

The Politics of Property Taxation: Fiscal Infrastructure and Electoral Incentives in Brazil^{*}

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Abstract

Land titling encourages private investment and enables tax collection. Yet, governments across the developing world often fail to invest in land registration systems, such as cadastral maps that record land ownership and values. In this paper, we describe and estimate the fiscal benefits and political costs that elected officials face when deciding whether to invest in this critical fiscal infrastructure. Focusing on Brazilian municipalities, we find that cadaster updates increase property tax revenue by around 15 percent. Officials covet this revenue, but they simultaneously seek to secure their reelection. Investing in the cadaster can generate political costs by angering tax-averse voters or undermining clientelism. When these political costs are large, we expect to see greater investment in the cadaster when officials do not face reelection pressures. Using a close-election regression discontinuity, we find that term-limited incumbents are around 15 percentage points more likely to update the cadaster.

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1. Introduction

Taxation is a basic government function, enabling states to maintain their monopoly on violence, fund legal institutions, and pay for policies (e.g., [Tilly 1985](#); [Besley and Persson 2011](#); [Hoffman 2015](#)). Beyond the simplest poll tax, taxation requires information about who owns taxable assets (e.g., income, exportable goods, property) and in what amounts. To compile this register, governments must build and maintain the fiscal infrastructure to log owners and the value of their properties.

In the case of property taxation, the cadastral map is the cornerstone of this infrastructure. The cadaster stores information about the boundaries of a plot, who owns it, and its valuation. According to [Scott \(1999, 36\)](#), the cadastral map is the crowning artifact of states' efforts to codify property rights and thus enable the taxation of land. "Since the driving logic behind the maps is to create a manageable and reliable format for taxation," he explains, "the map is associated with a property register in which each specified (usually numbered) lot on the maps is linked to an owner who is responsible for paying its taxes." These maps make property tax collection feasible at scale: lacking any local knowledge about property claims, a collector knows who to tax and in what amount.¹

As with other types of critical infrastructure, a functional land registry is often taken for granted. Yet, the development of a cadastral map has long been recognized as a political act: [Kain and Baigent \(1992, 344\)](#) write, "where knowledge is power, [the cadastral map] provides comprehensive information to be used to the advantage of some and the detriment of others, as rulers and ruled were well aware in the tax struggles of the eighteenth and nineteenth centuries." Beyond serving as a key component of a working property tax system, the cadastral map codifies property rights over land and forms the basis of their enforcement, with direct implications for economic development. We focus in this paper on contemporary efforts to sustain working cadasters. Using Brazilian municipalities as a laboratory, we enumerate and estimate the fiscal benefits and political costs that local elected officials face when deciding whether to invest in this fiscal infrastructure.

¹ The "legibility" that the cadastral map provides may also broaden the tax base by encouraging external investment as in [Christensen, Hartman and Samii \(2018\)](#).

Past work argues that leaders invest in the cadaster when the expected increase in tax receipts exceeds the surveying costs (Kain and Baigent 1992). In Brazil, cadastral overhauls include re-registering properties with faulty records, updating property boundaries and ownership information, and adjusting assessed values. These investments generate more accurate and current records that support property tax collection. They also reduce the cost to titling informal properties, which, in turn, can increase the tax base. Using a difference-in-differences design that compares changes in property tax revenue in municipalities that update their cadaster, relative to the change in municipalities that do not, we find a sizable and immediate fiscal return: property tax revenue increases by around 15 percent. In the subset of municipalities with available data, we also show that cadaster updates increase the proportion of registered properties by about 4 percentage points. This represents a (within-municipality) standard deviation increase in registration rates.

Despite these fiscal benefits, uniform investment in local cadasters has not followed: between 2010 and 2015, just over half of Brazil's municipalities met current technical standards by updating their cadasters. Moreover, a simple fiscal cost-benefit explanation cannot account for existing cadaster deficiencies in Brazil. We find that reductions in the cost of investing in the cadaster — measured through access to the *Programa de Modernização da Administração Tributária* (PMAT), a program of subsidized loans intended to modernize municipal tax administrations — do not lead to a higher probability of a cadastral overhauls.

We argue, instead, that political costs impede investment. Incumbents in modern democracies face electoral incentives: they may want to enhance local tax efforts, but they simultaneously want to bolster their reelection prospects. And investing in the cadaster could work against the latter goal in two ways: first, voters, including the wealthy, may balk at higher property taxes; second, in a clientelist system, politicians may secure political support from unregistered dwellers (e.g., squatters) by promising protection from eviction or access to public services. By reducing tenure informality, a comprehensive cadastral map could eliminate an important tactic used to mobilize voters.

If electoral costs weigh heavily on incumbents, then we would expect to see greater investment in the cadaster when officials do not face reelection contests. Using a close-election regression

discontinuity (RD), we find exactly that: term-limited incumbents are around 15 percentage points more likely to update the cadaster, an increase of almost 40 percent over the mean in control municipalities. These results are robust to covariate adjustment, as well as different bandwidths and orders of the local polynomial regressions employed to estimate the term-limit effect at the discontinuity.

We look for evidence that election-seeking incumbents defer investments because they fear a tax revolt or wish to maintain a larger block of voters susceptible to clientelistic appeals. If an incumbent's primary goal is to increase taxes without triggering voter backlash, including from wealthy property owners, then we would expect a concerted effort to raise tax rates when freed from reelection concerns. Yet, beyond updating the cadaster, term-limited incumbents are not more likely to reform local property tax laws (which set tax rates) or revise the formulas that assign the fiscal value of properties. Instead, we find that our estimated term-limit effect on cadastral investment is larger in municipalities with high inequality and poverty — conditions that have been identified as conducive to clientelism. This suggests that reelection-seeking officials fear the weakening of local political machines, which thrive in informal settlements where households require political intermediation to secure public services and are vulnerable to eviction threats.

Past research has highlighted other political determinants of fiscal capacity development. Yet, this primarily historical work has tended to focus on unconstrained autocrats (often monarchs), whose incentives to invest in fiscal capacity were shaped by geographic constraints (e.g., [Mayshar, Moav and Neeman 2017](#)), interstate war (e.g., [Tilly 1985; Queralt 2018](#)), intra-elite conflict (e.g., [Beramendi, Dincecco and Rogers 2018; Garfias 2018](#)), and institutions of limited government (e.g., [Dincecco 2011; Cox 2016](#)). More contemporary work, specific to cadastral investments and property taxation, has focused on the role of internal conflict, as well as on the local capture of tax institutions (e.g., [Ch et al. 2018; Hollenbach and Silva n.d.](#)). We contribute to this body of research by exploring the role of electoral incentives, as well as by presenting quasi-experimental evidence of their relevance in shaping incumbents' decisions to invest in fiscal capacity.

The political costs we identify also help explain a larger puzzle: given the social and individual benefits to secure property rights, why do so many households remain untitled? Recent findings suggest that the demand for titling may be more muted than suggested by earlier research (De Soto 2000). Squatters may not fear eviction, and titling does not seem to ease credit constraints (Galiani and Schargrodsy 2010; 2011), especially in urban settings. As such, despite the documented effects of titling, unregistered households may not anticipate outsized benefits to formalizing their properties. Our research helps illuminate problems on the supply-side. Electoral politics may discourage officials from investing in the land registry and, in so doing, providing the infrastructure required for delineating ownership. This can contribute to high registration or re-registration costs, which has led to de-regularization in some contexts (e.g., Galiani and Schargrodsy 2016; Gutierrez and Molina 2016).

This paper also adds to existing empirical work that characterizes the effects of political term limits, particularly in Brazil. In the absence of electoral incentives, mayors find it more tempting to engage in rent-seeking activities, such as corruption (Ferraz and Finan 2011). Moreover, when weak parties cannot constrain their members' behavior, term limits may engender a systematic incumbency disadvantage by damaging party brands (Klašnja and Titiunik 2017). This work suggests that accountability is not well served by political term limits. Our findings do not speak to how tax revenues are spent and thus do not challenge this conclusion. We do, however, show that term limits can generate the right incentives to invest in essential fiscal infrastructure.

2. The Costs of Property Taxation

Government officials have an ostensible interest in registering property. Scott (1999, 36), in fact, argues that “the fiscal or administrative goal toward which all modern states aspire is to measure, codify, and simplify land tenure.” “The cadastral map is,” he notes, “the crowning artifact of this mighty simplification.” And its purpose is clear: “create a manageable and reliable format for taxation [...] The cadastral map and property register are to the taxation of land as the maps and tables of the scientific forester were to the fiscal exploitation of the forest.” In this sense, the cadaster is a key

part of the infrastructure that enhances states' capacity to mobilize revenue, similar to civil registries, statistical offices, and censuses (e.g., Brambor et al. 2016; Lee and Zhang 2017).

The anticipated fiscal benefits of the cadastral map have motivated domestic and donor-led efforts to institute and update land-registration systems. Durand-Lasserve et al. (2007, 48-9) note that the “the integration of informal settlements into the formal urban land and housing market is widely held to increase tax revenues to local governments.” They cite the cases of Thailand and Ukraine, where titling programs generated large increases in tax revenues.² Updates to the cadaster have also been shown to generate a substantial increase in property tax proceeds in Colombia (Sánchez Torres and Pachón 2013; Martínez 2017).

Government investments in the cadaster and land-registration systems can increase tax receipts through multiple channels. First, they can improve the capacity of the government to crack down on tax evasion by detecting additional irregular construction on already registered parcels (e.g., Casaburi and Troiano 2015). Second, if investments in the cadaster lower households’ land titling costs, the number of formalized properties potentially assessed and taxed can increase. Finally, if a (well functioning) cadaster increases tenure security or access to credit, it can encourage investments that ultimately increase the value of properties (e.g., Alston, Libecap and Schneider 1996; Field 2005; Galiani and Schargrodsky 2010). For this to occur, the cadaster must be kept up to date in order to reassess properties after households make any investments or market prices change. These channels are not mutually exclusive; investments in land registration could simultaneously impact both the extensive and intensive margins of property taxation, affecting how many properties are registered and the taxes collected on those properties.

Across Brazilian municipalities and cross-nationally, there is wide variation in how much governments invest in their land administrations. Despite a large number of unregistered households — as many as three quarters of land parcels globally and half of the Brazilian population (United Nations

² D'Arcy and Nistotskaya (2018) show that European states with a longer history of administering a cadaster have higher tax-to-GDP ratios today.

Task Team on Habitat III 2015, 3) — many governments do not facilitate titling.³ The fiscal upside that Scott identifies, and that we document for the Brazilian case below, must sometimes be offset by the administrative or political costs associated with rationalizing land registration.

The administrative costs of updating the cadaster are substantial and upfront. Costs can include surveying, the adjudication of boundary disputes, new IT infrastructure, and specially trained staff. These investments are financially burdensome for many local governments (e.g., [Bahl and Bird 2008](#); [Carvalho Jr. 2017](#)). In interviews we conducted with municipal governments across Brazil, these outlays were cited as one reason for foregoing the establishment or maintenance of the cadaster. And even if tax receipts increase in response to public investments, they may do so slowly; the link, for example, between land registration, property investment, and increased tax receipts can operate over years. Elected officials may worry that they will be out of office before their cadastral investments pay off in the form of higher tax receipts. This suggests that incumbents with longer time horizons should be more inclined to invest in their local cadasters. In our context — and assuming the political consequences of cadaster updates are inconsequential — first-term mayors should be most likely expend resources on the cadaster, as they can expect to realize the benefits over their remaining years in office.

Elected officials may, however, be concerned about the political ramifications of establishing or maintaining the cadaster. Voters, especially wealthy property owners, reliably resent the regular reassessment of their property values if this implies a firm enforcement of tax obligations — property taxes are, after all, especially visible (e.g., [Cabral and Hoxby 2012](#); [Bordignon, Grembi and Piazza 2017](#)). Moreover, in settings with low initial fiscal capacity, like Brazil, voters may expect little benefit from marginal increases in taxation, which may not be enough to fund public goods ([Gottlieb and Hollenbach 2018](#)). Fearing punishment at the polls, reelection-seeking incumbents may tradeoff increased tax receipts for their political survival (however, see [Casaburi and Troiano 2015](#)).

³ Arsenault, Chris, 2017. "Half of Brazil's Population lack full property rights, government says." *Reuters*, 28 January. Available at <<https://www.reuters.com/article/us-brazil-landrights-politics/half-of-brazils-population-lack-full-property-rights-government-says-idUSKBN15C00A>>.

More cynically, incumbents may exploit informal tenure to mobilize voters (e.g., Collier 1974; Boone 2009). In a clientelistic system, incumbents can trade protection for electoral support, for example, promising squatters relief from harassment or eviction threats in return for votes. Formalizing these squatters' property rights eliminates the need for any such exchange. Larreguy, Marshall and Trucco (2015, 4) make a similar argument in Mexico, observing that:

Political brokers and municipal government officials often offer squatters protection against eviction and the basic infrastructure that informal communal settlements lack in exchange for political support for the municipal incumbent party [...] Consequently, the establishment of land property rights has the potential to substantially diminish the dependency of squatters upon incumbent political parties, particularly at the municipal level, and thus break down clientelistic ties.

Relatedly, Holland (2016) documents the specific ways in which mayors sabotage eviction efforts, including refusing to sign eviction orders or stalling police action in Bogotá and Lima. She emphasizes the political incentives driving these decisions, especially when they affect poor squatters.

The risk of eviction is not the only source of vulnerability for squatters. In cities across the developing world, irregular settlements face challenges — including legal barriers — securing public services, a situation that generates additional opportunities for clientelism. Well-documented examples include irregular settlements in India (e.g., Jha, Rao and Woolcock 2007; Auerbach 2016), Argentina (e.g., Auyero 2001), Ecuador (e.g., Burgwald 1995), Peru (e.g., Collier 1974; Stokes 1991), Mexico (e.g., Cornelius 1975; Lomnitz 1978; Varley 1994), and Brazil (e.g., Perlman 1976; Gay 1990; 1994).

Incumbents up for reelection may not want to reduce households' costs to registering their properties if informality provides a lever for pushing these households to the polls. In our context, these political considerations weigh most heavily on first-term mayors, who are still eligible for reelection. If these are paramount in incumbents' decision making then our prediction is reversed: freed from reelection concerns, second-term mayors should be more inclined to invest in the cadaster.⁴

⁴ Beyond the electoral incentives that we focus on, elite capture remains prevalent in young electoral democracies

2.1 Formalizing the Incumbent's Problem

We offer a simple formalization to illustrate our argument. An official is elected and can serve up to two terms, provided they win reelection. Absent any investment, the official can collect $\tau \geq 0$ in property taxes in each term. She values this revenue, which enables the implementation of her preferred policies or can be a source of rents.⁵

The official can pay a one-time cost $k \geq 0$ to update the cadaster and thereby increase tax receipts by $e \geq 0$ in every current and subsequent term. We denote this decision $i \in \{0, 1\}$. The downside of investment is that it reduces the official's reelection probability: $\phi(i) \in (0, 1)$ and $\phi(i = 1) \leq \phi(i = 0)$.⁶ That is, updating the cadaster *reduces* the official's probability of staying in office for a second term.

In the official's second and final term, relieved from any reelection concerns, she chooses to invest if $e \geq k$. This *direct profitability condition* allows for the possibility that administrative costs, k , are simply too high relative to the fiscal benefits of a cadastral overhaul — including instances in which updates bring sizable fiscal benefits that nonetheless are not realized fast enough to offset the upfront investment cost.

Let us assume that the *direct profitability condition* is met. Of course, the official could collect even more tax receipts by making the cadastral investment in her first term. However, she will want to pay the electoral penalty for doing so if and only if:

$$(\tau + e - k) + \phi(i = 1)(\tau + e) \geq \tau + \phi(i = 0)(\tau + e - k)$$

$$\frac{e - k}{\tau + e} \geq \underbrace{\phi(i = 0) - \phi(i = 1)}_{\text{Electoral Penalty}}$$

and stands as a complementary explanation for the observed deficiencies in their fiscal infrastructure (e.g., [Acemoglu, Vindigni and Ticchi 2011](#)). For the case of Brazil, [Hollenbach and Silva \(n.d.\)](#) show that municipalities with high levels of inequality — where the wealthy have the strongest incentives to capture local administrations — collect less property taxes and are less likely to undertake fiscal capacity-enhancing investments.

⁵ Note that the actions of a revenue-maximizing official do not necessarily lead to improved welfare outcomes. Specifically, our argument does not require that officials are well-intentioned and use increased tax revenue to provide public services.

⁶ This reduced-form approach captures two political costs described earlier. First, updating the cadaster reduces the cost of titling for informal households, which in turn weakens political machines that thrive in informal settlements; and second, the increased property taxes generate an electoral backlash from property owners, including the wealthy.

This *political profitability condition* is more likely to be satisfied when the electoral penalty is small or when the fiscal benefits of the update (e) are larger.

This result is only true when cadaster updates generate an electoral penalty.⁷ Consider the possibility that this does not happen, $\phi(i = 0) = \phi(i = 1) = \phi$. When this is the case, the right side of the *political profitability condition* is zero, and the condition is always satisfied when the *direct profitability condition* is met.

This simple model generates clear predictions about which incumbents should invest in the cadaster. If administrative costs are overwhelming, then the *direct profitability condition* is not met, and no incumbent invests in updating the cadaster. When this is not the case, whether first- or second-term incumbents are more likely to invest depends on the magnitude of the electoral penalty. If the electoral penalty is small, then first-term incumbents should be most likely to update the cadaster, as they could enjoy the fiscal benefits over multiple terms. Where the electoral penalty is consequential, we expect greater investment among term-limited officials, who will not face voters again at the polls.

3. Land Administration and Local Politics in Brazil

3.1 Land Administration and Taxation

Cadasters store data on land parcels: what are the boundaries of the plot, who owns it, how is it zoned, what is its fiscal valuation. Well-functioning cadasters guide local planning, facilitate property registration, and provide governments with a solid fiscal foundation. Yet, they are of uneven, often deficient quality in Brazil, and more broadly in Latin America (De Cesare 2012).

Up-to-date cadasters facilitate the registration and titling of property. Despite the formal separation between the cadaster (*Cadastro Imobiliario*) and the property registry (*Cartorio de Registro de Imoveis*) in Brazil, updated cadasters provide a formal and reliable record of occupation, which facilitates the

⁷ If updating the cadaster improves incumbents' reelection prospects — for example, because they can repurpose increased tax revenues for their reelection campaigns — then first-term mayors would be far more likely to update. Our results below reject this implication. Moreover, among first-term mayors, we find no relationship between deciding to update the cadaster prior to the 2012 election and reported campaign expenditures (Appendix Table A.2).

registration process. Local officials report that an current cadaster can be used to determine whether squatters have been peacefully inhabiting a plot for five years — a requirement for acquiring a formal title. Absent this information, a lengthy and expensive judicial process is required to prove that a plot has no prior owner. Investments in the cadaster can, thus, shave several years and considerable costs off of registering new properties.⁸ This is especially relevant for Brazil, where land registration continues to be a major challenge: [Carvalho Jr. \(2006\)](#) estimates that only 60 percent of urban parcels were registered by 2004, and more recent figures from the Ministry of Cities estimate that half of Brazilian households lack full property rights over their dwellings.

Throughout Latin America, cadasters were originally devised to levy property taxes. In Brazil, this tax, the *Imposto sobre a Propriedade Predial e Territorial Urbana* (IPTU), is administered by municipal governments and based on the fiscal valuation of properties. Cadasters enable governments to collect the IPTU by keeping the official assessments of property values, tax payers, and tax liabilities ([Pinto Domingos 2011](#); [De Cesare 2012](#)). Below, we empirically assess the role of cadaster updates on IPTU revenue by compiling comprehensive annual data on local tax revenue in 2015 constant reals from *Finanças do Brasil*, FINBRA ([2018b](#)) for 2004–2012; and from the *Sistema de Informações Contábeis e Fiscais do Setor Público Brasileiro*, SICONFI ([2018a](#)) for 2013–2015.

Property taxes are the second largest source of local taxes, accounting for roughly a quarter of local tax receipts.⁹ There is a widespread recognition that property taxes could play an even larger role in local public finances (e.g., [Pinto Domingos 2011](#); [De Cesare 2012](#); [Carvalho Jr. 2017](#)). These types of taxes have several attractive qualities. They are more likely to be spent in public goods rather than in private rents (e.g., [Gadenne 2017](#); [Martínez 2017](#)).¹⁰ Property taxes also provide a stable

⁸ The use of new technologies in maintaining the cadaster — including topographical, remote sensing, and photogrammetric surveys — can also help reduce the direct costs of registration for local governments, by providing many of the required inputs for land titling drives ([Erba 2007](#)).

⁹ Municipal government revenue in Brazilian comes mostly from federal and state transfers, which account for about 70 percent of local budgets (68 percent in 2014). The remaining income comes from fees (11 percent) and locally generated tax revenue (21 percent). A local services tax, the *Imposto sobre Serviços de Qualquer Natureza* (ISSQN), provides 48 percent of locally generated tax revenue ([Ministério da Fazenda do Brasil 2014](#); [Carvalho Jr. 2017](#)).

¹⁰ Conversely, federal transfers or natural resource rents reduce spending in public goods and increase local corruption ([Brollo et al. 2013](#); [Caselli and Michaels 2013](#)). These findings are in line with a larger literature that characterizes fiscal contracts, in which taxation is linked to state performance (e.g., [Levi 1988](#); [Timmons 2005](#); [Paler 2013](#); [Timmons and Garfias 2015](#)).

and predictable source of revenue. Finally, among different types of taxes, these generate the least negative effect on economic growth ([OECD 2010](#)). When households can choose where to relocate among many jurisdictions, property taxes are equivalent to user fees (e.g., [Oates 1969](#); [Glaeser 1996](#)).

In our empirical analysis, we focus on cadaster updates, given the importance of these investments for land registration and property tax collection.¹¹ We use data from the *Pesquisa de Informações Básicas Municipais 2015*, which reports the last year that each municipality updated its cadaster in its entirety. The overhaul includes reinspecting properties to identify physical and ownership changes, and ultimately reassessing their cadastral or fiscal value. Re-registration of properties with faulty records is also common. (We identify cadaster updates separately from reforms to the property tax rates and revisions to the formulas used to determine fiscal land values, which need not occur simultaneously.) Cadastral updates entail high up-front costs: highly skilled staff, aerial imagery, and tax mapping, in addition to extensive fieldwork and organized record-keeping ([Carvalho Jr. 2017](#)). International organizations recommend that cadasters be updated every 4, and no longer than 6 years ([Pinto Domingos 2011](#); [IAAO 2013](#)); yet, as Table 1 shows, only roughly half of Brazil's municipalities follow these guidelines.

Table 1: Last Year of Cadaster Update as of 2015

Years Since Last Update	Period of Last Update	Number of Municipalities	Percentage of Municipalities
More than 6	2009 or before	2,177	39%
Up to 6	2010 – 2015	2,944	53%
Up to 4	2012 – 2015	2,452	44%

Percentages do not add to 100% because of non-reporting municipalities.

Source: *Pesquisa de Informações Básicas Municipais 2015*.

This low level of investment is not due to legal constraints on mayors. Mayors (*prefeitos*) in Brazil play a decisive role in local land administration and property taxation. There are a number of important measures that mayors can implement by executive decree, without the approval of the city council (*Câmara de Vereadores*). One of these measures is the cadaster update, which includes

¹¹ We do not focus on the initial decision to set up a cadaster due to data limitations; by 2012, almost 93.9 percent of Brazilian municipalities already had a cadaster, which leaves little variation to explore.

reassessing properties, as well as rebasing land values using the national inflation rate. Other policies that do require the ratification of the city council include major reforms to the local property tax law, modifying tax rates, or revising the assessment formulas in ways that effectively increase fiscal values above the inflation rate.

3.2 Mayoral Politics

Since 1996, Brazilian mayors (*prefeitos*) are elected for four-year periods by plurality and are eligible for reelection once.¹² By and large, mayoral positions do not serve as a launching pad for higher offices: from 1996-2008, only 1.6 percent of mayors moved to a state or federal office, and 96.1 percent either won reelection (38.1 percent) or left electoral politics altogether (58 percent) (Magalhães and Hirvonen 2015, 16).¹³

Mayors and city councilors engage in vote-buying across Brazil, where clientelism has deep historic roots and remains widespread (Roniger 1987; Hagopian 1996; Speck 2003; Gingerich 2014). Under anti-vote-buying legislation, for instance, 667 politicians were removed from local office from 2000 to 2008 (Nichter 2011). In a nationally representative survey, 28 percent of respondents reported witnessing vote-buying during the 2014 electoral cycle.¹⁴ Conditions for clientelistic exchanges are particularly prevalent in irregular settlements, where tenure insecurity can be exploited for political gain. In these settlements, public services and safety are deficient, creating opportunities for political entrepreneurs that trade handouts and protection for support (Gay 1990; 1994; Nichter and Peress 2016).

¹² In municipalities with populations higher than 200,000, a run-off election is held if no candidate wins a simple majority. Mayors, even term-limited ones, can run for office in a later, non-consecutive term.

¹³ While Brazil displays a very strong federalism, and municipalities have substantial policy responsibilities — including the provision education, health, transportation, local infrastructure, and land management — subnational political power lies at the state level (Samuels 2000; 2004). Furthermore, while elsewhere incumbents generally possess an electoral advantage when seeking reelection, this is less clear for Brazilian mayors, who have been shown to face an incumbency *disadvantage* (Titunik 2009; Brambor and Ceneviva 2011; but see Magalhães 2015). At the municipal level, this disadvantage may be linked to Brazil's notoriously weak party system, where party-switching is pervasive (Desposato 2006; Klašnja and Titunik 2017; Novaes 2017).

¹⁴ Survey conducted by Checon Pesquisa/Borghi Lowe and commissioned by the Tribunal Superior Eleitoral (TSE): 1,914 respondents in all states.

To study the role of mayoral time horizons and political incentives on their decision to update the cadaster, we use electoral data from the 2012 local election from the *Tribunal Superior Eleitoral* (TSE), which includes election returns and individual characteristics of candidates.

4. Estimating the Benefits and Costs of Property Taxation

We turn now the the ramifications, both fiscal and political, of updating the local cadaster. In this section, we show that cadaster updates lead to a sizable increase in property tax revenues. The results point to a clear and pretty immediate fiscal upside (e , in our formalization). We do not see a simultaneous increase in other local taxes, suggesting the revenue increases are attributable to the updates. We also find that updates increase property registration rates.

We then characterize the determinants of these cadaster updates. First, we show that effective reductions in administrative costs (k , in our formalization), have no impact on the likelihood of cadaster overhauls. This casts doubt on a straightforward budgetary explanation for infrequent updates — if external subsidized financing for local fiscal capacity does not increase the likelihood of updates, then the *direct profitability condition* is unlikely to bind.

We turn to estimating the political cost of cadaster overhauls. Using close elections, we show that second-term mayors who cannot run for reelection are substantially more likely to invest. This suggests a consequential electoral penalty (i.e., $\phi(i = 0) > \phi(i = 1)$). Term-limited mayors do not, however, institute other reforms that raise tax revenue. Descriptively, we also find that cadastral investments are more likely in more unequal municipalities with high poverty rates — settings past work suggests are conducive to clientelism. These findings suggest that consequential political costs can rationalize the prevalent underinvestment in the cadaster and, more broadly, defective systems of land administration and property taxation.

4.1 The Effect of Cadaster Updates

First, we evaluate whether updating the cadaster leads to higher property tax revenues. If this is not true, then it is not puzzling that mayors fail to invest. We implement a difference-in-differences

estimation strategy, comparing changes in property tax revenue (IPTU) in municipalities that update their cadaster, relative to the change in municipalities that do not. Our basic specification is:

$$\log(\text{IPTU}_{it}) = \beta \text{ Cadaster Update}_{it} + \lambda_t + \gamma_i + \varepsilon_{it}, \quad (1)$$

where $\log(\text{IPTU}_{it})$ is the logged property tax revenue in municipality i in year t ; $\text{Cadaster Update}_{it}$ is an indicator that takes the value of one when the cadaster is updated and in subsequent years; λ_t and γ_i are year and municipality fixed effects, respectively; and ε_{it} is an error term. We cluster all standard errors at the municipality level.

We amend this base model, adding indicators for related reforms, such as revisions to the fiscal land values and local property tax laws. To further demonstrate robustness, we also add state-by-year fixed effects and include the last year of a cadaster update for those municipalities that do not update under the period of analysis.¹⁵

The updating of the cadaster is surely affected by municipal-specific factors, such as the economic structure and geography, that may also correlate with property tax revenues. However, our empirical strategy accounts for these factors so long as they do not vary over the period of analysis. $\hat{\beta}$ estimates the average causal effect of cadaster updates on those municipalities that update when $E(\varepsilon_{it} | \text{Cadaster Update}_{it}, \lambda_t, \gamma_i) = 0$. This implies the standard parallel-trends assumption: that, in the absence of the update, the trends in property tax revenue (logged) in municipalities that do and do not update would have remained parallel. We provide supportive evidence of parallel trends prior to treatment in Figure 1. The coefficient estimates to the left of zero are negligible, indicating that property tax revenues do not increase in anticipation of treatment (i.e., pre-trends are not diverging).

Table 2 presents the main results. Columns 1 and 2 report estimates from the basic specification, while columns 3 and 4 include additional covariates. Columns 4 to 6 present similar estimates but are limited to the 2012-2015 period, which is the focus of our subsequent analysis. We find positive and statistically significant coefficients on the cadaster update in all specifications. The magnitude is economically meaningful: updating the cadaster increases property tax revenue by over 10 percent.

¹⁵ Our control municipalities include those that have yet to update their cadaster and those that never do during

Table 2: Cadaster Updates and Property Tax Revenue

	Property Tax Revenue, IPTU (log)					
	2004–2015			2012–2015		
	(1)	(2)	(3)	(4)	(5)	(6)
Cadaster Renovation	0.20*** (0.023)	0.15*** (0.025)	0.12*** (0.026)	0.083*** (0.030)	0.13*** (0.035)	0.10*** (0.038)
Revision to Fiscal Land Values Formula		0.076*** (0.029)		0.085*** (0.030)		0.064* (0.034)
Reform to IPTU Law		0.24*** (0.037)		0.22*** (0.038)		0.21*** (0.076)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
GDP per cap (log)	No	No	Yes	Yes	Yes	Yes
Year × State FE	No	No	Yes	Yes	Yes	Yes
Year × Year of Last Pre-2004 Cadaster Update	No	No	Yes	Yes	Yes	Yes
Within-Mun. Mean of DV	11.3	11.9	11.4	12.0	11.7	12.3
Within-Mun. SD of DV	0.76	0.64	0.77	0.64	0.47	0.39
R sq.	0.85	0.88	0.85	0.88	0.92	0.93
Observations	59236	38188	49086	31682	19096	12394
Number of Municipalities	5121	3276	5121	3276	5098	3266

OLS estimations. See equation (1) for the econometric specification. The unit-of-analysis is the municipality-year. Standard errors (clustered at the municipality level) in parentheses.

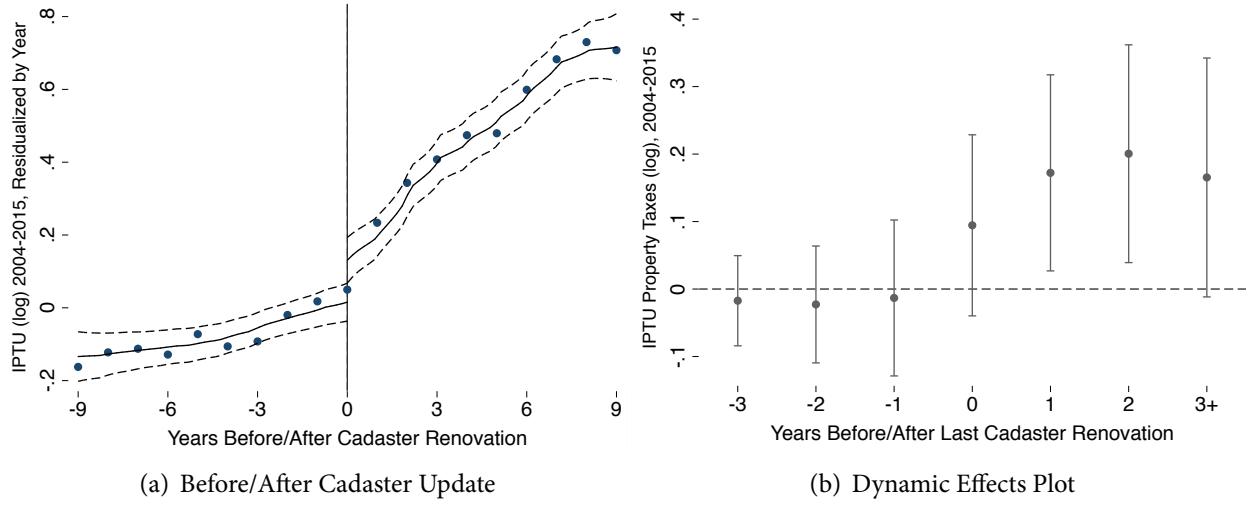
Figure 1 presents the results graphically, and further shows that the effect of cadaster updates emerges clearly with a one-year lag and persists for at least one additional year. This pattern suggests that elected officials who may be considering investing in improving the cadaster can reasonably expect fiscal benefits over the short term.¹⁶

In Section B.1, we also present results of the effect of cadaster updates on property registration rates. Given the relative paucity of these data, which are not collected systematically by the central government, we rely on census-based estimates of property registration rates and survey responses

the 2004–2012 period. We include time-interacted year of a last cadaster update prior to 2004 to flexibly account for differential time trends by time since the last update.

¹⁶ In Section B.2, we show that cadaster updates do not affect the other major source of local tax revenue, the services tax. This suggests that the estimated effect of updates on property tax revenue does not simply reflect a general effort to increase tax collection, but the impact of the update itself.

Figure 1: Cadaster Updates and Property Tax Revenue



The figure on the **left** plots Nadaraya-Watson regression of logged IPTU, after partialling out calendar year fixed effects, on the years before and after the cadaster update. Scatter points bin and average the residualized logged IPTU taxes. The figure on the **right** displays the point estimates and 95% confidence intervals from a dynamic panel regression including municipality and year fixed effects on indicator variables for three leads and lags of a cadaster update. The final lag is equal to 1 for every year beginning with the third year after the update.

by local tax officials. This reduces the number of municipalities with registration rate estimates in at least two points in time to approximately 60. Despite this much smaller sample, we find an increase in the rate of property registration of around 4 percentage points — an effect that is close to a full within-municipality standard deviation in registration rates over time — using a similar difference-in-differences approach as above.

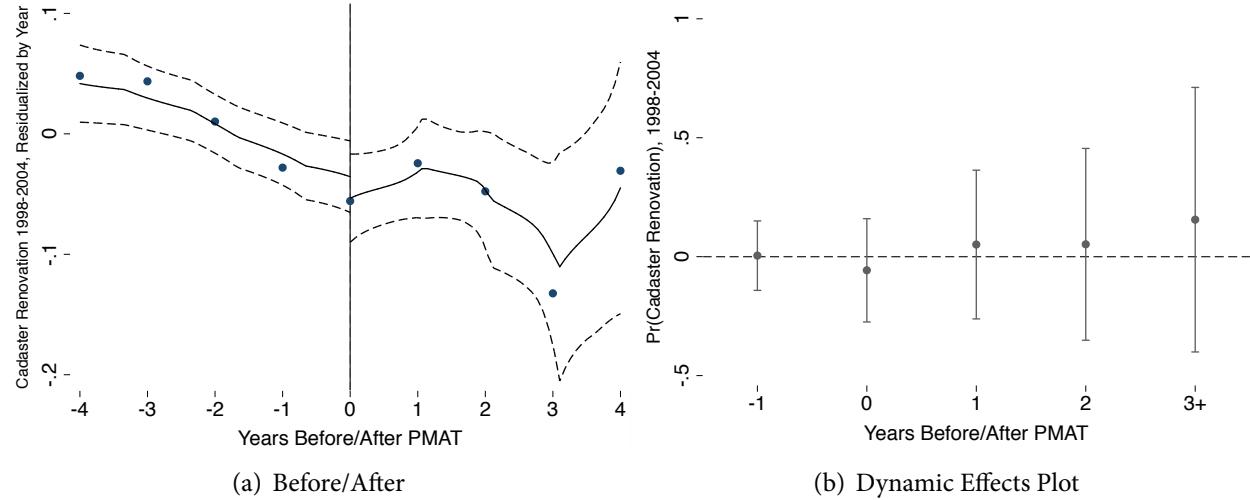
4.2 The Fiscal Determinants of Cadaster Updates

Cadaster updates lead to higher property tax revenues within just two years. These fiscal benefits, however, need to be weighed against the administrative and political costs of an update. The administrative costs of an update could be so high that mayors opt not to invest (i.e., the *direct profitability condition* might not be met).

To evaluate whether this simple fiscal calculus explains the prevalence of deficient cadasters, we leverage a national program implemented by the Brazilian Development Bank. The PMAT grants subsidized loans to municipalities to enable three types of investments in fiscal capacity: bolstering enforcement through audits; increasing tax compliance by expanding and simplifying payment options; and increasing monitoring capacity by updating tax registries, including the cadaster. We

use data on the PMAT from 1998 to 2004, compiled by [Gadenne \(2017\)](#), which includes the time of application and receipt of the first subsidized loan, as well data on the last year of a complete cadaster update, from the *Pesquisa de Informações Básicas Municipais 2004*.

Figure 2: The PMAT Program and Cadaster Updates



The figure on the **left** plots Nadaraya-Watson regression of cadaster update, after partialling out calendar year fixed effects, on the years before and after receiving the PMAT program. Scatter points bin and average the residualized cadaster update. The figure on the **right** displays the point estimates and 95% confidence intervals from a dynamic panel regression including municipality and year fixed effects on indicator variables for one lead and three lags of receiving the PMAT. The final lag is equal to 1 for every year beginning with the third year after receiving the program. The data corresponds to 248 municipalities that received the PMAT from 1998 to 2004.

Past work has shown that participation in the PMAT increases municipal tax revenue ([Gadenne 2017](#)). However, despite reducing the cost of updating the cadaster, the PMAT has no discernible impact on the probability that a municipality undertakes this specific investment. Figure 2 illustrates the null effect of receiving the PMAT on the probability of a cadaster update, by comparing those municipalities that receive the PMAT earlier in the period to those that receive it later. In Section B.3, we present estimates of the impact of the PMAT on cadaster updating, using a difference-in-difference approach similar to equation 1, and employing alternative control groups. The results consistently show no impact of lowering the cost of fiscal-capacity investments on cadaster updates.

For the municipalities that apply to the PMAT, administrative costs do not seem to explain the infrequency of cadaster updates. This sample is not representative; yet, despite being richer and larger, 40 percent of PMAT municipalities' cadasters had failed to update in the last 4 years (by 2004), and

30 percent had last let it lapse for longer than 6 years ([Instituto Brasileiro de Geografia e Estatística 2004](#)). While these figures are smaller than those for 2015 shown in table 1, the rates are similar to the universe of Brazilian municipalities, with 37 percent and 28 percent failing to update in the last 4 and 6 years, respectively.

4.3 The Political Determinants of Cadaster Updates

Given the demonstrable fiscal upside and affordable administrative costs, we argue that two political considerations might discourage reelection-seeking mayors from investing: higher effective tax rates might anger property owners, tenure insecurity may be the basis for clientelistic exchanges, or both. This leaves first-term mayors facing a difficult tradeoff (characterized by our earlier *political profitability condition*). On the one hand, early investments in the cadaster offer the largest expected stream of fiscal benefits; on the other, updating the cadaster could imperil a mayor’s chance of winning reelection.

For second-term mayors things are simpler: while they have less time in office to enjoy the increased tax receipts, there is no political downside to overhauling the cadaster.¹⁷ In this section, we empirically evaluate which mechanism — time horizons or political constraints — dominate in Brazilian municipalities. To do this, we compare rates of cadaster update among mayors facing term limits versus those with the possibility to run for reelection.

We recognize that simple comparisons between first- and second-term mayors may be misleading. Reelected mayors and the municipalities they govern are likely different along many unobserved dimensions. Any of these unobserved factors can spuriously generate differences in the rate of cadaster updates. We overcome these difficulties by evaluating cadaster updates in closely contested elections. By focusing on narrow victories, we can reasonably assume random assignment of term limits at the victory threshold, which allows us to estimate the local average treatment effect of term-limits on the probability of a cadaster update.¹⁸

¹⁷ A term-limited incumbent may still worry about the electoral penalty if an ally or family member plans to run for office. Despite this, the difference in political incentives for term-limited mayors persists; after all, first-term mayors will also consider their allies’ prospects.

¹⁸ We consider updates that occur in the 2013–2015 period to avoid attributing overhauls that started during the 2008–2012 term to the incoming administration.

We estimate a sharp regression discontinuity (RD). Adopting the potential outcomes notation, we define $Y_i(1)$ and $Y_i(0)$ as the outcome of interest in municipality i — e.g, a cadaster update in the 2013-2015 period — under a term-limited (treatment) or first-term (control) mayor, respectively. Assignment to treatment occurs if the incumbent candidate wins, i.e., the margin of victory is positive ($V_i \geq 0$).¹⁹ We focus on the sharp average treatment effect at the threshold, $\tau = E\{Y_i(1) - Y_i(0)|V_i = 0\}$, and estimate

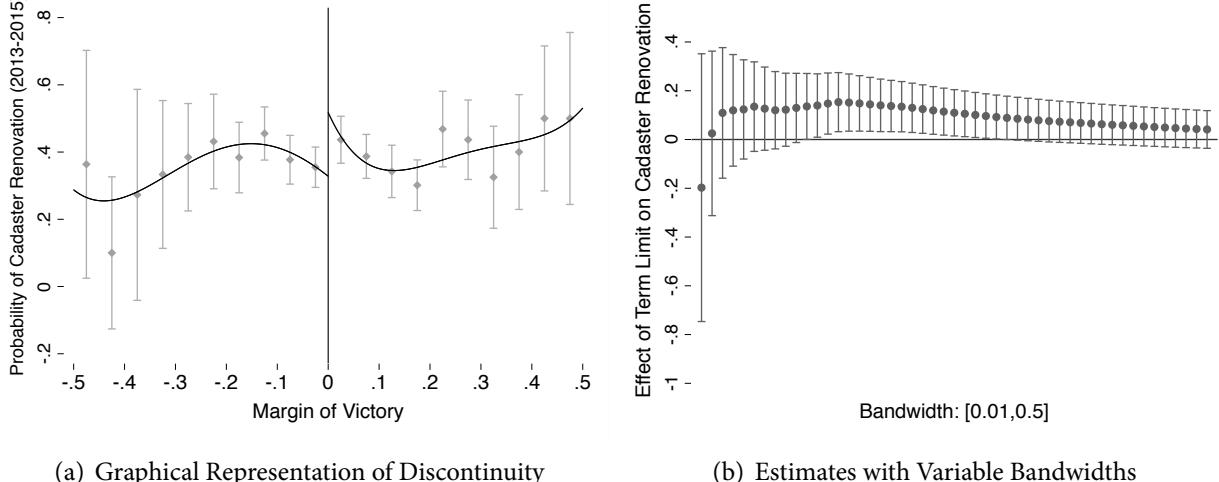
$$\tau = \mu_+ - \mu_-, \quad (2)$$

where $\mu_+ = \lim_{v \downarrow 0} \mu(v)$, $\mu_- = \lim_{v \uparrow 0} \mu(v)$, and $\mu(v) = E(Y_i|V_i = v)$. We employ the following local polynomial RD estimator:

$$\hat{\tau}_p = \hat{\mu}_+(h_n) - \hat{\mu}_-(h_n),$$

where $\hat{\mu}_+(h_n)$ and $\hat{\mu}_-(h_n)$ correspond to the intercept at the electoral victory threshold ($v = 0$) of a weighted p th order polynomial regression for treatment and control municipalities, respectively.

Figure 3: Mayoral Term-Limits and Cadaster Updates in Close Elections



The figure on the **left** plots the discontinuity. Each line is a 4th-order polynomial fitted over the interval [-50%, +50%], in the vote-share margin of victory of incumbent mayors. Scatter points are sample averages over 10-unit intervals. The figure on the **right** displays the point estimates and 95% conventional confidence intervals on 1-st order local-polynomial RD estimates at variable bandwidths, ranging from 1% to 50%. We use triangular kernels.

In Figure 3, we visualize the discontinuity. There is a visible jump at the electoral threshold in the probability of cadaster updates in treated municipalities, where an incumbent is reelected and now faces a term limit. In Table C.1, we also present evidence of balance at the discontinuity on other

¹⁹ We drop municipalities with no first-term mayor running for reelection.

covariates, including incumbent candidate characteristics (gender, college education, affiliation to the PT, *Partido dos Trabalhadores*) and pre-2012 municipal characteristics (population, proportion rural, any IPTU collected, Gini coefficient, and proportion poor). This demonstrates that other covariates do not change sharply at the discontinuity, bolstering the identifying assumption.

Table 3: Effect of Mayoral Term-Limits on Cadaster Updates in Close Elections

	Cadaster Update, 2013-2015							
	No Covariate Adjustment				Covariate Adjustment			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Incumbent Won in 2012	0.11* (0.055) [0.051]	0.15** (0.062) [0.014]	0.17** (0.072) [0.016]	0.16* (0.084) [0.052]	0.091* (0.055) [0.098]	0.15** (0.062) [0.014]	0.17** (0.072) [0.019]	0.18** (0.075) [0.018]
Robust Std. Errors	0.065	0.070	0.080	0.090	0.065	0.069	0.081	0.080
Robust P-Value	0.031	0.011	0.026	0.085	0.060	0.012	0.034	0.027
Order of the Local Polynomial	0	1	2	3	0	1	2	3
Covariate Adjustment	No	No	No	No	Yes	Yes	Yes	Yes
Bandwidth	0.047	0.14	0.23	0.31	0.045	0.13	0.22	0.38
Mean of Control	0.35	0.40	0.39	0.39	0.35	0.40	0.39	0.39
Observations	416	1077	1467	1624	386	1042	1427	1702

See equation (2) for the econometric specifications. The unit-of-analysis is the municipality. Conventional standard errors and p-values in parentheses and brackets, respectively. MSE-optimal bandwidths and heteroskedasticity-robust nearest neighbor standard errors described in [Calonico, Cattaneo and Titiunik \(2014\)](#). We use triangular kernels. Covariates include the incumbent candidate's gender, college education and affiliation to the PT; the municipalities' logged population, Gini index, and % poor in 2010; and avg. 2009-2011 logged total budget and any IPTU collection by 2012.

Table 3 presents estimates of local average treatment effect of mayoral term limits on the probability of a cadaster update. Each estimate is based on data-driven MSE-optimal bandwidths described in [Calonico, Cattaneo and Titiunik \(2014\)](#) and different orders of the local polynomial regressions. Figure 3 also plots estimates at varying bandwidths. These results are largely robust to adjusting for covariates (columns 5-8) and to other alternative bandwidth selection procedures (Table C.2). Across columns, the effect of mayoral term-limits is positive and large. It hovers around 15 percentage points, which corresponds to close to a 40 percent increase with respect to the mean of the control group.

For first-term mayors in competitive municipalities, these results suggest that the political conse-

quences of updating the cadaster dominate its potential fiscal benefits. Yet, for second-term mayors the opposite is true, despite the strict limits on their remaining time in office.

First-term mayors' reluctance to update the cadaster could be due to fears that (1) reducing tenure informality eliminates certain clientelistic exchanges, or (2) increasing property taxation will anger voters. In Latin American democracies, including in Brazil, incumbent politicians often exploit citizens' vulnerability to secure their political support. Such practices include offering particularistic benefits in exchange for votes (e.g., [Stokes 2005](#); [Hicken 2011](#); [Gans-Morse, Mazzuca and Nichter 2013](#); [Diaz-Cayeros, Estévez and Magaloni 2016](#); [Bobonis et al. 2017](#)). Untitled households face threats of eviction and challenges accessing public services. These voters are particularly susceptible to local politicians' contingent promises of protection or access in return for electoral support (e.g., [Collier 1974](#); [Larreguy, Marshall and Trucco 2015](#); [Holland 2016](#)). This is not lost on reelection-seeking politicians. They recognize that facilitating formalization by improving the cadaster eliminates this strategy for mobilizing political support. However attractive the fiscal windfall might appear to first-term mayors, the prospect of losing such a powerful political tool may guide their decision-making.

We first note that the effect of cadaster updates on property registration rates described above (and in Section B.1) is consistent with this mechanism: newly titled property owners are more difficult for politicians to mobilize electorally.²⁰ In Table 4, we look for additional evidence in support of this clientelistic mechanism. Systematic data on the presence and strength of local political machines is unavailable for Brazilian municipalities. We instead focus on observable conditions that have been identified as conducive to clientelism: income inequality and poverty (e.g., [Robinson and Verdier 2013](#); [Nichter and Peress 2016](#)).²¹ The first two columns split our sample into municipalities with below- and above-median municipal Gini, respectively. Consistent with a clientelistic mechanism,

²⁰ Furthermore, these new registered properties are likely contributing to the documented higher property tax outlays. While some municipalities waive property taxes to poor residents, this is hardly the norm. For instance, in a sample of 50 municipalities, only a third reported some form of exemptions based on income or ability-to-pay ([Lincoln Institute of Land Policy 2015](#)).

²¹ An alternative measure that directly identifies irregular settlements — *aglomerados subnormais* — using the 2010 population census is unfortunately only available for a small subset of municipalities, and has little overlap with our RD. Both Gini and poverty, however, are positively correlated with this measure (see Figure A.1).

Table 4: Effect of Mayoral Term-Limits on Cadaster Updates in Close Elections
Heterogeneous Effect By Income Inequality and Poverty

	Cadaster Update, 2013-2015			
	By Gini Coefficient		By Gini Coefficient and % Poor	
	Below Median	Above Median	Below Median	Above Median
	(1)	(2)	(3)	(4)
Incumbent Won in 2012	0.087 (0.087) [0.32]	0.21** (0.090) [0.021]	0.092 (0.070) [0.19]	0.23** (0.11) [0.038]
Robust Std. Errors	0.10	0.10	0.082	0.12
Robust P-Value	0.30	0.018	0.23	0.028
Order of the Local Polynomial	1	1	1	1
Covariate Adjustment	No	No	No	No
Bandwidth	0.15	0.15	0.16	0.13
Mean of Control	0.41	0.38	0.37	0.41
Observations	494	631	722	405

See equation (2) for the econometric specifications. The unit-of-analysis is the municipality. Conventional standard errors and p-values in parentheses and brackets, respectively. MSE-optimal bandwidths and heteroskedasticity-robust nearest neighbor standard errors described in [Calonico, Cattaneo and Titiunik \(2014\)](#). We use triangular kernels. The median municipal Gini and proportion poor are 0.49 and 18.2%, respectively. These measures are computed from the 2010 population census.

the term-limit effect is twice as large in high-inequality municipalities. This gap in the term-limit effect is similar when estimating the RD on municipalities with both above-median Gini and poverty incidence (column 4) or not (column 3).²²

A second possible political cost does not depend on clientelistic motives. Voters, especially wealthy property owners, may simply punish reelection-seeking mayors who increase their tax obligations, either through higher rates or improved enforcement (e.g., [Besley and Case 1995](#); [Alt, Bueno de Mesquita and Rose 2011](#); [Gottlieb and Hollenbach 2018](#)). This alternative political mechanism does not explain the heterogeneous effects presented in Table 4, but it is also not ruled out by them. We more directly test for this second mechanism by estimating the effect of term-limits on two other

²² While these differences in magnitude are notable, we likely cannot reject the null of no difference between the coefficients in models 1 and 2 or 3 and 4.

Table 5: Null Effect of Term-Limits on Other Property Tax Reforms

	Revision to Fiscal Land Values Formula, 2012-2015							
	No Covariate Adjustment				Covariate Adjustment			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Incumbent Won in 2012	0.0088 (0.039) [0.82]	0.017 (0.056) [0.76]	0.015 (0.071) [0.83]	0.019 (0.085) [0.82]	-0.0080 (0.037) [0.83]	-0.0052 (0.056) [0.93]	-0.0093 (0.070) [0.89]	0.000079 (0.083) [1.00]
Robust Std. Errors	0.052	0.067	0.080	0.092	0.049	0.066	0.078	0.091
Robust P-Value	0.76	0.80	0.83	0.81	0.91	0.86	0.91	0.94
Order of the Local Polynomial	0	1	2	3	0	1	2	3
Covariate Adjustment	No	No	No	No	Yes	Yes	Yes	Yes
Bandwidth	0.091	0.17	0.24	0.30	0.095	0.16	0.23	0.28
Mean of Control	0.30	0.31	0.31	0.32	0.30	0.31	0.32	0.32
Observations	758	1226	1475	1602	790	1176	1444	1570

	Reform to IPTU Law, 2012-2015							
	No Covariate Adjustment				Covariate Adjustment			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Incumbent Won in 2012	-0.0041 (0.023) [0.86]	0.011 (0.029) [0.71]	0.0088 (0.035) [0.80]	-0.020 (0.045) [0.65]	0.00029 (0.024) [0.99]	0.011 (0.030) [0.70]	0.010 (0.035) [0.77]	-0.012 (0.044) [0.78]
Robust Std. Errors	0.029	0.034	0.038	0.048	0.029	0.034	0.039	0.046
Robust P-Value	0.79	0.66	0.83	0.59	0.70	0.69	0.84	0.70
Order of the Local Polynomial	0	1	2	3	0	1	2	3
Covariate Adjustment	No	No	No	No	Yes	Yes	Yes	Yes
Bandwidth	0.079	0.19	0.29	0.27	0.073	0.17	0.26	0.27
Mean of Control	0.082	0.096	0.098	0.099	0.083	0.096	0.098	0.099
Observations	687	1331	1593	1560	627	1265	1529	1557

See equation (2) for the econometric specifications. The unit-of-analysis is the municipality. Conventional standard errors and p-values in parentheses and brackets, respectively. MSE-optimal bandwidths and heteroskedasticity-robust nearest neighbor standard errors described in [Calonico, Cattaneo and Titiunik \(2014\)](#). We use triangular kernels. Covariates include the incumbent candidate's gender, college education and affiliation to the PT; the municipalities' logged population, Gini index, and % poor in 2010; and avg. 2009-2011 logged total budget and any IPTU collection by 2012.

property tax reforms that are unrelated to land-registration costs: first, revisions to fiscal land values formulas, which specify how properties are appraised; and second, any reforms to the local property tax (IPTU) law, which sets tax rates.²³ We estimate equation 2 employing the RD design introduced

²³ Reforms to the IPTU law and major revisions to the fiscal land values require approval from city council. However,

earlier.

The results are reported in Table 5. In contrast to cadaster updates, the local average treatment effect of term limits on these other tax-increasing policies is estimated to be zero across specifications and bandwidth-selection procedures. If an incumbent's primary hangup was that voters revolt in response to higher property taxes, we would expect the mayor to ramp up tax obligations when freed from reelection concerns.²⁴ This is not borne out in our data and indirectly suggests that clientelistic concerns may weigh more heavily on the mayor's mind.²⁵

5. Conclusion

In this paper, we offer a political explanation for faulty cadasters. While there is mounting evidence that land titling encourages private investment and can increase tax revenues, governments across the developing world frequently fail to build this critical fiscal infrastructure or allow it to fall into disrepair.

Cadastral maps make property visible to the state and were originally developed in non-democratic settings — from the *tabulariums* in Ancient Rome, and the Domesday Book in medieval England, to Spain's Catastro de Ensenada, and the modern Napoleonic cadaster in revolutionary France ([Kain and Baigent 1992](#)). Historically, monarchs and other autocrats put off investing in fiscal infrastructure due to sizable, upfront administrative costs and the risks of rebellion or threatening powerful private interests (e.g., [Besley and Persson 2011](#); [Garfias 2018](#)).²⁶

smaller revisions to fiscal land values formulas, up to the national inflation rate, can be enacted by mayoral decree ([Pinto Domingos 2011](#)).

²⁴ These results are in line with work by [Casaburi and Troiano \(2015\)](#), who find that a program that increased property tax enforcement (by identifying unregistered or 'ghost' constructions) increased reelection rates in Italian cities.

²⁵ Our heterogeneous effects and null results on other tax reforms also cast doubt on an alternative explanation for our findings — namely, that second-term mayors are more experienced and thus better able to institute reforms. An account based on mayors' experience does not predict that inequality or poverty moderate the term-limit effect, nor does it imply that reform efforts concentrate on the cadaster.

²⁶ Political institutions that solve commitment problems between rulers and taxpayers have also enabled investments in fiscal capacity; such institutions helped to sustain fiscal pacts in which taxes were traded for public services (e.g., [Bates and Lien 1985](#); [Dincecco 2011](#)), or in which tax policies were constrained by taxpayers (e.g., [Cox 2016](#); [Garfias 2019](#)). To a large extent, this is the trajectory of local property taxes in the US (e.g., [Wallis 2001](#); [Sokoloff and Zolt 2007](#)). These fiscal pacts may be harder to emerge for property taxation in settings like Brazil's, where local budgets are covered mostly by transfers from other levels of government.

In present-day democracies, such as Brazil, political conflict among the political elite is mediated by electoral institutions, with candidates competing for office. These officials, just as autocratic rulers, value higher tax receipts, which enable them to implement their agendas or secure rents. Yet, they must also consider how investments in the cadaster affect their reelection prospects. Voters qua taxpayers might revolt against higher effective property taxes. Alternatively, enabling registration may reduce tenure informality and thereby the efficiency of political machines that mobilize electoral support through promises to unregistered households. These political costs do not fall evenly on candidates — in particular, incumbents that do not expect to continue their political careers are not affected. If the political costs are substantial, we argue that these term-limited officials should be more likely to implement cadaster overhauls.

To assess these ideas, we use subnational data from Brazilian municipalities, which enjoy broad legal authority to implement local taxation and manage their cadasters. First, using a difference-in-differences design, we show that cadaster updates generate a roughly 15 percent increase in property tax receipts, the second most important source of locally generated revenue in Brazilian municipalities. We also find that cadaster overhauls lead to about a 4 percentage point increase in the rate of property registration among a subset of municipalities with available data. This represents a (within-municipality) standard deviation increase in registration rates. We rule out the straightforward explanation that investments in the cadaster are simply too costly; we find that reductions in the cost of updates, through subsidized loans earmarked to modernize the local tax administration, do not increase the likelihood of investing in updating the cadaster.

We then turn to evaluate a political explanation. We focus on close local elections between new challengers and incumbents, who become term-limited if they win. Using a close-election RD, we find that term-limited mayors are around 15 percentage points more likely to update the local cadaster. The political effect we document — by definition a local average treatment effect of term-limits at the electoral discontinuity — could account for a sizable share of all cadaster updates in Brazil if we extrapolated across the country: it corresponds to 34 percent of the overall updates that occur within

the recommended periods.²⁷ We also show that this term-limit effect is strongest in highly unequal and poor municipalities. This suggests that the political costs faced by incumbents arise from the weakening of local political machines, which lose influence when households gain formal tenure. In contrast, we find that term-limited mayors are no more likely to reform the local property tax law or to revise the formulas that determine the fiscal assessment of properties. These findings are inconsistent with an account in which incumbents fear punishment from voters for raising effective tax rates.

While we study Brazilian municipalities, our findings can help inform the varying quality of the local tax infrastructure elsewhere in Latin America. Mexico, for instance, has until very recently lacked municipal reelection, but unlike Brazil has strong parties that discipline mayors who seek to climb the party ranks or to become embedded in patronage networks (e.g., [Langston 2009](#)). Under these conditions, our argument implies that local officials, even if uniformly term-limited, will have weaker incentives to update the cadaster. In Colombia, on the other hand, cadaster overhauls are administered by a federal agency, which likely mitigates local political backlash for mayors (e.g., [Martínez 2017](#)). In line with our ideas, while Mexico displays one of the lowest rates of property tax collection as a proportion of GDP in the region, Colombia is one of the top performers, and Brazil sits in between ([De Cesare 2012](#)).

Our findings also suggest that the problem of deficient fiscal infrastructure may not be entirely technological. Promising new technologies reduce the cost of cadaster overhauls, such as the use of satellite imagery described by [Ayalew Ali, Deininger and Wild \(2018\)](#). These are important innovations, but may not, on their own, ultimately provide a durable solution in the presence of the political costs that we document.

²⁷ We have no evidence to conclude that our estimated local treatment effect generalizes; however, we note that the RD sample is not too different from the rest of Brazilian municipalities along many observables (see Table A.1).

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Supporting Information

The Politics of Property Taxation: Fiscal Infrastructure and Electoral Incentives in Brazil

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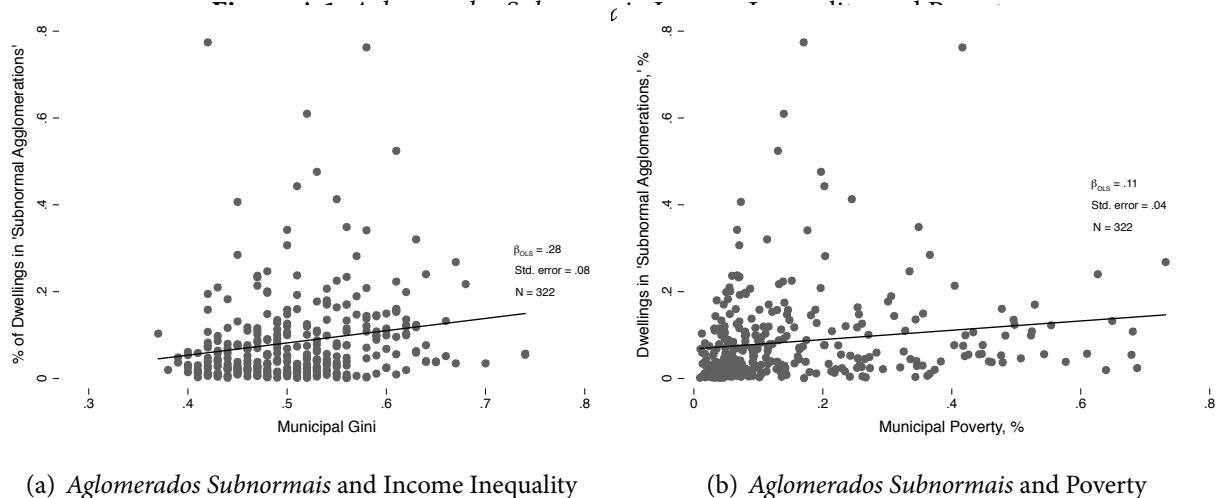
A. Descriptives

A.1 Descriptive Statistics

Table A.1: Descriptive Statistics

	All Municipalities			Municipalities with Incumbents Running for Reelection			Municipalities with Incumbents Running for Reelection in Close Elections ($h_{CCT} = 0.12$)		
	count	mean	sd	count	mean	sd	count	mean	sd
Cadaster Renovation	5567	0.40	0.49	1919	0.39	0.49	987	0.39	0.49
Revision to Fiscal Land Values	5568	0.34	0.47	1919	0.33	0.47	987	0.30	0.46
New IPTU Law, 2013-2015	5568	0.09	0.28	1919	0.08	0.27	987	0.08	0.27
Population (log), 2010	5563	9.41	1.15	1919	9.42	1.11	987	9.33	1.04
Proportion Rural, 2010	5563	0.31	0.20	1919	0.32	0.20	987	0.33	0.19
Collects Any IPTU by 2012	5563	0.94	0.24	1919	0.93	0.25	987	0.92	0.27
Gini, 2010	5563	0.49	0.07	1919	0.49	0.07	987	0.50	0.07
Poverty Incidence, 2010	5561	0.23	0.18	1918	0.24	0.18	986	0.25	0.18
Female Incumbent				1919	0.11	0.31	987	0.12	0.33
Incumbent with College Education				1919	0.49	0.50	987	0.49	0.50
PT Incmbent				1919	0.12	0.33	987	0.13	0.33

A.2 Irregular Settlements (*Aglomerados Subnormais*), Income Inequality, and Poverty



The unit-of-analysis is the municipality. *Aglomerados subnormais* are irregular settlements identified by the clustering of at least 51 dwellings with recent irregular tenure and either a lack of public services or irregular urbanization. Data from the 2010 population census.

A.3 Prior Cadaster Renovation (2008-2012) and Reported Campaign Expenditures (2012)

Table A.2: Past Cadaster Renovations and Reported Campaign Expenditures

	Reported Campaign Expenditures (log) in 2012		
	(1)	(2)	(3)
Cadaster Renovation (2008-2012)	-0.031 (0.077)	-0.034 (0.074)	0.012 (0.060)
Margin of Victory, 2008		0.18 (0.22)	-0.072 (0.15)
Number of Candidates, 2012		0.40*** (0.036)	0.0072 (0.032)
Covariates	No	No	Yes
State FE	No	No	Yes
Mean of DV	12.6	12.6	12.6
SD of DV	1.13	1.12	1.12
R sq.	0.00016	0.13	0.50
Number of Municipalities	1176	1155	1150

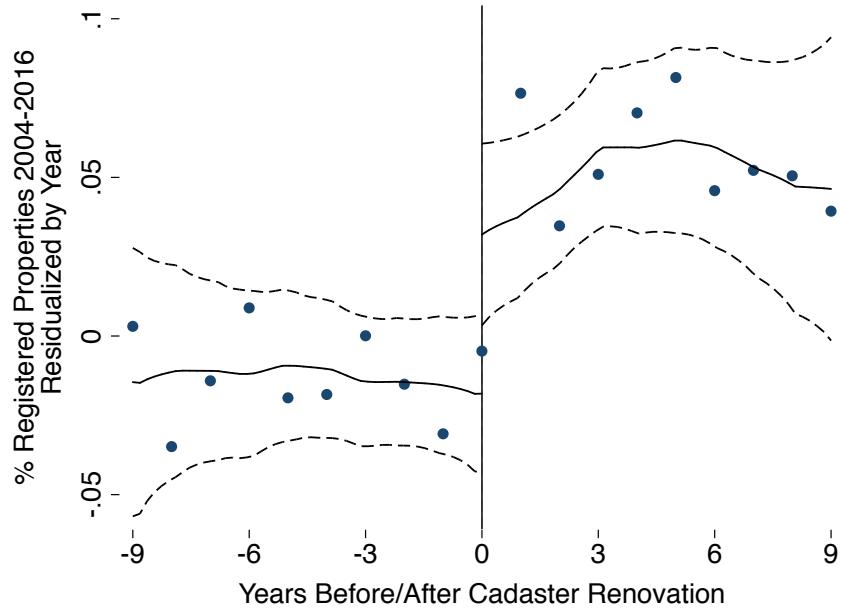
OLS estimations. The unit-of-analysis is the municipality. Robust standard errors in parentheses. The sample is limited to municipalities with a first-term incumbent that ran for reelection in the 2012 elections, and in which the cadaster was not renovated after 2012.

B. Additional Evidence: Mechanisms

B.1 Cadaster Renovation and Property Registration Rates

In this section, we document the effect of cadaster renovations on property registration rates for a sample of Brazilian municipalities. In contrast with public finance data, information on local property registration is not collected systematically by the Brazilian federal government. For this reason, we rely on two alternative sources. First, we use survey responses by local officials collected by the [Lincoln Institute of Land Policy \(2015\)](#) and [Carvalho Jr. \(2017\)](#). These responses correspond to years that range from 2008 to 2016, depending on the municipality. To leverage changes within municipalities over time, we follow [Carvalho Jr. \(2006\)](#) and indirectly generate a second set of approximate property registration rates in 2004.

Figure B.1: Cadaster Renovation and Property Registration Rates in a Sample of Municipalities
Property registration rates increase after a cadaster renovation.



The figure plots Nadaraya-Watson regression of the proportion of registered properties, after partialling out year fixed effects, on the years before and after the cadaster renovation. Scatter points bin and average the residualized registration rates. The sample is limited to 58 municipalities that responded surveys by the [Lincoln Institute of Land Policy \(2015\)](#) and [Carvalho Jr. \(2017\)](#). Registration rates for 2004 are estimated using census information on the number of households and business offices along with the [Pesquisa de Informações Básicas Municipais 2004](#).

Concretely, we use data on the number of registered properties (*unidades prediais cadastradas*) in 2004, reported in the [Pesquisa de Informações Básicas Municipais 2004](#), and divide it by the sum of

the number of business offices (also in 2004, from the *Cadastro Central de Empresas* 2004) and the total number of residences, as measured by the 2000 census. Despite potential measurement error, this approximation has been found to display the expected geographic patterns ([Carvalho Jr. 2006](#)).²⁸ Among municipalities with at least two measurements (one in 2004, and others in 2008-2016), we construct a panel by linearly interpolating registration rates. With these data, which is available for only up to 61 municipalities, we estimate equation 1.²⁹

In Figure B.1 presents the main result graphically: after partialling out year fixed effects, there is a visible increase in registration rates after a cadaster renovation. This pattern is borne out in the estimation results, which are presented in Table B.1. Columns 1 and 2 present the baseline results, while columns 3 and 4 include year by state fixed effects and the time-interacted year of last cadaster renovation prior to 2004 to flexibly account for differential time trends by time since the last update. All columns include a time-interacted indicator for whether the measure was obtained by the Lincoln surveys (as opposed to the Carvalho Jr. one), which display higher average registration rates, arguably due to the employed survey instrument.

Despite the small sample of municipalities, we are able to detect the effect of cadaster renovations. The results indicate that a cadaster overhaul leads to an increase of around 4 percentage points in registration rates, though the inclusion of additional covariates reduces the magnitude and precision of the point estimate. In contrast, other measures that local governments take to increase property tax revenue, such as revisions to the fiscal land values formulas or reforms to the local property tax laws have no effect on registration rates.

²⁸ Sources of measurement error include, for example, differential migration between 2000 and 2004; understatements in registration rates in municipalities where multiple residential or commercial units are aggregated into single registrations; or even overstatements in registration rates when registered units do not correspond to residences or offices (e.g., parking lots). Assuming these errors in measurement are not systematically related to cadaster updates, they would lead to a reduction in the precision of our estimates.

²⁹ The surveys are mostly conducted in medium or large municipalities, which might account for the relatively high baseline coverage rates in the subsample. Using the 2004 measurement, which is available for most of the country, the average registration rate is 63%, while in the panel subsample this figure is 81% .

Table B.1: Cadaster Renovation and Property Registration Rates

	Property Registration Rates					
	(1)	(2)	(3)	(4)	(5)	(6)
Cadaster Renovation	0.043** (0.020)	0.047* (0.024)	0.045** (0.020)	0.048* (0.025)	0.028 (0.024)	0.027 (0.027)
Revision to Fiscal Land Values Formula		-0.013 (0.025)		-0.011 (0.022)		-0.011 (0.022)
Reform to IPTU Law		-0.014 (0.022)		0.015 (0.030)		0.023 (0.032)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Year × Lincoln Sample	Yes	Yes	Yes	Yes	Yes	Yes
GDP per cap (log)	No	No	Yes	Yes	Yes	Yes
Year × State FE	No	No	Yes	Yes	Yes	Yes
Year × Year of Last Pre-2004 Cadaster Update	No	No	No	No	Yes	Yes
Within-Mun. Mean of DV	0.81	0.81	0.81	0.81	0.81	0.81
Within-Mun. SD of DV	0.058	0.054	0.057	0.054	0.057	0.054
R sq.	0.82	0.84	0.84	0.85	0.84	0.86
Observations	600	537	599	536	599	536
Number of Municipalities	61	55	61	55	61	55

OLS estimations. See equation (1) for the econometric specification. The unit-of-analysis is the municipality-year. Standard errors (clustered at the municipality level) in parentheses. The sample is limited to municipalities that responded surveys by the [Lincoln Institute of Land Policy \(2015\)](#) and [Carvalho Jr. \(2017\)](#). Registration rates for 2004 are estimated using census information on the number of households and business offices along with the [Pesquisa de Informações Básicas Municipais 2004](#). The missing values between registration rate estimates are linearly interpolated.

B.2 Cadaster Renovation and Other Taxes

Table B.2: Cadaster Renovation and Local Services Tax Revenue

	Local Services Tax Revenue, ISSQN (log)					
	2004–2015			2012–2015		
	(1)	(2)	(3)	(4)	(5)	(6)
Cadaster Renovation	0.026 (0.016)	0.0048 (0.019)	0.020 (0.018)	-0.0034 (0.022)	0.046 (0.028)	0.042 (0.034)
Revision to Fiscal Land Values Formula		-0.014 (0.020)		-0.012 (0.020)		-0.021 (0.031)
Reform to IPTU Law		0.088*** (0.025)		0.073*** (0.026)		0.086 (0.053)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
GDP per cap (log)	No	No	Yes	Yes	Yes	Yes
Year × State FE	No	No	Yes	Yes	Yes	Yes
Year ×						
Year of Last Pre-2004 Cadaster Update	No	No	Yes	Yes	Yes	Yes
Within-Mun. Mean of DV	13.0	13.2	13.0	13.3	13.4	13.7
Within-Mun. SD of DV	0.68	0.66	0.70	0.67	0.36	0.32
R sq.	0.86	0.88	0.86	0.89	0.89	0.92
Observations	59541	38300	49391	31794	19401	12506
Number of Municipalities	5121	3276	5121	3276	5106	3268

OLS estimations. See equation (I) for the econometric specification. The unit-of-analysis is the municipality-year.
Standard errors (clustered at the municipality level) in parentheses.

B.3 The PMAT and Cadaster Renovation

To evaluate the role of the *direct profitability condition* in explaining the prevalence of deficient cadasters, we estimate the impact of the PMAT program, which grants subsidized loans that are earmarked to modernize local tax administrations, on the probability of a cadaster renovation. If the main constraint to overhauling the cadaster is the cost of the investment relative to the anticipated fiscal benefit, then the PMAT should increase the probability of a renovation.

Table B.3: The PMAT Program and Cadaster Renovation

	Cadaster Renovation (1998-2004)			
	PMAT Sample: 1998-2004		PMAT Sample: 1998-2009	
	(1)	(2)	(3)	(4)
PMAT	0.044 (0.048)	0.022 (0.043)	0.017 (0.042)	-0.016 (0.031)
Has applied	-0.032 (0.037)	-0.031 (0.031)	-0.030 (0.033)	-0.035 (0.026)
Municipality FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
GDP per cap (log)	No	Yes	No	Yes
Year × State FE	No	Yes	No	Yes
Year ×				
Year of Last Pre-1998	No	Yes	No	Yes
Cadaster Update				
Within-Mun. Mean of DV	0.70	0.70	0.70	0.70
Within-Mun. SD of DV	0.32	0.32	0.33	0.33
R sq.	0.63	0.73	0.63	0.74
Observations	1736	1736	2359	2359
Number of Municipalities	248	248	337	337

OLS estimations. Econometric specification similar to equation (1). The unit-of-analysis is the municipality-year. Standard errors (clustered at the municipality level) in parentheses. We lead the dependent variable (cadaster renovation) by one year. The sample is limited to municipalities that participate in the PMAT between 1998 and 2004 (columns 1 and 2) or 2009 (columns 3 and 4). PMAT participation data from [Gadenne \(2017\)](#).

We use PMAT data from [Gadenne \(2017\)](#), which we match using official population figures to data on the last complete cadaster update by 2004, from [Instituto Brasileiro de Geografia e Estatística \(2004\)](#). We are able to match 248 out of the 249 municipalities that enter the program by 2004, and 337 out of the 339 that enter the program by 2009.

We present differences-in-differences estimates, using a similar specification to equation 1, in table B.3. We take a one-year lead of the dependent variable, cadaster renovation. In columns 1 and 2, we use the set of municipalities that apply and receive the PMAT during the 1998-2004 period or up to our cadaster-renovation data ($N = 248$); in columns 3 and 4, we use those municipalities that apply and receive the program during 1998-2009 ($N = 337$). The point estimates suggest a very small impact of the program. The largest estimate, in column 1, indicates an increase in the probability of a cadaster renovation of 4.4 percentage points, or just over 10% of a within-municipality standard deviation; the rest of the columns indicate smaller or even negative effects. In no case are these point estimates statistically distinguishable from zero at standard thresholds.

C. Additional Evidence: Regression Discontinuity

C.1 Covariate Balance at the Election Discontinuity

Table C.1: Covariate Balance at the Election Discontinuity

	Cadaster Renovation, 2013-2015							
	CCT Bandwidth							
	Gender (female==1)	College Education	PT affiliation of incumbent	Population in 2010 (log)	Rural (%)	Any IPTU Collected by 2012	Gini Index (2010)	Pop. in Poverty (2010)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Incumbent Won in 2012	0.015 (0.037) [0.69]	0.018 (0.054) [0.75]	-0.0062 (0.035) [0.86]	-0.16 (0.11) [0.15]	0.022 (0.020) [0.28]	0.046 (0.030) [0.12]	-0.000024 (0.0077) [1.00]	-0.011 (0.022) [0.62]
Robust Std. Errors	0.053	0.081	0.048	0.16	0.029	0.045	0.012	0.033
Robust P-Value	0.95	0.45	0.62	0.38	0.54	0.48	0.82	0.84
Order of the Local Polynomial	1	1	1	1	1	1	1	1
Covariate Adjustment	No	No	No	No	No	No	No	No
Bandwidth	0.18	0.21	0.19	0.17	0.24	0.17	0.18	0.16
Observations	1291	1385	1321	1227	1471	1228	1314	1193
IK Bandwidth								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Incumbent Won in 2012	0.0070 (0.044) [0.87]	0.038 (0.064) [0.55]	-0.0090 (0.037) [0.81]	-0.14 (0.13) [0.26]	0.021 (0.020) [0.30]	0.048 (0.032) [0.13]	0.0014 (0.0092) [0.88]	-0.0079 (0.025) [0.75]
Robust Std. Errors	0.060	0.095	0.051	0.18	0.030	0.048	0.014	0.037
Robust P-Value	0.91	0.58	0.51	0.34	0.55	0.69	0.98	0.56
Order of the Local Polynomial	1	1	1	1	1	1	1	1
Covariate Adjustment	No	No	No	No	No	No	No	No
Bandwidth	0.13	0.15	0.16	0.13	0.22	0.15	0.13	0.13
Observations	996	1116	1206	1014	1427	1121	1020	995
CV Bandwidth								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Incumbent Won in 2012	0.0014 (0.027) [0.96]	-0.011 (0.035) [0.75]	-0.0016 (0.023) [0.95]	-0.12* (0.072) [0.098]	0.022 (0.014) [0.11]	0.031* (0.018) [0.095]	0.00050 (0.0047) [0.92]	0.0099 (0.013) [0.44]
Robust Std. Errors	0.037	0.046	0.030	0.091	0.018	0.024	0.0062	0.017
Robust P-Value	0.43	0.95	0.88	0.25	0.17	0.33	0.54	0.48
Order of the Local Polynomial	1	1	1	1	1	1	1	1
Covariate Adjustment	No	No	No	No	No	No	No	No
Bandwidth	0.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Observations	1781	1868	1868	1868	1868	1868	1868	1867

See equation (2) for the econometric specification. The unit-of-analysis is the municipality. Conventional standard errors and p-values in parentheses and brackets, respectively. MSE-optimal bandwidths and heteroskedasticity-robust nearest neighbor standard errors described in [Calonico, Cattaneo and Titiunik \(2014\)](#). CV bandwidths described in [Ludwig and Miller \(2007\)](#); IK bandwidths described in [Imbens and Kalyanaraman \(2012\)](#). We use triangular kernels.

C.2 Alternative Data-Driven Bandwidth Selection Procedures

Table C.2: Alternative Data-Driven Bandwidth Selection Procedures

	Cadaster Renovation, 2013-2015			
	CCT Two-Sided Bandwidths			
	(1)	(2)	(3)	(4)
Incumbent Won in 2012	0.11** (0.053) [0.042]	0.15** (0.060) [0.012]	0.17** (0.073) [0.020]	0.17** (0.080) [0.030]
Robust Std. Errors	0.10	0.089	0.096	0.099
Robust P-Value	0.23	0.19	0.23	0.28
Order of the Local Polynomial Bandwidth	0	1	2	3
Bandwidth (Left)	0.058	0.15	0.23	0.29
Bandwidth (Right)	0.047	0.15	0.23	0.40
Observations	464	1130	1449	1680

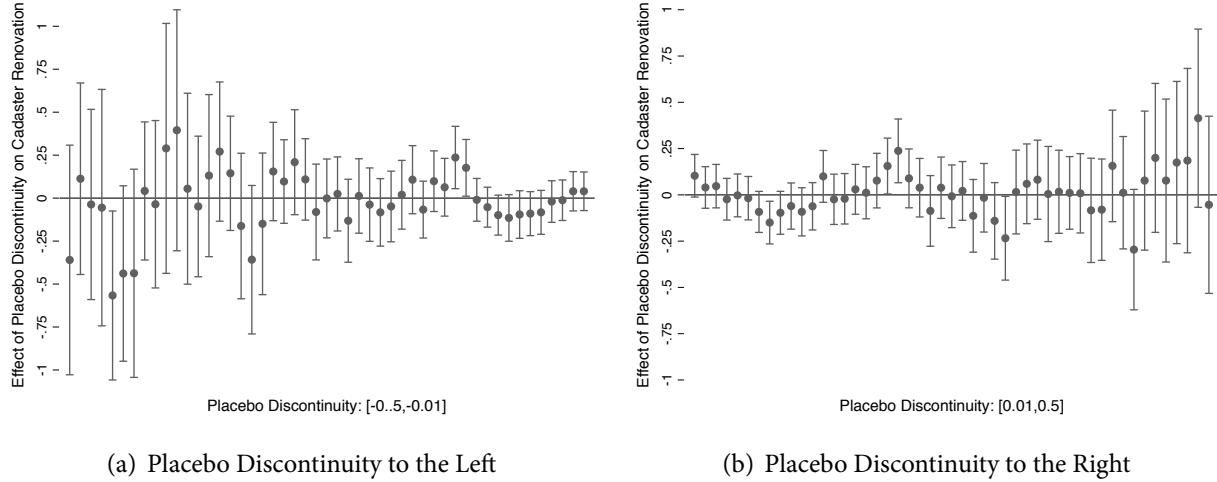
	IK Bandwidth			
	(1)	(2)	(3)	(4)
Incumbent Won in 2012	0.092** (0.044) [0.035]	0.15** (0.057) [0.010]	0.13 (0.087) [0.15]	0.086 (0.12) [0.45]
Robust Std. Errors	0.084	0.084	0.12	0.14
Robust P-Value	0.15	0.10	0.45	0.33
Order of the Local Polynomial Bandwidth	0	1	2	3
Bandwidth (Left)	0.074	0.16	0.15	0.16
Bandwidth (Right)				
Observations	640	1224	1160	1172

	CV Bandwidth			
	(1)	(2)	(3)	(4)
Incumbent Won in 2012	0.0097 (0.023) [0.67]	0.11** (0.048) [0.025]	0.11** (0.050) [0.030]	0.15*** (0.057) [0.0093]
Robust Std. Errors	0.034	0.070	0.063	0.068
Robust P-Value	0.93	0.011	0.0070	0.0094
Order of the Local Polynomial Bandwidth	0	1	2	3
Bandwidth (Left)	1.00	0.25	0.65	0.90
Bandwidth (Right)				
Observations	1868	1510	1828	1854

See equation (2) for the econometric specifications. The unit-of-analysis is the municipality. Conventional standard errors and p-values in parentheses and brackets, respectively. MSE-optimal bandwidths and heteroskedasticity-robust nearest neighbor standard errors described in [Calonico, Cattaneo and Titiunik \(2014\)](#). CV bandwidths described in [Ludwig and Miller \(2007\)](#); IK bandwidths described in [Imbens and Kalyanaraman \(2012\)](#). We use triangular kernels.

C.3 Placebo Discontinuity Thresholds

Figure C.1: Placebo Discontinuity Thresholds and Cadaster Renovation
Arbitrary election victory thresholds reveal no effects in almost all cases.



(a) Placebo Discontinuity to the Left

(b) Placebo Discontinuity to the Right

The figure on the **left** displays point estimates and 95% conventional confidence intervals on 1-st order local-polynomial RD estimates using placebo electoral threshold margins of victory to the left of the real cutoff of 0. The figure on the **right** displays similar estimates for placebo thresholds to the right of the actual cutoff. Each estimation uses the MSE-optimal bandwidths described in [Calonico, Cattaneo and Titiunik \(2014\)](#). We use triangular kernels.