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

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Abstract

Property titling enables tax collection and encourages private investment. 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 property tax revenue increases by over 10 percent following cadaster updates. Officials covet this revenue, but they simultaneously seek to secure their reelection, and investing in the cadaster can generate political costs by angering tax-averse voters or undermining clientelism. When these political costs are large, officials who do not face reelection pressures have greater incentives to invest in the cadaster. 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.

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 transformative political act; by improving the state's ability to assess taxable wealth, technologies like the cadaster helped support the rise of the fiscal state in early modern Europe (e.g., Slantchev and Kravitz 2019). During this period's tax struggles, rulers and ruled were well aware that the controversial cadastral map, because of the information it conveyed, could be used to the advantage of some and the detriment of others (Kain and Baigent 1992). Beyond serving as a key component of a working property tax system, the cadastral map codifies property rights over land, with direct implications for investment economic development.[1]

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, immediate, and persistent fiscal return: property tax revenues rise by over 10 percent — roughly a quarter of a within-municipality standard deviation. In the subset of municipalities with available data, we also show that the proportion of registered properties increases by about 4 percentage points following cadaster updates. This represents a full (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 specifically to modernize municipal tax administrations, including cadaster updates — 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 (e.g., Besley and Case 1995; Alt, Bueno de Mesquita and Rose 2011; Sances 2016). 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 2019), intra-elite conflict (e.g., Beramendi, Dincecco and Rogers 2019; 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 2019). 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? 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 Schargrodsky 2016; Gutierrez and Molina 2016).[2]

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. Measuring, codifying, and simplifying land tenure stand as central administrative objectives of modern governments (Scott 1999). The cadastral map enables this simplification and provides a manageable and reliable format for taxation. 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., Lee and Zhang 2017; Brambor et al. 2020).

The anticipated fiscal benefits of the cadastral map have motivated domestic and donor-led efforts to institute and update land-registration systems. Payne, Durand-Lasserve and Rakodi (2009, 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

[2]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 Schargrodsky 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.

Thailand and Ukraine, where titling programs generated large increases in tax revenues.[3] 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 Task Team on Habitat III 2015, 3) — many governments do not facilitate titling.[4] The fiscal upside that Scott identifies, and that we document for the Brazilian case below, must then 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

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

[4] 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-idUSKBN15C0OA>.

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).

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), while not focusing specifically on clientelism, documents how mayors control 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 to 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.[5]

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.[6]

[5] In a related argument, Fergusson, Larreguy and Riaño (2018) describe how entrenched incumbent parties with a comparative advantage in clientelism may have an incentive to dismantle existing capacity to provide public public services when faced with intense electoral competition. Beyond the electoral incentives, elite capture remains prevalent in young electoral democracies 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 (2019) 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.

[6] We show below that cadaster updates not only substantially increase property tax revenues, but also lead to greater municipal spending on public works projects (see Appendix Table B.4). This additional spending on public works projects could benefit the incumbent in several ways — by realizing their policy priorities or providing vehicles for corruption. Our

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 $\phi(i = 1) \leq \phi(i = 0)$.[7] 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 — a claim that we corroborate empirically below. 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:

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

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

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 if cadaster updates generate an electoral penalty.[8] 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.

argument does not require that mayors are benevolent public goods providers; to the contrary, incumbents' investments in fiscal capacity could also be motivated by rent-seeking. We lack the data to empirically assess whether mayors misappropriate new property tax revenues; the well-studied randomized audits of Brazilian municipalities do not track locally generated revenue.

[7] This 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.

[8] Cadaster updates increase municipal spending on public works projects (see Appendix Table B.4). Such expenditure could impress and benefit voters, diminishing any electoral penalty. We do not, however, find evidence that these incumbents repurpose increased property tax revenues for their reelection campaigns: Appendix Table A.2 shows no relationship between deciding to update the cadaster prior to 2012 and formal campaign expenditures.

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. To evaluate the role of electoral costs in the decision to invest in the cadaster, we next examine the case of Brazilian municipalities in light of the model's predictions.

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 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).

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 registration process. In our interviews, local officials report that a 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.[9] 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

[9]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).

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 (2018*b*) for 2004–2012; and from the *Sistema de Informações Contábeis e Fiscais do Setor Público Brasileiro*, SICONFI (2018*a*) for 2013–2015.

Property taxes are the second largest source of local taxes, accounting for roughly a quarter of local tax receipts.[10] 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).[11] Property taxes also provide a stable 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.[12] 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

[10] 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).

[11] 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 that link taxation to state performance (e.g., Levi 1988; Timmons 2005; Paler 2013; Timmons and Garfias 2015).

[12] 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. We use the phrases cadaster "investment", "renovation", and "update" synonymously to describe this decision.

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 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.[13] 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

[13] 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.

96.1 percent either won reelection (38.1 percent) or left electoral politics altogether (58 percent) (Magalhães and Hirvonen 2015, 16).[14]

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.[15] 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). Fernandes (2006, 155) summarizes the precarious situation of untitled households in Brazil: "the residents remain politically vulnerable and become regular pawns in political games involving service provision, the implementation of infrastructure and land titling, thus reinforcing clientelist relations." In a more recent report, Fernandes (2011, 36) describes efforts to regularize informal settlements in Brazil as "titles for votes" schemes.[16]. And this characterization is reflected in interviews conducted by Coates and Garmany (2017, 50) in irregular settlements: "it's a case of 'I'll help you if you can get me a vote, your family's votes, understand? Or I will not help you legalize your house'" (see also Perlman 2010, on how clientelism exploits and perpetuates informality and exclusion).

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.

[14] 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* (Titiunik 2009; Brambor and Ceneviva 2011; but see Boas and Hidalgo 2011; 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 Titiunik 2017; Novaes 2017).

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

[16] "Regularization of Informal Settlements in Latin America." Policy Focus Report. Lincoln Institute of Land Policy.

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 are followed by a sizable, differential 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. These first two results — how cadaster updates affect property tax revenues (Section 4.1) and how subsidized loans affect the likelihood of cadaster updates (Section 4.2) — employ difference-in-differences designs.

Second, in Section 4.3 we estimate the political cost of cadaster overhauls using a close-elections regression discontinuity design. 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:

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

where $\log(\text{IPTU}_{it})$ is the logged property tax revenue in municipality i in year t; 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 year-by-state fixed effects and include the last year of a cadaster update for those municipalities that do not update under the period of analysis.[17]

Table 2: Cadaster Updates and Property Tax Revenue

	Property Tax Revenue, IPTU (log)					
	2004–2015				2012–2015	
	(1)	(2)	(3)	(4)	(5)	(6)
Cadaster Update	0.14***	0.10***	0.12***	0.084***	0.13***	0.10***
	(0.025)	(0.025)	(0.026)	(0.027)	(0.035)	(0.036)
Revision to Fiscal Land Values Formula		0.019		0.090***		0.071**
		(0.027)		(0.027)		(0.034)
Reform to IPTU Law		0.23***		0.18***		0.19***
		(0.034)		(0.034)		(0.065)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes				
GDP per cap (log)	No	No	Yes	Yes	Yes	Yes
Year by State FE	No	No	Yes	Yes	Yes	Yes
Year FE × Year of Last Pre-2004 Cadaster Update	No	No	Yes	Yes	Yes	Yes
Within-Mun. Mean of DV	11.1	11.1	11.4	11.4	11.7	11.7
Within-Mun. SD of DV	0.84	0.84	0.77	0.77	0.47	0.47
R sq.	0.84	0.84	0.86	0.86	0.92	0.92
Observations	62161	61360	49086	48475	19096	18858
Number of Municipalities	5401	5331	5121	5057	5098	5034

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. $^{*}p < 0.1,\ ^{**}p < 0.05,\ ^{***}p < 0.01$.

[17] Our control municipalities include those that have yet to update their cadaster and those that never do during 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.

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.[18]

This design invokes 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.[19] 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.

Figure 1 presents the results graphically, and further shows that the effect of cadaster updates emerges immediately and persists for the next few of years. This pattern suggests that elected officials who may be considering investing in improving the cadaster can reasonably expect fiscal benefits over the short term.[20]

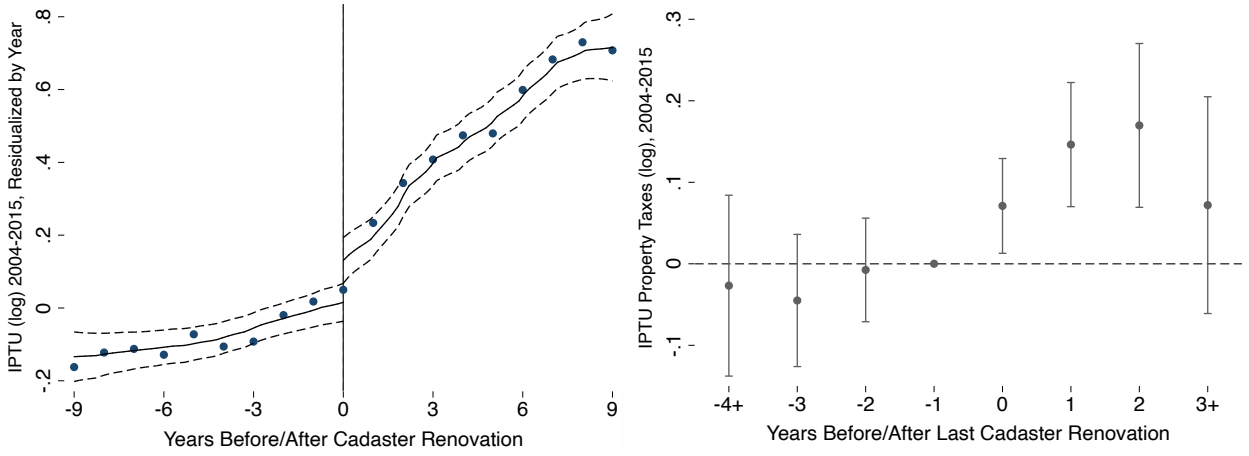
In Section B.1, we also show the effect of cadaster updates on property registration rates. Given the relative paucity of these data, which are not collected systematically by the central government, we rely on census-based estimates of property registration rates and survey responses by local tax officials.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

[18] We include GDP per capita (logged) as a time-varying control. We also run additional robustness checks: (1) substituting the municipality fixed effects for municipality-by-term fixed effects to account for some time-varying confounds at the municipal level, such as mayoral elections (see Table B.2); and (2) including transfers from federal and state governments (logged) as a time-varying control (see Table B.3). We lag the transfers variable to reduce concerns about endogeneity (e.g., transfers responding to local tax revenue).

[19] More technically, $\hat{\beta}$ estimates the average causal effect of cadaster updates on those municipalities that update when $E(\varepsilon_{it}|\text{Cadaster Update}_{it},\lambda_t,\gamma_i) = 0$.

[20] In Section B.4, we show that cadaster updates do not affect the other major source of local tax revenue, such as 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



(a) Before/After Cadaster Update

(b) Dynamic Effects Plot

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** restricts the sample to municipalities that update at some point and displays the point estimates and 95% confidence intervals from a dynamic panel regression that includes municipality and year fixed effects. The initial lead is equal to 1 for every year prior to four years before the update, and the final lag is equal to 1 for every year beginning with the third year after the update. The omitted category corresponds to the year before the update.

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.

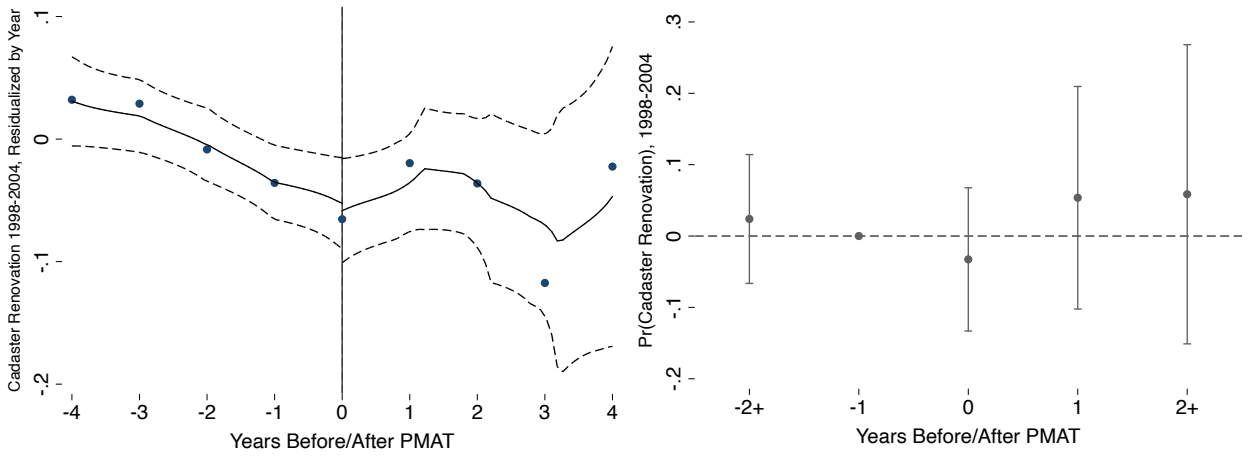
4.2 The Fiscal Determinants of Cadaster Updates

Cadaster updates are followed by persistently 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 profitaility 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



(a) Before/After (b) Dynamic Effects Plot

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 two lags of receiving the PMAT. The lead is equal to 1 for every year prior to one year before receiving the PMAT, and the final lag is equal to 1 for every year beginning with the second year after receiving the PMAT. The omitted category corresponds to the year before receiving the PMAT. The data corresponds to 248 municipalities that received the PMAT between 1998 and 2004.

Past work has shown that participation in the PMAT increases municipal tax revenue (Gadenne 2017). However, despite explicitly targeting cadaster updates and reducing their cost, 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.6, we present estimates of the impact of the PMAT on cadaster updating, using a difference-in-difference approach similar to equation 1, employing alternative control groups, and expanding the analysis to 2011. 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.[21] 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

[21] 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.

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.[22]

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 ($V_i \geq 0$).[23] We focus on the sharp average treatment effect at the threshold, $\tau = E\{Y_i(1) - Y_i(0)|V_i = 0\}$, and estimate

$$\tau = \mu_+ - \mu_-, \tag{2}$$

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 pth order polynomial regression for treatment and control municipalities, respectively.

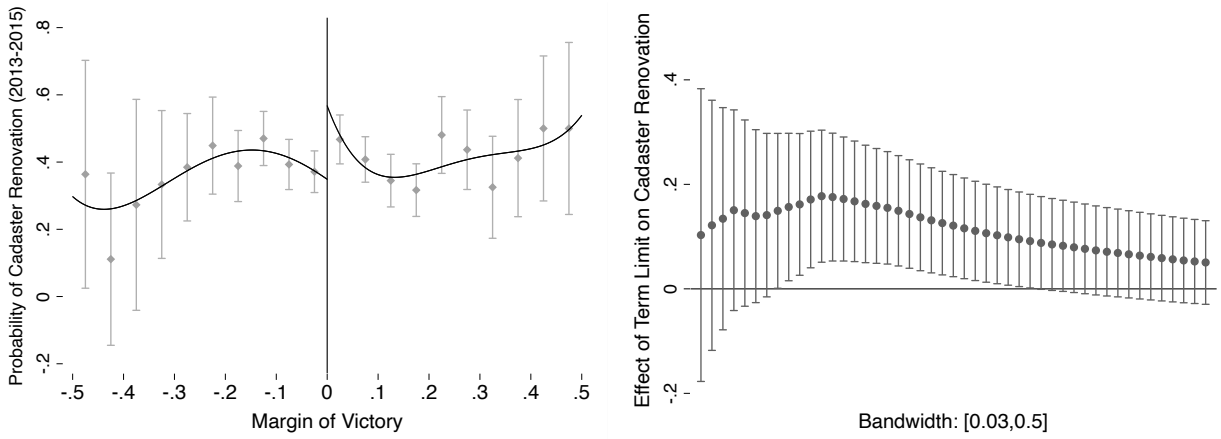
In Figure 3, we visualize the discontinuity. There is a visible jump at the electoral threshold in the probability of cadaster updates in treated municipalities, where an incumbent is reelected and now faces a term limit. In Table C.1, we also present evidence of balance at the discontinuity on other covariates, including incumbent candidate characteristics (gender, college education, affiliation to the PT, *Partido dos Trabalhadores*), pre-2012 municipal characteristics (population, proportion rural, any IPTU collected, Gini coefficient, and proportion poor), and the number of candidates contesting the election. This demonstrates that other covariates do not change sharply at the discontinuity, bolstering the identifying assumption.

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

[22] 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.

[23] We drop municipalities with no first-term mayor running for reelection.

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



(a) Graphical Representation of Discontinuity

(b) Estimates with Variable Bandwidths

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 1st order local-polynomial RD estimates at variable bandwidths, ranging from 3% to 25%. We use triangular kernels.

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	0.13**	0.18***	0.20***	0.19**	0.10*	0.17***	0.19***	0.20***
	(0.059)	(0.064)	(0.075)	(0.088)	(0.057)	(0.064)	(0.075)	(0.077)
	[0.031]	[0.0059]	[0.0076]	[0.035]	[0.069]	[0.0071]	[0.0099]	[0.0089]
Robust Std. Errors	0.070	0.072	0.084	0.096	0.067	0.071	0.084	0.082
Robust P-Value	0.018	0.0047	0.014	0.063	0.040	0.0056	0.019	0.014
Order of the Local Polynomial	0	1	2	3	0	1	2	3
Covariate Adjustment	No	No	No	No	Yes	Yes	Yes	Yes
Bandwidth	0.044	0.14	0.23	0.30	0.042	0.13	0.22	0.39
Mean of Control	0.37	0.41	0.41	0.41	0.37	0.41	0.40	0.40
Observations	364	1036	1402	1547	347	998	1360	1642

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. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

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 bandwitdth 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 consequences 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.[24] Our theory implies that, unless the electoral penalty of a cadaster update is very large, our local average treatment effects are unlikely to generalize to politically uncompetitive municipalities: in an uncompetitive setting, updating the cadaster may not meaningfully change an incumbent's chances at the polls — they are going to win (or lose) regardless. In such cases, updating the cadaster will not depend on whether an incumbent is term-limited.[25]

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; Hidalgo and Nichter 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

[24] Among second-term mayors, we find that the probability of a cadaster update peaks early in their term (in the second year) and then falls off sharply by their final year in office (see Figure A.1). This pattern is consistent with term-limited mayors initiating updates early in their term to benefit from increased property tax revenues, and those cadaster updates then completing in years two and three given the time required for implementation.

[25] In terms of our formalization, in an uncompetitive municipality there may not be a consequential electoral penalty: $\phi(i = 1) \approx \phi(i = 0)$. In such settings, an incumbent will invest iff the *direct profitability condition* is met — a decision-rule that does not differ for first- and second-term incumbents.

windfall might appear to first-term mayors, the prospect of losing such a powerful political tool may guide their decision-making.

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	0.11	0.23**	0.12*	0.24**
	(0.092)	(0.093)	(0.073)	(0.11)
	[0.25]	[0.013]	[0.091]	[0.036]
Robust Std. Errors	0.11	0.11	0.085	0.13
Robust P-Value	0.23	0.011	0.12	0.025
Order of the Local Polynomial	1	1	1	1
Covariate Adjustment	No	No	No	No
Bandwidth	0.15	0.14	0.16	0.13
Mean of Control	0.43	0.39	0.38	0.44
Observations	480	600	698	391

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. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

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.[26] 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

[26] 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).

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).[27] The first two columns split our sample into municipalities with below- and above-median municipal Gini, respectively. Consistent with a clientelistic mechanism, 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).[28]

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; Sances 2016; 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.[29] We more directly test for this second mechanism by estimating the effect of term-limits on two other 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.[30] We estimate equation 2 employing the RD design introduced 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

[27] These variables are highly correlated (0.6 across all municipalities), but measure distinct features of municipalities' social structure. 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.2).

[28] To identify these heterogeneous effects, we need to further assume that the relationship between the margin of victory and the probability of a cadaster update are equal across sub-samples. While these differences in magnitude are notable, we cannot reject the null of no difference between the coefficients in models 1 and 2 or 3 and 4; in Appendix Table B.6, we estimate local linear models that allow to directly test for the difference in the coefficients; this difference remains substantively large, but is imprecisely estimated.

[29] We also note that the estimates in Table 4 are uninformative about the direct relationship between the presence of a wealthy elite that resists taxation and the likelihood of fiscal capacity investments such as cadaster updates, which has been the focus of other work (e.g., Acemoglu, Vindigni and Ticchi 2011; Hollenbach and Silva 2019).

[30] Reforms to the IPTU law and major revisions to the fiscal land values require approval from city council. However, smaller revisions to fiscal land values formulas, up to the national inflation rate, can be enacted by mayoral decree (Pinto Domingos 2011).

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	0.0096	0.018	0.015	0.018	-0.0067	-0.0046	-0.0092	-0.0018
	(0.039)	(0.056)	(0.071)	(0.085)	(0.037)	(0.056)	(0.070)	(0.083)
	[0.80]	[0.75]	[0.83]	[0.83]	[0.85]	[0.93]	[0.89]	[0.98]
Robust Std. Errors	0.052	0.067	0.080	0.092	0.049	0.066	0.078	0.091
Robust P-Value	0.75	0.80	0.84	0.82	0.94	0.86	0.90	0.96
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	0.32	0.33	0.30	0.31	0.32	0.32
Observations	752	1220	1468	1593	781	1167	1434	1564
	Reform to IPTU Law, 2012-2015							
	No Covariate Adjustment				Covariate Adjustment			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Incumbent Won in 2012	-0.0044	0.010	0.0073	-0.021	-0.00042	0.0096	0.0060	-0.013
	(0.023)	(0.029)	(0.035)	(0.045)	(0.024)	(0.030)	(0.036)	(0.044)
	[0.85]	[0.72]	[0.84]	[0.64]	[0.99]	[0.75]	[0.87]	[0.77]
Robust Std. Errors	0.029	0.034	0.039	0.049	0.029	0.034	0.040	0.046
Robust P-Value	0.80	0.67	0.87	0.58	0.72	0.74	0.95	0.69
Order of the Local Polynomial	0	1	2	3	0	1	2	3
Covariate Adjustment	No	No	No	No	Yes	Yes	Yes	Yes
Bandwidth	0.080	0.19	0.28	0.27	0.073	0.17	0.25	0.27
Mean of Control	0.083	0.096	0.099	0.100	0.083	0.095	0.099	0.099
Observations	684	1331	1585	1555	629	1247	1495	1554

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. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

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.[31] This is not borne out in our data and indirectly suggests that clientelistic concerns may weigh more heavily on the mayor's mind.[32] These results are not dispositive: sophisticated voters could hold divergent preferences over these fiscal policy instruments, in which case election-seeking incumbents face different political costs to implementation. If, for example, voters are particularly hostile to cadaster updates but less concerned about these other tax reforms, then incumbent's decisions to put off cadaster updates to their final term could still reflect concerns about an electoral backlash.[33]

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).[34]

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,

[31] 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.

[32] 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.

[33] We find no effect of cadaster updates on reported campaign expenditures in Table A.2; if cadaster updates anger voters in ways that reduce their campaign contributions, this not reflected in incumbents' campaign expenditures.

[34] 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.

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 produce a roughly 10 percent increase in property tax receipts, the second most important source of locally generated revenue in Brazilian municipalities. This effect is immediate and persists over the next few years. We also find that the rate of property registration rises by about 4 percentage points following cadaster overhauls among the 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.[35] We also show that this term-limit effect is strongest

[35] 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).

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.

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Supporting Information

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

Contents

A. Descriptives

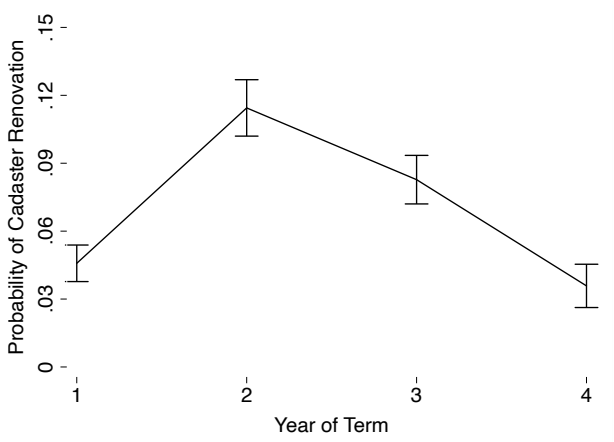
A.1 Descriptive Statistics

Table A.1: Descriptive Statistics

	All Municipalities			Municipalities with Incumbents Running for Reelection			Municipalities with Incumbents Running for Reelection in Close Elections ($h_{CCT} = 0.14$)		
	count	mean	sd	count	mean	sd	count	mean	sd
Cadaster Renovation	5401	0.42	0.49	1856	0.41	0.49	1036	0.41	0.49
Revision to Fiscal Land Values	5540	0.34	0.47	1911	0.33	0.47	1076	0.31	0.46
New IPTU Law, 2013-2015	5564	0.09	0.28	1916	0.08	0.27	1078	0.08	0.28
Population (log), 2010	5563	9.41	1.15	1919	9.42	1.11	1081	9.33	1.04
Proportion Rural, 2010	5563	0.31	0.20	1919	0.32	0.20	1081	0.33	0.20
Collects Any IPTU by 2012	5563	0.94	0.24	1919	0.93	0.25	1081	0.92	0.26
Gini, 2010	5563	0.49	0.07	1919	0.49	0.07	1081	0.50	0.07
Poverty Incidence, 2010	5561	0.23	0.18	1918	0.24	0.18	1080	0.25	0.18
Female Incumbent				1919	0.11	0.31	1081	0.12	0.32
Incumbent with College Education				1919	0.49	0.50	1081	0.49	0.50
PT Incmbent				1919	0.12	0.33	1081	0.12	0.33

A.2 Timing of Cadaster Updates within Mayoral Terms

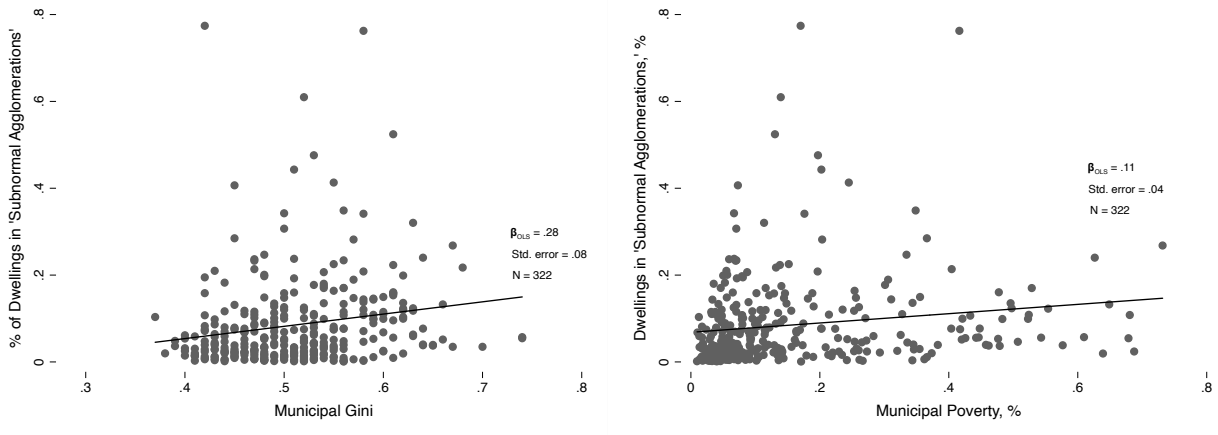
Figure A.1: Cadaster Updates by Year in Administration in Term-Limited Municipalities, 2009-2015



The graph plots the mean probability of a cadaster update in each year of a mayoral term, for the 2009-2012 and 2013-2016 administrations, with a 95% confidence intervals.

A.3 Irregular Settlements (*Aglomerados Subnormais*), Income Inequality, and Poverty

Figure A.2: *Aglomerados Subnormais*, Income Inequality, and Poverty



(a) *Aglomerados Subnormais* and Income Inequality

(b) *Aglomerados Subnormais* 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.4 Prior Cadaster Updates (2008-2012) and Reported Campaign Expenditures (2012)

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

	Reported Campaign Expenditures (log) in 2012		
	(1)	(2)	(3)
Cadaster Renovation (2008-2012)	-0.054	-0.046	0.016
	(0.078)	(0.075)	(0.061)
Margin of Victory, 2008		0.17	-0.063
		(0.23)	(0.16)
Number of Candidates, 2012		0.41***	0.015
		(0.037)	(0.033)
Covariates	No	No	Yes
State FE	No	No	Yes
Mean of DV	12.6	12.6	12.6
SD of DV	1.14	1.13	1.13
R sq.	0.00047	0.14	0.51
Number of Municipalities	1113	1094	1090

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.
$^{*}p < 0.1,\ ^{**}p < 0.05,\ ^{***}p < 0.01.$

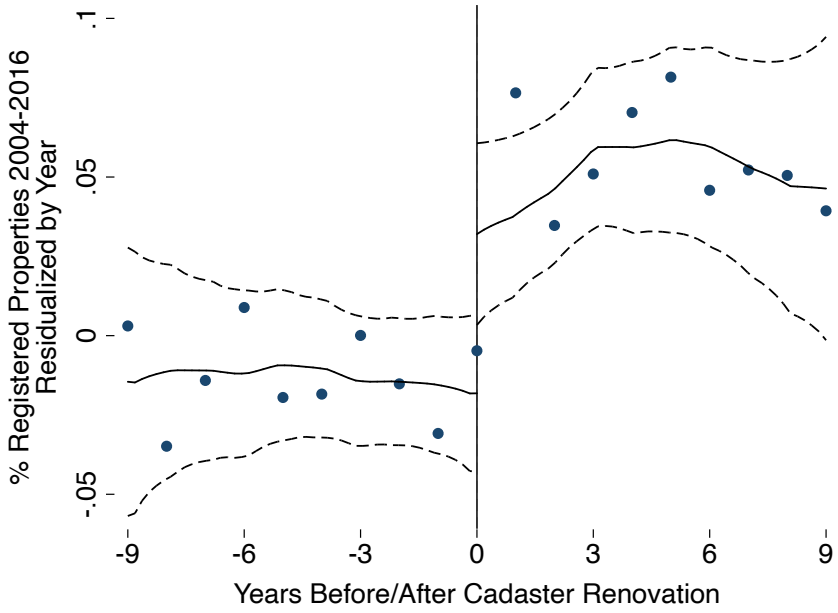
B. Additional Evidence: Mechanisms

B.1 Cadaster Updates and Property Registration Rates

In this section, we document the effect of cadaster updates 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 Updates and Property Registration Rates in a Sample of Municipalities

Property registration rates increase after a cadaster update.



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 update. 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).[36] 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.[37]

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 update. 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 update 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 update. 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.

[36] 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.

[37] 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 Updates and Property Registration Rates

	Property Registration Rates					
	(1)	(2)	(3)	(4)	(5)	(6)
Cadaster Renovation	0.043**	0.047*	0.039	0.028	0.034	0.021
	(0.020)	(0.024)	(0.032)	(0.044)	(0.034)	(0.047)
Revision to Fiscal Land Values Formula		-0.013		0.014		0.014
		(0.025)		(0.039)		(0.040)
Reform to IPTU Law		-0.014		-0.13		-0.18*
		(0.022)		(0.097)		(0.098)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes				
Year FE × Lincoln Sample	Yes	Yes	Yes	Yes	Yes	Yes
GDP per cap (log)	No	No	Yes	Yes	Yes	Yes
Population (log)	No	No	Yes	Yes	Yes	Yes
Year by State FE	No	No	Yes	Yes	Yes	Yes
Year FE ×						
Year of Last Pre-2004	No	No	No	No	Yes	Yes
Cadaster Update						
Within-Mun. Mean of DV	0.81	0.81	0.81	0.81	0.81	0.81
Within-Mun. SD of DV	0.057	0.054	0.063	0.059	0.063	0.059
R sq.	0.82	0.84	0.86	0.90	0.86	0.90
Observations	599	536	480	429	480	429
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.
$^{*}p < 0.1,\ ^{**}p < 0.05,\ ^{***}p < 0.01$.

We also find a significant and sizable increase in property tax revenues as property registration rates rise. We re-estimate equation 1 including the property registration rate as an additional independent variable. Controlling for other measures that local governments can use to increase tax revenues, we find that ten percentage point increase in the property registration rates increases property tax revenues (logged) by 0.06, or roughly one within-municipality standard deviation in this sample ($\widehat{\beta} = 0.57, \text{SE} = 0.28$).

B.2 Cadaster Updates and Property Taxes

Table B.2: Cadaster Updates and Property Tax Revenue: Including Municipality-Term Fixed Effects

	Property Tax Revenue, IPTU (log)					
	2004–2015				2012–2015	
	(1)	(2)	(3)	(4)	(5)	(6)
Cadaster Update	0.11***	0.092***	0.075**	0.059*	0.073	0.057
	(0.030)	(0.031)	(0.033)	(0.034)	(0.045)	(0.047)
Revision to Fiscal Land Values Formula		0.015		0.039		0.040
		(0.037)		(0.039)		(0.045)
Reform to IPTU Law		0.18***		0.15***		0.12*
		(0.051)		(0.052)		(0.075)
Municipality X Term FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes				
GDP per cap (log)	No	No	Yes	Yes	Yes	Yes
Year by State FE	No	No	Yes	Yes	Yes	Yes
Year FE ×						
Year of Last Pre-2004	No	No	Yes	Yes	Yes	Yes
Cadaster Update						
Within-Mun. Mean of DV	11.1	11.1	11.4	11.4	11.7	11.7
Within-Mun. SD of DV	0.84	0.84	0.77	0.77	0.47	0.47
R sq.	0.90	0.90	0.91	0.91	0.96	0.96
Observations	62161	61360	49086	48475	19096	18858
Number of Municipalities	5401	5331	5121	5057	5098	5034

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.
$^{*}p < 0.1,\ ^{**}p < 0.05,\ ^{***}p < 0.01$.

Table B.3: Cadaster Updates and Property Tax Revenue: Including Lagged Transfers

	Property Tax Revenue, IPTU (log)			
	2004–2015		2012–2015	
	(1)	(2)	(3)	(4)
Cadaster Update	0.12***	0.085***	0.12***	0.086**
	(0.027)	(0.028)	(0.037)	(0.038)
Revision to Fiscal Land Values Formula		0.087***		0.078**
		(0.027)		(0.037)
Reform to IPTU Law		0.15***		0.19***
		(0.036)		(0.064)
Lagged Transfers (log)	0.022	0.022	-0.069*	-0.069*
	(0.020)	(0.020)	(0.039)	(0.039)
Municipality FE	Yes	Yes	Yes	Yes
GDP per cap (log)	Yes	Yes	Yes	Yes
Year by State FE	Yes	Yes	Yes	Yes
Year FE ×				
Year of Last Pre-2004	Yes	Yes	Yes	Yes
Cadaster Update				
Within-Mun. Mean of DV	11.5	11.5	11.7	11.7
Within-Mun. SD of DV	0.70	0.70	0.47	0.47
R sq.	0.87	0.87	0.92	0.92
Observations	42994	42459	18421	18192
Number of Municipalities	5118	5054	5062	5000

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. $^{*}p < 0.1,\ ^{**}p < 0.05,\ ^{***}p < 0.01$.

B.3 Cadaster Updates and Municipal Spending

Table B.4: Cadaster Updates and Spending in Public Works

	Municipal Spending in Public Works (log)			
	2004–2015		2009–2015	
	(1)	(2)	(3)	(4)
Cadaster Update	0.11**	0.11**	0.11*	0.11
	(0.049)	(0.053)	(0.065)	(0.068)
Municipality FE	Yes	Yes	Yes	Yes
Year FE	Yes		Yes	
GDP per cap (log)	No	Yes	No	Yes
Year by State FE	No	Yes	No	Yes
Year FE × Year of Last Pre-2004 Cadaster Update	No	Yes	No	Yes
Within-Mun. Mean of DV	13.6	13.5	13.5	13.4
Within-Mun. SD of DV	1.68	1.65	1.50	1.43
R sq.	0.39	0.43	0.51	0.57
Observations	62612	49416	36313	29477
Number of Municipalities	5401	5121	5395	5116

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.
$^{*}p < 0.1,\ ^{**}p < 0.05,\ ^{***}p < 0.01$.

B.4 Cadaster Updates and Other Taxes

Table B.5: Cadaster Updates and Local Services Tax Revenue

	Local Services Tax Revenue, ISSQN (log)					
	2004–2015				2012–2015	
	(1)	(2)	(3)	(4)	(5)	(6)
Cadaster Update	0.017	0.0083	0.021	0.014	0.046	0.045
	(0.016)	(0.017)	(0.018)	(0.019)	(0.028)	(0.029)
Revision to Fiscal Land Values Formula		0.0026		0.0024		-0.0022
		(0.018)		(0.018)		(0.029)
Reform to IPTU Law		0.069***		0.063***		0.061
		(0.021)		(0.021)		(0.045)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes				
GDP per cap (log)	No	No	Yes	Yes	Yes	Yes
Year by State FE	No	No	Yes	Yes	Yes	Yes
Year FE ×						
Year of Last Pre-2004	No	No	Yes	Yes	Yes	Yes
Cadaster Update						
Within-Mun. Mean of DV	12.9	12.9	13.0	13.0	13.4	13.4
Within-Mun. SD of DV	0.70	0.70	0.70	0.70	0.36	0.36
R sq.	0.85	0.85	0.87	0.87	0.89	0.89
Observations	62592	61783	49391	48774	19401	19157
Number of Municipalities	5401	5331	5121	5057	5106	5042

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.
$^{*}p < 0.1,\ ^{**}p < 0.05,\ ^{***}p < 0.01$.

B.5 Heterogeneous Effect Mayoral Term-Limits, Local Linear Interactions

Table B.6: Effect of Mayoral Term-Limits on Cadaster Updates in Close Elections: Heterogeneous Effect by Income Inequality and Poverty Local Linear Interactions

	Cadaster Update, 2013-2015	
	Gini Coefficient	Gini Coefficient and % Poor
	(1)	(2)
Incumbent Won in 2012	0.14	0.14*
	(0.086)	(0.076)
Above-Median Gini	-0.0033	
	(0.079)	
Won in 2012 × Above-Median Gini	0.092	
	(0.12)	
Above-Median Gini and % Poor		0.047
		(0.081)
Won in 2012 × Above-Median Gini and % Poor		0.12
		(0.12)
Term Limit + (Term Limit × Above-Median Gini)	0.23**	
	(0.08)	
Term Limit + (Term Limit × Above Median Gini and % Poor)		0.26**
		(0.09)
Order of the Local Polynomial	1	1
Bandwidth	0.14	0.14
Mean of Control	0.41	0.41
Observations	1036	1036

OLS estimations, which include a full set of interactions with the margin of victory. The unit-of-analysis is the municipality. Conventional standard errors in parentheses. MSE-optimal bandwidths described in Calonico, Cattaneo and Titiunik (2014). $^{*}p < 0.1,\ ^{**}p < 0.05,\ ^{***}p < 0.01$.

Table B.7: Effect of Mayoral Term-Limits on Cadaster Updates in Close Elections: Heterogeneous Effect by Other Covariates

	Cadaster Update, 2013-2015			
	Female Incumbent	College Educ. Incumbent	PT Incumbent	% of Local Taxes in Total Revenue
	(1)	(2)	(3)	(4)
Incumbent Won in 2012	0.19***	0.14*	0.21***	0.059
	(0.064)	(0.084)	(0.064)	(0.095)
Female Incumbent	0.038			
	(0.12)			
Won in 2012 × Female Incumbent Mayor	0.014			
	(0.18)			
Incumbent with College Education		-0.11		
		(0.078)		
Won in 2012 × College Educ. Incumbent Mayor		0.099		
		(0.12)		
PT Incumbent Mayor			0.041	
			(0.12)	
Won in 2012 × PT Incumbent Mayor			-0.25	
			(0.18)	
% of Local Taxes in Total Revenue				-1.04
				(0.82)
Won in 2012 × % of Local Taxes in Total Revenue				2.30*
				(1.27)
Term Limit + (Term Limit × Female Incumbent)	0.20**			
	(0.17)			
Term Limit + (Term Limit × College Educ. Incumbent)		0.24**		
		(0.08)		
Term Limit + (Term Limit × PT Incumbent Mayor)			-0.04**	
			(0.17)	
Term Limit + (Term Limit × % of Local Taxes)				2.36**
				(1.20)
Order of the Local Polynomial	1	1	1	1
Bandwidth	0.14	0.14	0.14	0.14
Mean of Control	0.41	0.41	0.41	0.41
Observations	1036	1036	1036	1034

OLS estimations, which include a full set of interactions with the margin of victory. The unit-of-analysis is the municipality. Conventional standard errors in parentheses. MSE-optimal bandwidths described in Calonico, Cattaneo and Titiunik (2014).
$^{*}p < 0.1,\ ^{**}p < 0.05,\ ^{***}p < 0.01$.

B.6 The PMAT and Cadaster Updates

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 update. 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 an update.

Table B.8: The PMAT Program and Cadaster Updates

	Cadaster Update (1998-2004)				Cadaster Update (1998-2011)			
	Only PMAT Sample 1998-2004		All Municipalities		Only PMAT Sample 1998-2011		All Municipalities	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
PMAT	0.049	0.032	0.0063	0.013	-0.011	-0.018	0.0058	0.0040
	(0.049)	(0.051)	(0.030)	(0.030)	(0.027)	(0.027)	(0.021)	(0.021)
Has applied	-0.033	-0.057	-0.049	-0.052*	-0.042	-0.057**	-0.043*	-0.054**
	(0.037)	(0.038)	(0.030)	(0.029)	(0.027)	(0.026)	(0.025)	(0.024)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes		Yes		Yes		Yes	
GDP per cap (log)	No	Yes	No	Yes	No	Yes	No	Yes
Year by State FE	No	Yes	No	Yes	No	Yes	No	Yes
Year FE × Year of Last Pre-2004 Cadaster Update	No	Yes	No	Yes	No	Yes	No	Yes
Within-Mun. Mean of DV	0.61	0.61	0.62	0.62	0.78	0.78	0.78	0.78
Within-Mun. SD of DV	0.33	0.33	0.34	0.34	0.30	0.30	0.29	0.29
R sq.	0.67	0.71	0.68	0.69	0.65	0.69	0.68	0.69
Observations	1736	1736	27280	27280	4718	4718	55069	55069
Number of Municipalities	248	248	4102	4102	337	337	4102	4102

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. The outcome is an indicator that takes the value of one when the cadaster is updated and in subsequent years. We lead the dependent variable (cadaster update) by one year. PMAT participation data from Gadenne (2017).
$^{*}p < 0.1,\ ^{**}p < 0.05,\ ^{***}p < 0.01$.

We use PMAT data from Gadenne (2017), which we match using official population figures to data on the last complete cadaster update by 2004 and 2015, from Instituto Brasileiro de Geografia e Estatística (2004; 2015) . 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 2011.[38]

We present differences-in-differences estimates, using a similar specification to equation 1, in Table B.8. We take a one-year lead of the dependent variable, cadaster update. 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-update data ($N = 248$); in columns 3 and 4, we include all remaining municipalities that did not participate in the PMAT during the period as control units. We do a similar analysis in columns 5-8, but using the full set of PMAT municipalities during 1998-2011 ($N = 337$). The point estimates suggest a small impact of the program. The largest estimate, in column 1, indicates an increase in the probability of a cadaster update of 4.9 percentage points, or less than 15% 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.

We are interested in the onset of cadaster updates, but recognize that renovations remain effective for the next few years. To examine the robustness of our main results, which consider renovated cadasters to be updated throughout the period of analysis, we conduct two sets of additional estimations. First, we use an alternative measure of the duration of a cadaster update, where let all updates lapse after five years (and consider subsequent observations as missing if a new update is not certain). Second, we follow McGrath (2015) and use a binary onset variable while conditioning on the lagged value of the original duration-of-update outcome. The results, presented in Tables B.9, B.10 and B.11, also show no detectable impact of the program on cadaster updates.

[38] To combine the 2004 and 2015 sources for cadaster updates, we make the following coding decisions. Once a cadaster is renovated, it remains updated throughout; cadasters updates lapse if they occur prior to five years to the beginning of the panel (i.e., prior to 1998); finally, we give precedence to information from 2004 when the last update occurred in that year of before. When we alternatively let all updates lapse after five years, the results are similar to those in Table B.8, and are presented in tables B.10 and B.11.

Table B.9: The PMAT Program and Cadaster Updates
Binary Onset and Lagged Duration

	Cadaster Update Onset (1998-2004)				Cadaster Update Onset (1998-2011)			
	Only PMAT Sample 1998-2004		All Municipalities		Only PMAT Sample 1998-2011		All Municipalities	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
PMAT	-0.031	-0.039	-0.020	-0.019	0.0069	0.0050	0.0083	0.0055
	(0.042)	(0.045)	(0.025)	(0.025)	(0.020)	(0.021)	(0.012)	(0.013)
Has applied	-0.053	-0.074**	-0.043	-0.048	-0.026	-0.037*	-0.031	-0.038*
	(0.034)	(0.036)	(0.030)	(0.030)	(0.022)	(0.022)	(0.021)	(0.020)
Cadaster Update (lagged)	-0.60***	-0.60***	-0.61***	-0.62***	-0.39***	-0.40***	-0.41***	-0.42***
	(0.028)	(0.030)	(0.0068)	(0.0069)	(0.015)	(0.016)	(0.0044)	(0.0047)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes		Yes		Yes		Yes	
GDP per cap (log)	No	Yes	No	Yes	No	Yes	No	Yes
Year by State FE	No	Yes	No	Yes	No	Yes	No	Yes
Year FE ×								
Year of Last Pre-2004	No	Yes	No	Yes	No	Yes	No	Yes
Cadaster Update								
Within-Mun. Mean of DV	0.66	0.66	0.68	0.68	0.82	0.82	0.82	0.82
Within-Mun. SD of DV	0.31	0.31	0.31	0.31	0.26	0.26	0.25	0.25
R sq.	0.32	0.38	0.35	0.36	0.21	0.26	0.24	0.26
Observations	1488	1488	23738	23738	4381	4381	51527	51527
Number of Municipalities	248	248	4090	4090	337	337	4102	4102

OLS estimations. The unit-of-analysis is the municipality-year. Standard errors (clustered at the municipality level) in parentheses. The outcome is an indicator that takes the value of one only in the year when the cadaster is updated and zero otherwise. Econometric specification similar to equation (1); however, following McGrath (2015), we include a lag for a variable that takes the value of one when the cadaster is updated and in subsequent years. PMAT participation data from Gadenne (2017).
$^{*}p < 0.1,\ ^{**}p < 0.05,\ ^{***}p < 0.01$.

Table B.10: The PMAT Program and Cadaster Updates
Alternative Cadaster Update Measure

	Cadaster Update (1998-2004)				Cadaster Update (1998-2011)			
	Only PMAT Sample 1998-2004		All Municipalities		Only PMAT Sample 1998-2011		All Municipalities	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
PMAT	0.041	0.036	-0.011	0.0090	-0.050	-0.044	-0.042	-0.027
	(0.064)	(0.068)	(0.046)	(0.047)	(0.040)	(0.041)	(0.040)	(0.039)
Has applied	-0.065	-0.082*	-0.065	-0.057	-0.042	-0.060	-0.045	-0.046
	(0.046)	(0.049)	(0.042)	(0.043)	(0.038)	(0.039)	(0.036)	(0.036)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes		Yes		Yes		Yes	
GDP per cap (log)	No	Yes	No	Yes	No	Yes	No	Yes
Year by State FE	No	Yes	No	Yes	No	Yes	No	Yes
Within-Mun. Mean of DV	0.60	0.60	0.62	0.62	0.74	0.74	0.74	0.74
Within-Mun. SD of DV	0.34	0.34	0.34	0.34	0.33	0.33	0.32	0.32
R sq.	0.44	0.49	0.46	0.48	0.47	0.53	0.49	0.51
Observations	1696	1696	26610	26610	3893	3893	43619	43619
Number of Municipalities	248	248	4091	4091	337	337	4096	4096

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. The outcome is an indicator that takes the value of one the year a cadaster is updated and for the next five years; observations are considered missing afterwards if a new update is not certain. Reporting gaps between the 2004 and 2015 sources are also considered missing. We lead the dependent variable (cadaster update) by one year. PMAT participation data from Gadenne (2017).
$^{*}p < 0.1,\ ^{**}p < 0.05,\ ^{***}p < 0.01$.

Table B.11: The PMAT Program and Cadaster Updates
Alternative Cadaster Update Measure; Binary Onset and Lagged Duration

	Cadaster Update Onset (1998-2004)				Cadaster Update Onset (1998-2011)			
	Only PMAT Sample 1998-2004		All Municipalities		Only PMAT Sample 1998-2011		All Municipalities	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
PMAT	-0.011	-0.019	-0.00035	0.0040	0.011	0.010	0.014	0.015
	(0.044)	(0.048)	(0.025)	(0.025)	(0.022)	(0.022)	(0.013)	(0.013)
Has applied	-0.044	-0.066*	-0.036	-0.040	-0.020	-0.031	-0.026	-0.031
	(0.035)	(0.037)	(0.030)	(0.030)	(0.023)	(0.024)	(0.022)	(0.022)
Cadaster Update (lagged)	-0.41***	-0.40***	-0.42***	-0.43***	-0.26***	-0.27***	-0.28***	-0.29***
	(0.039)	(0.041)	(0.0098)	(0.0098)	(0.018)	(0.020)	(0.0056)	(0.0058)
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes		Yes		Yes		Yes	
GDP per cap (log)	No	Yes	No	Yes	No	Yes	No	Yes
Year by State FE	No	Yes	No	Yes	No	Yes	No	Yes
Year FE ×								
Year of Last Pre-2004	No	Yes	No	Yes	No	Yes	No	Yes
Cadaster Update								
Within-Mun. Mean of DV	0.66	0.66	0.68	0.68	0.80	0.80	0.79	0.79
Within-Mun. SD of DV	0.31	0.31	0.31	0.31	0.28	0.28	0.27	0.27
R sq.	0.25	0.32	0.27	0.29	0.20	0.25	0.23	0.24
Observations	1488	1488	23738	23738	3801	3801	43590	43590
Number of Municipalities	248	248	4090	4090	337	337	4094	4094

OLS estimations. The unit-of-analysis is the municipality-year. Standard errors (clustered at the municipality level) in parentheses. The outcome is an indicator that takes the value of one only in the year when the cadaster is updated and zero otherwise. Econometric specification similar to equation (1); however, following McGrath (2015), we include a lag for a variable that takes the value of one the year a cadaster is updated and for the next five years; observations are considered missing afterwards if a new update is not certain. Reporting gaps between the 2004 and 2015 sources are also considered missing for this variable. PMAT participation data from Gadenne (2017).
$^{*}p < 0.1,\ ^{**}p < 0.05,\ ^{***}p < 0.01$.

C. Additional Evidence: Regression Discontinuity

C.1 Covariate Balance at the Election Discontinuity

Table C.1: Covariate Balance at the Election Discontinuity

	Cadaster Updates, 2013-2015								
	CCT Bandwidth								
	Gender (female==1)	College Education	PT affiliation of incumbent	Pop. in 2010 (log)	Rural (%)	Any IPTU Collected by 2012	Gini Index (2010)	Pop. in Poverty (2010)	Num. of candidates (2012)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Incumbent Won in 2012	0.015	0.018	-0.0062	-0.16	0.022	0.046	-0.000024	-0.011	-0.0081
	(0.037)	(0.054)	(0.035)	(0.11)	(0.020)	(0.030)	(0.0077)	(0.022)	(0.11)
	[0.69]	[0.75]	[0.86]	[0.15]	[0.28]	[0.12]	[1.00]	[0.62]	[0.94]
Robust Std. Errors	0.053	0.081	0.048	0.16	0.029	0.045	0.012	0.033	0.17
Robust P-Value	0.95	0.45	0.62	0.38	0.54	0.48	0.82	0.84	0.77
Order of the Local Polynomial	1	1	1	1	1	1	1	1	1
Covariate Adjustment	No	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	0.16
Observations	1291	1385	1321	1227	1471	1228	1314	1193	1176
	IK Bandwidth								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Incumbent Won in 2012	0.0070	0.038	-0.0090	-0.14	0.021	0.048	0.0014	-0.0079	0.0037
	(0.044)	(0.064)	(0.037)	(0.13)	(0.020)	(0.032)	(0.0092)	(0.025)	(0.13)
	[0.87]	[0.55]	[0.81]	[0.26]	[0.30]	[0.13]	[0.88]	[0.75]	[0.98]
Robust Std. Errors	0.060	0.095	0.051	0.18	0.030	0.048	0.014	0.037	0.19
Robust P-Value	0.91	0.58	0.51	0.34	0.55	0.69	0.98	0.56	0.41
Order of the Local Polynomial	1	1	1	1	1	1	1	1	1
Covariate Adjustment	No	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	0.13
Observations	996	1116	1206	1014	1427	1121	1020	995	996
	CV Bandwidth								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Incumbent Won in 2012	0.0014	-0.011	-0.0016	-0.12	0.022	0.031	0.00050	0.0099	-0.039
	(0.027)	(0.035)	(0.023)	(0.072)*	(0.014)	(0.018)*	(0.0047)	(0.013)	(0.064)
	[0.96]	[0.75]	[0.95]	[0.098]	[0.11]	[0.095]	[0.92]	[0.44]	[0.54]
Robust Std. Errors	0.037	0.046	0.030	0.091	0.018	0.024	0.0062	0.017	0.083
Robust P-Value	0.43	0.95	0.88	0.25	0.17	0.33	0.54	0.48	0.81
Order of the Local Polynomial	1	1	1	1	1	1	1	1	1
Covariate Adjustment	No	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	1.00
Observations	1781	1868	1868	1868	1868	1868	1868	1867	1868

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.
$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

C.2 Alternative Data-Driven Bandwidth Selection Procedures

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

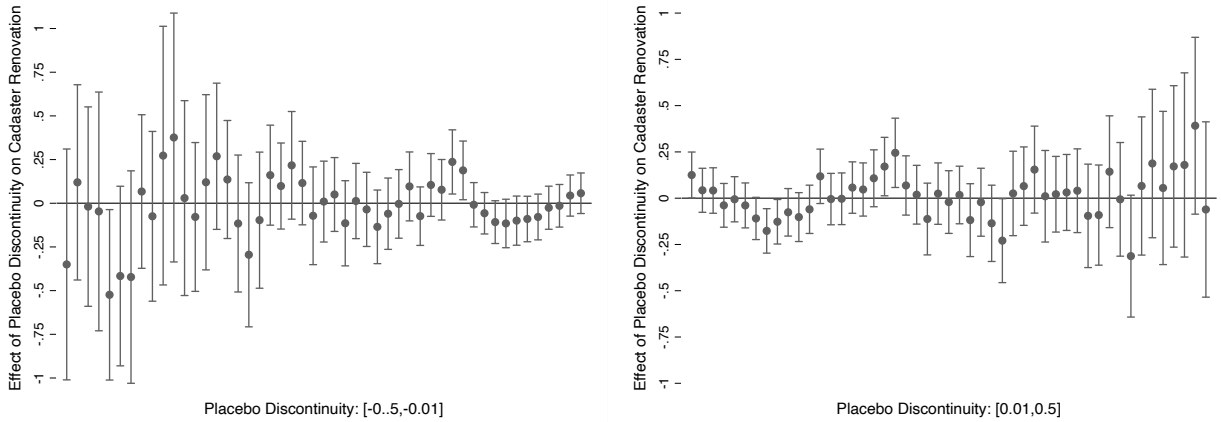
	Cadaster Updates, 2013-2015			
	CCT Two-Sided Bandwidths			
	(1)	(2)	(3)	(4)
Incumbent Won in 2012	0.13**	0.18***	0.20***	0.20**
	(0.056)	(0.064)	(0.076)	(0.086)
	[0.021]	[0.0054]	[0.0098]	[0.022]
Robust Std. Errors	0.11	0.094	0.10	0.11
Robust P-Value	0.21	0.17	0.19	0.32
Order of the Local Polynomial	0	1	2	3
Bandwidth				
Bandwidth (Left)	0.060	0.15	0.23	0.28
Bandwidth (Right)	0.043	0.14	0.22	0.36
Observations	426	1059	1383	1583
	IK Bandwidth			
	(1)	(2)	(3)	(4)
Incumbent Won in 2012	0.10**	0.16**	0.12	0.099
	(0.042)	(0.069)	(0.10)	(0.12)
	[0.015]	[0.019]	[0.23]	[0.42]
Robust Std. Errors	0.080	0.10	0.14	0.15
Robust P-Value	0.080	0.23	0.36	0.34
Order of the Local Polynomial	0	1	2	3
Bandwidth	0.089	0.12	0.12	0.15
Bandwidth (Left)				
Bandwidth (Right)				
Observations	704	920	918	1099
	CV Bandwidth			
	(1)	(2)	(3)	(4)
Incumbent Won in 2012	0.012	0.15***	0.12**	0.17***
	(0.024)	(0.055)	(0.052)	(0.059)
	[0.62]	[0.0049]	[0.017]	[0.0048]
Robust Std. Errors	0.035	0.080	0.065	0.070
Robust P-Value	0.95	0.021	0.0035	0.0048
Order of the Local Polynomial	0	1	2	3
Bandwidth	1.00	0.20	0.65	0.90
Bandwidth (Left)				
Bandwidth (Right)				
Observations	1805	1319	1765	1791

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.
$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

C.3 Placebo Discontinuity Thresholds

Figure C.1: Placebo Discontinuity Thresholds and Cadaster Updates

Arbitrary election victory thresholds reveal no effects in almost all cases.



(a) Placebo Discontinuity to the Left

(b) Placebo Discontinuity to the Right

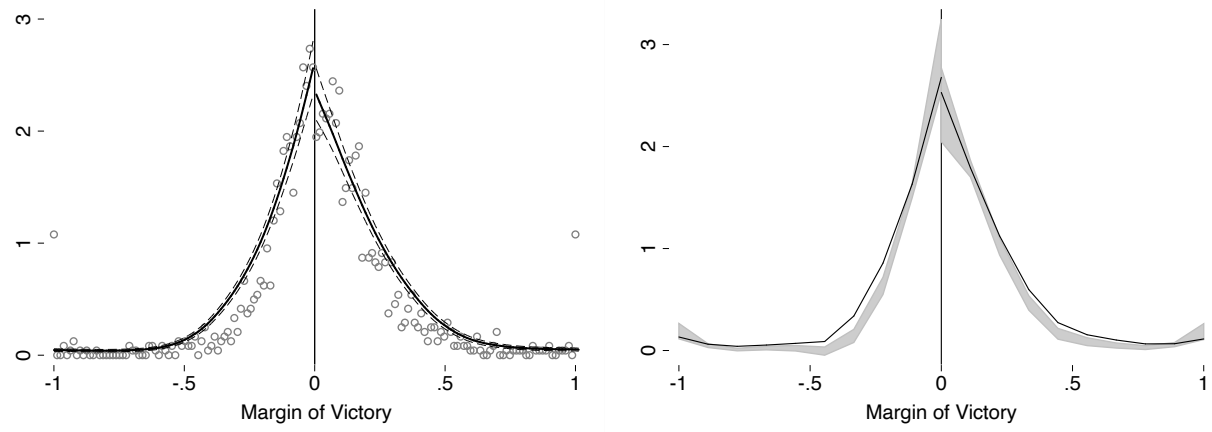
The figure on the **left** displays point estimates and 95% conventional confidence intervals on 1-st order local-polynomial RD estimates using placebo electoral threshold margins of victory to the left of the real cutoff of 0. The figure on the **right** displays similar estimates for placebo thresholds 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.

C.4 Continuity of the Electoral Margin at the Victory Threshold

In Figure C.2, we present two related approaches to assessing the continuity of our running variable, the electoral victory margin. We first select the bandwidth using a data-driven procedure based the MSE of difference of densities in each side of the discontinuity (Cattaneo, Jansson and Ma 2019). Next, we assess whether the electoral margin discontinuously jumps at the cutoff, using McCrary's density estimator (left panel) and a local-polynomial density estimator (right panel). We fail to reject the null of continuity in the electoral threshold using either approach.

While the jump is not significant, we see a slight bunching of observations to the left of the cutoff. Our balance tests — particularly those using the narrower IK bandwidth — focus attention on this range of the forcing variable. In Table C.1 we find no differences between municipalities where incumbent mayors barely lose and those in which they barely win.

Figure C.2: Continuity of the Electoral Margin at the Victory Threshold



(a) McCrary Density Estimator (b) Local Polynomial Density Estimator

The figure on the **left** plots the density of the margin of victory for first-term mayors running for reelection using McCrary's density estimator (McCrary 2008). The figure on the **right** uses a local polynomial density estimator (Cattaneo, Jansson and Ma 2019) of order 2, and includes a bias-corrected confidence interval. In both, we first select the bandwidth (0.39) based on the MSE of difference of densities in each side of the discontinuity and assume a common density, which increases the power of the continuity test.

C.5 Donut RD, Excluding Municipalities with Margin of Victory $< 1\%$

In Table C.3, we exclude municipalities with a tight margin of victory (less than one percentage point) and re-estimate the main results from Table 3. This "donut" RD helps to address concerns about unobserved sorting at the discontinuity, while requiring more extrapolation (Barreca et al. 2011; Eggers et al. 2015). These dropped observations correspond to 20% of the sample of municipalities when using a 4.4% margin-of-victory bandwidth and 7% of municipalities when using a 14% bandwidth (which correspond to the first two columns in Table 3). Reassuringly, the main estimates remain almost unchanged with this modified design.

Table C.3: Effect of Mayoral Term-Limits on Cadaster Updates in Close Elections
Donut RD, Excluding Municipalities with Margin of Victory $< 1\%$

	Cadaster Update, 2013-2015							
	No Covariate Adjustment				Covariate Adjustment			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Incumbent Won in 2012	0.13**	0.18***	0.21***	0.23***	0.12**	0.19***	0.22***	0.23***
	(0.059)	(0.068)	(0.078)	(0.085)	(0.059)	(0.068)	(0.078)	(0.083)
	[0.025]	[0.0069]	[0.0059]	[0.0076]	[0.039]	[0.0063]	[0.0048]	[0.0054]
Robust Std. Errors	0.069	0.076	0.086	0.092	0.069	0.076	0.086	0.090
Robust P-Value	0.013	0.0052	0.0086	0.012	0.021	0.0046	0.0073	0.0082
Order of the Local Polynomial	0	1	2	3	0	1	2	3
Covariate Adjustment	No	No	No	No	Yes	Yes	Yes	Yes
Bandwidth	0.043	0.12	0.21	0.31	0.042	0.12	0.20	0.32
Mean of Control	0.36	0.41	0.40	0.40	0.36	0.41	0.40	0.40
Observations	371	915	1290	1511	356	896	1271	1516

See equation (2) for the econometric specifications. We exclude observations within 1% of the electoral victory threshold. 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.
$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

D. Supporting Information References

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