n} + \epsilon_{i,n}$ for each of the 44 provincial government tax collectors considered in Section 7.2. $y_{i,n}$ is an indicator for tax compliance of property owner i living in neighborhood n, $c(n)$ denotes the tax collectors assigned to neighborhood n, $X_{i,n}$ is an indicator for the property value band and $\epsilon_{i,n}$ denotes the error term. Because the collectors were randomly assigned to work in pairs, and the pair was then randomly assigned to work in a neighborhood, we cluster standard errors at the tax collector pair level. We discuss these results in Section 7.2.

Figure B12: Treatment Effects on Tax Revenue — Heterogeneity by Tax Collector



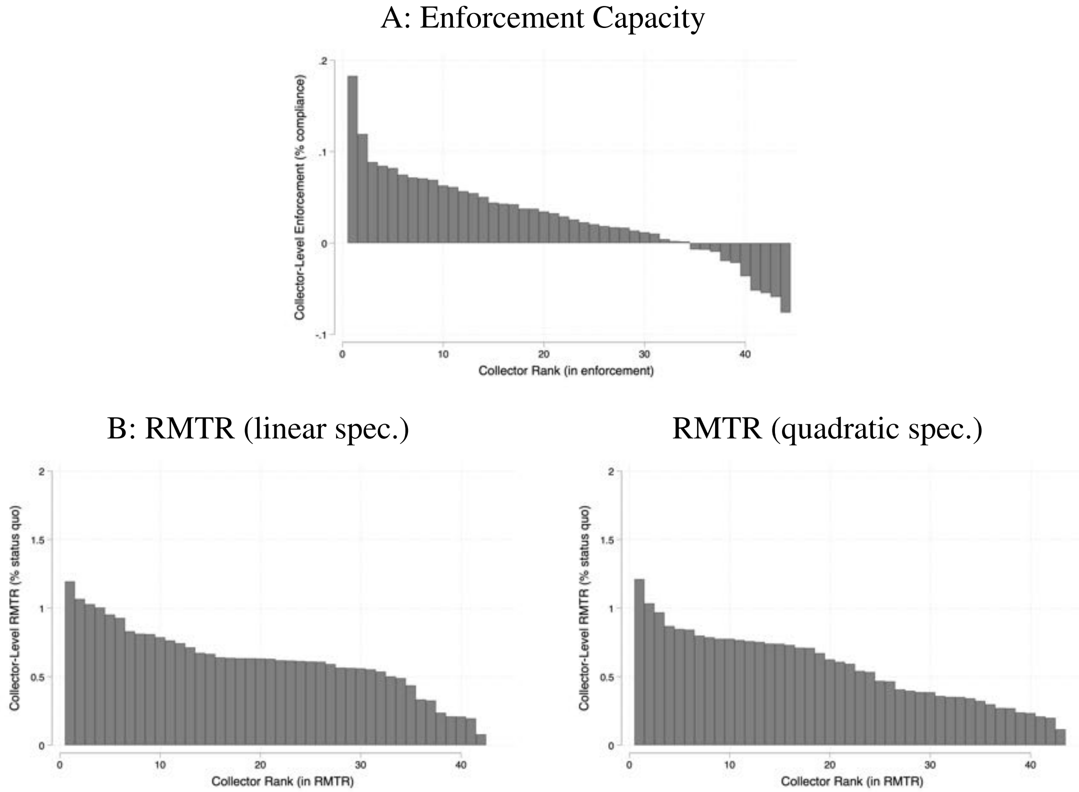
Notes: This figure reports estimates from equation $y_{i,n} = \sum_c \alpha_c^0 1[c(n) = c] + \sum_c \alpha_c^1 1[c(n) = c] Reduction17\%_{i,n} + \sum_c \alpha_c^2 1[c(n) = c] Reduction33\%_{i,n} + \sum_c \alpha_c^3 1[c(n) = c] Reduction50\%_{i,n} + \beta X_{i,n} + \epsilon_{i,n}$ for each of the 44 provincial government tax collectors considered in Section 7.2. $y_{i,n}$ is an indicator for tax revenue for property owner i living in neighborhood n, $c(n)$ denotes the tax collectors assigned to neighborhood n, $X_{i,n}$ is an indicator for the property value band, and $\epsilon_{i,n}$ denotes the error term. Because the collectors were randomly assigned to work in pairs, and the pair was then randomly assigned to work in a neighborhood, we cluster standard errors at the tax collector pair level. We discuss these results in Section 7.2.

FIGURE B13: TAX COLLECTOR ENFORCEMENT CAPACITIES AND REVENUE-MAXIMIZING TAX RATE



Notes: This figure shows estimated collector-specific enforcement capacities and revenue-maximizing tax rates (RMTR). Panel A contains estimates of each tax collector's enforcement capacity following regression specification (7). The estimated enforcement capacity is expressed as the percentage of owners who pay the property tax on average among neighborhoods to which each collector is randomly assigned. Some of the estimates of E_c are negative, reflecting the fact that E_c should be interpreted as the predicted additional compliance brought by collector c when paired with a randomly chosen tax collector and randomly assigned to a neighborhood. The fact that some $\widehat{E_c}$ are negative reflects that low-performing collectors on average lowered the compliance achieved in collector pairs to which they were randomly assigned. By contrast, when we estimate enforcement capacity at the collector-pair level, rather than the collector level, the estimates can be interpreted as the predicted compliance associated with the collector pair when randomly assigned to a neighborhood, and consequently all of them are positive (Panel A of Figure B18). Panels B and C report the collector-specific RMTR in Equation (4). In Panel B, the estimated RMTR assumes linearity of tax compliance with respect to the tax rate and is obtained from estimating Equation (8). In Panel C, the estimated RMTR assumes a quadratic relationship between tax compliance and the tax rate. All estimates of the RMTR are expressed as a percentage of the status quo tax rate. We discuss these results in Section 7.2.

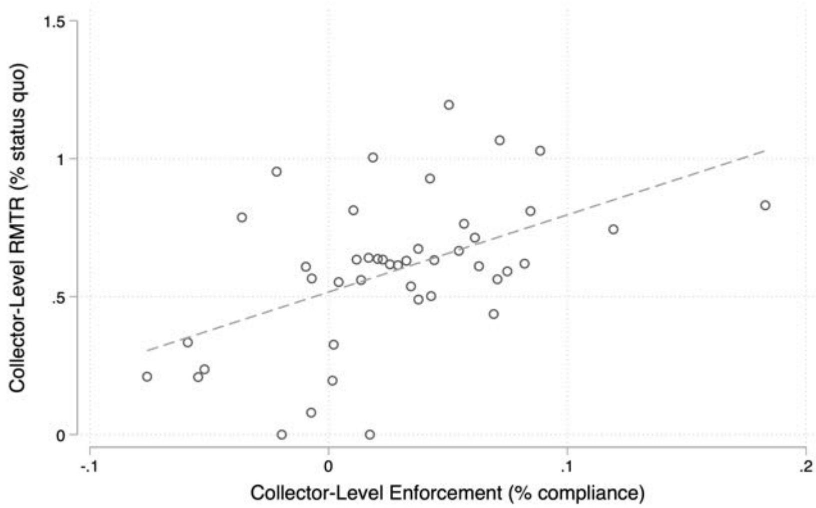
FIGURE B14: TAX COLLECTOR ENFORCEMENT CAPACITIES AND RMTRS — EMPIRICAL BAYES ESTIMATES



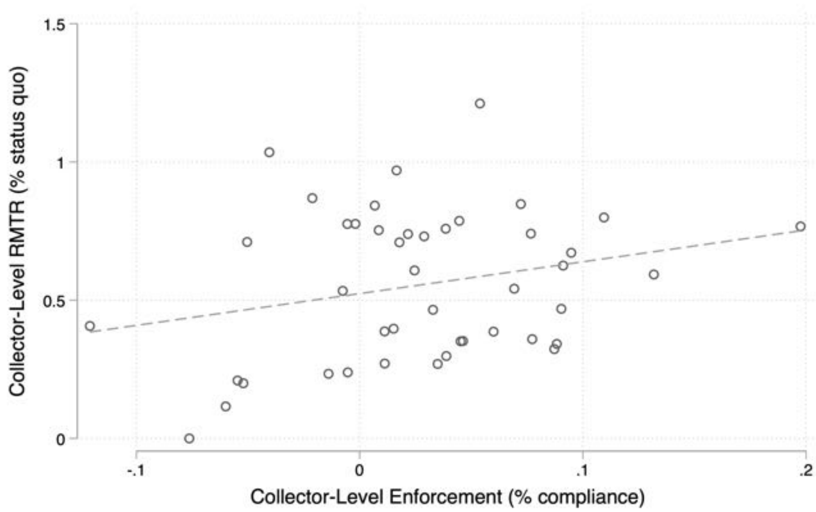
Notes: This figure shows estimated collector-specific enforcement capacities and revenue-maximizing tax rates (RMTR) with all estimates adjusted using the empirical Bayes approach presented in Section B4. Panel A contains estimates of each tax collector's enforcement capacity following regression specification (7). The estimated enforcement capacity is expressed as the percentage of owners who pay the property tax on average among neighborhoods to which each collector is randomly assigned. Some of the estimates of E_c are negative, reflecting the fact that E_c should be interpreted as the predicted additional compliance brought by collector c when paired with a randomly chosen tax collector and assigned to a randomly selected neighborhood. The fact that some $\widehat{E_c}$ are negative reflects that low-performing collectors on average lowered the compliance achieved in collector pairs to which they were randomly assigned. By contrast, when we estimate enforcement capacity at the collector-pair level, rather than the collector level, the estimates can be interpreted as the predicted compliance associated with the collector pair when randomly assigned to a neighborhood, and consequently all of them are positive (Panel A of Figure B18). Panels B and C report the collector-specific RMTR in Equation (4). In Panel B, the estimated RMTR assumes linearity of tax compliance with respect to the tax rate and is obtained from estimating Equation (8). In Panel C, the estimated RMTR assumes a quadratic relationship between tax compliance and the tax rate. All estimates of the RMTR are expressed as a percentage of the status quo tax rate. We discuss these results in Section 7.2.

Figure B15: Collector Revenue-Maximizing Tax Rates by Enforcement Capacity — Empirical Bayes Estimates

A: RMTR (linear spec.) by Enforcement Capacity



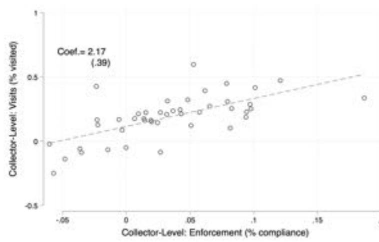
B: RMTR (quadratic spec.) by Enforcement Capacity



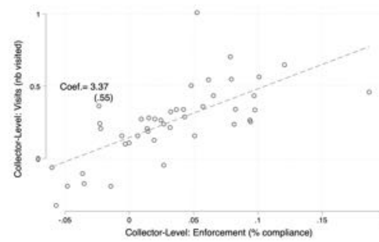
Notes: This figure shows the relationship between collector-level revenue-maximizing tax rates (RMTR) and collector enforcement capacities with all estimates adjusted using the empirical Bayes approach presented in Section B4. The x-axis contains estimates of collector enforcement capacity from Equation (7). The y-axis reports the collector-specific RMTR in Equation (4). In Panel A, the estimated RMTR assumes linearity of tax compliance with respect to the tax rate and is obtained from estimating Equation (8). In Panel B, the estimated RMTR assumes a quadratic relationship between tax compliance and the tax rate. All estimates of enforcement capacity are expressed as the percentage of owners who pay the property tax, and all estimates of the RMTR are expressed as a percentage of the status quo tax rate. The best-fit line and the corresponding regression coefficient of the x-axis on the y-axis are reported with the corresponding robust standard errors. These estimates correspond to those in Table A16. We discuss these results in Section 7.2.

Figure B16: Collector-Level Analysis — Robustness to Split Sample Approach

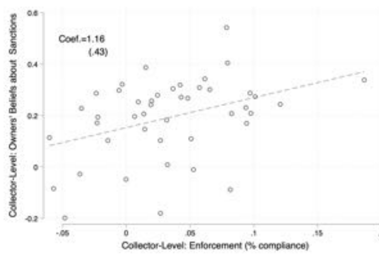
A: Visit Indicator
by Enforcement Capacity



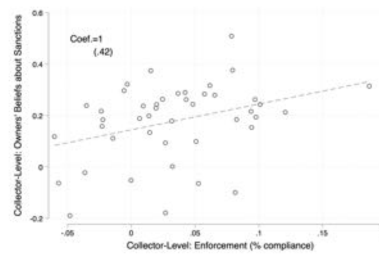
B: Number of Visits
by Enforcement Capacity



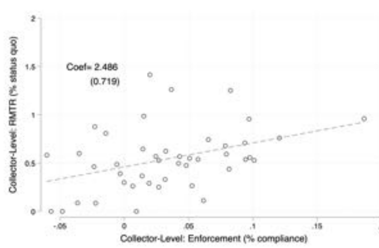
C: Perceptions of Sanction
(No Controls)



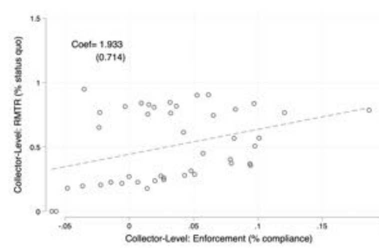
D: Perceptions of Sanction
(Number of Visits Controls)



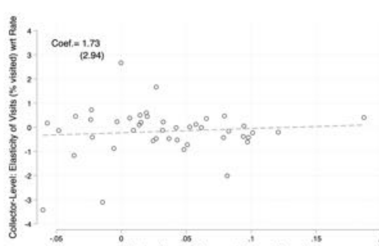
E: RMTR (linear spec.)
by Enforcement Capacity



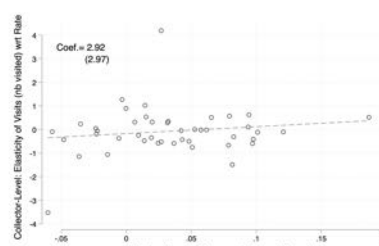
F: RMTR (quadratic spec.)
by Enforcement Capacity



G: Elasticity of Visit Indicator
wrt Tax Rates by Enforcement Capacity



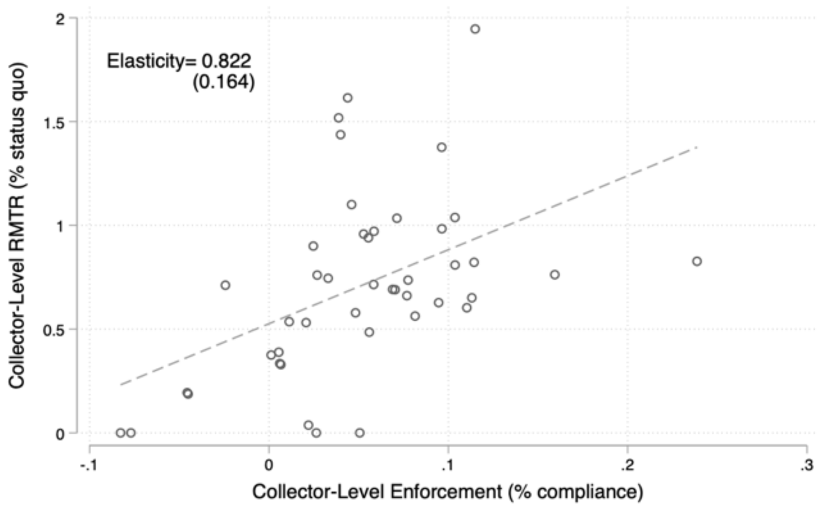
H: Elasticity of Number of Visits
wrt Tax Rates by Enforcement Capacity



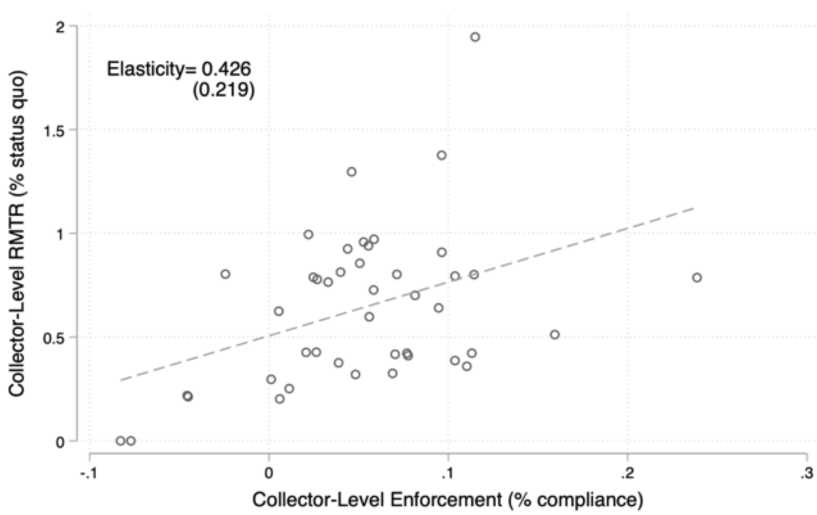
Notes: This figure demonstrates the robustness of the collector-based analysis to a split-sample approach, in which we split the sample in two and estimate collector enforcement capacities (on the x-axis) using the first sample and then the different variables on the y-axis using the second sample. We repeat this analysis to replicate the results in Figure A4 (Panels A–D), Panel B of Figure 1 (Panels E and F), and Figure A6 (Panels G and H). We discuss these results in Section 7.2.

FIGURE B17: REVENUE-MAXIMIZING TAX RATE BY ENFORCEMENT CAPACITY — COLLECTOR VARIATION CONTROLLING FOR PROPERTY CHARACTERISTICS

A: Linear Specification

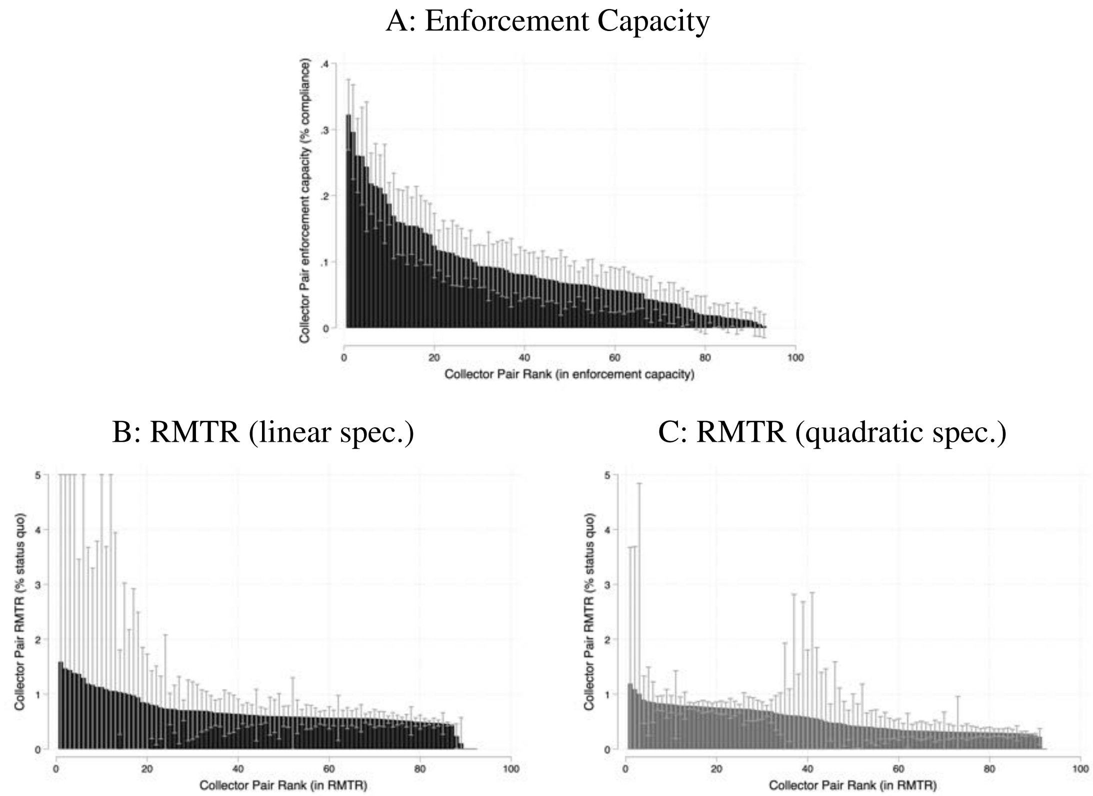


B: Quadratic Specification



Notes: This figure shows the relationship between the collector-level revenue-maximizing tax rate (RMTR) and collector enforcement capacities. We control for the variables used to assess balance in Panels A–C of Table A3 when estimating the collector-level RMTR and collector enforcement capacity. The x-axis denotes collector enforcement capacities from Equation (7). The y-axis denotes the collector-specific RMTR in percent of the status quo rate. Panel A shows the RMTR estimated assuming linearity of tax compliance with respect to the tax rate and is obtained from estimating Equation (8) in Panel A. Panel B shows the quadratic analog. Estimates of enforcement capacity are expressed as the percentage of owners who pay the property tax. Estimates of the RMTR are expressed in percent of the status quo tax rate. The best-fit line and the corresponding regression coefficient of the x-axis on the y-axis are reported with the corresponding robust standard errors. We discuss these results in Section 7.2.

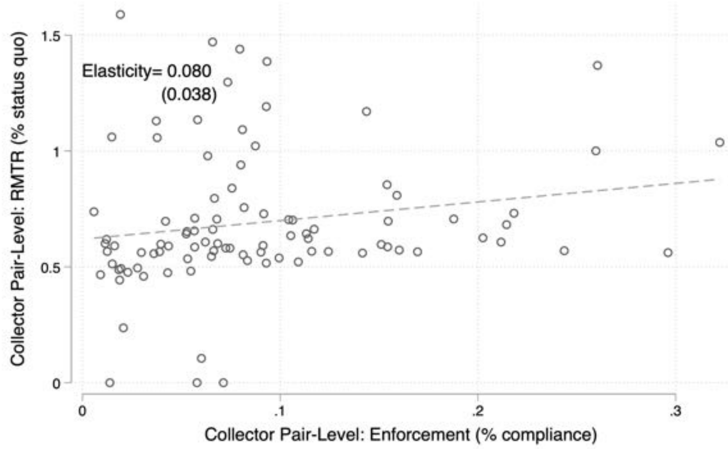
FIGURE B18: COLLECTOR PAIR ENFORCEMENT CAPACITIES AND REVENUE-MAXIMIZING TAX RATE



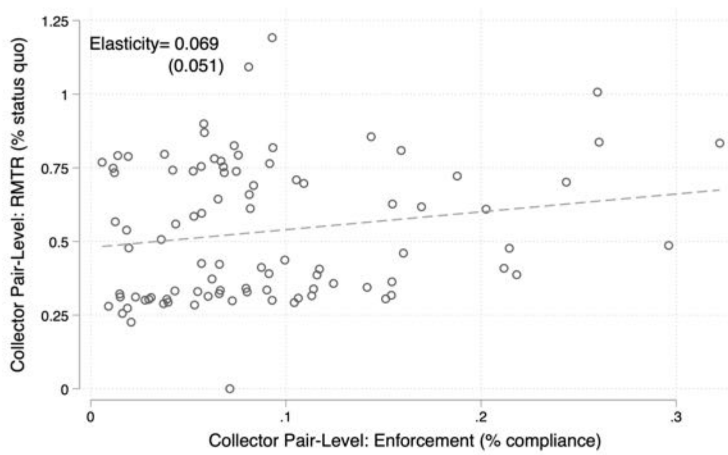
Notes: This figure shows the distribution of collector-pair-level enforcement capacities and revenue-maximizing tax rates (RMTR), rather than the collector-level quantities reported in Figure B13. Panel A reports estimates of collector pair enforcement capacity estimated using regression specification (7) but replacing dummies for each collector with dummies for collector pairs. Estimated enforcement capacities are expressed as the percentage of owners who pay the property tax. Panels B and C report the collector-pair RMTR in Equation (4). In Panel B, the estimated RMTR assumes linearity of tax compliance with respect to the tax rate and is obtained from estimating empirical specification (8) but replacing dummies for each collector by dummies for collector pairs and clustering standard errors at the collector pair level. In Panel C, the estimated RMTR assumes a quadratic relationship between tax compliance and the tax rate but replacing dummies for each collector by dummies for collector pairs and clustering standard errors at the collector pair level. All estimates of the RMTR are expressed as a percentage of the status quo tax rate. We discuss these results in Section 7.2.

FIGURE B19: REVENUE-MAXIMIZING TAX RATE BY ENFORCEMENT CAPACITY — COLLECTOR PAIR VARIATION

A: Linear Specification



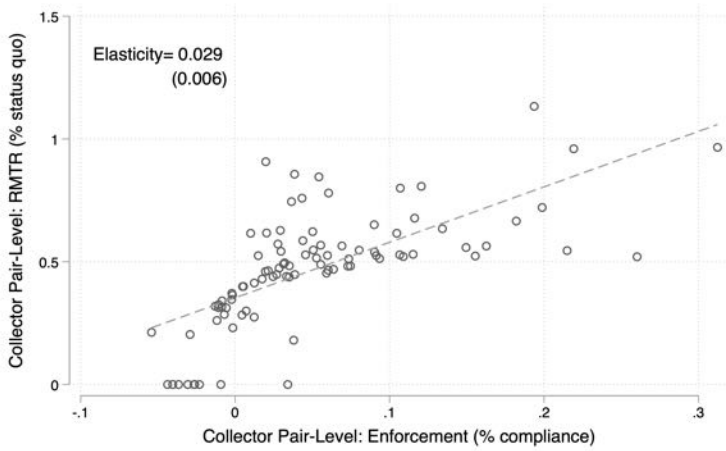
B: Quadratic specification



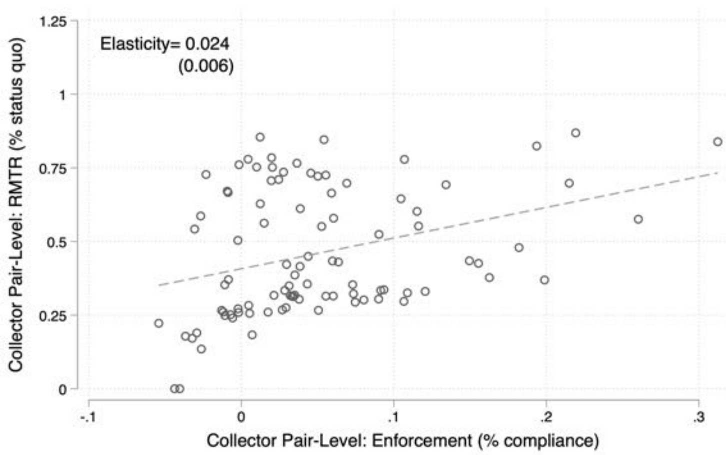
Notes: This figure explores the relationship between collector pair revenue-maximizing tax rates (RMTR) and the collector pair enforcement capacity. The x-axis reports estimates of tax collector pair enforcement capacity from Equation (7) but replacing collector dummies with collector pair dummies. The y-axis reports collector-specific RMTR in Equation (4). In Panel A, the estimated RMTR assumes linearity of tax compliance with respect to the tax rate and is obtained from estimating Equation (8), replacing dummies for each collector by dummies for collector pairs. In Panel B, the estimated RMTR assumes a quadratic relationship between tax compliance and the tax rate, replacing dummies for each collector with dummies for collector pairs. All estimates of enforcement capacity are expressed as the percentage of owners who pay the property tax, and all estimates of the RMTR are expressed as a percentage of the status quo tax rate. We also report the best-fit line. We discuss these results in Section 7.2.

FIGURE B20: REVENUE-MAXIMIZING TAX RATE BY ENFORCEMENT CAPACITY — COLLECTOR PAIR VARIATION CONTROLLING FOR PROPERTY CHARACTERISTICS

A: Linear Specification



B: Quadratic specification



Notes: This figure explores the relationship between collector pair revenue-maximizing tax rates (RMTR) and the collector pair enforcement capacity. We control for the property characteristics used to assess balance in Panel A of Table A3 when estimating the collector pair RMTR and collector pair enforcement capacity. The x-axis reports estimates of tax collector pair enforcement capacity from Equation (7) but replacing collector dummies with collector pair dummies. The y-axis reports collector-specific RMTR in Equation (4). In Panel A, the estimated RMTR assumes linearity of tax compliance with respect to the tax rate and is obtained from estimating Equation (8), replacing dummies for each collector by dummies for collector pairs. In Panel B, the estimated RMTR assumes a quadratic relationship between tax compliance and the tax rate, replacing dummies for each collector with dummies for collector pairs. All estimates of enforcement capacity are expressed as the percentage of owners who pay the property tax, and all estimates of the RMTR are expressed as a percentage of the status quo tax rate. We also report the best-fit line. We discuss these results in Section 7.2.

TABLE B21: CORRELATES OF COLLECTOR ENFORCEMENT CAPACITY

	Coef. (1)	SE (2)	p-value (3)	Mean (4)	R-squarred (5)	Obs. (6)
Panel A: Demographics						
Female	-0.056	0.069	0.423	0.068	0.003	44
Age	0.247	0.153	0.114	30.535	0.062	43
Main Tribe	-0.117	0.178	0.514	0.250	0.014	44
Years of Education	0.193*	0.110	0.086	3.674	0.038	43
Math Score	0.204	0.130	0.124	-0.052	0.042	43
Literacy (Tshiluba)	0.135	0.156	0.393	0.042	0.019	43
Literacy (French)	0.258*	0.145	0.082	0.013	0.068	43
Monthly Income	0.447***	0.124	0.001	98.562	0.203	43
Possessions	0.323***	0.095	0.002	1.698	0.106	43
Born in Kananga	0.061	0.155	0.694	0.488	0.004	43
Panel B: Trust in the Government						
Trust Nat. Gov.	0.027	0.159	0.864	2.841	0.001	44
Trust Prov. Gov.	0.033	0.141	0.817	2.955	0.001	44
Trust Tax Min.	0.195	0.155	0.216	3.500	0.038	44
Index	0.109	0.152	0.479	0.065	0.012	44
Panel C: Perceived Performance of Government						
Prov. Gov. Capacity	-0.085	0.132	0.521	0.364	0.007	44
Prov. Gov. Responsiveness	-0.246*	0.142	0.091	1.795	0.060	44
Prov. Gov. Performance	0.067	0.121	0.583	4.545	0.004	44
Prov. Gov. use of Funds	0.058	0.192	0.764	0.624	0.003	44
index	-0.085	0.134	0.531	0.077	0.007	44
Panel D: Government Connections						
Job through Connections	0.032	0.167	0.849	0.275	0.001	40
Relative work for Prov. Gov.	-0.106	0.143	0.462	0.209	0.011	43
Relative work for Tax Ministy	-0.104	0.142	0.470	0.209	0.011	43
Index	-0.083	0.164	0.615	-0.095	0.007	43
Panel E: Tax Morale						
Taxes are Important	0.265*	0.136	0.058	2.750	0.070	44
Work of Tax Min. is Important	0.118	0.181	0.517	3.727	0.014	44
Paid Taxes in the Past	0.087	0.168	0.610	0.367	0.010	30
Index	0.217	0.141	0.132	0.013	0.047	44
Panel F: Redistributive Preferences						
Imp. of Progressive Taxes	0.018	0.132	0.891	1.682	0.000	44
Imp. of Progressive Prop. Taxes	-0.101	0.125	0.421	1.227	0.010	44
Imp. to Tax Employed	0.343**	0.165	0.044	3.318	0.118	44
Imp. to Tax Owners	0.187	0.130	0.156	3.000	0.035	44
Imp. to Tax Owners w. title	0.310**	0.119	0.013	3.227	0.096	44
Index	0.295**	0.132	0.031	-0.096	0.087	44
Panel G: Motivation						
Intrinsic Motivation	-0.204	0.147	0.177	-0.092	0.050	27
Extrinsic Motivation	-0.303*	0.160	0.069	0.022	0.111	27
Gap: Intrinsic - Extrinsic	0.091	0.181	0.619	-0.097	0.010	27.000

Notes: This table reports the correlations between collector enforcement capacities and other collector characteristics, measured from surveys conducted with each collector. The columns report the correlation coefficient, robust standard error, p-value, mean of the characteristic among collectors, R-squared, and the total number of collectors for which we have characteristics. The variables come from surveys with tax collectors and are described in Section B8. We discuss these results in Section 7.2.

TABLE B22: CORRELATES OF COLLECTOR REVENUE-MAXIMIZING TAX RATES

	RMTR: Linear Specification						RMTR: Quadratic Specification					
	Coef. (1)	SE (2)	p-value (3)	Mean (4)	R-squarred (5)	Obs. (6)	Coef. (7)	SE (8)	p-value (9)	Mean (10)	R-squarred (11)	Obs. (12)
Panel A: Demographics												
Female	0.071	0.091	0.439	0.068	0.005	44	0.172***	0.045	0.000	0.068	0.030	44
Age	-0.114	0.193	0.556	30.535	0.013	43	0.138	0.190	0.470	30.535	0.020	43
Main Tribe Indicator	-0.045	0.181	0.807	0.250	0.002	44	-0.046	0.200	0.821	0.250	0.002	44
Years of Education	-0.033	0.139	0.816	3.674	0.001	43	-0.257**	0.119	0.037	3.674	0.069	43
Math Score	0.253*	0.140	0.078	-0.052	0.065	43	0.089	0.167	0.598	-0.052	0.008	43
Literacy (Tshiluba)	0.037	0.115	0.749	0.042	0.001	43	0.177	0.139	0.209	0.042	0.033	43
Literacy (French)	0.106	0.136	0.440	0.013	0.011	43	0.147	0.150	0.334	0.013	0.022	43
Monthly Income	0.291***	0.088	0.002	98.562	0.087	43	0.151	0.118	0.208	98.562	0.024	43
Possessions	0.155	0.134	0.253	1.698	0.025	43	-0.010	0.146	0.948	1.698	0.000	43
Born in Kananga	0.283*	0.149	0.064	0.488	0.082	43	0.191	0.151	0.212	0.488	0.038	43
Panel B: Trust in the Government												
Trust Nat. Gov.	0.010	0.107	0.926	2.841	0.000	44	-0.122	0.133	0.367	2.841	0.015	44
Trust Prov. Gov.	0.048	0.116	0.681	2.955	0.002	44	-0.075	0.155	0.633	2.955	0.006	44
Trust Tax Min.	0.079	0.201	0.695	3.500	0.006	44	-0.192	0.180	0.293	3.500	0.037	44
Index	0.059	0.132	0.659	0.065	0.003	44	-0.170	0.140	0.231	0.065	0.029	44
Panel C: Perceived Performance of Government												
Prov. Gov. Capacity	0.161	0.165	0.333	0.364	0.026	44	0.075	0.158	0.639	0.364	0.006	44
Prov. Gov. Responsiveness	0.159	0.207	0.447	1.795	0.025	44	-0.059	0.197	0.768	1.795	0.003	44
Prov. Gov. Performance	0.005	0.154	0.976	4.545	0.000	44	-0.079	0.183	0.670	4.545	0.006	44
Prov. Gov. use of Funds	0.172	0.151	0.261	0.624	0.030	44	0.321**	0.133	0.020	0.624	0.103	44
index	0.201	0.163	0.224	0.077	0.040	44	0.100	0.175	0.571	0.077	0.010	44
Panel D: Government Connections												
Job through Connections	-0.025	0.179	0.889	0.275	0.001	40	-0.035	0.194	0.858	0.275	0.001	40
Relative work for Prov. Gov.	0.083	0.154	0.592	0.209	0.007	43	0.037	0.167	0.828	0.209	0.001	43
Relative work for Tax Ministry	0.210	0.242	0.391	0.209	0.045	43	0.234	0.214	0.279	0.209	0.057	43
Index	0.135	0.196	0.496	-0.095	0.018	43	0.119	0.208	0.571	-0.095	0.015	43
Panel E: Tax Morale												
Taxes are Important	0.009	0.191	0.961	2.750	0.000	44	-0.145	0.198	0.468	2.750	0.021	44
Work of Tax Min. is Important	0.207	0.131	0.120	3.727	0.043	44	0.086	0.149	0.565	3.727	0.007	44
Paid Taxes in the Past	-0.237	0.174	0.183	0.367	0.048	30	-0.099	0.187	0.603	0.367	0.008	30
Index	0.019	0.175	0.916	0.013	0.000	44	-0.065	0.183	0.724	0.013	0.004	44
Panel F: Redistributive Preferences												
Imp. of Progressive Taxes	-0.102	0.155	0.516	1.682	0.010	44	0.195	0.129	0.137	1.682	0.038	44
Imp. of Progressive Prop. Taxes	-0.191	0.120	0.118	1.227	0.037	44	-0.138	0.127	0.282	1.227	0.019	44
Imp. to Tax Employed	-0.094	0.138	0.498	3.318	0.009	44	-0.095	0.199	0.636	3.318	0.009	44
Imp. to Tax Owners	-0.129	0.184	0.487	3.000	0.017	44	0.022	0.144	0.880	3.000	0.000	44
Imp. to Tax Owners w. title	-0.079	0.112	0.485	3.227	0.006	44	-0.048	0.109	0.659	3.227	0.002	44
Index	-0.148	0.130	0.260	-0.081	0.022	44	-0.001	0.143	0.993	-0.081	0.000	44
Panel G: Motivation												
Intrinsic Motivation	-0.205	0.182	0.271	-0.092	0.029	27	-0.122	0.219	0.583	-0.092	0.011	27
Extrinsic Motivation	0.450*	0.253	0.088	0.022	0.141	27	0.192	0.187	0.314	0.022	0.028	27
Gap: Intrinsic - Extrinsic	-0.553**	0.248	0.035	-0.097	0.213	27	-0.265	0.203	0.204	-0.097	0.054	27

Notes: This table reports the correlations between collectors' revenue-maximizing tax rates (RMTR) and other collector characteristics. In Columns 1–6, we assume linearity of tax compliance with respect to the tax rate and use empirical specification (8), while in Columns 7–12 we assume a quadratic relationship between tax compliance and the tax rate. The columns report the correlation coefficient, robust standard error, p-value, mean of the characteristic among collectors, R-squared, and the total number of collectors for which we have characteristics. The variables come from surveys with tax collectors and are described in Section B8. We discuss these results in Section 7.2.

B7 Predicting Property Value with Machine Learning

This section discusses how we estimate the value of each property in the sample using machine learning methods. More detail is provided in Bergeron et al. (2020a).

B7.1 Data Collection

B7.1.1 Training Sample

To train our Machine Learning and Computer Vision algorithms, we constructed a training sample of 1,654 property values. These 1,654 properties were randomly chosen from our baseline sample. To estimate their market value, land surveyors from the Provincial Government of Kasaï-Central conducted appraisal field visits on these properties between August and September 2019.

During these field appraisal visits, the government land surveyors estimated the market value of each property based on the neighborhood, the property's land area and fruit trees, the property built area and the materials used in construction as well as their depreciation. The median (mean) property value in the training sample was US\$797 (US\$3,125).

Estimating the market value of properties in Kananga is one of the key components of the training of the provincial governments' land surveyors with whom we worked. These surveyors are often employed by formal banks in Kananga to value the properties of clients who apply for mortgages or loans.[75]

B7.1.2 Feature Vector

To train our machine learning algorithms, we constructed a vector of features using survey data, GPS information, and the value of the properties in the training sample:

- **Property Features.** Property-level features come from the midline survey conducted with property owners in Kananga between July 2018 and February 2019 as described in Section 4. The midline survey recorded the GPS location of the property, the materials and quality of the walls, roof and fence of the main house as well as the quality of the street road and whether the property and road are threatened by erosion. These variables are described in Table B23.

- **Geographic Features.** Geographic information comes from combining the GPS location of every property from the registration survey described in Section 4 and the GPS location of important buildings/infrastructure in Kananga. In September 2019, enumerators recorded the GPS location of all the following in Kananga: (1) hospitals and health centers, (2) public and private schools, (3) universities, (4) markets, (5) gas stations, (6) government buildings (communal, provincial, and national), and (7) police stations. Maps of the (8) main roads and (9) large ravines (sources of erosion) were also digitized by our research team. For each property in Kananga, we compute the distance to the nearest of these geographic features as described in Table B23.

[75] One of the surveyors is the former head of the Provincial Cadastral Division and the other is the Chief Technical Officer of the Cadastral Division.

- **Neighborhood Property Value Features.** Additional information about the average value of nearby properties comes from the property values of the 1,654 properties in our training sample. We use this information to create several additional features: average property value in the neighborhood and in the geographical strata, average property value within a close radius (200, 500, and 1000 meters), and the average price of the nearest 3 and 5 houses. These additional features are also summarized in Table B23.

B7.2 Machine Learning Predictions

B7.2.1 Algorithms

Our goal is to use the training sample of 1,654 property values and the vector of features to predict as accurately as possible the value of the remaining properties in Kananga using the following machine learning algorithms:

1. **Penalized linear models (LASSO, Ridge, and Elastic Net) -** Penalized linear models are widely used by econometricians, Least Absolute Shrinkage and Selection Operator (LASSO) (Tibshirani, 1996), Ridge (Hoerl and Kennard, 1970) and Elastic Net (Zou and Hastie, 2005) methods allow creating a linear model that is penalized for having too many variables in the model, by adding a constraint in the equation, and are also known for this reason as shrinkage or regularization methods.

2. **Kernel models (SVM and SVR).** Support Vector Machine (SVM) and its regression equivalent, Support Vector Regression (SVR), usually perform well on small datasets due to their nonparametric nature and the flexibility of kernel functions (Bierens, 1987). A kernel is essentially a feature map of the input data to a higher dimensional space. While data may not be linear on the original input space, moving to a higher dimensional space may help finding a linear line of best fit. In SVR, the linear regression function is fit in the kernel space and often turns out to be a non-linear function in the original input space. We tested the two most commonly use kernels, Linear and Radial Basis Function (RBF).

3. **Regression Trees and Forests.** Regression trees (Breiman et al., 1984) and their extension, random forests (Breiman, 2001), have also become very popular and effective methods for flexibly estimating regression functions in settings where out-of-sample predictive power is important. They are considered to have great out-of-the box performance without requiring subtle regularization.

4. **Boosting.** Boosting is a general-purpose technique to improve the performance of simple supervised learning methods. In the context of tree-based models, boosting works as tree ensembles that are grown sequentially, with a new tree fitted on

residuals of the previous model. Tree are not full grown, and as such are considered "weak learners." The combination of multiple rounds of sequential weak learners has been show to deliver a "strong learner," characterized by high predictive performance (Schapire and Freund, 2012).

5. **Ensemble modeling.** Another key feature of the machine learning literature is the use of model averaging and ensemble methods (e.g., Dietterich (2000)). In many cases, a single model or algorithm does not perform as well as a combination of different models, averaged using weights obtained by optimizing out-of-sample performance. Here we investigate the out-of-sample performance of a combination of boosting algorithms with different loss functions for different types of properties.

B7.2.2 Results

Each machine learning model has well-known advantages and drawbacks (Hastie et al., 2001). The advantage of machine learning is that it allows to systematically compare the performance of different algorithms by assessing their out-of-sample accuracy. We use 10-fold cross validation to compare the performance of our machine learning algorithms for the task of assigning a property value to each property in our sample.

Table B24 assesses the out-of-sample accuracy of each machine learning algorithm using several evaluation metrics.[76] Table B24 shows that the boosted trees models outperform penalized linear models, kernel models, and tree models. This is in line with recent studies that have found that in many contexts, boosting algorithms tend to perform better than other machine learning algorithms (Schapire and Freund, 2012).

The performance of the boosting algorithm is greatly affected by the choice of loss function.[77] The best performing algorithm uses a boosted tree algorithm with MAPE loss function for properties we predict as "low-value" and with MAE loss function for property we predict as "high-value."[78] This algorithm performs better than a boosted tree algorithm with MAPE loss function or a boosted tree algorithm with MAE loss function.[79] It is

[76]In Column 1, we report the *Mean Absolute Error (MAE)*, which is defined as the average of absolute difference between the target value and the predicted value and is a commonly used evaluation metric for regression models. It has the advantage of penalizing large errors and being robust to outliers. In Column 2, we report the *Mean Absolute Percentage Error (MAPE)*, defined as the average absolute difference between the target value and the predicted value expressed in percentage of the actual value, which is also a commonly used evaluation metric for regression models due to its scale-independency and interpretability, though it has the inconvenience of producing infinite or undefined values for close-to-zero actual values. In Columns 3, 4 and 5 we use the share of prediction within a 20%, 50% and 150%, band of the target value.

[77]In the case of random forest or tree-based boosting, the loss function is the function used by the algorithm to decide tree splits.

[78]To differentiate between "low-value"' and "high-value" properties, we fit a random forest classifier. The random classifier predicts whether a house is worth less than US$1,000 ("low-value") or more than US$1,000 USD ("high-value").

[79]This is because with a MAPE loss function, the prediction procedure will overweight "low-value" proper-

this ensemble modeling approach that yields what we refer to as our preferred measure of predicted property value in the paper.

While machine learning models' predictive performance typically comes at the cost of explainability, we can describe how our preferred machine learning algorithm based its prediction by looking at the features that were used most often for prediction.[80] Figure B21 presents the results. It shows that the value of neighboring properties, which constitutes 7 of the most 15 important features, is the most effective at predicting the value of a property in Kananga. Then comes relative location (distance to nearest ravine, distance to the nearest road, to the city center, or to any major infrastructure) with 4 of the 15 most important features. Finally the remaining important features are the characteristics of the property such as quality of the walls, roof, and the road.

ties and all the property value predictions will be pushed downwards. Similarly, with a MAE loss function, the prediction procedure will overweight "high-value" properties and all the property value predictions will be pushed upwards.

[80]The number of tree splits made on this feature in the learning process.

TABLE B23: FEATURES USED TO TRAIN MACHINE LEARNING MODELS

Category	Description
Property Features	Property latitude
	Property longitude
	Communes (1-5 indicator)
	Geographic stratum (1-12 indicator)
	Materials of the fence - 1-4 scale
	Materials of the roof - 1-4 scale
	Roof quality - 1-4 scale
	Wall quality - 1-7 scale
	Road quality - 1-5 scale
	Erosion threat - 1-3 scale
Geographic Features	Distance of the property to the city center
	Distance of the property to the nearest commune building
	Distance of the property to the nearest gas station
	Distance of the property to the nearest health center
	Distance of the property to the nearest hospital
	Distance of the property to the nearest market
	Distance of the property to the nearest police station
	Distance of the property to the nearest private school
	Distance of the property to the nearest public school
	Distance of the property to the nearest university
	Distance of the property to the nearest government building
	Distance of the property to the nearest road
	Distance of the property to the nearest ravine
	Cumulative distance
Neighborhood Property Value Features	K-Fold target encoded geographic stratum property value
	K-Fold target encoded neighborhood property value
	Average property value in a 200 m radius
	Average property value in a 500 m radius
	Average property value in a 1 km radius
	Average price of the 3 closest properties
	Average price of the 5 closest properties

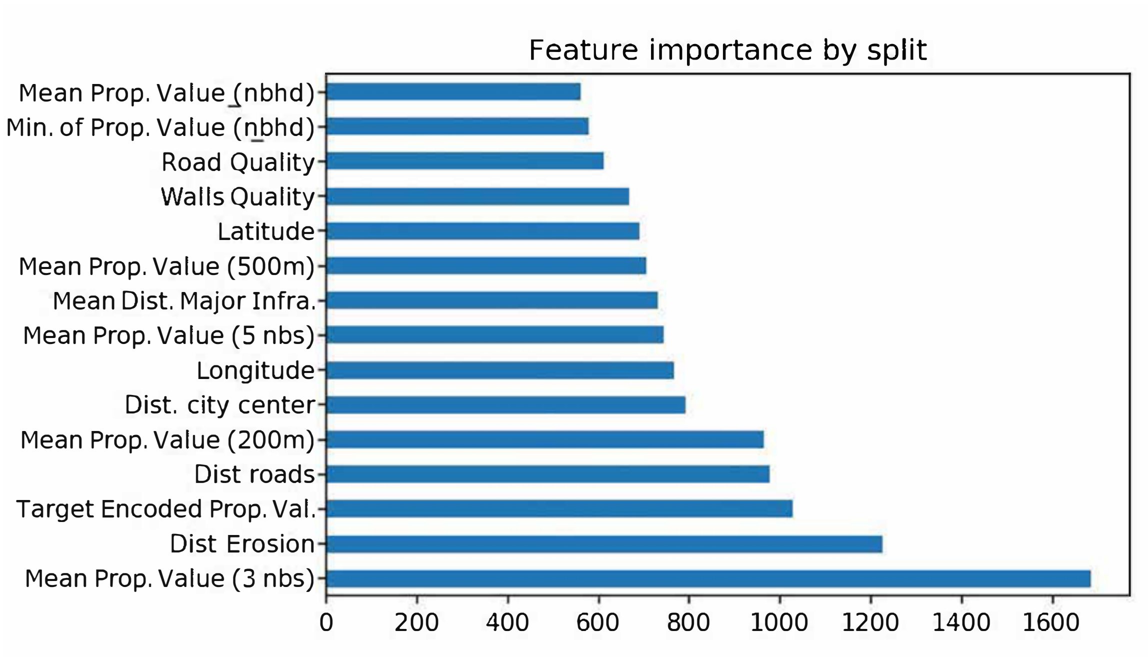
Notes: This table shows the features used to train the machine learning models. The property features come from registration and midline surveys and from administrative data about the boundaries of the five communes in Kananga. Geographic strata are those used in Balan et al. (2022), reflecting slightly finer geographic units than communes. The geographic features were computed as the crow-flies distance between the GPS location of the house and the nearest (noted) building/infrastructure from a city census conducted in September 2019. The neighborhood property value features were computed using the training sample of 1,654 property values. The variables are described in Section B8. The prediction procedure is described above and in depth in Bergeron et al. (2020a).

TABLE B24: PERFORMANCE OF MACHINE LEARNING MODELS

Model	MAE Score	MAPE	Within 20%	Within 50%	Share $\leq$ 150%
	(1)	(2)	(3)	(4)	(5)
Linear regression	2687.9458	241.33%	11.30%	26.96%	53.60%
Elastic Net	2871.1446	265.33%	10.87%	27.20%	50.43%
SVR - Linear kernel	2687.9458	241.33%	11.30%	26.96%	53.60%
SVR - RBF Kernel	2567.4541	154.49%	6.40%	21.86%	49.81%
Random Forest	2259.1849	154.31%	17.83%	41.30%	55.03%
Boosting - MAPE loss	2227.2905	55.95%	17.64%	48.88%	89.38%
Boosting - MAE loss	1983.1291	116.13%	18.88%	43.23%	59.32%
Ensemble modeling	1912.2261	69.57%	22.11%	53.54%	79.88%

Notes: This table assesses the out-of-sample accuracy of each machine learning model used in Bergeron et al. (2020a) to predict property values in Kananga. We examine the following algorithms: penalized linear model (Lasso, Ridge, and Elastic Net), kernel models (SVR), regression trees and forests (random forest), and boosting algorithms. Column 1 reports the mean absolute error (MAE), the average of absolute difference between the target value and the predicted value. Column 2 reports the absolute percentage error (MAPE), the average absolute difference between the target value and the predicted value expressed in percentage of the actual target value. In Columns 3, 4, and 5, we use the share of predictions within a 20%, 50%, and 150% band of the target value. The prediction procedure is described above and in depth in Bergeron et al. (2020a).

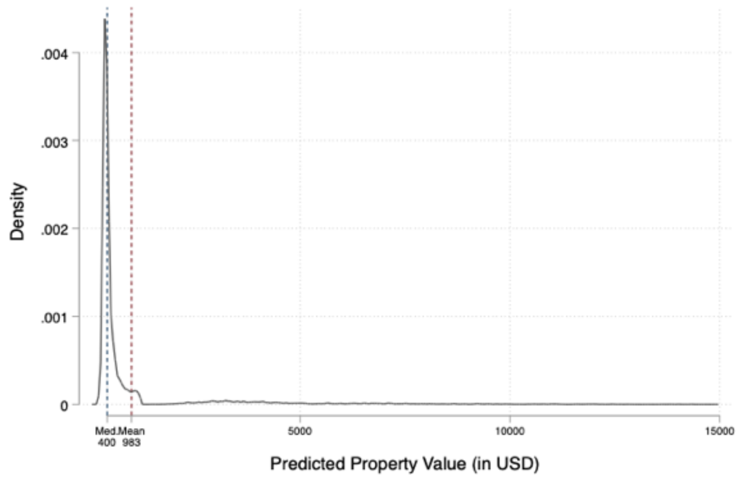
FIGURE B21: FEATURE IMPORTANCE BY SPLIT



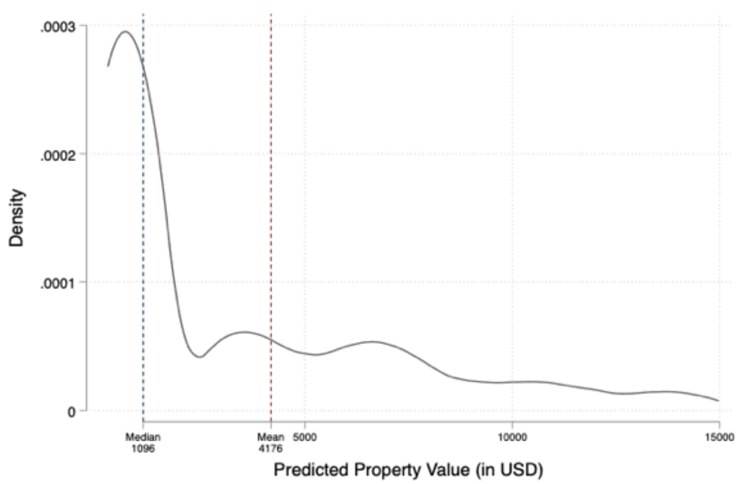
Notes: This figure shows how the preferred machine learning model in Bergeron et al. (2020a) based its prediction by showing the features that were used most often, i.e., the number of tree splits made on each feature in the learning process. These features are described in Table B23. The prediction procedure is described above and in more detail in Bergeron et al. (2020a).

FIGURE B22: DISTRIBUTION OF ESTIMATED PROPERTY VALUES BY VALUE BANDS

A: Estimated Property Value (in USD): Low-Value Band



B: Estimated Property Value (in USD): High-Value Band



Notes: This figure shows the distributions of the predicted property values (in USD) for the best performing algorithm. Panel A concerns properties in the low-value band, and Panel B properties in the high-value band. The median property value is represented by a blue dotted line, and the mean property value by a red dotted line. The prediction procedure is described above and in depth in Bergeron et al. (2020a).

B8 Detailed Survey-Based Variable Descriptions

This section provides the exact text of the questions used to construct all survey-based variables examined in this paper.

B8.1 Property and Property Owner Surveys

1. *Roof Quality.* This is a Likert scale variable, increasing in the quality of the roof of the respondent's house. It was recorded in the midline survey in response to the prompt: 'Observe the principal material of the roof.' [thatch/ straw, mat, palms/ bamboos, logs (pieces of wood), concrete slab, tiles/slate/eternit, sheet iron]

2. *Wall Quality.* This is a Likert scale variable, increasing in the quality of the walls of the respondent's house. It was recorded in the midline survey in response to the prompt: 'Observe the principal material of the walls of the main house.' [sticks/palms, mud bricks, bricks, cement]

3. *Fence Quality.* This is a Likert scale variable, increasing in the quality of the fence of the respondent's house. It was recorded in the midline survey in response to the prompt: 'Does this compound have a fence? If so, select the type of fence.' [no fence, bamboo fence, brick fence, cement fence]

4. *Erosion Threat.* This is a Likert scale variable, increasing in the threat to the respondent's house caused by erosion. It was recorded in the midline survey in response to the prompt: 'Is this compound threatened by a ravine?' [no, yes - somewhat threatened, yes - gravely threatened]

5. *Distance of the property to the city center/ to the nearest commune building/ to the nearest gas station/ to the nearest health center/ to the nearest hospital/ to the nearest market/ to the nearest police station/ to the nearest private school/ to the nearest public school/ to the nearest university/ to the nearest government building.* These distances were based on a survey that recorded the GPS locations of all the important buildings in Kananga. The shortest distance between the respondent's property and each type of location was then computed using ArcGIS.

6. *Distance of the property to the nearest road / to the nearest ravine.* These distances were also measured using GIS. The locations of roads and ravines were digitized on GIS by the research office enabling computation of the distance between the respondent's property and the nearest road or ravine.

7. *Employed Indicator.* This is a dummy variable that equals 1 if the respondent reports any job (i.e., is not unemployed). It was recorded in the midline survey in response to the question: 'What type of work do you do now?' [Unemployed-no work, Medical assistant, Lawyer, Cart pusher, Handyman, Driver (car and taxi moto), Tailor, Diamond digger, Farmer, Teacher, Gardner, Mason, Mechanic, Carpenter, Muyanda,

Military officer/soldier or police officer, Fisherman, Government personnel, Pastor, Porter, Professor, Guard, Work for NGO, Seller (in market), Seller (in a store), Seller (at home), Student, SNCC, Other]

8. *Salaried Indicator.* This is a dummy variable that equals 1 if the respondent reports one of the following jobs: medical assistant, lawyer, teacher, military officer/soldier or police officer, government personnel, professor, guard, NGO employee, bank employee, brasserie employee, Airtel (telecommunication services) employee, SNCC (national railway company of the Congo) employee. It was recorded in the midline survey in response to the question 'what type of work do you do now?' [responses noted above]

9. *Work for the Government Indicator.* This is a dummy variable that equals 1 if the respondent reports having one of the following jobs: military officer/soldier or police officer, government personnel, or SNCC (national railway company of the Congo) employee. It was recorded in the midline survey in response to the question 'what type of work do you do now?' [responses noted above]

10. *Relative Work for the Government Indicator.* This is a dummy variable that equals 1 if the respondent reports that someone in her/his family works for the government. It was recorded in the midline survey in response to the question: 'Does a close member of the family of the property owner work for the provincial government, not including casual labor?' [no, yes]

11. *Gender.* This is a variable reporting the respondent's gender. It was recorded in the baseline survey in response to the prompt: 'Is the owner a man or a woman? '

12. *Age.* This is a variable reporting the respondent's age. It was recorded in the baseline survey in response to the question: 'How old were you at your last birthday?'

13. *Main Tribe Indicator.* This is a dummy variable that equals 1 the respondent reports being Luluwa, the main tribe in Kananga. It was recorded in the baseline survey in response to the question: 'What is your tribe?' [Bindi, Bunde, Dekese, Dinga, Kefe, Kele, Kete, Kongo, Kuba, Kuchu, Kusu, Lele, Lualua, Luba, Lubakat, Luluwa, Lunda/Rund, Luntu, Lusambo, Mbala, Mfuya, Mongo, Ndumbi, Ngwandji, Nyambi, Nyoka, Pende, Rega, Sakata, Sala, Shi, Songe, Tetela, Tshokwe, Tutsi, Utu, Uvira, Wongo, Yaka, Yeke, Other]

14. *Years of Education.* This is variable reports the respondent's years of education. It was calculated using responses to two baseline survey questions:

    - 'What is the highest level of school you have reached?' [never been to school, kindergarten, primary, secondary, university]
    - 'What is the last class reached in that level?' [1, 2, 3, 4, 5, 6, >6]

15. *Has electricity.* This is a dummy variable that equals 1 if the household reports in the baseline survey that they have access to electricity. It was recorded in the baseline survey in response to the question: ‘Do you have any source of electricity at your home?’ [no, yes]

16. *Monthly Income.* This variable reports the respondent’s household income over the past month. This variable was recorded in the baseline survey in response to the question: ’What was the household’s total earnings this past month?’ [amount in USD]

17. *Trust in Provincial Government / National Government / Tax Ministry.* This is a Likert scale variable, increasing in the level of trust the respondent reports having in different organizations. It was recorded in the baseline and endline survey in response to the question:

    - ‘I am going to name a number of organizations. For each one, could you tell me how much confidence you have in them: no confidence at all, not much confidence, quite a lot of confidence, a great deal of confidence?’
    - Organizations:
        (a) ‘NGOs’
        (b) ‘Local leaders’
        (c) ‘The national government (in Kinshasa)’
        (d) ‘The provincial government’
        (e) ‘The tax ministry’
        (f) ‘Foreign research organizations’.

18. *Knows Neighbors’ Rate.* This is a dummy variable that equals 1 if the respondent knows the property tax rates his neighbors were assigned to during the property tax campaign. It was recorded in the midline survey in response to the question: ‘Do you know how much the collectors asked your neighbors or friends to pay?’ [no, yes]

19. *Knows about Reductions.* This is a dummy variable that equals 1 if the respondent is aware of anyone receiving a tax reduction during the property tax campaign. It was recorded in the midline survey in response to the question: ‘Have you heard of anyone receiving an official reduction in the amount they were supposed to pay for the property tax in 2018?’ [no, yes]

20. *Knows Past Rate.* This is a dummy variable that equals 1 if the respondent guessed correctly the 2016 tax rate. It was recorded in the midline survey in response to the question: ‘According to you, how much does one pay for the property tax?’ [amount in Congolese Francs]

21. *Exemption Status.* We construct dummy variables that equal 1 if a property owner was declared exempted by the tax collectors. It was recorded at property registration in response to the questions:

    - 'Is this household exempted? [no, yes]
    - 'Why is it exempted? [elderly, government pensioner, handicapped, widow, orphanage, convent, church, school]

22. *Collector Messages.* We construct dummy variables that equal 1 if a message was used by the tax collectors during property tax collection, according to household self-reports. It was recorded in the midline survey in response to the question: 'Now let's talk about the messages used by the property tax collectors in 2018 to convince property owners to pay the property tax. For each of the following messages, please indicate if you heard the tax collectors say this, or if you heard that they said this to other people.'

    - 'If you refuse to pay the property tax, you may be asked to go to the chief for monitoring and control.' [no, yes]
    - 'If you refuse to pay the property tax, you may be asked to go to the provincial tax ministry for monitoring and control.' [no, yes]
    - 'The Provincial Government will only be able to improve public infrastructure in your community if its residents pay property taxes.' [no, yes]
    - 'The Provincial Government will only be able to improve public infrastructure in Kananga if residents pay property tax.' [no, yes]
    - 'Pay the property tax to show that you have confidence in the state and its officials.' [no, yes]
    - 'It is important.' [no, yes]
    - 'Payment is a legal obligation.' [no, yes]
    - 'Many households are paying; you should pay to avoid embarrassment in your community.' [no, yes]
    - 'If you don't pay, there could be violent consequences.' [no, yes]

23. *Past Payment.* This is a dummy variable that equals 1 if the household reports that they paid the property tax during the 2016 property tax campaign. It was recorded in the baseline survey in response to the questions: 'Have you ever paid the property tax?' [no, yes]

24. *Weekly Transport.* This variable reports the respondent's transport expenditures over the past week. It was recorded in the baseline survey in response to the question: 'How much money have you spent on transport in the past seven days?' [amount in Congolese Francs]

25. *Number of Possessions.* This is a variable equal to the number of possessions the respondent reports having. This variable was recorded in the baseline survey in response to the question: 'In your household, which (if any) of the following do you own?

    - A motorbike [no, yes]
    - A car or a truck [no, yes]
    - A radio [no, yes]
    - A television [no, yes]
    - An electric generator [no, yes]
    - A sewing machine [no, yes]
    - None.' [no, yes]

26. *Went to Bed Hungry — Past month.* This is a dummy variable that equals 1 if the respondent reports going to bed hungry at some point in the past 30 days. The variable was recorded in the endline survey in response to the question: 'In the past 30 days, has your household had to go to bed starving because you haven't had enough money on hand?' [no, yes]

27. *Can find 3,000 CF — Next 4 Days.* This is a dummy variable that equals 1 if the respondent reports being able to find 3,000 Congolese Francs in the next four days. This variable was recorded in the endline survey in response to the question: 'Imagine that today you learn that you need to pay an additional 3000 Congolese Francs for a school fee in order for your child to continue in school. Could you find this money in the next 4 days?' [no, yes]

28. *Number of Days without 3,000 CF — Past month.* This is a dummy variable that is equal to the number of days the respondent reported not having 3,000 Congolese Francs in the past month. It was recorded in the endline survey in response to the question: 'In the past 30 days, on which days could you not have paid this fee?' [days]

29. *Perception of Enforcement.* This is a variable reporting the respondent's perception of the likelihood of sanctions for evading the property tax. The exact endline survey question is as follows: 'Now, imagine that next week a tax collector comes and visits one of your neighbors. Imagine he absolutely refuses to pay the property tax. In this case, what is the probability that the government will pursue and enforce sanctions?' [he is very unlikely to be pursued and punished, he is unlikely to be pursued and punished, he is very likely to be pursued and punished, he will definitely be pursued and punished]

30. *Perception of State Capacity.* This is a variable reporting the respondent's perception that the provincial government has the capacity to act on citizens' problems. The exact endline survey question is as follows: 'Imagine that many of the roads in central Kananga have been badly damaged due to bad weather. Do you think the provincial government would fix this problem within three months? ' [no, yes]

31. *Likelihood of Sanction Indicator.* This is a dummy variable that equals 1 if the respondent reports that sanctions for tax delinquency are likely. It was recorded in the midline survey in response to the question: 'In your opinion, do you think a public authority will pursue and enforce sanctions among households that did not pay the property tax in 2018?' [they will definitely not sanction them, they will probably not sanction them, they will probably sanction them, they will definitely sanction them]

32. *Bribe Payment Indicator.* This is a dummy variable that equals 1 if the respondent reports paying a bribe to the tax collectors. It was recorded in the midline and midline survey in response to the question: 'Did you (or a family member) pay the "transport" of the collector?' [no, yes]

33. *Bribe Amount.* This is a variable that indicates the amount of bribe paid to the tax collectors by the respondent. It was recorded in the midline and midline survey in response to the question: 'How much "transport" did you pay?' [amount in Congolese Francs]

34. *Paid Self Indicator.* This is a dummy variable that equals 1 if the respondent reports paying the property tax during the 2018 property tax campaign. It was recorded in the midline survey in response to the question: 'To date, has your household paid the property tax in 2018?' [no, yes]

35. *Other Informal Payments.* This a variable that indicate the amount of informal payments paid to state agents in the past six months. It was recorded in the endline survey in response to the question: 'Now, I'd like to talk about small payments made to government officials such as small amounts paid for transport, water, tea, etc. Please count up all the total such informal payments you made in the last six months. How much do you think you paid in total?' [amount in Congolese Francs]

36. *Participation to Salongo.* This is a dummy variable that equals 1 if the respondent reports participation in informal taxation (Salongo) in the past two weeks. It was recorded in the endline survey in response to the question: 'Did someone from your household participate in Salongo in the past two weeks?' [no, yes]

37. *Hours of Salongo.* This is a variable reporting the number of hours spend participating in informal taxation (Salongo) in the past two weeks. It was recorded in the endline survey in response to the question: 'For how many hours did you participate in Salongo in the past two weeks?' [number of hours]

38. *Paid Vehicle Tax.* This is a dummy variable that equals 1 if the respondent reports that his household paid the vehicle tax in 2018. It was recorded in the endline survey in response to the question: 'Let's discuss the vehicle tax. Did you pay this tax in 2018?' [no, yes]

39. *Paid Market Vendor Fee.* This is a dummy variable that equals 1 if the respondent reports that his household paid the market vendor fee in 2018. It was recorded in the endline survey in response to the question: 'Let's discuss the market vendor fee. Did you pay this tax in 2018?' [no, yes]

40. *Paid Business Tax.* This is a dummy variable that equals 1 if the respondent reports that his household paid the business tax in 2018. It was recorded in the endline survey in response to the question: 'Let's discuss the business tax (patente, registre de commerce). Did you pay this tax in 2018?' [no, yes]

41. *Paid Income Tax.* This is a dummy variable that equals 1 if the respondent reports that his household paid the income tax in 2018. It was recorded in the endline survey in response to the question: 'Let's discuss the income tax. Did you pay this tax in 2018?' [no, yes]

42. *Paid Fake Tax.* This is a dummy variable that equals 1 if the respondent reports that his household paid a fictitious poll tax in 2018. It was recorded in the endline survey in response to the question: 'Let's discuss the poll tax. Did you pay this tax in 2018?' [no, yes]

43. *Provincial Government Peformance.* This is a Likert scale variable increasing in the respondent's perception of the performance of the Provincial Government. The exact endline survey question was: 'How would you rate the performance of the provincial government in Kananga?' [terrible, very poor, poor, fair, very good, excellent]

44. *Provincial Government Corruption.* This is a variable that reports how much, according to the respondent, the Provincial Government diverted from the tax revenues of the 2018 property tax campaign. The exact endline survey question is as follows: 'Now I would like to ask you what you think the provincial government will do with the money it receives from this 2018 property tax campaign. Imagine that the provincial government of Kasaï-Central receives $1000 thanks to this campaign. How much of this money will be diverted or wasted?' [0-1000]

45. *Tax Ministry Performance.* This is a Likert scale variable increasing in the respondent's perception of the performance of the Provincial Tax Ministry. The exact endline survey question was: 'How would you rate the performance of the provincial tax ministry in Kananga?' [terrible, very poor, poor, fair, very good, excellent]

46. *Tax Ministry Corruption.* This is a variable that reports how much, according to the respondent, the tax collectors of the Provincial Tax Ministry diverted from the tax

revenues of the 2018 property tax campaign. The exact endline survey question is as follows: 'In general, think of what the property tax collectors did with the money they collected this year. Imagine the tax collectors collect $1000. How much of this money did they put in their pockets?' [0-1000]

47. *Fairness of Property Taxation.* This is a Likert scale variable that reports the respondent's perceived fairness of property tax collection in Kananga in 2018. The exact endline survey question was: 'In your opinion, how fair is it that households in your neighborhood must pay the property tax?' [very unfair, unfair, fair, very fair]

48. *Fairness of Property Tax Rates.* This is a Likert scale variable that reports the respondent's perceived fairness of property tax rates in Kananga in 2018. The exact endline survey question was: 'In your opinion, how fair were the tax amounts asked during the 2018 property tax?' [very unfair, unfair, fair, very fair]

49. *Fairness of Property Tax Collectors.* This is a Likert scale variable that reports the respondent's perceived fairness of property tax collectors in Kananga in 2018. The exact endline survey question was: 'In your opinion, how fair were the collectors who worked on the property tax campaign of 2018?' [very unfair, unfair, fair, very fair]

B8.2 Tax Collectors Surveys

1. *Female.* This is a dummy variable that equals 1 if the respondent is female. It was recorded in the baseline collector survey in response to the prompt: 'Select the sex of the interviewee.' [female, male]

2. *Age.* This is a variable reporting the respondent's age. It was recorded in the baseline collector survey in response to the question: 'How old were you at your last birthday?'

3. *Main Tribe Indicator.* This is a dummy variable that equals 1 the respondent reports being Luluwa, the main tribe in Kananga. It was recorded in the baseline collector survey in response to the question: 'What is your tribe?' [Bindi, Bunde, Dekese, Dinga, Kefe, Kele, Kete, Kongo, Kuba, Kuchu, Kusu, Lele, Lualua, Luba, Lubakat, Luluwa, Lunda/Rund, Luntu, Lusambo, Mbala, Mfuya, Mongo, Ndumbi, Ngwandji, Nyambi, Nyoka, Pende, Rega, Sakata, Sala, Shi, Songe, Tetela, Tshokwe, Tutsi, Utu, Uvira, Wongo, Yaka, Yeke, Other].

4. *Years of Education.* This variable reports the respondent's years of education. It was calculated using responses to two baseline collector survey questions:

   - 'What is the highest level of school you have reached?' [never been to school, kindergarten, primary, secondary, university]
   - 'What is the last class reached in that level?' [1, 2, 3, 4, 5, 6, >6]

5. *Math Score.* This variable is a standardized index increasing in the respondent's math ability. The exact baseline collector survey questions used to create the standardized index are: 'Now we would like to ask you some math problems. Don't worry if you are not sure of the answer, just do your best to answer them.'

   - 'Can you tell me what 2 plus 3 equals?'
   - 'Can you tell me what 2 plus 3 equals?'
   - 'Can you tell me what 2 plus 3 equals?'
   - 'Can you tell me what 10 percent of 100 is?'

6. *Literacy* . This variable is a standardized index increasing in the respondent's ability to read Tshiluba. The exact baseline collector survey questions used to create the standardized index are: 'Now we would like to ask you if you could read two separate paragraphs about tax collection by the provincial government. The first paragraph is in Tshiluba and the second paragraph is in French. Don't worry if you're not sure of certain words, just do your best to read the paragraphs.'

   - 'How well did they read the Tshiluba paragraph?' [could not read, read with lots of difficult
   - 'How confidently did they read the Tshiluba paragraph?' [not at all confident, not very confident, a bit confident, very confident]
   - 'How well did they read the French paragraph?' [could not read, read with lots of difficult
   - 'How confidently did they read the French paragraph?' [not at all confident, not very confident, a bit confident, very confident]

7. *Monthly Income.* This variable is the self-reported income of the respondent. It was recorded in response to the baseline collector survey question: 'What was the household's total earnings this past month?' [amount in USD]

8. *Number of Possessions.* This variable report the number of possessions owned by the collector's household. The exact baseline collector survey question is as follows: 'In your household, which (if any) of the following do you own?

   - A motorbike [no, yes]
   - A car or a truck [no, yes]
   - A radio [no, yes]
   - A television [no, yes]
   - An electric generator [no, yes]
   - A sewing machine [no, yes]

- None.' [no, yes]

9. *Born in Kananga.* This is a dummy variable that equals 1 if the respondent was born in Kananga. The exact baseline collector survey question is as follows: 'Were you born in Kananga?' [no, yes]

10. *Trust in Provincial Government / National Government / Tax Ministry.* This is a Likert scale variable increasing in the level of trust the respondent reports having in each organization. The exact baseline collector survey question is as follows:

    - 'I am going to name a number of organizations. For each one, could you tell me how much confidence you have in them: no confidence at all, not much confidence, quite a lot of confidence, a great deal of confidence?'
    - Organizations:
      (a) 'The national government (in Kinshasa)'
      (b) 'The provincial government'
      (c) 'The tax ministry'

    The values were reversed to code this variable.

11. *Provincial Government Capacity.* This is a dummy variable equal to 1 if the collector believes that the government has the capacity to respond to an urgent situation. The exact baseline collector survey question is as follows: 'Imagine that many of the roads in central Kananga have been badly damaged due to bad weather. Do you think the local government would fix this problem within three months?' [no, yes]

12. *Provincial Government Responsiveness.* This is a Likert scale variable increasing in the respondent's perception of how responsive the provincial government is. The exact baseline collector survey question is as follows: 'To what degree does the provincial government respond to the needs of your avenue's inhabitants?' [Not very hard working, Hard working, Somewhat hard working, Not hard working]

13. *Provincial Government Performance.* This is a variable increasing in the respondent's perception of the overall performance of the provincial government. The exact baseline collector survey question is as follows: 'How would you rate the performance of the provincial government in Kananga?' [terrible, very poor, poor, fair, very good, excellent]

14. *Provincial Government Corruption.* This is a variable that reports what fraction of the tax revenues from the 2018 property tax campaign the respondent thinks the Provincial Government will put to good use. The exact baseline collector survey question is as follows: 'Now I would like to ask you what you think the provincial government will do with the money it receives from the property tax campaign this year. Imagine that the Provincial Government of Kasaï-Central receives $1000

thanks to this campaign. How much of this money will be put to good use, for example providing public goods?' [0-1000]

15. *Employed Through Connections.* This is a dummy variable equals to 1 if the respondent got his job as a tax collector for the Provincial Tax Ministry through a personal connection. The exact baseline collector survey question is as follows: 'How did you know that a position was available at the Provincial Tax Ministry?' [through a connection at the Provincial Tax Ministry, through a connection in the Provincial Government, I responded to job announcement from the Provincial Tax Ministry, I applied without knowing that the Provincial Tax Ministry was hiring]

16. *Relatives are Provincial Tax Ministry Employees.* This is a dummy variable that equals 1 if the respondent has a family member working at the Provincial Tax Ministry. The exact baseline collector survey question is as follows: 'Do you have a family member who is a Provincial Tax Ministry employee?' [no, yes]

17. *Relatives are Provincial Government Employee.* This is a dummy variable that equals 1 if the respondent has a family member working for the provincial government. The exact baseline collector survey question is as follows: 'Do you have a family member who is a Provincial Government employee?' [no, yes]

18. *Taxes are Important.* This is a Likert scale variable increasing in how important the respondent considers taxes to be. The exact baseline collector survey question is as follows: 'To what degree do you think that paying the property and rent taxes are important for the development of the province?' [not important, important, somewhat important, important, very important]

19. *Provincial Tax Ministry is Important.* This is a Likert scale variable increasing in how important the respondent considers the work of the Provincial Tax Ministry to be. The exact baseline collector survey question is as follows: 'To what degree do you think the work of the Provincial Tax Ministry is important for the development of the province?' [not important, important, somewhat important, important, very important]

20. *Paid Property Tax in the Past.* This is a dummy variable that equals 1 if if the respondent declared having paid the property tax in the past. The exact baseline collector survey question is as follows: 'Have you (or your family) paid your own property tax this year?' [no, yes]

21. *Importance of Progressive Taxes.* This is a dummy variable that equals 1 if the respondent reports that taxes in general should be progressive. The exact baseline collector survey question is as follows: 'Do you think all individuals should be taxed the same amount or should taxes be proportional to someone's income/wealth?' [everyone should pay the same amount, taxes should be proportional to someone's income/wealth]

22. *Importance of Progressive Property Taxes.* This is a dummy variable that equals 1 if the respondent reports that property tax rates should be progressive. The exact baseline collector survey question is as follows: ‘According to you who should pay more property tax?’ [only the poorest, mostly the poorest but also a little bit the rest of society, everyone should contribute the same amount, mostly the wealthiest but also a little bit the rest of society, only the wealthiest]

23. *Important to Tax Employed Individuals.* This is a Likert scale variable reporting respondent’s view of the importance of taxing individuals with salaried jobs in Kananga. The exact baseline collector survey question is ‘How important do you think it is to pay the property tax for property owners who are employed?’ [not important, somewhat important, important, very important]

24. *Important to Tax Property Owners.* This is a Likert scale variable increasing in respondent’s view of the importance of taxing property in Kananga. The exact baseline collector survey question is ‘How important do you think it is to pay the property tax for property owners who have lived in a compound for many years?’ [not important, somewhat important, important, very important]

25. *Important to Tax Property Owners with a Title.* This is a Likert scale variable reporting respondent’s view of the importance of taxing property owners in Kananga. The exact baseline collector survey question is ‘How important do you think it is to pay the property tax for property owners who have a formal land title?’ [not important, somewhat important, important, very important]

26. *Intrinsic Motivation.* This variable is a standardized index increasing in respondents’ intrinsic motivation to work as a tax collector. The exact endline collector survey questions used to create the standardized index are: ‘Now, I want you to reflect on why you worked as a tax collector for the IF campaign of 2018. I am going to give you a series of possible reasons for why you did this work. For each reason, indicate if you strongly disagree, disagree, neutral, agree, strongly agree that this is a reason why you worked on the property tax campaign of 2018.’ Responses:

    - ‘I did this work because I derived much pleasure from learning new things.’
    - ‘I did this work for the satisfaction I experienced from taking on interesting challenges.’
    - ‘I did this work for the satisfaction I experienced when I was successful at doing difficult tasks.’

27. *Extrinsic Motivation.* This variable is a standardized index increasing in respondents’ extrinsic motivation to work as a tax collector. The exact endline collector survey questions used to create the standardized index are: ‘Now, I want you to reflect on why you worked as a tax collector for the IF campaign of 2018. I am going to give you a series of possible reasons for why you did this work. For each reason, indicate

if you strongly disagree, disagree, neutral, agree, strongly agree that this is a reason why you worked on the property tax campaign of 2018. Responses:

- 'I did this work because of the income it provided me.'
- 'I did this work because it allowed me to earn money.'
- 'I did this work because it provided me financial security.'

B9 Ethical Considerations

The design of this study involved careful consideration of the potential risks to participants. In the following sections, we provide details on these risks and how we endeavored to minimize them, as well as the ethics review process we undertook.

IRB Approval. We obtained approval from Harvard University (protocol IRB17-0724) in 2017, before commencing field research. Our submission outlined the experimental design and included all survey instruments, consent forms, and other material needed to judge the potential risks and benefits to research participants. Although the D.R. Congo does not have a national ethics board, we sought out local ethical approval from the oldest and most highly regarded university in Kananga, the University of Notre-Dame du Kasai. We submitted the same set of materials and our Harvard IRB protocol to the academic dean of the university. We received a formal approval letter in 2017.

Compensation. Randomly sampled participants in the surveys we administered received compensation to thank them for their time. They were informed of the compensation during the consent, and then received the compensation at the end of the survey. Participants received approximately USD$2 per hour of survey. Thus, the baseline survey took roughly 1 hour, and individuals received USD$2. The midline survey took 20–30 minutes, and individuals received USD$1. The endline survey took 90–120 minutes, and individuals received USD$4. We have used a similar survey respondent compensation amount in Kananga since 2013. We chose this amount based on how other international organizations had compensated survey respondents in the city in the past.

Risks and benefits. In designing the study, we judged the risks to participants to be minimal, in other words, no greater than those they would encounter in the study's absence. Concerning benefits, the data we collected from human subjects enabled us to write an evaluation that may help the government to reduce the incidence of bribe taking and to increase its revenues. We discuss each of these in turn.

The principal risk facing our participants, a random sample of the city population of Kananga, concerned potentially sensitive and identifiable data falling into the hands of other actors, such as the government.

The primary sensitive topics broached in surveys included questions about tax payment, bribe payment, as well as attitudes about the government and local neighborhood chiefs (who acted as collectors in some neighborhoods). Since the topics of taxation and corruption concern behavior deemed illegal by Congolese Law, these data were potentially sensitive (even if in practice such behaviors are common and punishment of them is very rare). We were particularly concerned about the government or chiefs gaining access to survey data and using these data to pursue sanctions against non-compliant (or bribe-paying) households. This was one important risk faced by survey participants.

After consulting with the Harvard IRB and the University of Notre-Dame du Kasai academic dean, we undertook a number of steps to mitigate these risks as much as possible. We collected all data on password-protected tablets, and we wiped the memory of these tablets on a regular basis. The survey program we use (ODK) also stores responses in XML format and in a folder on the tablet that is difficult to access and interpret unless an individual has prior training. If a government official or the chief gained access to a tablet, they would have had a difficult time accessing the data. We then stored the identifiable data in our research office on password-protected computers. The office is in a walled compound that is guarded 24–7.

In light of these measures, we believe that participation in the study would not represent greater risk than respondents might encounter in their daily lives. Fortunately, there were no instances of lost or stolen tablets during the study, nor instances of theft from the research office.

The benefits of participating in this study — in a research ethics sense distinct from compensation — would primarily accrue at the societal level. Although we did not share identifiable or disaggregated survey data with the government, we did provide a report of our analysis of the impacts of the tax campaign on neighborhood-level tax compliance, revenues, and bribe payment. The survey data was an essential component of this report, and it will help the government to improve its tax collection policies in the future.

Such improvements could lead to benefits to citizens in both direct and indirect ways. In terms of more direct social benefits, our evaluation should help the government in its efforts to reduce corruption and bribes collected by tax collectors by providing information about the level of nature of bribe-taking. To the extent that our evaluation helps the government learn how to collect more tax, this could help the government obtain the resources it needs to provide public goods, enforce contracts, correct externalities–broadly, to fulfill the essential role governments must play if countries are to achieve peace and prosperity. Indeed, revenues are sorely needed by the provincial government, which collected on average USD$0.30 per person in the province in 2015. As we note in the paper, low tax capacity is widely regarded as a key development challenge in low-income countries like the DRC (Besley and Persson, 2013).

Regarding indirect benefits, there is evidence that taxation can help promote a social contract between citizens and the government. Indeed, past evidence from the 2016 tax campaign in Kananga suggested that property tax collection raised citizen engagement with the provincial government (Weigel 2020). We therefore view evaluations of policies used by the provincial government to expand its fiscal capacity as helping to usher in a range of governance benefits related to the tax-based social contract.

Discussion. In light of the potential risks, our measures to mitigate them, and the potential societal benefits from evaluating government tax policies, we firmly believe that this research meets widely accepted ethical standards for social science research. As indicated by the IRB approvals we received from Harvard University and the University of Notre-Dame du Kasai, the risk-benefit ratio was also judged to be favorable by two different independent bodies with expertise in research ethics.

In addition to the specific risks and benefits to survey participants enumerated above, we discuss here several other ways in which we were involved in the taxation campaign and the possibility that by evaluating this tax campaign implemented by the government our mere presence as international researchers could influence its outcomes in more subtle ways. We also noted these points in our IRB submissions.

First, the government had planned to collect property taxes and to test the effectiveness of property-level tax rate abatements in raising revenues regardless of whether we conducted an evaluation of the campaign. However, the assignment of rate abatements to different individual property owners would likely have been conducted in a different way absent the involvement of researchers. As noted in the paper (Section 3.3), we conducted the randomization that was ultimately used for the implementation of the tax campaign of 2018. Relatedly, we helped create assignments for several other components of the tax campaign that involved randomization, including the messages contained on tax letters (cf. Section 7.1), collectors' compensation scheme (cf. Section 5.3.4), and collectors' assignment to neighborhoods (cf. Section 7.2).

Given that there was considerable uncertainty ex ante about the outcomes of the different tax rate abatement treatments examined in the context of the 2018 campaign — as well as the other randomized elements — our position is that randomization was the most equitable approach to assignment, and a likely improvement (from an ethical statement) over plausible counterfactual assignments. We were pleased to assist the government to conduct these assignments using our technical background in power calculations and randomization.

Second, we conducted technical trainings for tax ministry-based staff who worked on the tax campaign regarding the receipt printers used by tax collectors. Although these technologies had been purchased by the government in 2015 from an Indian company (KS Infosystems), outside of a handful of tax collectors working at the city's tolls and airport, few tax ministry staff were familiar with the receipt printers and the management of the database associated with them. We therefore helped adapt these devices for collection of the property tax and conducted a series of trainings on the use of these technologies (and the management of data).[81] None of this involvement relates to experimental variation we study in the research. We view these trainings as important investments in the technical capacity of the provincial government. The goal of the government in using the handheld receipt printers was to create a paper trail for tax collectors in order to enhance monitoring capacity and reduce the payment of bribes. We were happy to help the government with this goal.

Third, it is possible that the very fact of our conducting an evaluation of this cam-

[81] In fact, we suggested the government consider an alternative receipt printing technology, but the tax ministry leadership chose to continue using the KS machines for the 2018 campaign.

paign may have changed the behavior of tax collectors or other government officials, akin to a more macro-level "Hawthorne Effect." We provide evidence against the existence of Hawthorne Effects in our companion paper (Balan et al., 2022) by showing that collectors who at baseline were more informed about the evaluation activities of the research team did not collect fewer bribes. However, we of course cannot rule out this possibility completely because we do not observe the counterfactual campaign (in which we did not conduct an evaluation). Moreover, even if Hawthorne Effects existed, we suspect any such influences would likely be benign from a research ethics point of view.[82] For instance, if tax collectors learned of the surveys our enumerators were conducting in the city to evaluate the campaign, it would have most likely led them to behave in a more professional manner and to collect fewer illicit payments. We do not think there are plausible scenarios in which awareness of the evaluation could have created incentives for collectors to act in ways that would reduce the welfare of average citizens in Kananga. This is all of course quite speculative, and we do not wish to overestimate our ability to predict the direction of such big-picture "Hawthorne Effects." However, we wanted to note that these were factors we took into consideration when deciding whether and how to conduct this research.

References

Amodio, Francesco, Giacomo De Giorgi, and Aminur Rahman, "Bribes vs. Taxes: Market Structure and Incentives," *CEPR Discussion Paper No. DP13055*, 2018.

Ashraf, Nava, Oriana Bandiera, Edward Davenport, and Scott S. Lee, "Losing Prosociality in the Quest for Talent? Sorting, Selection and Productivity in the Delivery of Public Service," *American Economic Review*, 2020, *110* (5).

Balan, Pablo, Augustin Bergeron, Gabriel Tourek, and Jonathan Weigel, "Local Elites as State Capacity: How City Chiefs Use Local Information to Increase Tax Compliance in the D.R. Congo," *Working Paper*, 2020.

Bergeron, Augustin, Arnaud Fournier, Gabriel Tourek, and Jonathan Weigel, "Using Machine Learning to Increase Property Tax Collection in the D.R. Congo," *Working Paper*, 2020.

Besley, Timothy and Torsten Persson, "Taxation and Development," *Handbook of Public Economics*, 2013, *5*, 51–110.

Best, Michael, Francois Gerard, Evan Kresch, Joana Naritomi, and Laura Zoratto, "Greener on the Other Side? Spatial Discontinuities in Property Tax Rates and their Effects on Tax Morale," *Working Paper*, 2020.

__ , Jonas Hjort, and David Szakonyi, "Individuals and Organizations as Sources of State Effectiveness," *Working Paper*, 2019.

[82]From an internal validity perspective, since abatements were randomized at the individual level, we think it unlikely that any such effects were constant across the rate treatments.

Bierens, Herman J., "Kernel Estimators of Regression Functions," *Advances in Econometrics: Fifth World Congress*, 1987, *1*, 99–144.

Breiman, Leo, "Random Forests," *Machine Learning*, 2001, *45* (1), 5–32.

_, Jerome Friedman, Charles J. Stone, and Richard A. Olshen, *Classification and Regression Trees*, CRC Press, 1984.

Callen, Michael, Saad Gulzar, Ali Hasanain, Yasir Khan, and Arman Rezaee, "Personalities and Public Sector Performance: Evidence from a Health Experiment in Pakistan," *National Bureau of Economic Research Working Paper 21180*, 2018.

Chandra, Amitabh, Amy Finkelstein, Adam Sacarny, and Chad Syverson, "Health Care Exceptionalism? Performance and Allocation in the US Health Care Sector," *American Economic Review*, 2006, *106* (8), 2110–2144.

Chetty, Raj and Nathan Hendren, "The Impacts of Neighborhoods on Intergenerational Mobility II: County-Level Estimates," *The Quarterly Journal of Economics*, 2018, *133* (3), 1163—-1228.

Dietterich, Thomas G., "Ensemble methods in machine learning," *International workshopon multiple classifier systems*, 2000, pp. 1–15.

Gelman, Andrew, John B Carlin, Hal S. Stern, David B. Dunson, Aki Vehtari, and Donald B. Rubin, *Bayesian Data Analysis*, Taylor and Francis Group, 2013.

Gordon, Robert, Thomas J. Kane, and Douglas O. Staiger, "Identifying Effective Teacher Using Performance on the Job," *Working Paper*, 2006.

Hastie, Trevor, Robert Tibshirani, and Jerome H. Friedman, *Element of statistical learning*, Massachusetts Institute of Technology, 2001.

Hendren, Nathaniel, "The Policy Elasticity," *Tax Policy and the Economy*, 2016, *30.*

_ and ben Sprung-Keyser, "A Unified Welfare Analysis of Government Policies," *Quarterly Journal of Economics*, 2020.

Hoerl, Arthur E and Robert W. Kennard, "Ridge Regression: Biased Estimation for Nonorthogonal Problems," *Technometrics*, 1970, *12* (1), 55–67.

Jibao, Samuel S, Wilson Prichard, and Vanessa Van den Boogaard, "Informal Taxation in Post-Conflict Sierra Leone: Taxpayers' Experiences and Perceptions," 2017.

Khaldun, Ibn, *The Muqaddimah*, Translated by Franz Rosenthal. Introduction by N.J. Dawood. St. Edmunds Press Ltd. Great Britain., 1978.

Khan, Adnan Q, Asim I Khwaja, and Benjamin A Olken, "Tax Farming Redux: Experimental Evidence on Performance Pay for Tax Collectors," *The Quarterly Journal of Economics*, 2015, *131* (1), 219–271.

Luttmer, Erzo and Monica Singhal, "Tax Morale," *The Journal of Economic Perspectives*, 2014, *28* (4), 149–168.

Morris, Carl N., "Parametric Empirical bayes Inference: Theory and Applications," *Journal of the American Statistical Association*, 1983, *78* (381), 47–55.

Reid, Otis and Jonathan Weigel, "Citizen Participation in Corruption: Evidence from Roadway Tolls in the Democratic Republic of the Congo," *Working Paper*, 2019.

Schapire, Robert E. and Yoav Freund, *Boosting: Foundations and Algorithms*, Springer, 2012.

Tibshirani, Robert, "Regression Shrinkage and Selection via the Lasso," *Journal of the Royal Statistical Society. Series B*, 1996, pp. 267–288.

Waseem, Mazhar, "Taxes, Informality and Income Shifting: Evidence from a recent Pakistani Tax Reform," *Journal of Public Economics*, 2018, *157*, 41–77.

Weigel, Jonathan, "The Participation Dividend of Taxation: How Citizens in Congo Engage More with the State when it Tries to Tax Them," *Quarterly Journal of Economics*, 2020.

Xu, Guo, "The Costs of Patronage: Evidence from the British Empire," *American Economic Review*, 2018, *108* (11), 3170–3198.

Zou, Hui and Trevor Hastie, "Regulatization and Variable Selection via the Elastic Net," *Journal of the Royal Statistical Society. Series B (Statistical Methodology)*, 2005, *67* (2), 301–320.