Are Tax Rates too High in Developing Countries? Evidence from Randomized Property Tax Rates

Augustin Bergeron (Harvard) with Gabriel Tourek (Harvard) and Jonathan Weigel (LSE)

112th Annual Conference on Taxation, November 23rd 2019
Raising Tax Revenues in Developing Countries

- Tax capacity is key for public good provision and development (Kaldor 1967; Besley and Persson 2009, 2014)
  - LICs collect 10% GDP in tax vs. 30-40% in HICs
  - Local governments in LICs have relatively lower tax take

- Tax policy tools:
  1. Tax rates
  2. Tax enforcement
    - Audits and monitoring - Kleven et al. 2011; Pomeranz et al. 2019
    - Third-party info - Kleven et al. 2011; Pomeranz 2015; Naritomi 2016
    - Effects of change in rate endogenous to enforcement - Kopczuk and Slemord 2002; Kleven 2014; Keen and Slemrod 2017; Jensen 2019

- This paper studies how to set tax rates and how they interact with enforcement in low-capacity settings
Questions and Empirical Strategy

1. Are tax rates above or below the Laffer rate in settings with low state capacity and tax compliance?

2. Can governments in LICs shift the Laffer rate?

3. Can governments in LICs exploit heterogeneity in the Laffer rate?

**Empirical strategy:** Randomized property tax rates

- Property tax key source of revenue for local governments (Slack, 2013)
- Partnership with provincial government of Kasai-Central, DRC
- Property tax rates were randomized on property level during 2018 tax campaign in the city of Kananga
1. Tax rate on wrong side of Laffer curve:
   - Elasticity of tax revenue wrt tax rates: \( e_{\text{revenue}} = -0.26 \)
   - Elasticity of tax compliance wrt tax rates: \( e_{\text{compliance}} = -1.19 \)

2. Beyond higher revenue, lowering rates also:
   - Lowers bribes collected
   - Improves view of government

3. Governments can shift the Laffer rate:
   - Analyze tax collector heterogeneity
   - Collectors with high enforcement capacity have \( e_{\text{revenue}} > 0 \)
     \( \Rightarrow \) Increasing enforcement capacity permits higher tax rates
   - Collectors’ characteristics: policy tool to shift the Laffer rate

4. Governments can use heterogeneity in Laffer rates:
   - Analyze heterogeneous treatment effects
   - A progressive tax schedule would maximize revenue
Related Literature

- Elasticity of taxable income
  - Elasticity of taxable income - Feldstein (1995); Gruber and Saez (2002); Saez (2004); Saez, Slemrod and Giertz (2012); Kleven and Waseem (2013); Waseem (2018)
  - Elasticity of taxable income and enforcement - Kopczuk and Slemord (2002); Keen and Slemrod (2017)
  - Elasticity of tax compliance - Fisman and Wei (2004)

- Increasing tax compliance
  - Tax Reporting Margin - Slemrod et al. (2001); Kleven et al. (2011); Carrillo et al. (2014); Pomeranz (2015); Naritomi (2016)
  - Tax Compliance Margin - Fisman and Wei (2004); Kleven et al. (2011); Brockmeyer et al. (2019)

- Property taxation in developing countries
  - Del Carpio (2017); Khan, Khwaja and Olken (2015); Okunogbe (2019); Brockmeyer et al. (2019)
1 Context

2 Experimental Design and Data Collection

3 Effects on Tax Compliance and Revenue
   - Reduced Form Results
   - Marginal Value of Public Funds
   - Resulting Elasticities
   - Robustness Checks

4 Secondary Outcomes
   - Bribe Payments
   - Compliance with Other Taxes
   - View of the Government

5 Tax Collectors: Can Governments Shift the Laffer Rate?

6 HTE: Can Governments use Heterogeneity in Laffer Rate?
Kananga, D.R. Congo

- Sixth most populated city in the DRC
  - Population $\approx 500,000$
- Capital of Kasai-Central Province
- Average income: $\approx $1.5 per person per day
Provincial revenues are extremely low: $\approx 0.3$ per person

- Majority comes from national transfers and resource rents
- One of many local governments trying to raise revenue through property tax:
  - Tax revenue stays local
  - Efficient form of taxation
Property Tax Collection in Kananga

- Door-to-door property **tax collection** is new:
  - First door-to-door collection the year before in 2/3 of the city but...
  - $\leq 10\%$ of owners paid the property tax despite tax collectors’ visits
  - Only 2.6\% of owners know of the official tax liability at baseline

- Low level of property **tax enforcement**:
  - In theory: fine for tax evasion = $2.5 \times$ liability to pay within 30 days and if unpaid the case goes to court
  - In practice: sanctions very rarely implemented
Outline

1. Context

2. Experimental Design and Data Collection

3. Effects on Tax Compliance and Revenue
   - Reduced Form Results
   - Marginal Value of Public Funds
   - Resulting Elasticities
   - Robustness Checks

4. Secondary Outcomes
   - Bribe Payments
   - Compliance with Other Taxes
   - View of the Government

5. Tax Collectors: Can Governments Shift the Laffer Rate?

6. HTE: Can Governments use Heterogeneity in Laffer Rate?
Design of the Property Tax Campaign

Door-to-door tax collection is done in **two stages** in each neighborhood:

1. **Registration**: First day of the month. Property owners receive a *tax letter* with information about the property tax and their tax liability.
   - Randomized assignment of tax rate embedded in tax letter

2. **Tax collection**: Rest of the month. Taxpayers receive a *printed receipt*.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Period</th>
<th>Collectors</th>
<th>Enumerators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registration</td>
<td>First days of the month</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Tax collection</td>
<td>Rest of the month</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>
Randomized Property Tax Rates

- **Tax liability:** fixed annual fee (common in developing countries in the absence of a property valuation roll)

- **Control:**
  - Status quo liability decided ex ante by building materials
    - Low value properties (95% of properties): 3,000 FC (≈$2)
    - High value properties (5% of properties): 13,200 FC (≈$9)
  - Rate: ≈ 0.22% of property value (USA 0.27% – 2.35%)

- **Treatments:**
  - 17% reduction in tax liability
  - 33% reduction in tax liability
  - 50% reduction in tax liability

- Treatment is randomized at the property level and stratified at the neighborhood (polygon) level.
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).

Il est important de payer l'impôt foncier.

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

Si vous avez des questions ou des plaintes, veuillez contacter 0974982998 ou 0811439515. Ce sont les coordonnées téléphoniques d’Harvard-RDC, une organisation indépendante de chercheurs scientifiques réalisant une évaluation de la campagne de l’impôt foncier. Ils garderont votre identité confidentielle.

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.

Si vous avez des questions ou des plaintes, veuillez contacter 0974982998 ou 0811439515. Ce sont les coordonnées téléphoniques d’Harvard-RDC, une organisation indépendante de chercheurs scientifiques réalisant une évaluation de la campagne de l’impôt foncier. Ils garderont votre identité confidentielle.
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).

Il est important de payer l'impôt foncier.

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

Si vous avez des questions ou des plaintes, veuillez contacter 0974982998 ou 0811439515. Ce sont les coordonnées téléphoniques d'Harvard-RDC, une organisation indépendante de chercheurs scientifiques réalisant une évaluation de la campagne de l'impôt foncier. Ils garderont votre identité confidentielle.

---

Status quo Tax Liability

50% Reduction in Tax Liability

A. Bergeron

Are Tax Rates too High in Developing Countries? Evidence from Randomized Property Tax Rates

11 / 43
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).

Il est important de payer l'impôt foncier.

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

Si vous avez des questions ou des plaintes, veuillez contacter 0974982998 ou 0811439515. Ce sont les coordonnées téléphoniques d'Harvard - RDC, une organisation indépendante de chercheurs scientifiques réalisant une évaluation de la campagne de l'impôt foncier. Ils garderont votre identité confidentielle.

---

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.

Si vous avez des questions ou des plaintes, veuillez contacter 0974982998 ou 0811439515. Ce sont les coordonnées téléphoniques d'Harvard - RDC, une organisation indépendante de chercheurs scientifiques réalisant une évaluation de la campagne de l'impôt foncier. Ils garderont votre identité confidentielle.
Low Value vs High Value Properties

Low Value Property
- Status quo tax liability: 3,000 CF
- 17% reduction: 2,500 CF
- 33% reduction: 2,000 CF
- 50% reduction: 1,500 CF

High Value Property
- Status quo tax liability: 13,200 CF
- 17% reduction: 11,000 CF
- 33% reduction: 8,800 CF
- 50% reduction: 6,600 CF

A. Bergeron
Are Tax Rates too High in Developing Countries?
Low Value Property
Status quo tax liability: 3,000 CF
17% reduction: 2,500 CF
33% reduction: 2,000 CF
50% reduction: 1,500 CF

High Value Property
Status quo tax liability: 13,200 CF
17% reduction: 11,000 CF
33% reduction: 8,800 CF
50% reduction: 6,600 CF
Data Collection

- **Universe of Property Owners:** \( N = 48,000 \)
  - Census Survey: Implemented during property registration
  - Midline Survey: Takes place 2 weeks after tax collection ends in nbhd
  - Administrative Data: Property tax data from the receipt printers

- **Subsample of Property Owners:** \( N = 4,332 \)
  - Baseline and Endline Survey: Administered to a random sample of property owners (12 per neighborhood)

- **Tax Collectors:** \( N = 50 \)
  - Baseline and Endline Survey: Administered to all tax collectors
Outline

1 Context

2 Experimental Design and Data Collection

3 Effects on Tax Compliance and Revenue
   - Reduced Form Results
   - Marginal Value of Public Funds
   - Resulting Elasticities
   - Robustness Checks

4 Secondary Outcomes
   - Bribe Payments
   - Compliance with Other Taxes
   - View of the Government

5 Tax Collectors: Can Governments Shift the Laffer Rate?

6 HTE: Can Governments use Heterogeneity in Laffer Rate?
We estimate the following regression:

\[ y_{ip} = \beta_0 + \beta_1 \text{Reduction}17\%_{ip} + \beta_2 \text{Reduction}33\%_{ip} + \beta_3 \text{Reduction}50\%_{ip} + \gamma_{ip} + \delta_p + \epsilon_{ip} \]

- \( y_{ip} \) = outcome for individual \( i \) in polygon \( p \).
- \( \text{Reduction}17\%_{ip} \) = indicator for being assigned to 17% reduction in annual tax liability. Likewise for \( \text{Reduction}33\%_{ip} \) and \( \text{Reduction}50\%_{ip} \).
- \( \gamma_{ip} \) = type of house (low or high value) indicator.
- \( \delta_p \) = polygon (\( \sim130 \) properties) fixed effects.
- \( \epsilon_{ip} \) = error term.

Balance Tests and Omnibus Tests show balance on characteristics of the property and of the property owner.
Should tax rates be reduced in low-income countries?

**Marginal Value of Public Funds (MVPF)** of reducing $\tau$ (Hendren 2016; Hendren and Sprung-Keyser 2019):

$$\text{MVPF} = \frac{WTP}{dR/d(-\tau)} = \frac{WTP}{\text{Net Cost}}$$

- $WTP_{17\%} = 0.17 \times 249$, $WTP_{33\%} = 0.33 \times 249$, $WTP_{50\%} = 0.5 \times 249$
- Net Cost < 0 $\Rightarrow$ MVPF = $\infty$

- Reducing property tax rates produces a ”Laffer effect”, raising total revenue (Werning 2007; Hendren and Sprung-Keyser 2019)
The Elasticity of Tax Compliance and Tax Revenue

To estimate the elasticity of tax compliance and revenue, we use the following 2SLS regressions framework:

\[ y_{ip} = \alpha + \beta \log(\tau_{i,p}) + \gamma_{ip} + \delta_{p} + \nu_{ip} \]  \hspace{1cm} (1)

\[ \log(\tau_{i,p}) = \beta_{0} + \beta_{1} \text{Reduction17\%}_{ip} + \beta_{2} \text{Reduction33\%}_{ip} + \beta_{3} \text{Reduction50\%}_{ip} + \gamma_{ip} + \delta_{p} + \epsilon_{ip} \]  \hspace{1cm} (2)

\( y_{ip} \) is the outcome (tax compliance or tax revenue) and the mean tax rate is \( \tau_{i,p} = \frac{\text{Tax Liability}_{ip}}{\text{Prop. Value}_{ip}} \) for property \( i \) in neighborhood \( p \).

- Eq (2) is the first stage of the IV model, and Eq (1) the second stage.
- From marginal effect \( \beta \) to elasticity \( e \):

\[ e_{ip} = \frac{\partial y_{ip}}{\partial \tau_{i,p}} \times \frac{\tau_{i,p}}{y_{ip}} \Rightarrow e = \frac{\beta}{\text{mean}(y_{ip})} \]

A. Bergeron
Are Tax Rates too High in Developing Countries? Evidence from Randomized Property Tax Rates
To compute \( \tau_{i,p} = \frac{\text{TaxLiability}_{ip}}{\text{Prop.Value}_{ip}} \) we need to estimate the value of every property in Kananga:

- We use **Supervised Machine Learning** to predict the conditional mean of property value given a set of features.

\[
\mathbb{E}[Y_i | X_i = x]
\]

- As a **training sample** we use the value of 1,500 properties from our baseline sample estimated by a team of 6 professional land surveyors in July-Nov 2019.
Low Value Property
Property value: $1,000

High Value Property
Property value: $8,134
Most performant algorithm is a Gradient Boosting Decision Tree Model (LightGBM).

Avoid overfitting: only include 15 most important property and neighborhood features.

Mean Absolute Percentage Error (MAPE) using 10-fold cross validation is 42%.

Work in progress: Data collection ongoing (70% done).
Predicting Property Values using Machine Learning

A. Bergeron

Are Tax Rates too High in Developing Countries? Evidence from Randomized Property Tax Rates
The Elasticity of Tax Compliance and Tax Revenue

<table>
<thead>
<tr>
<th></th>
<th>Compliance 2SLS (1)</th>
<th>Revenue 2SLS (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>In(Tax Rate in %)</td>
<td>-0.105*** (0.008)</td>
<td>-61.816** (28.769)</td>
</tr>
<tr>
<td>Observations</td>
<td>38,379</td>
<td>38,379</td>
</tr>
<tr>
<td>Sample</td>
<td>All</td>
<td>All</td>
</tr>
<tr>
<td>House</td>
<td>Pooled</td>
<td>Pooled</td>
</tr>
<tr>
<td>Strata</td>
<td>363</td>
<td>363</td>
</tr>
<tr>
<td>Mean</td>
<td>.09</td>
<td>234.11</td>
</tr>
<tr>
<td>Elasticity</td>
<td>-1.19</td>
<td>-.26</td>
</tr>
</tbody>
</table>

- **Tax rates > Laffer rate**: The government can increase revenues by lowering tax rates
  - Elasticity of tax compliance wrt tax rates: $-1.19$
  - Elasticity of tax revenue wrt tax rates: $-0.26$

- Similar elasticities wrt total tax liability
Robustness Checks: Information Spillovers

- Property owners might know that their tax rate differs from their neighbor’s tax rate and from past tax rates
  - Could affect tax compliance through taxpayers’ preferences for a fair tax system (Besley and Persson, 2009; Jensen and Persson, 2015)
  - Could affect tax compliance through taxpayers’ transaction utility (Thaler, 1983)

- The elasticity of tax compliance and revenue are not affected by
  1. Controlling for neighbors’ tax rate $\tau_{-i,p}$, 2. Whether the owner knows her neighbors’ tax rate $\tau_{-i,p}$ or not, 3. Whether the owner knows the official tax liability at baseline
Outline

1. Context

2. Experimental Design and Data Collection

3. Effects on Tax Compliance and Revenue
   - Reduced Form Results
   - Marginal Value of Public Funds
   - Resulting Elasticities
   - Robustness Checks

4. Secondary Outcomes
   - Bribe Payments
   - Compliance with Other Taxes
   - View of the Government

5. Tax Collectors: Can Governments Shift the Laffer Rate?

6. HTE: Can Governments use Heterogeneity in Laffer Rate?
Bribe payments are a first-order issue when taxation is door-to-door due to principal-agent problem (Khan, khwaja and Olken 2016)

**Extensive Margin** - "Did you pay the *transport* of the collectors?"

![Chart showing bribe payments at different tax rate reductions]
Bribe payments are a first-order issue when taxation is door-to-door due to principal-agent problem (Khan, khwaja and Olken 2016)

**Intensive Margin** - "How much did you pay for their transport?"

![Graph showing bribe payments at different tax rates]
Beyond higher revenues, lowering tax rates also lowers bribes:

- Elasticity of bribe payment wrt tax rates: 0.98
- Elasticity of bribe amounts wrt tax rates: 1.94

Suggests higher tax rates increase collector’s bargaining power.
## Elasticity of Bribe Payments

<table>
<thead>
<tr>
<th></th>
<th>Bribe Payment</th>
<th>Bribe Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2SLS</td>
<td>2SLS</td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>In(Tax Rate in %)</td>
<td>0.021***</td>
<td>27.290***</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(4.261)</td>
</tr>
<tr>
<td>Observations</td>
<td>26757</td>
<td>26757</td>
</tr>
<tr>
<td>Sample</td>
<td>Endline</td>
<td>Endline</td>
</tr>
<tr>
<td>House</td>
<td>Pooled</td>
<td>Pooled</td>
</tr>
<tr>
<td>Strata</td>
<td>363</td>
<td>363</td>
</tr>
<tr>
<td>Mean</td>
<td>.02</td>
<td>21.18</td>
</tr>
<tr>
<td>Elasticity</td>
<td>.98</td>
<td>1.94</td>
</tr>
</tbody>
</table>

- Beyond higher revenues, lowering tax rates also lowers bribes:
  - Elasticity of bribe payment wrt tax rates: 0.98
  - Elasticity of bribe amounts wrt tax rates: 1.94

- Another motive for lowering tax rates in low capacity settings: Set bargaining power of tax collector low and minimize bribes
Compliance with Other Taxes

- Changes in property tax rates do not crowd out or crowd in informal taxes (weekly labor contributions).
  - Informal taxes have a high burden in developing countries (Olken and Singhal, 2011; Walker, 2018).
  - Especially high burden in the DRC (Paler et al., 2017).

- Changes in property tax rates do not crowd out or crowd in other formal taxes.
  - Market tax
  - Firm tax
  - Vehicle tax
  - Income tax
Perceptions of the Government

- Changes in property tax rates do not affect **attitudes** toward the provincial government.
  - Trust in provincial government
  - Perceived performance
  - Perceived corruption

- But evidence that lowering tax rates increases perceptions that the provincial government should **provide public goods**.
  - ”Who should provide?” → With lower tax rates shift from other providers to provincial government
  - Public goods: schools, water, health, safety, helping the poor, development, roads
Outline

1 Context

2 Experimental Design and Data Collection

3 Effects on Tax Compliance and Revenue
   - Reduced Form Results
   - Marginal Value of Public Funds
   - Resulting Elasticities
   - Robustness Checks

4 Secondary Outcomes
   - Bribe Payments
   - Compliance with Other Taxes
   - View of the Government

5 Tax Collectors: Can Governments Shift the Laffer Rate?

6 HTE: Can Governments use Heterogeneity in Laffer Rate?
Can Governments Shift the Laffer Rate?

- Low tax capacity but tax rates already **above the Laffer rate**
- Limits ability to raise tax revenue and contributes to
  - Low public good provision (Besley and Persson, 2014)
  - Low government accountability (Besley and Persson, 2009)
- Can the government **shift the Laffer rate**?
- To answer this question we analyze **tax collector heterogeneity**
Estimate tax collectors’ **enforcement capacity** and **elasticity**

**Random Assignments** of tax collectors:
- Random assignment of collectors to another collector
- Random assignment of collector pairs to neighborhoods (polygon)

**Sample**: 50 tax collectors from provincial tax ministry randomly assigned to work in pairs in 250 neighborhoods
Outcome $y_i$ is **tax revenue** collected from owner $i$

- Tax collectors’ **enforcement capacity** $\mu = (\mu_1, \ldots, \mu_{50})$:

$$y_i = \mu_{c_1} 1[c(i) = c_1] + \mu_{c_2} 1[c(i) = c_2] + \epsilon_{ip}$$

- Tax collectors’ **elasticity** $\nu = (\nu_1, \ldots, \nu_{50})$:

$$y_i = \nu_{c_1} \log(\tau_i, p) 1[c(i) = c_1] + \nu_{c_2} \log(\tau_i, p) 1[c(i) = c_2]$$

$$+ \alpha_1 1[c(i) = c_1] + \alpha_2 1[c(i) = c_2] + \epsilon_{ip}$$

**Problem:** Estimates of $\mu_c$ and $\nu_c$ are unbiased but have high variance because of the small sample size ($N \approx 1000$) for each collector.
Tax Collector Analysis
Shrunk Estimates

- **Empirical Bayes** shrinkage estimator (Morris, 1983)

\[ \mu_c^{EB} = \rho_{1,c} \hat{\mu}_c + \rho_{2,c} \bar{\mu}_c \]

with \( \hat{\mu}_c \) estimated value of \( \mu_c \) and \( \bar{\mu}_c \) mean of \( \hat{\mu}_c \)

\[ \rho_{1,c} = \frac{\sigma^2}{\pi_c^2 + \sigma^2} \quad \rho_{2,c} = \frac{\pi_c^2}{\pi_c^2 + \sigma^2} \]

with \( \pi_c^2 \) variance of measurement error and \( \sigma^2 \) signal variance

- Optimal forecast shrinks noisy estimates of \( \hat{\mu}_c \) towards the mean \( \bar{\mu}_c \)

- Average signal variance to total variance ratio \( \rho_{1,c} \):
  - 0.70 for tax collectors’ enforcement capacity \( \mu_c \)
  - 0.84 for tax collectors’ elasticity \( \nu_c \)
Elasticity of Tax Revenue Increases with Enforcement

Collectors who are more effective at getting people to pay can overcome citizens' low WTP at higher rates ⇒ Increasing enforcement capacity permits higher tax rates

A. Bergeron

Are Tax Rates too High in Developing Countries? Evidence from Randomized Property Tax Rates
Elasticity of Tax Revenue Increases with Enforcement

Collector Level Elasticity (shrunken) vs. Collector Level Enforcement in CF (shrunken)

- coeff: 0.009
- se: 0.003
Elasticity of Tax Revenue Increases with Enforcement

Collectors who are more effective at getting people to pay can also overcome citizens’ low WTP at higher rates.
Collectors who are more effective at getting people to pay can also overcome citizens’ low WTP at higher rates

⇒ Increasing enforcement capacity permits higher tax rates
Can Collectors' Characteristics Shift the Laffer Rate?

- Imp. of Progressive Taxes (-)
- Imp. to Tax Wealthy (-)
- Imp. to Tax Employed (-)
- Poor Unlucky (-)
- Poor Priority Gov. (+)
- Poor Priority NGO (-)
- Taxes Important (+)
- Tax Min. Important (+)
- Prov. Gov. use of Funds (+)
- Prov. Gov. Performance (+)
- Prov. Gov. Responsiveness (-)
- Prov. Gov. Capacity (-)
- Trust Tax Min. (+)
- Trust Prov. Gov. (+)
- Trust Nat. Gov. (+)
- Relative Tax Min. Employee (+)
- Relative Prov. Gov. Employee (+)
- Number of Possessions (-)
- Log Monthly Income (+)
- Education (+)

Regression Coefficient

A. Bergeron

Are Tax Rates too High in Developing Countries?
Tax Collector’s Characteristics Matter

- Tax collectors’ characteristics can help **shift the Laffer rate**

**Static perspective:**

- **At rate > Laffer rate** (e.g. *low levels of enforcement capacity*) the government should lower tax rates and hire tax collectors who:
  - Have stronger preferences for progressive taxes (e.g. through training)

- **If rate < Laffer rate** (e.g. *high levels of enforcement capacity*) the government should increase tax rates and hire tax collectors who:
  - Have stronger tax morale (e.g. through selection or training)
  - Have more positive views of the government (e.g. through selection)
  - Are more connected to the government (e.g. through selection)
• Tax collectors’ characteristics can also **shift the Laffer rate**:

• **Dynamic perspective:**

  • Governments can hire collector with certain characteristics to increase the **Laffer rate** and permit higher rates (i.e. get to rate $< \text{Laffer rate}$)
    - Have stronger tax morale (e.g. through selection or training)
    - Have more positive views of the government (e.g. through selection)
    - Are more connected to the government (e.g. through selection)
Outline

1. Context
2. Experimental Design and Data Collection
3. Effects on Tax Compliance and Revenue
   - Reduced Form Results
   - Marginal Value of Public Funds
   - Resulting Elasticities
   - Robustness Checks
4. Secondary Outcomes
   - Bribe Payments
   - Compliance with Other Taxes
   - View of the Government
5. Tax Collectors: Can Governments Shift the Laffer Rate?
6. HTE: Can Governments use Heterogeneity in Laffer Rate?
Can Governments Use Heterogeneity in Laffer Rate?

- Low tax capacity but tax rates already **above the Laffer rate**
- Limits ability to raise tax revenue and contributes to
  - Low public good provision (Besley and Persson, 2014)
  - Low government accountability (Besley and Persson, 2009)
- Can the government exploit **heterogeneity in the Laffer rate**?
- To answer this question we analyze **heterogeneous treatment effect**
Heterogeneous Treatment Effects

- We use **Machine Learning** to guide predictions instead of pre-registering every hypothesis.

- Interested in the **Conditional Average Treatment Effect**:

\[ s_0(Z) = \mathbb{E}[Y|D = 1, Z] - \mathbb{E}[Y|D = 0, Z] \]

where \( Y \) is tax revenue and \( D = 1 \) if owner assigned to 50\% reduction in tax liability, \( D = 0 \) if owner assigned to status quo tax liability.

- Use Chernozhukov et al. (2007) which relies on **data splitting** into a main sample and an auxiliary sample to avoid overfitting and achieve validity.
GATES and CLAN

- **Group Average Treatment Effects (GATEs):** $\gamma_k = \mathbb{E}[S_0(Z)|G_k]$
  where $G_k = S \in I_k$ explain as much variation in $s_0(Z)$ as possible
  - Substantial heterogeneity in the effect of assignment to lower tax rates on tax revenue
  - For the 20% most affected reducing tax rates increases revenues for the 20% least affected it decreases revenue

- **Classification Analysis (CLAN):** $\delta_k = \mathbb{E}[g(Y_i, Z_i)|S_i \in I_k]$
  - Revenue maximization enough to justify a progressive tax schedule
    - **Lower tax rates** for low value properties and cash constrained individuals
    - **Keep status quo tax rates** for high value properties and unconstrained individuals
## Classification Analysis (CLAN)

<table>
<thead>
<tr>
<th></th>
<th>LASSO 20 % Most Affected</th>
<th>LASSO 20 % Least Affected</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walls Quality</td>
<td>2.042 (1.982,2.101)</td>
<td>2.450 (2.391,2.508)</td>
<td>-0.413 (-0.499,-0.328) [0.000]</td>
</tr>
<tr>
<td>Roof Quality</td>
<td>6.918 (6.885,6.951)</td>
<td>6.955 (6.922,6.985)</td>
<td>-0.029 (-0.079,0.016) [0.421]</td>
</tr>
<tr>
<td>Erosion Threat</td>
<td>0.530 (0.491,0.569)</td>
<td>0.416 (0.378,0.454)</td>
<td>0.144 (0.091,0.197) [0.000]</td>
</tr>
<tr>
<td>Employed</td>
<td>0.786 (0.764,0.809)</td>
<td>0.816 (0.794,0.839)</td>
<td>-0.038 (-0.070,-0.007) [0.035]</td>
</tr>
<tr>
<td>Salaried</td>
<td>0.256 (0.231,0.281)</td>
<td>0.345 (0.320,0.370)</td>
<td>-0.089 (-0.124,-0.053) [0.000]</td>
</tr>
<tr>
<td>Work for Gov. Self</td>
<td>0.119 (0.098,0.140)</td>
<td>0.251 (0.231,0.271)</td>
<td>-0.132 (-0.161,-0.103) [0.000]</td>
</tr>
<tr>
<td>Work for Gov. Self or Relatives</td>
<td>0.229 (0.204,0.254)</td>
<td>0.334 (0.309,0.359)</td>
<td>-0.104 (-0.139,-0.068) [0.000]</td>
</tr>
<tr>
<td>Ethnic Majority</td>
<td>0.724 (0.701,0.746)</td>
<td>0.829 (0.806,0.852)</td>
<td>-0.111 (-0.142,-0.079) [0.000]</td>
</tr>
</tbody>
</table>
### Classification Analysis (CLAN)

<table>
<thead>
<tr>
<th></th>
<th>LASSO</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20 % Most Affected</td>
<td>20 % Least Affected</td>
<td>Difference</td>
</tr>
<tr>
<td>Walls Quality</td>
<td>2.042 (1.982,2.101)</td>
<td>2.450 (2.391,2.508)</td>
<td>-0.413 (-0.499,-0.328)</td>
</tr>
<tr>
<td>Roof Quality</td>
<td>6.918 (6.885,6.951)</td>
<td>6.955 (6.922,6.985)</td>
<td>-0.029 (-0.079,0.016)</td>
</tr>
<tr>
<td>Erosion Threat</td>
<td>0.530 (0.491,0.569)</td>
<td>0.416 (0.378,0.454)</td>
<td>0.144 (0.091,0.197)</td>
</tr>
<tr>
<td>Employed</td>
<td>0.786 (0.764,0.809)</td>
<td>0.816 (0.794,0.839)</td>
<td>-0.038 (-0.070,-0.007)</td>
</tr>
<tr>
<td>Salaried</td>
<td>0.256 (0.231,0.281)</td>
<td>0.345 (0.320,0.370)</td>
<td>-0.089 (-0.124,-0.053)</td>
</tr>
<tr>
<td>Work for Gov. Self</td>
<td>0.119 (0.098,0.140)</td>
<td>0.251 (0.231,0.271)</td>
<td>-0.132 (-0.161,-0.103)</td>
</tr>
<tr>
<td>Work for Gov. Self or Relatives</td>
<td>0.229 (0.204,0.254)</td>
<td>0.334 (0.309,0.359)</td>
<td>-0.104 (-0.139,-0.068)</td>
</tr>
<tr>
<td>Ethnic Majority</td>
<td>0.724 (0.701,0.746)</td>
<td>0.829 (0.806,0.852)</td>
<td>-0.111 (-0.142,-0.079)</td>
</tr>
<tr>
<td></td>
<td>LASSO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------------------</td>
<td>-------</td>
<td>------</td>
<td>------</td>
</tr>
<tr>
<td></td>
<td>20 % Most Affected</td>
<td>20 % Least Affected</td>
<td></td>
</tr>
<tr>
<td>Walls Quality</td>
<td>2.042</td>
<td>(1.982, 2.101)</td>
<td>2.450</td>
</tr>
<tr>
<td>Roof Quality</td>
<td>6.918</td>
<td>(6.885, 6.951)</td>
<td>6.955</td>
</tr>
<tr>
<td>Erosion Threat</td>
<td>0.530</td>
<td>(0.491, 0.569)</td>
<td>0.416</td>
</tr>
<tr>
<td>Employed</td>
<td>0.786</td>
<td>(0.764, 0.809)</td>
<td>0.816</td>
</tr>
<tr>
<td>Salaried</td>
<td>0.256</td>
<td>(0.231, 0.281)</td>
<td>0.345</td>
</tr>
<tr>
<td>Work for Gov. Self</td>
<td>0.119</td>
<td>(0.098, 0.140)</td>
<td>0.251</td>
</tr>
<tr>
<td>Work for Gov. Self or Relatives</td>
<td>0.229</td>
<td>(0.204, 0.254)</td>
<td>0.334</td>
</tr>
<tr>
<td>Ethnic Majority</td>
<td>0.724</td>
<td>(0.701, 0.746)</td>
<td>0.829</td>
</tr>
</tbody>
</table>
## Classification Analysis (CLAN)

<table>
<thead>
<tr>
<th></th>
<th>LASSO</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20 % Most</td>
<td>20 % Least</td>
<td>Difference</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Affected</td>
<td>Affected</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Walls</strong></td>
<td>2.042</td>
<td>2.450</td>
<td>-0.413</td>
<td></td>
</tr>
<tr>
<td><strong>Quality</strong></td>
<td>(1.982,2.101)</td>
<td>(2.391,2.508)</td>
<td>(-0.499,-0.328)</td>
<td>[0.000]</td>
</tr>
<tr>
<td><strong>Roof</strong></td>
<td>6.918</td>
<td>6.955</td>
<td>-0.029</td>
<td></td>
</tr>
<tr>
<td><strong>Quality</strong></td>
<td>(6.885,6.951)</td>
<td>(6.922,6.985)</td>
<td>(-0.079,0.016)</td>
<td>[0.421]</td>
</tr>
<tr>
<td><strong>Erosion</strong></td>
<td>0.530</td>
<td>0.416</td>
<td>0.144</td>
<td></td>
</tr>
<tr>
<td><strong>Threat</strong></td>
<td>(0.491,0.569)</td>
<td>(0.378,0.454)</td>
<td>(0.091,0.197)</td>
<td>[0.000]</td>
</tr>
<tr>
<td><strong>Employed</strong></td>
<td>0.786</td>
<td>0.816</td>
<td>-0.038</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.764,0.809)</td>
<td>(0.794,0.839)</td>
<td>(-0.070,-0.007)</td>
<td>[0.035]</td>
</tr>
<tr>
<td><strong>Salaried</strong></td>
<td>0.256</td>
<td>0.345</td>
<td>-0.089</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.231,0.281)</td>
<td>(0.320,0.370)</td>
<td>(-0.124,-0.053)</td>
<td>[0.000]</td>
</tr>
<tr>
<td><strong>Work for Gov.</strong></td>
<td>0.119</td>
<td>0.251</td>
<td>-0.132</td>
<td></td>
</tr>
<tr>
<td><strong>Self</strong></td>
<td>(0.098,0.140)</td>
<td>(0.231,0.271)</td>
<td>(-0.161,-0.103)</td>
<td>[0.000]</td>
</tr>
<tr>
<td><strong>Work for Gov.</strong></td>
<td>0.229</td>
<td>0.334</td>
<td>-0.104</td>
<td></td>
</tr>
<tr>
<td><strong>Self or Relatives</strong></td>
<td>0.204,0.254)</td>
<td>(0.309,0.359)</td>
<td>(-0.139,-0.068)</td>
<td>[0.000]</td>
</tr>
<tr>
<td><strong>Ethnic</strong></td>
<td>0.724</td>
<td>0.829</td>
<td>-0.111</td>
<td></td>
</tr>
<tr>
<td><strong>Majority</strong></td>
<td>(0.701,0.746)</td>
<td>(0.806,0.852)</td>
<td>(-0.142,-0.079)</td>
<td>[0.000]</td>
</tr>
</tbody>
</table>
### Classification Analysis (CLAN)

<table>
<thead>
<tr>
<th></th>
<th>LASSO</th>
<th></th>
<th></th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20 % Most</td>
<td>20 % Least</td>
<td>Difference</td>
<td></td>
</tr>
<tr>
<td>Affected</td>
<td>Affected</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walls Quality</td>
<td>2.042 (1.982, 2.101)</td>
<td>2.450 (2.391, 2.508)</td>
<td>-0.413 (-0.499, -0.328)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof Quality</td>
<td>6.918 (6.885, 6.951)</td>
<td>6.955 (6.922, 6.985)</td>
<td>-0.029 (-0.079, 0.016)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.421</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Erosion Threat</td>
<td>0.530 (0.491, 0.569)</td>
<td>0.416 (0.378, 0.454)</td>
<td>0.144 (0.091, 0.197)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employed</td>
<td>0.786 (0.764, 0.809)</td>
<td>0.816 (0.794, 0.839)</td>
<td>-0.038 (-0.070, -0.007)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.035</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salaried</td>
<td>0.256 (0.231, 0.281)</td>
<td>0.345 (0.320, 0.370)</td>
<td>-0.089 (-0.124, -0.053)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work for Gov.</td>
<td>0.119 (0.098, 0.140)</td>
<td>0.251 (0.231, 0.271)</td>
<td>-0.132 (-0.161, -0.103)</td>
<td></td>
</tr>
<tr>
<td>Self</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work for Gov.</td>
<td>0.229 (0.204, 0.254)</td>
<td>0.334 (0.309, 0.359)</td>
<td>-0.104 (-0.139, -0.068)</td>
<td></td>
</tr>
<tr>
<td>Self or Relatives</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethnic Majority</td>
<td>0.724 (0.701, 0.746)</td>
<td>0.829 (0.806, 0.852)</td>
<td>-0.111 (-0.142, -0.079)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.000</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Conclusion

- Study how governments should set tax rates using a unique case of randomized property tax rates in Kananga, DRC

- Tax rate on **wrong side of Laffer curve**:
  - Elasticity of **tax revenue** wrt tax rates: -0.26
  - Elasticity of **tax compliance** wrt tax rates: -1.19
  - Beyond higher revenue, lowering rates also:
    - Lowers **bribes** collected
    - Improves **view of government**

- Policies can exploit **heterogeneity in the Laffer rate**
  - Increasing enforcement capacity permits higher tax rates
  - Progressive tax schedule would maximize revenue
THANK YOU!
Similar property tax schemes in other countries (Franzsen and McCluskey, 2017):

- Common in developed countries until recently:
  - *United Kingdom*: Introduced a flat charge (the Community Charge or "Poll Tax") between 1989 and 1993.
  - *Republic of Ireland*: Property owners had to pay a flat rate charge (Household Charge and Residence Charge) until the implementation of the local property tax in 2013.

- Still common in developing countries:
  - *India*: Major Indian cities (e.g. New Delhi, Bangalore, Kolkata) have adopted flat rates by unit-area category in 2008.
  - *Tanzania*: All properties that are not included on the valuation roll are liable for flat rates.
  - *Sierra Leone, Liberia* and *Malawi*: Overall tax simplification agenda implies piloting flat rates for properties not on the valuation roll.
## Data Collection Timeline

<table>
<thead>
<tr>
<th></th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline Survey</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chief survey</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pilot</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tax Collection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collector survey</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Census Surveys</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Midline Surveys</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Endline Survey</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Property Value</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Baseline Survey: 100% complete
- Chief survey: 100% complete
- Pilot: 100% complete
- Tax Collection: 100% complete
- Collector survey: 100% complete
- Census Surveys: 100% complete
- Midline Surveys: 100% complete
- Endline Survey: 100% complete
- Property Value: 50% complete
**Omnibus Tests** of joint orthogonality fail to reject the null

- Status quo tax liability vs 17% reduction: $F = 0.44$ and $p = 0.93$
- Status quo tax liability vs 33% reduction: $F = 0.87$ and $p = 0.55$
- Status quo tax liability vs 50% reduction: $F = 1.51$ and $p = 0.13$
Robustness Checks

Tax Collector Effort Level

- **Concern:** Tax collectors earn a percentage (usually 30%) of the amount of tax collected. Different tax rates might affect *collectors’ effort level* through tax collectors’ compensation.

- **Strategy #1:** We randomized tax collectors’ compensation at the property level: 30% of the amount collected vs fixed compensation (equal to 25% of the full liability). We can estimate $\eta_{ip}$ for each compensation scheme as well as controlling for compensation level.

- **Strategy #2:** Estimate $\eta_{ip}$ using tax collector visit indicator (extensive margin) and number of visits by tax collectors (intensive margin) as the outcome.
# Robustness Checks

## Tax Collector Effort Level

<table>
<thead>
<tr>
<th>Tax Compliance</th>
<th>Tax Compliance</th>
<th>Tax Compliance</th>
<th>Tax Compliance</th>
<th>Tax Compliance</th>
<th>Visit Indicator</th>
<th>Nb visits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Spec. OLS</td>
<td>Compensation Proportional OLS</td>
<td>Compensation Flat OLS</td>
<td>Compensation Control OLS</td>
<td>Main Spec. OLS</td>
<td>Main Spec. OLS</td>
<td></td>
</tr>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
<td>(6)</td>
<td></td>
</tr>
</tbody>
</table>

| ln(Tax Liability) | -0.094*** (0.006) | -0.084*** (0.008) | -0.090*** (0.007) | -0.106*** (0.008) | -0.003 (0.009) | -0.028 (0.020) |
| Observations      | 39219            | 16979           | 21078           | 38385           | 39219          | 24581     |
| Sample            | All              | All             | All             | All             | All            | All        |
| House             | Pooled           | Pooled          | Pooled          | Pooled          | Pooled         | Pooled     |
| Strata            | 363              | 363             | 363             | 363             | 363            | 363        |
| Mean              | .09              | .09             | .08             | .09             | .62            | 1.63       |
| Elasticity        | -1.06            | -.98            | -1.1            | -1.16           | 0              | -.02       |
### Randomized Compensation for Tax Collectors

<table>
<thead>
<tr>
<th>Property Type</th>
<th>Tax Liability (CF)</th>
<th>30% Bonus (CF)</th>
<th>Constant Bonus (CF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Value Property</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,500</td>
<td>450</td>
<td>750</td>
<td></td>
</tr>
<tr>
<td>2,000</td>
<td>600</td>
<td>750</td>
<td></td>
</tr>
<tr>
<td>2,500</td>
<td>750</td>
<td>750</td>
<td></td>
</tr>
<tr>
<td>3,000</td>
<td>900</td>
<td>750</td>
<td></td>
</tr>
<tr>
<td>High Value Property</td>
<td>All rates</td>
<td></td>
<td>2,000</td>
</tr>
</tbody>
</table>
Controlling for Neighbor’s Tax Rates

Neighbor Defined by Geographic Distance

|                  | No Nbr Ctrl | 1 Nearest Nbr Ctrl | 2 Nearest Nbr Ctrl | 3 Nearest Nbr Ctrl | 4 Nearest Nbr Ctrl | 5 Nearest Nbr Ctrl | 6 Nearest Nbr Ctrl | 7 Nearest Nbr Ctrl | 8 Nearest Nbr Ctrl | 9 Nearest Nbr Ctrl | 10 Nearest Nbr Ctrl |
|------------------|-------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|---------------------|---------------------|
| ln(tax liability) | -0.104***   | -0.104***          | -0.104***          | -0.104***          | -0.104***          | -0.104***          | -0.104***          | -0.104***          | -0.104***          | -0.104***          | -0.104***          |
|                  | (0.008)     | (0.008)            | (0.008)            | (0.008)            | (0.008)            | (0.008)            | (0.008)            | (0.008)            | (0.008)            | (0.008)            | (0.008)            |
| ln(tax liability) Nearest Nbr | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
|                  | (0.004)     | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            |
| ln(tax liability) 2nd Nearest Nbr | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 |
|                  | (0.004)     | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            |
| ln(tax liability) 3rd Nearest Nbr | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 |
|                  | (0.004)     | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            |
| ln(tax liability) 4th Nearest Nbr | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 |
|                  | (0.004)     | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            |
| ln(tax liability) 5th Nearest Nbr | 0.006* | 0.006* | 0.006* | 0.006* | 0.006* | 0.006* | 0.006* | 0.006* | 0.006* | 0.006* | 0.006* |
|                  | (0.004)     | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            |
| ln(tax liability) 6th Nearest Nbr | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 |
|                  | (0.003)     | (0.003)            | (0.003)            | (0.003)            | (0.003)            | (0.003)            | (0.003)            | (0.003)            | (0.003)            | (0.003)            | (0.003)            |
| ln(tax liability) 7th Nearest Nbr | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 |
|                  | (0.004)     | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            |
| ln(tax liability) 8th Nearest Nbr | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
|                  | (0.004)     | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            |
| ln(tax liability) 9th Nearest Nbr | -0.003 | -0.003 | -0.003 | -0.003 | -0.003 | -0.003 | -0.003 | -0.003 | -0.003 | -0.003 | -0.003 |
|                  | (0.003)     | (0.003)            | (0.003)            | (0.003)            | (0.003)            | (0.003)            | (0.003)            | (0.003)            | (0.003)            | (0.003)            | (0.003)            |
| ln(tax liability) 10th Nearest Nbr | 0.007* | 0.007* | 0.007* | 0.007* | 0.007* | 0.007* | 0.007* | 0.007* | 0.007* | 0.007* | 0.007* |
|                  | (0.004)     | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            | (0.004)            |

Observations: 34567 34567 34567 34567 34567 34567 34567 34567 34567 34567 34567

Mean: .09 .09 .09 .09 .09 .09 .09 .09 .09 .09 .09

Elasticity: -1.19 -1.19 -1.19 -1.19 -1.19 -1.19 -1.19 -1.19 -1.19 -1.19 -1.19

A. Bergeron Are Tax Rates too High in Developing Countries 42 / 43
## Controlling for Neighbor’s Tax Rates

**Neighbor Defined by Successive compound Codes**

<table>
<thead>
<tr>
<th></th>
<th>No neighborCtrls</th>
<th>2 neighborCtrls</th>
<th>4 neighborCtrls</th>
<th>6 neighborCtrls</th>
<th>8 neighborCtrls</th>
<th>10 neighborCtrls</th>
</tr>
</thead>
<tbody>
<tr>
<td>ln(tax liability)</td>
<td>-0.099***</td>
<td>-0.099***</td>
<td>-0.099***</td>
<td>-0.099***</td>
<td>-0.099***</td>
<td>-0.099***</td>
</tr>
<tr>
<td></td>
<td>(0.008)</td>
<td>(0.008)</td>
<td>(0.008)</td>
<td>(0.008)</td>
<td>(0.008)</td>
<td>(0.008)</td>
</tr>
<tr>
<td>ln(Tax Rate in %)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>neighbor -1</td>
<td>0.001</td>
<td>0.002</td>
<td>0.002</td>
<td>0.002</td>
<td>0.002</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
</tr>
<tr>
<td>neighbor -2</td>
<td>-0.005</td>
<td>-0.005</td>
<td>-0.005</td>
<td>-0.005</td>
<td>-0.005</td>
<td>-0.005</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
</tr>
<tr>
<td>neighbor -3</td>
<td>-0.001</td>
<td>-0.002</td>
<td>-0.002</td>
<td>-0.002</td>
<td>-0.002</td>
<td>-0.002</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
</tr>
<tr>
<td>neighbor -4</td>
<td>0.003</td>
<td>0.003</td>
<td>0.003</td>
<td>0.003</td>
<td>0.003</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
</tr>
<tr>
<td>neighbor +1</td>
<td>0.003</td>
<td>0.003</td>
<td>0.003</td>
<td>0.003</td>
<td>0.003</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
</tr>
<tr>
<td>neighbor +2</td>
<td>0.000</td>
<td>-0.000</td>
<td>-0.000</td>
<td>-0.000</td>
<td>-0.001</td>
<td>-0.001</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
</tr>
<tr>
<td>neighbor +3</td>
<td>0.006</td>
<td>0.006</td>
<td>0.006</td>
<td>0.005</td>
<td>0.005</td>
<td>0.005</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
</tr>
<tr>
<td>neighbor +4</td>
<td>-0.001</td>
<td>-0.002</td>
<td>-0.002</td>
<td>-0.002</td>
<td>-0.002</td>
<td>-0.002</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
</tr>
<tr>
<td>neighbor +5</td>
<td>0.009**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>32725</td>
<td>32725</td>
<td>32725</td>
<td>32725</td>
<td>32725</td>
<td>32725</td>
</tr>
<tr>
<td>House</td>
<td>Pooled</td>
<td>Pooled</td>
<td>Pooled</td>
<td>Pooled</td>
<td>Pooled</td>
<td>Pooled</td>
</tr>
<tr>
<td>Mean</td>
<td>.09</td>
<td>.09</td>
<td>.09</td>
<td>.09</td>
<td>.09</td>
<td>.09</td>
</tr>
<tr>
<td>Elasticity</td>
<td>-1.15</td>
<td>-1.15</td>
<td>-1.15</td>
<td>-1.15</td>
<td>-1.15</td>
<td>-1.15</td>
</tr>
</tbody>
</table>
### By Knowledge of Neighbor’s Tax Rates

<table>
<thead>
<tr>
<th></th>
<th>Main Spec</th>
<th>Knows Nbr Rate</th>
<th>Doesn’t Know Nbr Rate</th>
<th>Main Spec</th>
<th>Knows Nbr Rate</th>
<th>Doesn’t Know Nbr Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>ln(tax liability)</td>
<td>-0.136***</td>
<td>-0.151***</td>
<td>-0.137***</td>
<td>-70.843</td>
<td>5.926</td>
<td>-86.293*</td>
</tr>
<tr>
<td></td>
<td>(0.013)</td>
<td>(0.045)</td>
<td>(0.014)</td>
<td>(46.232)</td>
<td>(117.514)</td>
<td>(51.544)</td>
</tr>
<tr>
<td>Observations</td>
<td>15637</td>
<td>1811</td>
<td>13355</td>
<td>15637</td>
<td>1811</td>
<td>13355</td>
</tr>
<tr>
<td>House</td>
<td>Pooled</td>
<td>Pooled</td>
<td>Pooled</td>
<td>Pooled</td>
<td>Pooled</td>
<td>Pooled</td>
</tr>
<tr>
<td>Mean</td>
<td>.11</td>
<td>.14</td>
<td>.11</td>
<td>284.11</td>
<td>318.11</td>
<td>282.23</td>
</tr>
<tr>
<td>Elasticity</td>
<td>-1.2</td>
<td>-1.11</td>
<td>-1.23</td>
<td>-.25</td>
<td>.02</td>
<td>-.31</td>
</tr>
</tbody>
</table>
### By Past Tax Collection Status

<table>
<thead>
<tr>
<th>Main Spec</th>
<th>Past Campaign</th>
<th>No Past Campaign</th>
<th>Main Spec</th>
<th>Past Campaign</th>
<th>No Past Campaign</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
<td>(6)</td>
</tr>
<tr>
<td>ln(tax liability)</td>
<td>-0.106***</td>
<td>-0.095***</td>
<td>-0.123***</td>
<td>-62.532**</td>
<td>-41.875</td>
</tr>
<tr>
<td>(0.008)</td>
<td>(0.010)</td>
<td>(0.012)</td>
<td>(28.868)</td>
<td>(35.174)</td>
<td>(49.376)</td>
</tr>
<tr>
<td>Observations</td>
<td>38238</td>
<td>23433</td>
<td>14805</td>
<td>38238</td>
<td>23433</td>
</tr>
<tr>
<td>House</td>
<td>Pooled</td>
<td>Pooled</td>
<td>Pooled</td>
<td>Pooled</td>
<td>Pooled</td>
</tr>
<tr>
<td>Mean</td>
<td>.09</td>
<td>.09</td>
<td>.09</td>
<td>239.25</td>
<td>234.26</td>
</tr>
<tr>
<td>Elasticity</td>
<td>-1.16</td>
<td>-1.04</td>
<td>-1.35</td>
<td>-.26</td>
<td>-.18</td>
</tr>
</tbody>
</table>
Distribution of Property Value in Training Sample

![Graph showing the distribution of property value in USD]
<table>
<thead>
<tr>
<th>Model</th>
<th>Accuracy (MAPE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ridge</td>
<td>142 %</td>
</tr>
<tr>
<td>SVR - Linear Kernel</td>
<td>120 %</td>
</tr>
<tr>
<td>SVR - RBF Kernel</td>
<td>83 %</td>
</tr>
<tr>
<td>KNN</td>
<td>167 %</td>
</tr>
<tr>
<td>Random Forest</td>
<td>99 %</td>
</tr>
<tr>
<td>Boosting - LGBM (MAPE loss)</td>
<td>58 %</td>
</tr>
<tr>
<td>Boosting - LGBM (MAPE and APE loss)</td>
<td>42 %</td>
</tr>
</tbody>
</table>
Feature Importance

Gain from Feature Split

Number of Splits
To estimate the elasticity of tax compliance $\eta_{ip}$ we run the following OLS regressions:

$$C_{ip} = \alpha + \beta \ln(T_{ip}) + \gamma_{ip} + \delta_{p} + \nu_{ip}$$

- $C_{ip}$ = tax compliance status of owner of property $i$ in neighborhood $p$.
- $T_{ip}$ = tax liability for property $i$ in neighborhood $p$.
- $\gamma_{ip}$ = type of house indicator.
- $\delta_{p}$ = polygon fixed effects.

The marginal effect $\beta$ is not an elasticity but can be easily transformed into $\eta_{1,ip}$ using the standard formula:

$$\eta_{1,ip} = \frac{\partial C_{ip}}{\partial T_{ip}} \times \frac{T_{ip}}{C_{ip}} \Rightarrow \eta_{1,ip} = \frac{\beta}{\text{mean}(C_{ip})}$$
## Tax Compliance (\(\eta_{1,ip}\))

<table>
<thead>
<tr>
<th></th>
<th>OLS (1)</th>
<th>OLS (2)</th>
<th>OLS (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\ln(\text{Tax Liability}))</td>
<td>-0.094***</td>
<td>-0.095***</td>
<td>-0.087***</td>
</tr>
<tr>
<td></td>
<td>(0.006)</td>
<td>(0.006)</td>
<td>(0.016)</td>
</tr>
<tr>
<td>Observations</td>
<td>39219</td>
<td>35012</td>
<td>4207</td>
</tr>
<tr>
<td>Sample</td>
<td>All</td>
<td>All</td>
<td>All</td>
</tr>
<tr>
<td>House</td>
<td>Pooled</td>
<td>Low Value</td>
<td>High Value</td>
</tr>
<tr>
<td>Strata</td>
<td>363</td>
<td>363</td>
<td>363</td>
</tr>
<tr>
<td>Mean</td>
<td>.09</td>
<td>.09</td>
<td>.07</td>
</tr>
<tr>
<td>Elasticity</td>
<td>-1.06</td>
<td>-1.04</td>
<td>-1.28</td>
</tr>
</tbody>
</table>
Can survey questions reliably measure bribes?

1. In high bribe settings 50% of citizens openly admit paying bribes (Reid and Weigel 2018)

2. High correlation between more and less overt bribe elicitation strategies (Reid and Weigel 2018; Weigel 2019)
Informal Taxes - Reduced Form

**Extensive margin**

- **Extensive Margin** - "Did you participate in *Salongo* in the past week?"
- **Intensive Margin** - "For how many hours did you participate?"
Informal Taxes and other Formal Taxes

<table>
<thead>
<tr>
<th></th>
<th>Salongo IV (1)</th>
<th>Salongo Hours IV (2)</th>
<th>Paid Market Tax IV (3)</th>
<th>Paid Firm Tax IV (4)</th>
<th>Paid Vehicle Tax IV (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ln(Tax Rate in %)</td>
<td>0.026</td>
<td>2.124*</td>
<td>-0.020</td>
<td>0.001</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>(0.036)</td>
<td>(1.101)</td>
<td>(0.013)</td>
<td>(0.005)</td>
<td>(0.006)</td>
</tr>
<tr>
<td>Observations</td>
<td>2745</td>
<td>1414</td>
<td>1677</td>
<td>2099</td>
<td>2262</td>
</tr>
<tr>
<td>Sample</td>
<td>Endline</td>
<td>Endline</td>
<td>Endline</td>
<td>Endline</td>
<td>Endline</td>
</tr>
<tr>
<td>House</td>
<td>Pooled</td>
<td>Pooled</td>
<td>Pooled</td>
<td>Pooled</td>
<td>Pooled</td>
</tr>
<tr>
<td>Strata</td>
<td>360</td>
<td>360</td>
<td>360</td>
<td>360</td>
<td>360</td>
</tr>
<tr>
<td>Mean</td>
<td>.43</td>
<td>7.63</td>
<td>.44</td>
<td>.22</td>
<td>.19</td>
</tr>
<tr>
<td>Elasticity</td>
<td>.06</td>
<td>.28</td>
<td>-.05</td>
<td>.01</td>
<td>0</td>
</tr>
</tbody>
</table>

Back - Secondary Outcomes
## Government Legitimacy

### Table: Government Legitimacy

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>In(Tax Rate in %)</strong></td>
<td>0.073 (0.065)</td>
<td>0.000 (0.084)</td>
<td>2.183 (24.666)</td>
<td>0.044 (0.074)</td>
<td>0.175* (0.090)</td>
<td>-33.107 (22.703)</td>
<td>0.051 (0.043)</td>
<td>-0.140** (0.063)</td>
<td>-0.007 (0.053)</td>
</tr>
<tr>
<td><strong>Observations</strong></td>
<td>2783</td>
<td>2732</td>
<td>2806</td>
<td>2787</td>
<td>2735</td>
<td>2789</td>
<td>2790</td>
<td>2554</td>
<td>2509</td>
</tr>
<tr>
<td><strong>Sample House</strong></td>
<td>Endline Pooled</td>
<td>Endline Midrange Pooled</td>
<td>Endline Periphery Pooled</td>
<td>Endline Midrange Pooled</td>
<td>Endline Midrange Pooled</td>
<td>Endline Midrange Pooled</td>
<td>All Pooled</td>
<td>All Pooled</td>
<td>All Pooled</td>
</tr>
<tr>
<td><strong>Strata</strong></td>
<td>363</td>
<td>363</td>
<td>363</td>
<td>363</td>
<td>363</td>
<td>363</td>
<td>363</td>
<td>363</td>
<td>363</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>1.77</td>
<td>3.91</td>
<td>576.4</td>
<td>2.04</td>
<td>4.07</td>
<td>426.99</td>
<td>2</td>
<td>1.38</td>
<td>1.69</td>
</tr>
<tr>
<td><strong>Elasticity</strong></td>
<td>.04</td>
<td>0</td>
<td>0</td>
<td>.02</td>
<td>.04</td>
<td>-.08</td>
<td>.03</td>
<td>-1</td>
<td>0</td>
</tr>
</tbody>
</table>

**Back - Secondary Outcomes**
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ln(Tax Rate in %)</td>
<td>-0.078**</td>
<td>-0.068*</td>
<td>-0.065*</td>
<td>-0.075**</td>
<td>-0.044</td>
<td>-0.069*</td>
<td>-0.059*</td>
<td>-0.458*</td>
</tr>
<tr>
<td></td>
<td>(0.036)</td>
<td>(0.036)</td>
<td>(0.036)</td>
<td>(0.036)</td>
<td>(0.035)</td>
<td>(0.036)</td>
<td>(0.036)</td>
<td>(0.236)</td>
</tr>
<tr>
<td>Observations</td>
<td>2806</td>
<td>2806</td>
<td>2806</td>
<td>2806</td>
<td>2806</td>
<td>2806</td>
<td>2806</td>
<td>2806</td>
</tr>
<tr>
<td>Sample</td>
<td>Endline</td>
<td>Endline</td>
<td>Endline</td>
<td>Endline</td>
<td>Endline</td>
<td>Endline</td>
<td>Endline</td>
<td>Endline</td>
</tr>
<tr>
<td>House</td>
<td>Pooled</td>
<td>Pooled</td>
<td>Pooled</td>
<td>Pooled</td>
<td>Pooled</td>
<td>Pooled</td>
<td>Pooled</td>
<td>Pooled</td>
</tr>
<tr>
<td>Strata</td>
<td>363</td>
<td>363</td>
<td>363</td>
<td>363</td>
<td>363</td>
<td>363</td>
<td>363</td>
<td>363</td>
</tr>
<tr>
<td>Mean</td>
<td>.42</td>
<td>.4</td>
<td>.42</td>
<td>.44</td>
<td>.36</td>
<td>.42</td>
<td>.44</td>
<td>2.89</td>
</tr>
<tr>
<td>Elasticity</td>
<td>-.19</td>
<td>-.17</td>
<td>-.16</td>
<td>-.17</td>
<td>-.12</td>
<td>-.16</td>
<td>-.14</td>
<td>-.16</td>
</tr>
</tbody>
</table>
Group Average Treatment Effects (GATES)

LASSO
- ATE
- 90% CB(ATE)
- GATES
- 90% CB(GATES)

Random Forest
- ATE
- 90% CB(ATE)
- GATES
- 90% CB(GATES)

Back - Heterogeneity
Tax Collector Elasticity
Raw Estimates

![Collector Elasticity Chart]
Tax Collector Enforcement Capacity

Shrink Estimates

Collector Level Enforcement

Collector Nb
Tax Collector Elasticity

Shrunk Estimates

A. Bergeron

Are Tax Rates too High in Developing Countries? Evidence from Randomized Property Tax Rates