# Decentralization, Tax Administration, and Taxation: Evidence from Brazil's Rural Land Tax[*]

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**Abstract**

This paper evaluates a nationwide reform in Brazil that offered municipalities the possibility to administer rural property taxes in exchange for receiving a higher share of revenues. Using over 120 million tax returns and a difference-in-differences design exploiting implementation failures, we find that decentralization increased tax revenue by over 15% within five years, largely via higher reported land values. Satellite imagery shows no distortive changes in land use. A cost-benefit exercise using administrative cost data indicates that the reform had large returns. Taken together, these results indicated that administrative decentralization—paired with incentive-compatible transfers and central oversight can improve tax enforcement without efficiency loss.

*JEL codes*: H26, H71, H77, O23.

*Keywords*: Decentralization, Tax Administration, Property Taxation, Fiscal Federalism.

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# 1 Introduction

Property taxes represent a much lower proportion of the overall tax revenues in developing countries than in developed ones (Brockmeyer et al., 2021). Increasing property taxation could help those countries to meet the goal of simultaneously increasing tax revenues and making the tax system more progressive (OECD, 2023). However, limited administrative resources and weak enforcement capacity often lead to chronic under-collection of property taxes in developing countries (Gordon and Li, 2009; Besley and Persson, 2014; Slemrod, 2019). Recent empirical work has focused the potential of increasing consumption and income taxation using tools such as third-party reporting (e.g., Carrillo, Pomeranz and Singhal (2017)), digital invoicing (e.g., Naritomi (2019)), deterrence-based audits (e.g., Brockmeyer et al. (2019), and increasing administrative resources (e.g., Basri et al. (2021)). However, research on the drivers of property tax performance remains sparse.[1]

We address this gap by studying Brazil's 2008 reform to decentralize the administration of the rural land tax (Imposto Territorial Rural, ITR). ITR is a progressive tax on landholdings created in the 1960s whose revenues have been historically low due to informational constraints and low enforcement capacity (Assunção and Moreira, 2001; Fendrich et al., 2022).[2] The 2008 reform aimed to tackle these issues by allowing municipalities to take over collection and auditing, in exchange for retaining 100% of revenues rather than 50%. The central government continued to set tax rates and legal procedures, limiting the risk of local political capture while giving municipalities stronger incentives to detect under-reporting. The roll-out was voluntary and staggered, with some municipalities failing to implement the minimum infrastructure required to implement the reform despite signing agreements, creating plausibly exogenous variation in exposure.[3]

[1]One exception is the work of Brockmeyer et al. (2021) who studies the effects of increasing tax rates and tax enforcement on the collection of property taxes in Mexico City.

[2]ITR due is the product of the value of the land, the share of the property not covered by forests, and the tax rate. The tax rate is increasing on property size and decreasing on the intensity of land use. All parameters are self-reported. See section 2.1 for details.

[3]The reform also made RFB responsible for providing IT infrastructure to the municipalities that enter

We exploit this variation using a staggered difference-in-differences design that compares municipalities that implemented the reform to those that signed but did not implement, conditioning on agreement year. This design ensures that treatment and controls municipalities are relatively similar, mitigates the concern that time-varying shocks correlated with tax revenues and the timing of entry in the program drive the results, and deals with the negative weighting problem identified in the recent literature on staggered differences-in-differences designs (e.g., Goodman-Bacon (2021)). We supplement this with robustness checks using modern estimators for staggered treatment timing and alternative specifications.

We explore microdata on 120 million tax returns from the period 2002-2021 to evaluate the effects of the partial decentralization of rural land taxation. This data enables us to estimate the effects of the decentralization on different margins and across different types of properties. We obtain four main results. First, we document that the partial decentralization reform increased ITR revenues by more than 15% after five years. The effects increase over time and are relatively homogeneous across treatment cohorts. Extrapolating the effects found for the earlier treatment cohorts to the full sample suggest that partial decentralization generates more than 25% growth in ITR revenues after ten years. These effects are quite similar across properties from different sizes and slightly larger in regions more intensive in crop cultivation.

Second, we find that increases in reported land values of properties that already paid land taxes explain most of the increases in revenues caused by the program. We do find other margins that are influenced by partial decentralization. At the intensive margin, taxable area (the share of the properties not covered by forests) increases and the effective tax rate (based on reported size and land use) decreases. At the extensive margin, the number of tax paying properties goes up. However, albeit statistically significant, the latter effects are economically small and do not explain the large increase of tax revenues observed as

the decentralization program.

a consequence of the partial decentralization. We further provide evidence that, although there is substantial bunching at the municipality-level minimum land values allowed by RFB, the bunching is not higher in municipalities participating in the decentralization program. This suggests that the observed effects cannot be explained solely by changes in information of the minimum land prices provided to central authorities.

Third, we use satellite-based information to document that the program did not lead to changes in observed land use. Partial decentralization affects neither the area covered by pastures nor the area cultivated with different crops. Because differences in land use are a key source of distinctions in agricultural productivity, this is *prima facie* evidence that the increase in taxation caused by the program did not have substantial efficiency costs.

Fourth, we find that the program is highly cost-effective. The estimates reported above indicate that the typical municipality participating in the program increased tax revenues by BRL 940,000 annually. The overall increase in ITR collection explains 57% of this growth in municipal revenues, whereas the increase in the share of the ITR revenues transferred to the municipalities explains 43%. In contrast, information on implementation costs obtained from RFB indicates that the reform increased costs related to tax administration by BRL 90,000-130,000 annually. Given the small efficiency costs documented previously, these numbers imply that the program has a high benefit-cost ratio either from the perspective of individual municipalities or from the perspective of the public sector as a whole.

Our work contributes to the growing body of empirical research on taxation on developing countries.[4] We make four contributions to this literature. First, we provide causal evidence that administrative and incentive reforms can improve property tax collection

[4]See Pomeranz (2015), Carrillo, Pomeranz and Singhal (2017), Perez-Truglia and Troiano (2018), Naritomi (2019), Brockmeyer et al. (2019), Brockmeyer et al. (2021), Londoño-Vélez and Ávila-Mahecha (2021), Basri et al. (2021), Balan et al. (2022), Carrillo et al. (2023), among others for examples of work in this literature.)

in low-capacity contexts – an understudied topic in the literature.[5] Second, our work advances the fiscal decentralization literature (see Oates et al. (1972) and Bardhan and Mookherjee (2000)) for opposing views on the topic and Balan et al. (2022) for recent evidence on this issue) by showing that local administration, when paired with central oversight, can raise compliance without efficiency costs. Third, we add to a growing body of literature documenting high returns of better tax administration (see Basri et al. (2021) for recent evidence). Fourth, our work demonstrates the value of integrating administrative microdata with satellite imagery to evaluate the behavioral impacts of tax reforms.[6]

# 2 Institutional background

This section provides an overview of the main facts about the rural property taxation in Brazil and discuss some features of its decentralization that are relevant to our study.

## 2.1 Rural land taxation in Brazil

Land taxation in Brazil begins with the first republican constitution of 1891. However, the ITR only arises in the 1930´s. The ITR administration switched over the years between all three tiers of government in Brazil, which reflects the administration challenges associated with this tax. Eventually, in more recent years, the Federal Government was assigned the duty to administer and enforce ITR. However, until the Constitution of 1988, tax revenues were entirely allocated to the municipalities where the land was located.

[5] Brockmeyer et al. (2021) documents that higher tax rates and more stringent enforcement both lead to increased collection of property taxes in Mexico City, but that increases in rates generate much smaller efficiency costs than increases in enforcement. Similar to them, we document that higher enforcement increase the collection of property taxes, but, different from them, finds that the efficiency costs of increasing enforcement are quite low. This difference is likely explained by the fact that under-reporting (as opposed to tax delinquencies in their work) is the main challenge for increasing property taxation in our context.

[6] Caldeira, Ehrl and Moreira (2023) studies the same 2008 decentralization reform studied in this paper but using aggregate data. They find that the program more than doubled revenues from rural land taxes in participating municipalities. We advance their work by using an identification strategy that better deals with time-varying shocks that simultaneously affect the entry in the program and ITR revenues and by using more detailed data that enables us to understand different margins of adjustment to the partial decentralization.

Hence, the tax design created a clear disincentive for the creation and maintenance of an adequate administration of ITR which involves informational challenges and expensive inspection activities. It is important to acknowledge that Brazil is a very unequal country, where 1% of the largest rural properties concentrates 48% of the total rural land. (IBGE (2017))

Since its creation, there has been a widespread dissatisfaction with the ITR´s results not only in terms of tax revenue but also in terms of extrafiscal outcomes.[7] In fact, the revenue collected from the ITR remained around 0.15% of GDP in the period 1970 to 1985, dropping to 0.11% of the GDP in the period 1985 to 1990, according to Blanco and Reis (1996). Since 1996, the tax has been levied by self declaration. The ITR due is calculated as shown in equation 1.

$$ITR_{due} = (Value\,of\,the\,land)\,.\left(\frac{taxable\,area}{total\,area}\right).\,(tax\,rate) \tag{1}$$

where $ITR_{due}$ is the amount of ITR to be paid. The value of the land (*Valor da Terra Nua* - VTN) is the value of the bare land. The taxable area is the total area of the property less the areas occupied by forests and of ecological interest.[8]

The tax rate of the ITR goes from 0,03% up to 20% according to the size of the property and to the degree of utilization (*Grau de Utilização* - GU) as shown in Table 1. The GU is calculated by the percentage ratio of the area actually used for rural production[9] in relation to the total usable area of the property.[10] Small properties are exempted from the

[7]The ITR is sometimes pejoratively referred to as "the ten reais tax" in allusion to the minimum value of the tax, which is the amount collected by a significant portion of taxpayers. The tax has also failed in achieving results in terms of reducing non used land and in landscapes preservation

[8]The non taxable areas are the parts of permanent preservation,legal reserve, Private Natural Heritage Reserve (RPPN), of ecological interest, of environmental easement, covered by native, primary or secondary forests in medium or advanced stage of regeneration and flooded for purposes of constituting a reservoir for hydroelectric plants authorized by the Public Authority

[9]Area effectively used by rural activity is the area planted, of pasture, of extractive exploration or used for farming or aquaculture activities

[10]The total usable area is considered to be the part of the property suitable for agricultural, livestock, poultry, aquaculture or forestry. It is the total area of the property, excluding the non-taxable areas and the

tax, when the owner do not have another rural or urban property.

Table 1: Tax Rates of the ITR

| Property Area (ha) | Degree of Utilization - GU (%) | | | | |
|---|---|---|---|---|---|
| | Over 80 | 65 - 80 | 50 - 65 | 30 - 65 | Up to 30 |
| Up to 50 | 0.03 | 0.20 | 0.40 | 0.70 | 1.00 |
| 50 - 200 | 0.07 | 0.40 | 0.80 | 1.40 | 2.00 |
| 200 - 500 | 0.10 | 0.60 | 1.30 | 2.30 | 3.30 |
| 500 - 1000 | 0.15 | 0.85 | 1.90 | 3.30 | 4.70 |
| 1000 - 5000 | 0.30 | 1.60 | 3.40 | 6.00 | 8.60 |
| Over 5000 | 0.45 | 3.00 | 6.40 | 12.00 | 20.00 |

*Notes*: This table presents the tax rates of the ITR according to the Federal Law n° 9,393/1996. The tax rate is defined by the total area of the property and the degree of land use.

## 2.2 The Decentralization of the Rural Property Tax

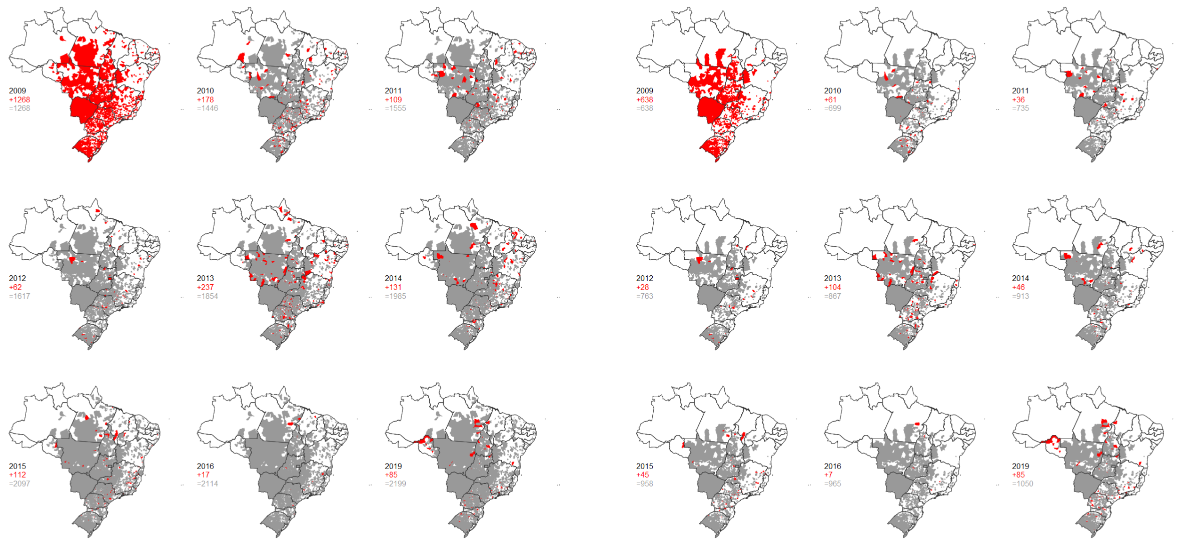
A Constitutional Amendment opening the possibility of municipalities to carry out inspections and collect the ITR was approved in 2008.[11] Municipalities could keep 100% of ITR taxation but they had to attend some requirements. They had to assess and publish the minimal value of its rural land[12] and to provide infrastructure and personnel to the task. The municipality employees also had to undergo training carried out by the RFB, before being able to use the system.

areas occupied with useful and necessary improvements intended for rural activity.

[11]The decentralization of the ITR arises with the Constitutional Amendment N° 42/2003. The amendment was regulated by Law N° 11,250/2005 but, only in 2008, with decree n° 6.433/2008 the ITR Management Committee was established, in other to regulate the requirements and conditions necessary for the conclusion of the agreements, municipalities were able to sign the agreement.

[12]The minimal value has to be assessed by engineers according to technical criterias and the value of the land has to be classified in 6 different categories

Figure 1: Evolution of the Decentralization Agreements




(a) All municipalities

(b) Municipalities that were not excluded

*Notes*: The figure shows the evolution of the decentralization agreements. In panel (a) all municipalities are included whereas in (b) only municipalities that were not excluded are shown.

The decentralization of the ITR does not represent a full decentralization of tax power but rather a decentralization in tax administration. This was done to prevent elite capture to influence the enforcement of this tax in decentralized municipalities. In fact, only the tax collection and auditing are transferred to municipalities that sign the agreement in exchange for receiving 100% of the tax revenue. The ultimate authority over the tax remains with the Federal Government. RFB is still the one to choose who is going to be audited and the order that taxpayers are going to be audited, based in the expected tax notice.

In 2016, a new regulation of the decentralization agreements was published and municipalities had one year to adjust under the penalty of exclusion. In the following year, RFB started revising the agreements and excluded 1,149 municipalities, in total, that were not complying with the obligations of the agreement. In most of the cases, these municipalities did not even had trained personnel with access to the system used to manage the tax. In Figure 1, it can be seen the evolution of the decentralization agreements according to the year the municipality signed the agreement. In 2021, out of the 5,570 municipalities of Brazil, the ITR was decentralized in 1,260 (22,6%). The total ITR revenue of that year was R$ 1,950 million (USD 360 million) and the 1,260 decentralized municipalities administered 86.7% of that tax. The total ITR revenue corresponds only to 0.02% of the GDP and Fendrich et al. (2022) estimates that the total tax collection should be almost four times the current value.

# 3 Data

In this section, we present the main administrative databases used in this paper and discuss the procedures employed to merge and to unidentified the confidential information.

## 3.1 Land Tax Returns

We use the universe of individual land tax returns administered by the Federal Revenue of Brazil - RFB (*Imposto Territorial Rural - ITR* from 2002 to 2021, totaling over 120 million returns. The returns identify the property by a unique tax id number (*Número do Imóvel na Receita Federal - NIRF* and the owner by the unique tax id of natural people (*Cadastro de Pessoa Física - CPF* and of legal entity (*Cadastro Nacional da Pessoa Jurídica - CNPJ*. The NIRF, CNPJ and CPF were unidentified to protect the confidential taxpayer information.

The ITR return is filled on a yearly basis and brings information of the municipality the property is located, the size of the property, the areas of construction, native forest, crops, pasture, the number of animals and the ITR tax rate and the amount due.

In table 2, we have the descriptive statistics of the data. It calls attention the reduction of the number of properties paying 10 BRL, the minimum tax due. Although the reduction began prior to the municipalization, it accelerates after that.

Table 2: Descriptive Statistics

| | 2000 | 2005 | 2010 | 2015 | 2020 |
|---|---|---|---|---|---|
| *Tax descriptives* | | | | | |
| Total ITR due (R$) | 30,403.29 | 42.032.57 | 80,619.71 | 183,962.09 | 292,989.08 |
| Mean ITR due per property (R$) | 65.25 | 81.03 | 138.58 | 295.28 | 481.99 |
| Number of declarations | 849.28 | 957.27 | 1083.88 | 1168.43 | 1110.76 |
| Share of exempt properties | 0.45 | 0.46 | 0.46 | 0.47 | 0.45 |
| Share paying 10 R$ | 0.33 | 0.31 | 0.27 | 0.21 | 0.16 |
| Average land value (R$) | 38,715.89 | 53,899.51 | 91,192.53 | 190,356.78 | 306,185.7 |
| Average tax rate (%) | 0.19 | 0.21 | 0.25 | 0.26 | 0.26 |
| Share of taxable land | 0.75 | 0.78 | 0.78 | 0.75 | 0.72 |
| *Land use* | | | | | |
| Share Agriculture | 0.15 | 0.16 | 0.17 | 0.17 | 0.19 |
| Share Pasture | 0.30 | 0.27 | 0.244 | 0.21 | 0.2 |

**Notes:** This table presents the mean values by municipality for each variable for the years shown. *Share of paying 10 R$* is the share of the properties that pay R$ on ITR, the minimum value. *Average land value* is the average assessed value accepted by the tax authority in R$, this is the value of the land without any improvements.

## 3.2 Additional Datasets

For this study, the FAO-GAEZ v3 (Food and Agriculture Organization - Global Agro-Ecological Zones) dataset was used to assess the suitability of soy and maize pastures, to control for increases in land value caused by soy production. Additionally, we use the Mapbiomas dataset, which provides us with information on land use and land cover changes yearly, for robustness checks on the pasture and crop data. For robustness tests on other taxes, IPTU and ISS, we use data from the National Treasury (*Tesouro Nacional*), FINBRA (Municipalities Finance), which provides the yearly tax levied by each municipality. For analysis of land usage, we use the MapBiomas dataset, which extracts, with satellite images, how land is used yearly in each of the Brazilian municipalities.

# 4 Empirical Strategy

As discussed in Section 2, the legislation does not force municipalities to become responsible for the collection of land taxes. The legislation merely authorizes the RFB to sign "decentralization" agreements with municipalities, thereby implying the decision to sign these agreements is endogenous.

We deal with this issue by comparing municipalities that signed decentralization agreements in year $t$ and implemented the minimum infrastructure to collect these taxes (treatment) with municipalities that signed decentralization agreements in year $t$, but were not able to implement the minimum infrastructure to collect land taxes and therefore had their agreements denounced by RFB (control group). Because treatment and control municipalities showed interest in signing agreements in the same period, this comparison reduces concerns that municipalities anticipated their revenues from land taxes would change differentially and entered the program because of this.

Formally, we pool municipalities that signed agreements on different periods and estimate the following dynamic differences-in-differences equation:

$$\log(y_{ict}) = \sum_{k=-6}^{-1} \beta_k T_{ic} + \sum_{k=0}^{5} \beta_k T_{ic} + \gamma' \mathbf{X}_{ict} + \lambda_i + \lambda_{tc} + \epsilon_{ict}, \tag{2}$$

in which $y_{ict}$ represents ITR revenues of municipality $i$, of treatment cohort $c$ in the period $t$, $T_{ic}$ is an indicator that municipality $i$ made an agreement with RFB in period $c$ and was never denounced. $X_{it}$ is a vector of controls, $\lambda_i$ is a municipality fixed effect, $\lambda_{tc}$ is a cohort $\times$ year fixed effect, and $\epsilon_{ict}$ is an idiosyncratic error term.

The parameters of interest in equation (2) are the $\beta_k$. The inclusion of cohort $\times$ year fixed effects implies that these parameters are a weighted average of within-cohort treatment effects (ATT) obtained for each $k$. These weights are strictly positive, depending solely on the relative size of the different cohorts. Therefore, despite treatment occurring in different time periods, our empirical design does not suffer from the negative weighting problem identified in the recent literature on differences-in-differences designs with staggered entry (e.g., Goodman-Bacon (2021)).

The $\beta_k$ estimated for $k < 0$ test whether ITR revenues were evolving similarly in treatment/control municipalities before decentralization agreements were signed. The $\beta_k$ estimated for $k \geq 0$, on their turn, test whether ITR revenues changed differentially in treatment/control municipalities after these agreements were signed, that is, it tests whether decentralization affected ITR revenues.

One concern with our empirical design is that treatment/control municipalities might face different shocks after agreements are signed. These shocks might in turn influence the dynamics of ITR revenues. While the focus on denounced and non-denounced municipalities mitigates these concerns, there are still differences in baseline characteristics that might be correlated with the dynamics of ITR revenues. To account for these differences, we re-weight the control group using entropy balancing, matching the 2004 (five years before treatment) values of land use, productivity, population, and administrative capacity. We also provide evidence that results are robust to other weighting procedures, controls, and estimators.

Our treatment group is composed by 934 municipalities that signed agreement until 2016 and were not excluded. In the control group, we assigned the 1,109 municipalities that signed the agreement until the same year and were later excluded. Table 3 reports descriptive characteristics of the treatment/control groups. The treatment group has higher initial ITR revenues and agricultural suitability, slightly higher collection of local taxes, similar GDP, and slightly lower number of public workers.[13]

[13] Table **??** reports means of these characteristics after re-weighting.

Table 3: Treatment and Control Group Characteristics

| | Treatment | Control | Diff. (1-2) | p-value |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Municipality GDP | 809531.86 | 682388.61 | 127143.24 | 0.65 |
| Public workers per capita | 0.04 | 0.05 | -0.00 | 0.00 |
| Public workers per capita ("estatutários") | 0.03 | 0.03 | -0.00 | 0.87 |
| Previous Year ISS (per Capita) | 22.13 | 18.25 | 3.87 | 0.17 |
| Previous Year IPTU (per Capita) | 7.88 | 6.73 | 1.15 | 0.06 |
| Previous Year ITR (per Capita) | 5.38 | 2.14 | 3.23 | 0.00 |
| Maize Productivity | 8084.93 | 8197.25 | -112.32 | 0.27 |
| Soybean productivity | 4244.20 | 4109.69 | 134.51 | 0.00 |

**Notes:** This table reports descriptive statistics of the estimating sample. Column 1 reports means for treatment municipalities, column 2 reports means for control municipalities, column 3 reports the differences in these means, and column 4 reports the p-value associated with this difference.

# 5 Results

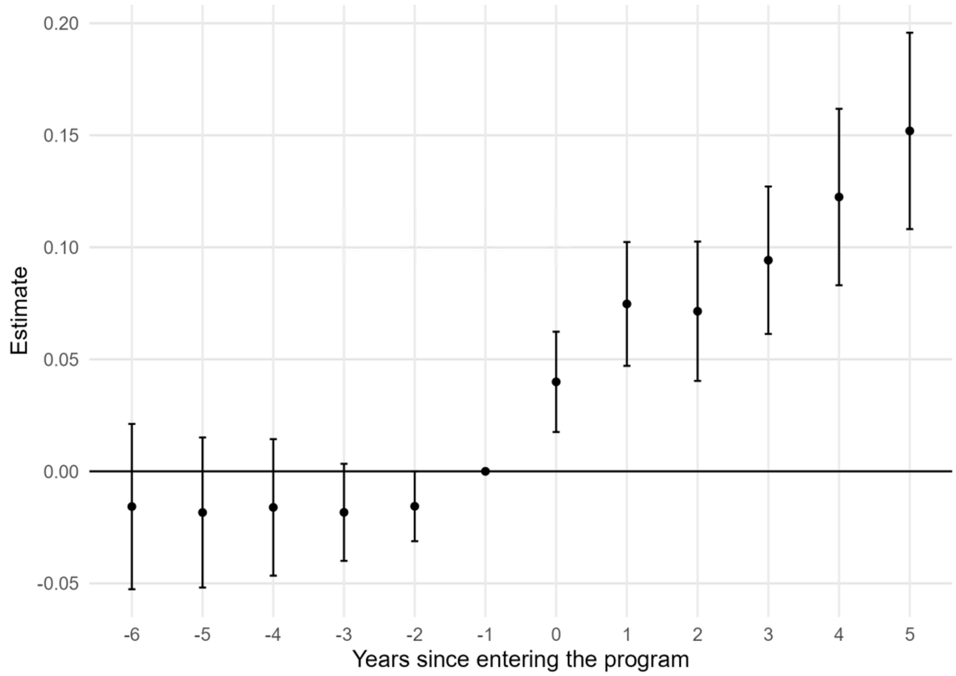
## 5.1 ITR revenues

Figure 2, Panel A reports the coefficients obtained from estimating equation (2). Before the decentralization agreements were signed, there was no noticeable difference in the evolution of ITR revenues between treatment and control municipalities. However, immediately after the agreements are signed, ITR revenues begin to increase faster in treatment municipalities relative to control municipalities. We observe a relative increase in ITR revenues in control municipalities of 4% in the year the agreements were signed. The effects increase over time to over 7% one to three years and to roughly 15% four to five years after the agreements were signed. The appendix provides evidence that these results are robust to different specifications. The results are robust to using untreated municipalities as controls (Figure A.1c), to controlling for state-level linear trends (Figures A.1a and A.1b), and to alternative estimators proposed by Callaway and Sant'Anna (2021) and Sun and Abraham (2021) (Figure A.1d).

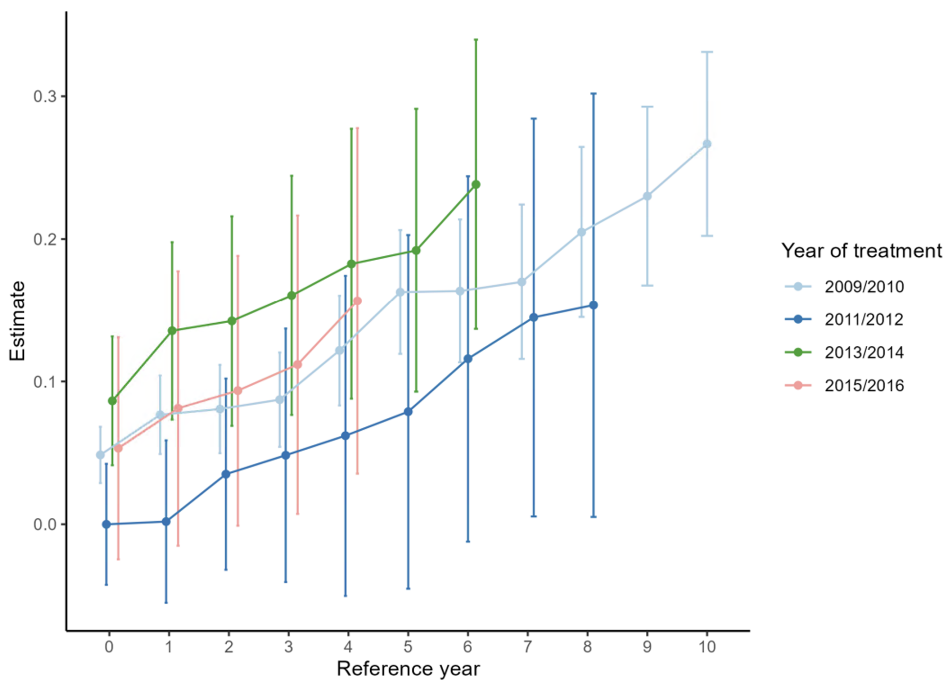
Figure 2, Panel B reports the coefficients obtained from estimating equation (2) separately for the different treatment cohorts. The effects of decentralization on ITR revenues are very similar across cohorts. Data from cohorts that signed the agreement earlier indicates that treatment effects continue to increase up to one decade after the decentralization agreements were signed – for these cohorts, ITR revenues increased 25% more in treatment municipalities than in control municipalities after one decade. The appendix explores other dimensions of heterogeneity of the results. We find no heterogeneity of treatment effects across farm size (Figure A.3) – the effects are quite similar for farms across four size bins ($<$ 50 hectares, 50-100 hectares, 100-1000 hectares, $>$ 1000 hectares). We document evidence of heterogeneity across regions (Table A.8) – the effects of decentralization are more pronounced in the Northeast, although this region includes only a small number of treated municipalities, and weaker in the South. Between these two extremes, we find comparable effects in the Southeast and Midwest and a slightly stronger effect in the North.

The effects reported in Figure 2 might reflect the fact that municipalities that sign decentralization agreements and implement them are municipalities in which tax revenues are increasing across the board due to economic growth or better tax administration. To test this hypothesis, we conduct placebo tests using local taxes as the outcome of interest. Figure 3 the results. Panel A examines revenues from the services tax (ISS) and panel B from the urban property tax (IPTU) revenues. Panel A reports no differences in the evolution of ISS revenues in treatment and control municipalities. Panel B reports small and statistically insignificant increases in IPTU revenues in treatment relative to control municipalities. These findings reduces concerns that increases in ITR revenues are reflecting increases in overall taxation or a stronger tax administration.

Figure 2: Effects of decentralization on ITR on revenues



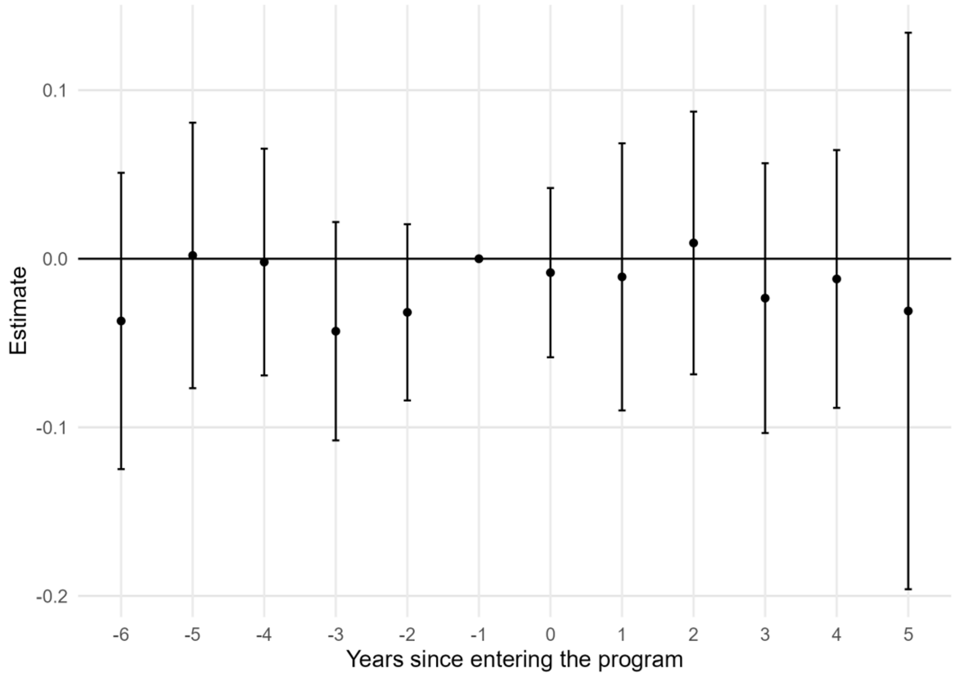

(a) Effect on log(ITR revenues)



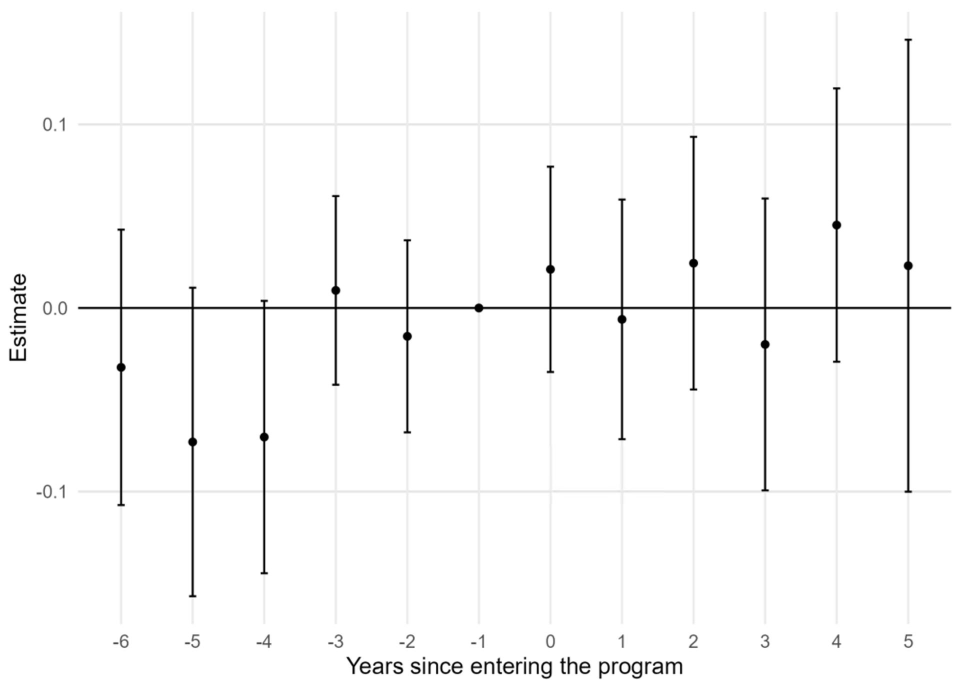

(b) Effects on log(ITR revenues) by cohort

**Notes:** These figures report estimates of the effects of the decentralization agreements on log(ITR revenues) obtained using equation (2). The x-axis shows the relative time since decentralization while the y-axis plot the coefficients and confidence intervals obtained. Panel A reports the average effect across all cohorts. Panel B reports the effects for different cohorts.

Figure 3: Placebo Tests




(a) Effect on log(ISS revenues)




(b) Effects on log(IPTU revenues)

**Notes:** These figures report estimates of the effects of the decentralization agreements on log(ISS revenues) (Panel A) and log(IPTU revenues) (Panel B). Effects are obtained using equation (2). The x-axis shows the relative time since decentralization while the y-axis plot the coefficients and confidence intervals obtained.

## 5.2 Mechanisms

Figure 4, Panels A and B decompose the effects of decentralization on ITR revenues between changes in the average tax rate and the (self-reported) land values.[14] Panel A documents that, after decentralization agreements are signed, tax rates immediately decline by 0.01 p.p. (5%) in treatment municipalities. Panel B documents that, after decentralization agreements are signed, self-reported land values increase strongly in treatment municipalities (16% after five years). The results indicate that the overall 15% increase in ITR revenues is the result of a combination of a 16% increase in self-reported land values and a 5% decrease in tax rates. We interpret these results as an indication that decentralization increased tax revenues operated mainly by inducing taxpayers to report land values closer to the real values.

Figure 4, Panels C and D decompose the effects of decentralization on ITR revenues between the intensive (average ITR paid) and extensive (number of taxpayers) margin.[15] The figures document that, after decentralization agreements are signed, average ITR paid increases in treatment municipalities. Although not statistically significant, the result also shows a small increase in the number of taxpayers in treated municipalities. However, increases in average ITR paid are much larger than increases in the number of taxpayers (15% vs. 1%) and explain most of the increases in overall taxation.

Figure 4, Panels E and F show a slight reduction in the number of properties with utilization rates below 80% and a modest increase in the average utilization rate. This pattern suggest that taxpayers responded to the increase in land values by changing the reporting of other parameters to raise the utilization rate and thereby reduce tax rates - possibly

[14] As discussed in section 2, ITR due is a product of self-reported land values and the tax rate. Let $T_{it}$ denote ITR due and $V_{it}$ denote the sum of self-reported land values in municipality $i$ and period $t$. Define $r_{it} = T_{it}/V_{it}$ as the average tax rate. The effect of the decentralization agreements on ITR revenues ($\log(T_{it})$) can be thus written as the sum of the effects on the tax rate ($\log(r_{it})$) and self-reported land values ($\log(V_{it})$.

[15] Let $T_{it}$ denote ITR due, $N_{it}$ denote the number of taxpayers, and $t_{it}$ the average ITR paid. By definition, $T_{it} = t_{it} \times N_{it}$. The effect of the decentralization agreements on ITR revenues ($\log(T_{it})$) can be thus written as the sum of the effects on the average ITR paid ($\log(t_{it})$) and the number of taxpayers ($\log(N_{it})$.

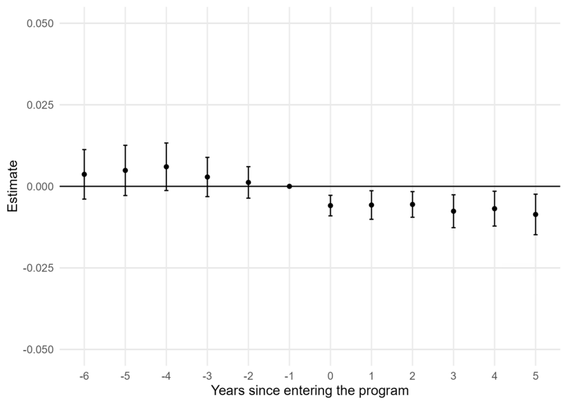
because these parameters are more difficult to monitor than land values. However, such adjustments only partially offset the increase in self-reported land values.

Together, the results from Figure 4 indicate that increases in ITR revenues are mostly led by increases in self-reported land values by existing taxpayers. Municipalities might be inducing taxpayers to report land values differently either by providing better information to RFB about land values or by increasing the likelihood of audits (or other enforcement measures in general). The two explanations have different implications for the distribution of self-reported land values – the former would generate bunching at the minimum values reported by RFB, whereas the latter would shift the distribution to the right.

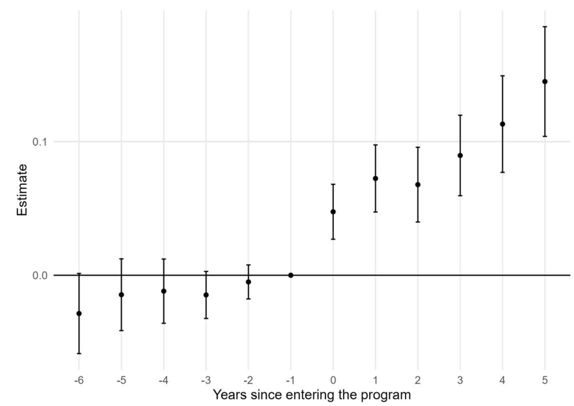
Figure 5 tests across these explanations. It plots the distribution of self-reported land values divided by the minimum land value for the treatment and the control groups.[16] There are two noticeable patterns. First, there is bunching on minimum values for both groups, but substantially less in the treatment group than in the control group. Second, the entire distribution of self-reported land values for the treatment group is to the right of the distribution control for the control group. These results provide suggestive evidence that the reform affected taxpayer behavior not only by changing the quality of information that the RFB receives about the taxpayers, but also by changing the overall enforcement. However, because the data on minimum land values is just available for the post-treatment period, these results should be interpreted with caution.

[16]The minimum land value is the value of one hectare of land covered with native vegetation. Municipalities that sign decentralization agreements report these values to RFB. RFB relies on other sources of data to construct these values for the other municipalities.

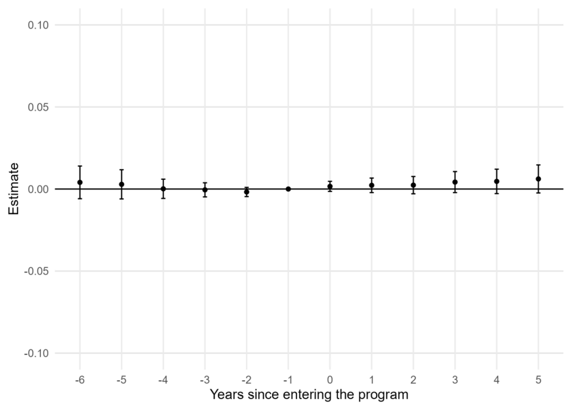
Figure 4: Decomposing the effects of decentralization on ITR revenues



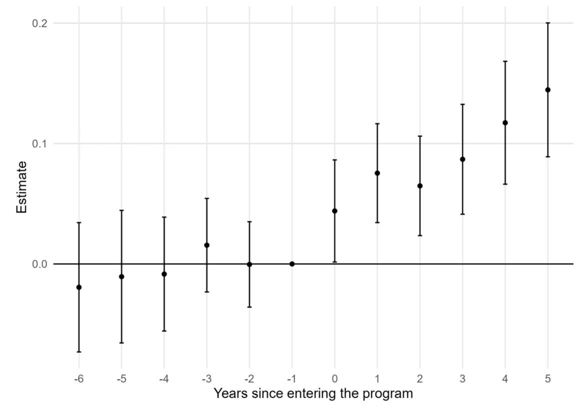

(a) Average Tax Rate



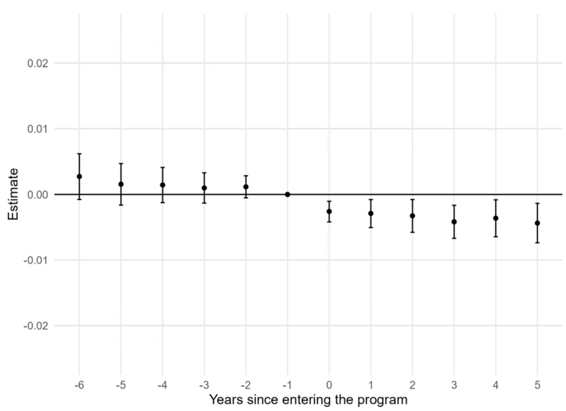

(b) log(Self-Reported Land Values)



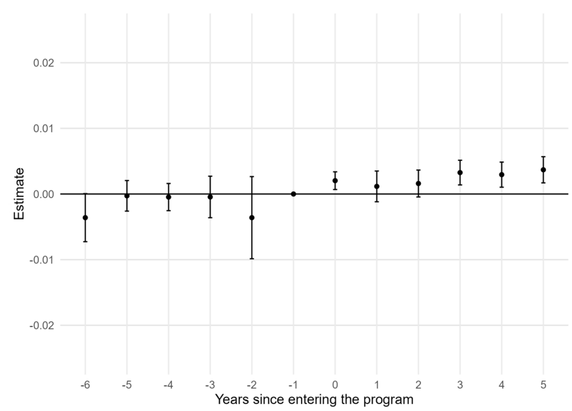

(c) Log(Num Properties)




(d) log(Avg ITR)



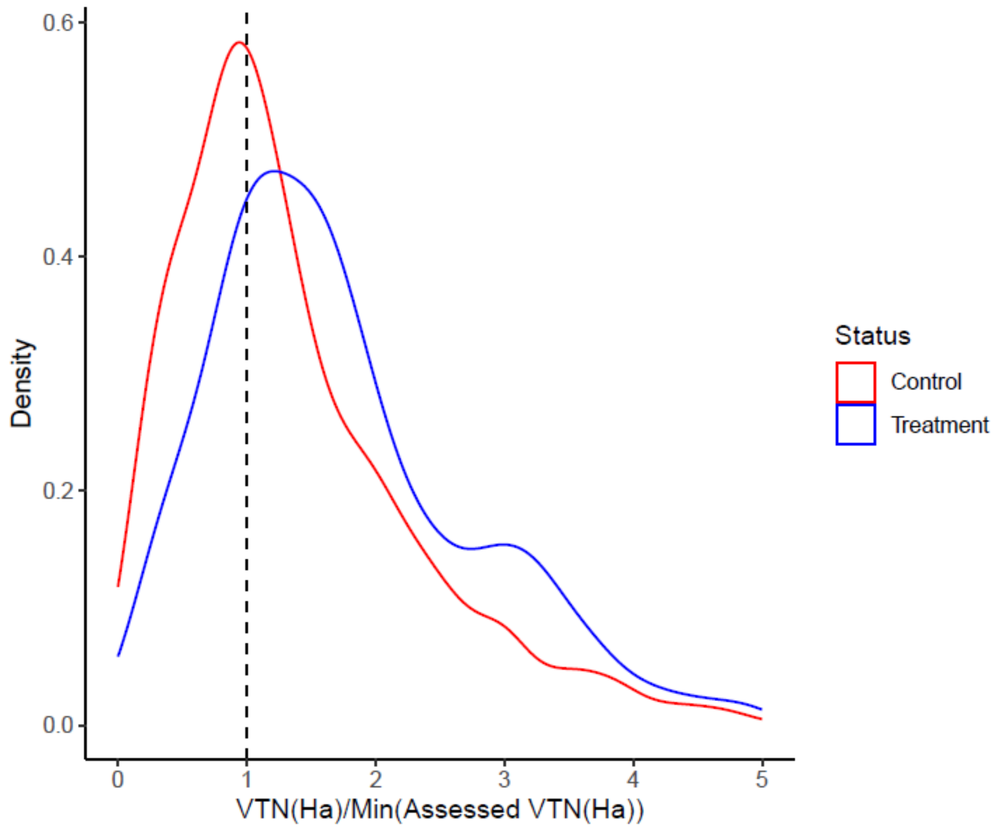

(e) Share GU (< 80%)




(f) Average GU

**Notes:** These figures report estimates of the effects of the decentralization agreements on different outcomes obtained using equation (2). The x-axis shows the relative time since decentralization while the y-axis plot the coefficients and their respective 95% confidence intervals. Panel A reports the effect of the decentralization agreements on the (log) of self-reported land values. Panel B reports the effects of the decentralization agreements on on the average tax rate. Panel C reports the effects of the decentralization agreements on the number of paying properties. Panel D reports the effects of the decentralization agreements on the average ITR paid. Panel E reports the effect of decentralization on the share of properties with a land utilization rate below 80% within a municipality. Panel F presents the effect of decentralization on the average utilization rate.

Figure 5: Self-reported versus minimum land values




**Notes:** The figure plots the distribution of self-reported land values divided by the minimum land value for the treatment and the control group.

## 5.3 Efficiency Costs

Figure 6 uses remote sensing data to investigate whether decentralization influences taxpayers' land use choices. Whether the land is used as pastureland or as cropland is an important dimension of intensification in Brazil's agriculture Bragança (2018); Bustos, Caprettini and Ponticelli (2016). Examining decentralization's effects on land use is therefore important to determine whether it influenced taxpayers behavior and therefore whether its efficiency costs were significant. We find that decentralization neither influenced the share of pastureland (Panel A) nor the share of cropland (Panel B).[17] This pro-

[17] We consider three different mutually exclusive land uses: cropland, pastureland and forests. We omit forests from the analysis as it is just the residual of cropland and pastureland.

vides suggestive evidence that the efficiency costs of decentralization are negligible. This is possibly linked to the fact that, even after the increase caused by decentralization, the effective ITR rates continue quite low and therefore unlikely to affect behavior considerably.

### 5.4 Cost Benefit

We monetize the costs and benefits of decentralization to compute its cost-benefit ratio. We focus on year 2021 – the last period in our data. Table 4 reports the results.

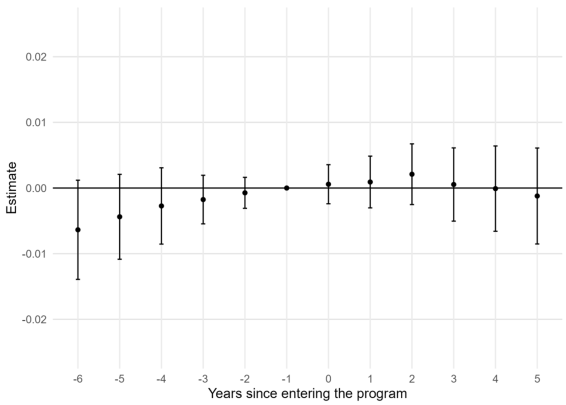
Combining the mean ITR revenues in 1,260 municipalities with active decentralization agreements with our estimates, we estimate that the reform increased municipal tax revenues by BRL 940,000 (USD 188,000). The overall increase in ITR collection explains 57% of this growth (BRL 557,000), whereas the increase in the share of the ITR revenues transferred to the municipalities explains 43% (403,000).

We the compare these benefits with the costs of implementing the decentralization agreements.[18] These implementation costs were obtained from interviews with the officials from RFB responsible for ITR administration. We consider two types of costs – the costs of assessing land values and the costs of the personnel involved in ITR collection at the local level (usually 1/2 of the time of a public employee). While there is some heterogeneity in the costs depending on local characteristics, RFB officials estimate these costs to be roughly between BRL 90,000-130,000.

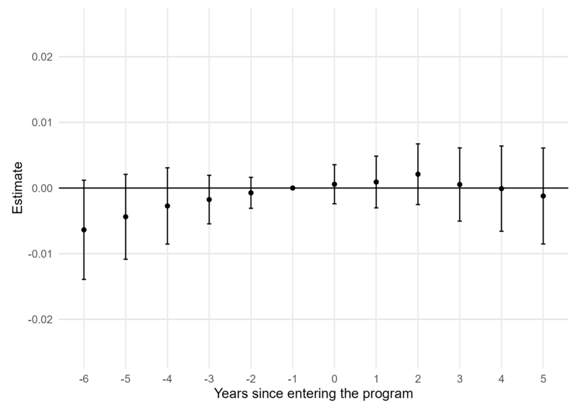
These numbers imply that ITR decentralization had a cost/benefit ratio of 7-10 from the perspective of the municipalities and 4-6 from the perspective of the public sector.

[18] We ignore efficiency costs as our findings indicate these costs are negligible.

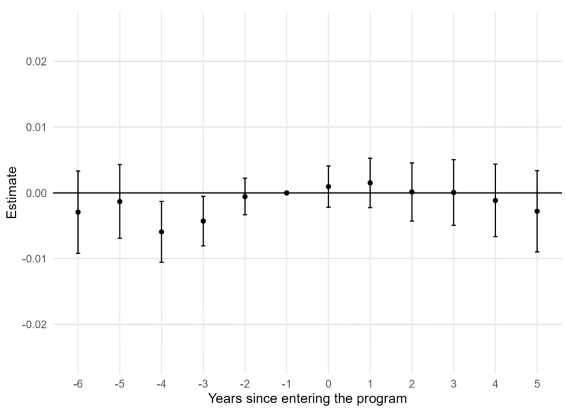
Figure 6: The effects of Decentralization on Land Use



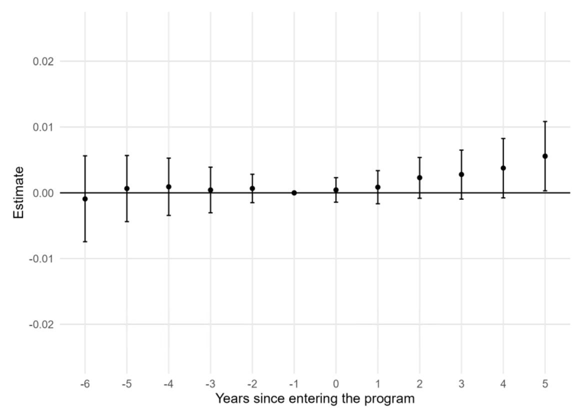

(a) Fraction of land used for pasture - Satellite




(b) Fraction of land used for agriculture - Satellite




(c) Fraction of land used for pasture - Declaration




(d) Fraction of land used for agriculture - Declaration

**Notes:** TFigures report estimated effects of decentralization agreements on land use composition. Panel A shows results for the share of pastureland and Panel B for the share of cropland, both measured using satellite-based land cover data. Panels C and D replicate the same specifications using self-declared land use data from farmers. Effects are obtained using equation (2). The x-axis shows the relative time since decentralization while the y-axis plot the coefficients and their respective 95% confidence intervals.

Table 4: Cost Benefit Analysis (2021)

| Description | Amount (BRL) |
|---|---|
| Total Revenue Gain by Municipality (1260) | 940,000 |
| Average increase in revenue collection by municipality | 537,000 |
| Tax transference from federal to municipality | 403,000 |
| Cost of Assessing Land | 50,000 |
| Cost of Land Tax Administration by Municipality | 40,000 - 80,000 |
| Total Cost by Municipality | 90,000 - 130,000 |
| Total Net Gain in Tax Revenue by Municipality | 407,000 - 850,000 |
| Total Per Capita Gain in Taxes (Including transference) | 55 |
| Net Per Capita Gain in Taxes | 28 |

**Notes:** This table reports the cost benefit analysis for the year 2021.

# 6 Conclusion

This paper evaluated the effects of a program that partially decentralized the administration of rural land taxes to local authorities in Brazil. Using microdata from tax returns, we find that the program led to an expansion of tax revenues by 15% after five years. While taxpayers responded to the decentralization in different margins, we find that it expanded tax revenues mainly by increasing self-reported land values. This increase in self-reported land values seems to be at least partially connected to increased enforcement. Using satellite data, we further found that partial decentralization did not influence farmer behavior significantly. A cost-benefit exercise indicates that the reform had large returns.

Our findings have important implications for policy design. First, the robust response of tax revenues (over 25% in one decade) indicates that partial decentralization schemes in which central governments use local officials for information collection and enforcement purposes, while keeping oversight responsibilities might be an effective way for increasing taxation in developing countries (Balan et al., 2022). Second, the negligible response of taxpayer behavior suggests that the current ITR rate is below the optimal rate. Third, the findings that taxpayers respond to the tax mainly by reporting land values that are closer to real land values indicates that moving from self-reported land values to market assessments (as done for the collection of urban property taxes) is a low hanging fruit to increase ITR revenues.

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# FOR ONLINE PUBLICATION

# Appendix to "Decentralization, Tax Administration, and Taxation: Evidence from Brazil's Rural Land Tax"

## A Additional Results

Table A.1: Event-study estimates of decentralization on ITR revenue

| | All Sample | 2009/2010 | 2011/2012 | 2013/2014 | 2015/2016 |
|---|---|---|---|---|---|
| Post × Non-Denounced | 0.106*** | 0.169*** | 0.040 | 0.147*** | 0.125* |
| | (0.017) | (0.028) | (0.068) | (0.049) | (0.068) |
| Non-Denounced × (t = 0) | 0.040*** | 0.043*** | −0.013 | 0.056* | 0.026 |
| | (0.011) | (0.014) | (0.024) | (0.025) | (0.040) |
| Non-Denounced × (t = 2) | 0.071*** | 0.080*** | -0.017 | 0.091** | 0.036 |
| | (0.016) | (0.019) | (0.042) | (0.048) | (0.060) |
| Non-Denounced × (t = 5) | 0.152*** | 0.167*** | 0.070 | 0.147** | 0.089 |
| | (0.022) | (0.026) | (0.075) | (0.063) | (0.081) |
| Non-Denounced × (t = 7) | | 0.177*** | 0.161* | 0.188** | |
| | | (0.035) | (0.083) | (0.084) | |
| Non-Denounced × (t = 9) | | 0.231*** | 0.231* | | |
| | | (0.041) | (0.127) | | |
| Non-Denounced × (t = 11) | | 0.255*** | | | |
| | | (0.046) | | | |
| Mean ITR (t=-1) | 147,121 | 148,138 | 153,229 | 133,342 | 166,338 |
| Obs | 24496 | 33554 | 4000 | 8415 | 2995 |
| Treated | 934 | 679 | 62 | 142 | 511 |
| Distinct Obs | 2043 | 1400 | 167 | 351 | 125 |

*Notes:* This table presents event-time regression estimates for log(ITR Revenue). The first row reports the average treatment effect, while subsequent rows display dynamic effects for the treatment period and for 2, 5, 7, 9, and 11 periods after treatment. The reference period is $t = -1$. Standard errors, shown in parentheses, are clustered at the municipality level. The bottom panel reports descriptive statistics for average ITR revenue in treated municipalities at $t = -1$. "All sample" pools all treatment cohorts, while "2009/2010" and subsequent labels restrict the sample to municipalities first treated in those years. Significance levels: $^{*}: p < 0.1$, $^{**}: p < 0.05$, $^{***}: p < 0.01$.

Table A.2: Differences-in-Differences results on municipal taxes (Placebo)

| | Log(ISS (Service Tax)) | Log(IPTU (Property Tax)) |
|---|---|---|
| Non-Denounced × (t = 0) | -0.010 | 0.022 |
| | (0.026) | (0.031) |
| Non-Denounced × (t = 1) | -0.004 | -0.026 |
| | (0.040) | (0.043) |
| Non-Denounced × (t = 2) | 0.012 | 0.012 |
| | (0.039) | (0.043) |
| Non-Denounced × (t = 3) | -0.026 | -0.029 |
| | (0.042) | (0.046) |
| Non-Denounced × (t = 4) | -0.018 | 0.026 |
| | (0.039) | (0.045) |
| Non-Denounced × (t = 5) | -0.025 | -0.001 |
| | (0.077) | (0.066) |
| Mean (t=-1) | 5,444.299 | 3,659.793 |
| Obs | 24,359 | 24,359 |
| # Treated | 934 | 934 |
| # Distinct | 2,043 | 2,043 |

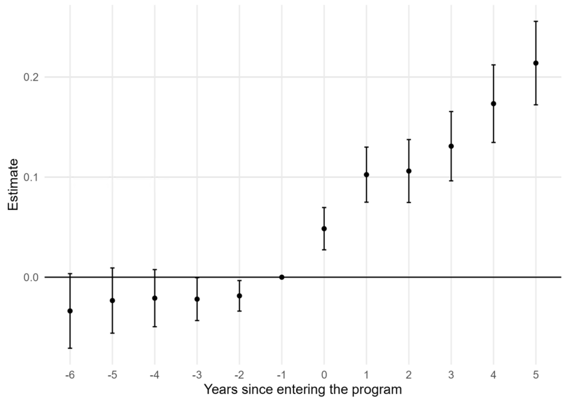
*Note:* This table reports Difference-in-Differences estimates of decentralization effects on municipal tax revenues. Outcomes are *ISS* (Service Tax) and *IPTU* (Urban Property Tax), measured in logs. "Mean ($t = -1$)" gives the pre-treatment average revenue for each tax (in thousands of BRL). Standard errors in parentheses, clustered at the municipality level. Significance levels: $^{*}: p < 0.1$, $^{**}: p < 0.05$, $^{***}: p < 0.01$.

Table A.3: **Differences-in-Differences results**

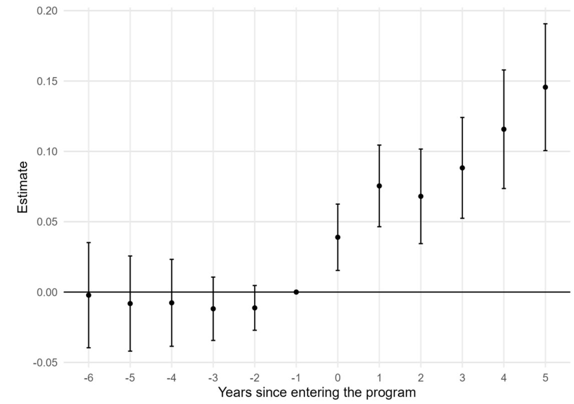
| | Avg Tax rate | Log(Land Value) | Log(Avg ITR) | Log(# Properties) |
|---|---|---|---|---|
| Post × Non-Denounced | -0.010*** | 0.102*** | 0.085*** | 0.004 |
| | (0.004) | (0.016) | (0.020) | (0.004) |
| Mean ($t = -1$) | 0.137 | 168,667.112 | 315.923 | 955.414 |
| Obs | 24,496 | 24,496 | 24,496 | 24,496 |
| # Treated | 934 | 934 | 934 | 934 |
| # Distinct Obs | 2,043 | 2,043 | 2,043 | 2,043 |

*Notes:* Each column reports Difference-in-Differences estimates for the outcome listed in the header. "Average Tax Rate" is the percentage tax rate paid in the municipality. "Log(Land Value)" refers to the self-reported land value (*valor de terra nua*). "Avg ITR" is the mean ITR paid in the municipality, and "# Properties" is the count of properties paying the tax. The row "Mean ($t = -1$)" reports the pre-treatment mean of each dependent variable; for log-transformed variables, the mean is presented in levels. Standard errors, shown in parentheses, are clustered at the municipality level. Significance levels are denoted as follows: $^{*}: p < 0.10$, $^{**}: p < 0.05$, $^{***}: p < 0.01$.

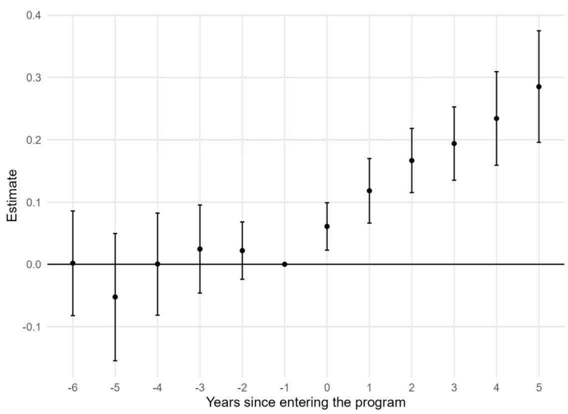
Figure A.1: Robustness checks using alternative estimation frameworks.



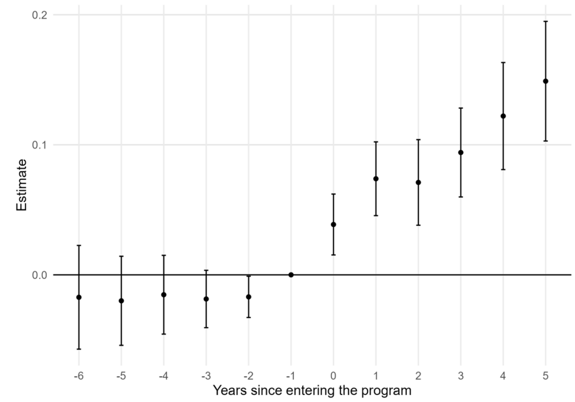

(a) Linear trend




(b) Linear trends and weighting




(c) Not treated as control




(d) Callaway and Sant'Anna (2021)

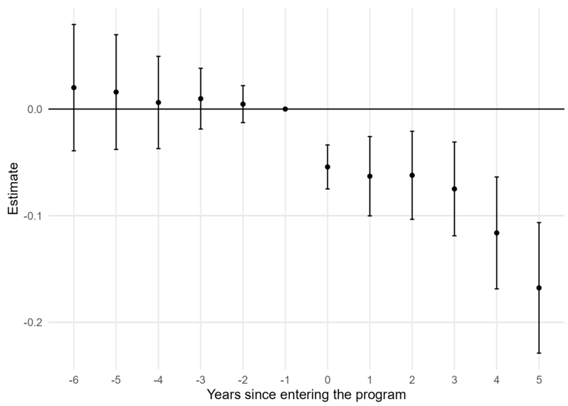
**Note:**Each panel reports the estimated effects of decentralization agreements under different modeling choices. (a) Includes state-level linear trends. (b) Applies weighting in addition to state-level linear trends. (c) Uses only untreated municipalities as controls and applies entropy balancing to match covariates. (d) Implements the Callaway and Sant'Anna (2021) difference-in-differences method, which accounts for treatment timing heterogeneity.The x-axis shows the relative time since decentralization while the y-axis plot the coefficients and their respective 95% confidence intervals.

Table A.4: Event-study estimates of decentralization on ITR revenue – Different specifications

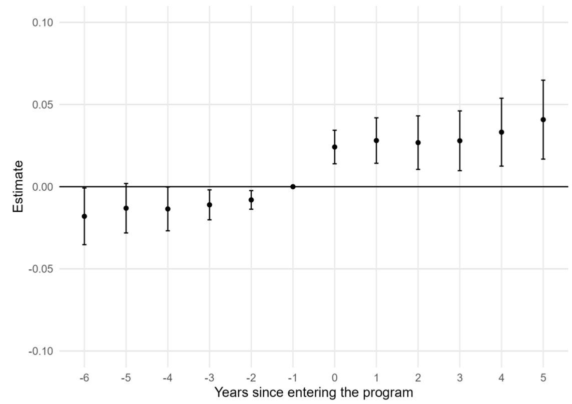
| | Not-Treated as Control | State-level trend | State-level trend + weighting | Callaway and Sant'Anna |
|---|---|---|---|---|
| Post × Non-Denounced | 0.180*** | 0.138*** | 0.090*** | 0.092*** |
| | (0.050) | (0.016) | (0.017) | (0.015) |
| Mean ITR (t=-1) | 217,536 | 217,323 | 217,323 | 217,323 |
| Obs | 291471 | 24496 | 24496 | 24496 |
| # Treated | 956 | 934 | 934 | 934 |
| # Distinct Obs | 4290 | 2043 | 2043 | 2043 |

*Notes:* This table reports regression results using alternative specifications. "Not-treated as control" replaces non-denounced municipalities with untreated municipalities as the control group. "State-level trend" adds state-specific time trends, while "State-level trend + weight" combines these trends with weighting, which serves as the main specification. The final column reports estimates from the method of Callaway and Sant'Anna (2021).. Standard errors in parentheses, clustered at the municipality level. Significance levels: $^{*}: p < 0.1$, $^{**}: p < 0.05$, $^{***}: p < 0.01$.

Figure A.2: Mechanisms




(a) Log(# Tax returns (= R$10) )




(b) Log(# Tax returns (>R$10) )

**Notes:** The figure plot estimates of the effects of the decentralization agreements on different outcomes obtained using equation (2). The x-axis shows the relative time since decentralization while the y-axis plot the coefficients and their respective 95% confidence intervals. Each panel reports results for farms in different size intervals.

Table A.5: **Differences-in-Differences results**

| | Log(#Tax returns $= R\$10$) | Log(#Tax returns $> R\$10$) | Share GU $<$ 80% | Average GU |
|---|---|---|---|---|
| Post $\times$ Non-Denounced | -0.103$^{***}$ | 0.043$^{***}$ | -0.005$^{***}$ | 0.004$^{***}$ |
| | (0.030) | (0.011) | (0.002) | (0.001) |
| Mean ($t = -1$) | 353.155 | 602.051 | 0.050 | 0.949 |
| Obs | 24,496 | 24,496 | 24,496 | 24,496 |
| # Treated | 934 | 934 | 934 | 934 |
| # Distinct Obs | 2,043 | 2,043 | 2,043 | 2,043 |

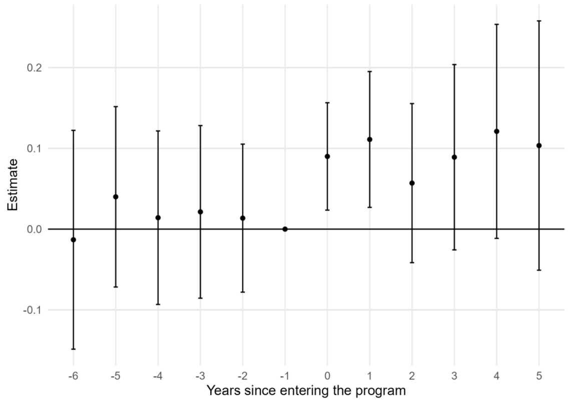
*Notes:* This table reports Difference-in-Differences estimates for the outcomes listed in the column headers. "# Tax Returns = R\$10" denotes the number of properties paying the minimum tax of R\$10, while "# Tax Returns > R\$10" denotes the number of properties paying above this amount. "Share GU < 80%" is the share of properties in a municipality with a land utilization rate $\left(\frac{\text{Used Area}}{\text{Usable Area}}\right)$ below 80%. "Average GU" is the mean utilization rate. The row "Mean ($t = -1$)" reports the pre-treatment mean of each dependent variable. Standard errors in parentheses, clustered at the municipality level.
Significance levels: $^*$ : $p < 0.1$, $^{**}$ : $p < 0.05$, $^{***}$ : $p < 0.01$.

Table A.6: **Differences-in-Differences results**

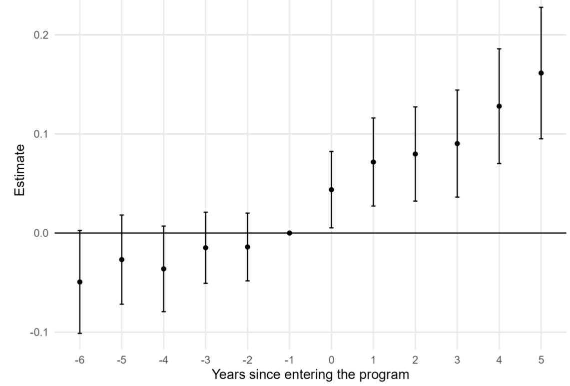
| | Share Pasture (Satellite) | Share Agriculture (Satellite) | Share Pasture (Declaration) | Share Agriculture (Declaration) |
|---|---|---|---|---|
| Post $\times$ Non-Denounced | 0.002$^{*}$ | -0.000 | 0.002 | 0.002 |
| | (0.004) | (0.003) | (0.003) | (0.003) |
| Mean ($t = -1$) | 0.341 | 0.252 | 0.433 | 0.314 |
| # Treated | 934 | 934 | 934 | 934 |
| # Distinct Obs | 2,043 | 2,043 | 2,043 | 2,043 |
| Obs | 24,496 | 24,496 | 24,496 | 24,496 |

*Notes:* This table reports Difference-in-Differences estimates for the outcomes listed in the column headers. "Share Pasture" denotes the fraction of municipal farmland used as pasture, while "Share Agriculture" denotes the fraction used for crops. "Satellite" columns use land-use data from MapBiomas, and "Self-declared" columns use information reported by farmers. All regressions include municipality and year fixed effects. The row "Mean ($t = -1$)" reports the pre-treatment mean of each dependent variable. Standard errors in parentheses, clustered at the municipality level.
Significance levels: $^*$ : $p < 0.1$, $^{**}$ : $p < 0.05$, $^{***}$ : $p < 0.01$.

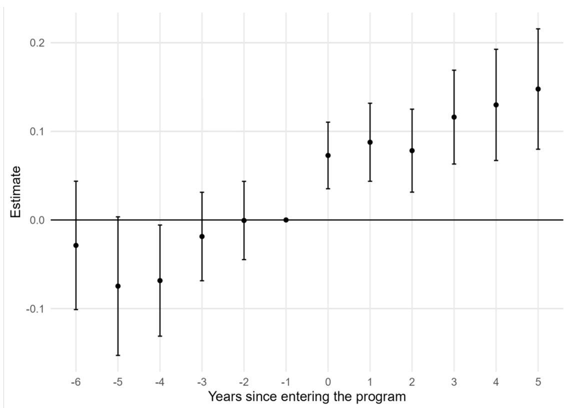
Figure A.3: IHS(ITR Due) by farm size



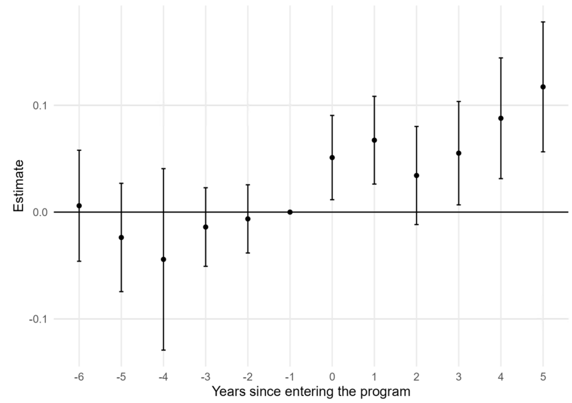

(a) Farms over 1000ha




(b) Farms between 100 to 1000ha




(c) Farms between 50 to 100ha




(d) Farms under 50ha

**Notes:** The figure plot estimates of the effects of the decentralization agreements on different outcomes obtained using equation (2). The x-axis shows the relative time since decentralization while the y-axis plot the coefficients and their respective 95% confidence intervals. Each panel reports results for farms in different size intervals.

Table A.7: Differences-in-Differences results by farm size

| | IHS(ITR Due) $\leq$ 50 ha | IHS(ITR Due) 51–100 ha | IHS(ITR Due) 101–1000 ha | IHS(ITR Due) $>$ 1000 ha |
|---|---|---|---|---|
| Post × Non-Denounced | 0.087*** | 0.140*** | 0.121*** | 0.059* |
| | (0.021) | (0.025) | (0.019) | (0.034) |
| Mean (t=-1) | 37.231 | 251.948 | 1167.756 | 27,289.244 |
| Obs | 24,496 | 24,468 | 24,341 | 19,300 |
| # Treated | 934 | 934 | 934 | 934 |
| # Distinct | 2,043 | 2,043 | 2,043 | 2,043 |

*Note:* This table reports Difference-in-Differences estimates of decentralization effects on the *average ITR paid*, disaggregated by farm size. "Mean ($t = -1$)" gives the pre-treatment average ITR. The number of observations, treated municipalities, and distinct municipalities are reported below. Estimates for farms larger than 1,000 hectares rely on a smaller sample (19,300 observations) because many municipalities have no farms in this size group. Municipalities without farms in a given size group are excluded from the corresponding averages. Standard errors in parentheses, clustered at the municipality level.
Significance levels: $^*: p < 0.1$, $^{**}: p < 0.05$, $^{***}: p < 0.01$.

Table A.8: Average effect of ITR by region

| | North | Northeast | Southeast | South | Midwest |
|---|---|---|---|---|---|
| Post × Non-Denounced | 0.219*** | 0.342*** | 0.185*** | 0.093*** | 0.186*** |
| | (0.071) | (0.104) | (0.028) | (0.023) | (0.035) |
| Obs | 2039 | 2701 | 10844 | 7536 | 5464 |
| # Distinct | 146 | 193 | 775 | 538 | 391 |
| Mean ITR ($t = -1$,Thousands R$) | 82.39 | 82.59 | 246.25 | 198.07 | 178.49 |
| # Treated | 58 | 26 | 254 | 321 | 275 |
| $R^2$ | 0.949 | 0.949 | 0.955 | 0.978 | 0.975 |

rm
*Note:* This table reports regression results restricted to municipalities within the same Brazilian region. The dependent variable is the logarithm of ITR revenue. "# Clusters" denotes the number of municipalities in the regional sample. "Mean pre (level)" gives the average pre-treatment ITR revenue (in thousands of BRL). "# Treated" indicates the number of treated municipalities in each region. Standard errors in parentheses, clustered at the municipality level.
Significance levels: $^*: p < 0.1$, $^{**}: p < 0.05$, $^{***}: p < 0.01$.