Cutting Special Interests by the Roots: Evidence from the Brazilian Amazon*

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Abstract

Government policies may impact economic outcomes directly but also indirectly through effects on political equilibria. This paper examines the effects of the PPCDAm – a centralized environmental policy that synced real-time satellite deforestation data with enforcement on the ground – on the behavior and electoral outcomes of a powerful special-interest group operating in the Amazon: farmers. Exploring close elections, we document that municipalities governed by farmer mayors had higher deforestation rates and CO2e emissions, earmarked more resources to agriculture, and experienced more land-related conflict before, but not after, the PPCDAm was implemented. Any electoral advantage these mayors had before the policy also disappear with the introduction of the PPCDAm. Our findings are consistent with a political agency model where candidates use their occupation to signal commitment to pro-deforestation policies.

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1 Introduction

Government policies may impact economic outcomes directly but also indirectly through effects on political equilibria (Acemoglu and Robinson, 2013; de Janvry et al., 2012). In the case of environmental destruction, when a particular equilibrium exists with politicians catering to voters' interests for resource extraction, conservation policy can have an extra effect by lowering the local electoral returns of depredation. Yet, environmental policy recommendations rarely take such considerations into account, partly for a lack of empirical corroboration.[1]

This paper examines this question in the context of conservation policies in the Brazilian Amazon. Specifically, we examine the extent to which the *Action Plan for the Prevention and Control of Deforestation in the Legal Amazon* (hereafter, PPCDAm) – a forest conservation policy that synced a real-time remote-sensing system for environmental monitoring with anti-deforestation enforcement on the ground implemented by the federal government in November 2004 – decreased the returns to deforestation and, in turn, affected the behavior and electoral performance of organized pro-deforestation groups.[2]

One challenge for studying the political effects of government policies is to identify special interest groups whose electoral behavior is affected by specific policies. We overcome this challenge by focusing on politicians connected to agriculture (henceforth, *farmers*). These politicians constitute a powerful interest group in Brazil notoriously opposed to conversation policies (Helfand, 1999; Richardson, 2012). We expect, therefore, their behavior to be strongly influenced by the introduction of more rigorous conservation policy.

To understand the differences in electoral incentives of farmer politicians compared to other politicians, we build a simple political agency model with multiple issues in the

[1] A burgeoning literature raises the point of general equilibrium and political effects in the context of scaling up interventions (Manacorda et al., 2011; Banerjee et al., 2017; Muralidharan and Niehaus, 2017).

[2] See Nepstad, Soares-Filho, Merry, Lima, Moutinho, Carter, Bowman, Cattaneo, Rodrigues, Schwartzman et al. (2009), Assunção, Gandour and Rocha (2015) and Burgess, Costa and Olken (2018) for detailed information about the PPCDAm.

spirit of List and Sturm (2006) and Besley (2006). In our model, incumbents implement policies to increase deforestation and attract voter support. Voters believe that farmer politicians are more likely to personally support policies to increase deforestation. In equilibrium, this implies farmer politicians are better able to signal commitment to pro-deforestation interests than ordinary politicians, increasing their incentives to promote deforestation and their reelection rates. Through a variety of channels, such as raising the cost of promoting deforestation or reducing the value of pro-deforestation policies to voters, the introduction of more rigorous conversation policy weakens the signaling effect, reducing the effect of farmer mayors on deforestation as well as hurting their electoral performance.

We test these predictions exploring detailed data on politicians' characteristics, electoral performance, and deforestation. We begin by classifying politicians as farmers if they report having an agricultural occupation. We document that these politicians correspond to 17.9% of the candidates for mayor and 18% of the mayors elected in the Amazon in 2000 and 2004.

We then implement a Regression Discontinuity (RD) design exploiting close elections to examine the effects of farmer mayors on environmental and political outcomes before and after the introduction of the PPCDAm. Our empirical design leverages the fact that the PPCDAm was implemented on November 2004, immediately before the mayors who governed during the term 2001-2004 left office and immediately after the mayors who governed during the term 2005-2008 were elected. Thus, the comparison of outcomes in these terms effectively compares politicians with comparable *selection* into running for office or being elected operating with different *incentives*. This enables us to isolate the effects of the PPCDAm on the behavior of farmer mayors.

Using Hansen et al. (2013)'s deforestation data, we document that municipalities governed by farmers have higher deforestation rates before but not after the implementation of the PPCDAm. The magnitude of the effects we uncover is quantitatively important.

Our preferred specification indicates that, before the introduction of the PPCDAm, municipalities governed by farmers deforested 170 square kilometers more than municipalities not governed by farmers. This represents nearly a threefold increase in the deforestation rate observed mean municipality during this period. This effect is also reflected in direct CO2e emissions to the atmosphere. The effect of politicians representing agricultural interests completely disappears after the introduction of PPCDAm – point estimates experience a large decline and become statistically insignificant. The analogous is true for farmer election rates in the next election: we find evidence, albeit less clear, that farmer mayors enjoyed better electoral performance when returns to deforestation were high, and none when they were low.

The differences in deforestation rates before the PPCDAm are solely explained by differences in the conversion of forests located outside protected areas into pasture. This is consistent with the existence of penalties and effective monitoring of deforestation inside protected areas even before the implementation of the PPCDAm. Furthermore, this suggests that environmental regulations are not inhibiting the growth of high productivity crop agriculture but rather of low productivity cattle ranching.[3]

To measure mayors' effort in different policy areas, we analyze data on matching grants between the federal and local governments, a type of revenue for which mayors have discretion on fund-raising. We find that farmer mayors increased the value of agricultural grants signed before the PPCDAm but not after, and never had any effects on grants for other areas such as the environment, education, or health. Because agricultural grants typically provide equipment or assistance for municipalities to invest in their agricultural sector, this finding indicates that tighter conservation policies decrease the subsidies politicians connected to agriculture give to the sector. Consistent with our find-

[3]Cattle productivity in the Amazon biome is typically a low productivity activity with substantial room for intensification. See Cohn, Mosnier, Havlík, Valin, Herrero, Schmid, O'Hare and Obersteiner (2014) for an example of the economic and environmental potential of cattle intensification. For this reason, agricultural growth in Brazil is typically connected to the expansion of cropland over pastures. See Assunção and Bragança (2015), Assunção, Pietracci and Souza (2016), and Bragança (2018) for evidence of the connection between pasture to cropland conversion and agricultural growth in different Brazilian regions.

ings on deforestation, with data on agricultural production and the cattle stock size at the municipality level, we also find that farmer mayors caused decreases in agricultural yield and increases in low-productivity cattle raising prior to PPCDAm, and vice-versa afterwards.

Lastly, land in the Amazon is often subject to dispute and conflict, particularly when new forest is cleared or economic conditions change (Hidalgo, Naidu, Nichter and Richardson, 2010). We collect data on the universe of conflict events in the Amazon for our period of study and test whether electing farmer mayors increases the likelihood of various types of violence. Also consistent with our prior results, we find that farmer mayors generate more land conflict and murders before the PPCDAm, but not after it. These findings reveal a new cause of land conflict previously not discussed in the literature (Miguel, Satyanath and Sergenti, 2004; Burke, Hsiang and Miguel, 2015).

Our findings are robust to numerous robustness checks. First, we provide evidence that the RD design is valid for each period. There is no evidence the distribution of the margin of victory of farmer politicians is discontinuous at the threshold. There also is no evidence of discontinuities on pre-determined characteristics. Second, we provide evidence that the sample of municipalities included in the RD in each period is comparable. The municipalities in the RD sample are smaller in terms of population, total area, forest area, and presence of protected areas. However, these differences do not change between 2001-2004 and 2005-2008. This indicates that the changes in the coefficients across periods are unlikely to reflect differences in the effects of farmer mayors in different parts of the distribution of municipalities. Third, we find the results are unaffected by changes in the bandwidth or the kernel used. Fourth, we find evidence that the results are broadly robust to different definitions of our indicator for farmer politicians.

Taken together,our work documents two new facts. First, we find a multiplier effect of the PPCDAm operating through electoral incentives. By changing the underlying returns to illegal deforestation, it reduced the electoral returns farmers received by enacting pro-deforestation policy. Second, despite the international community's desire to protect the Amazon and formal jurisdiction in Brazil to do so being at the federal level, we find that local governments matter for environmental conservation. This paper contributes to three different strands of literature.

First, we contribute to the literature on tropical deforestation. An existing literature documents that the PPCDAm reduced deforestation by increasing the enforcement of the environmental legislation in the Amazon (Assunção, Gandour and Rocha, 2015; Burgess, Costa and Olken, 2018; Assunção, Gandour and Rocha, 2019). Our findings indicate this increase in enforcement decreased deforestation both directly by increasing penalties associated with illegal deforestation and indirectly by eliminating the incentives of local politicians to cater to pro-deforestation interests. By documenting the importance of local governments for environmental protection, our findings complement those of Burgess, Hansen, Olken, Potapov and Sieber (2012), Morjaria (2018), and Sanford (2020), who study how politics impacts deforestation in Indonesia, Kenya, and worldwide, respectively.

Second, our work contributes to the literature on government capture. A growing body of empirical research examining how capture and corruption at the local level influence the effectiveness of public policy (Reinikka and Svensson, 2004; Baicker and Staiger, 2005; Olken, 2007; Ferraz, Finan and Moreira, 2012; Banerjee, Hanna, Kyle, Olken and Sumarto, 2018). Our findings indicate that policies can weaken local special-interest groups by affecting the resources on which an extraction equilibrium existed before and, therefore, have a larger impact than originally anticipated. This mechanism is often discussed theoretically (Stigler et al., 1971; Becker and Stigler, 1974; Grossman and Helpman, 1994; Bardhan and Mookherjee, 2000). However, to the best of our knowledge, the empirical evidence on it is limited to cross-country studies (Ades and Di Tella, 1999).

Third, our work contributes to the large body of research connecting the identity of politicians to public policy choice. This literature connects traits such as gender (Chattopadhyay and Duflo, 2004; Beaman et al., 2009; Brollo and Troiano, 2016), ethnicity (Franck and Rainer, 2012), ideology (Pettersson-Lidbom, 2008; Ferreira and Gyourko, 2009), religion (Meyersson, 2014), age (Alesina et al., 2018), and education (Besley et al., 2011) to the performance of politicians in delivering public goods, implementing public policy, and influencing economic outcomes. Our work provides evidence that a new measure of *occupational* identity, namely being a farmer, also influences economic outcomes. Moreover, our findings indicate that this measure of identity only influences economic outcomes when politicians are able to generate rents for their group. This might explain why some studies in the literature find that identity matters while others do not.

The remaining of the paper proceeds as follows. Section 2 discusses the context, focusing on environmental policy and the opposition of farmers and ranchers to it. Section 4 describes the data. Section 3 details the conceptual and empirical frameworks. Section 5 discusses the impacts of politicians representing agricultural interests on deforestation and other outcomes. Section 6 concludes.

2 Institutional Background

2.1 Deforestation and Environmental Policies in the Amazon

Covering 60% of the country's territory, the Amazon was sparsely populated until the 1960s. Most of the region was isolated with its mostly indigenous population living from either subsistence or the extraction of rubber. Non-indigenous population was concentrated around few cities which prospered during the rubber boom from 1860-1920.[4]

The dynamics of occupation of the Amazon changed during the military dictatorship that governed the country from 1964 to 1985. The military government believed that increasing migration to the region would serve both to increase exports of minerals and

[4]See Hecht and Cockburn (2010) for a historical account of the occupation of the Brazilian Amazon and Barham and Coomes (1994b) and Barham and Coomes (1994a) for detailed accounts of the rubber boom in the region.

agricultural products and ease pressures for land reform in other regions of the country (Houtzager and Kurtz, 2000). Incentives for the occupation of the Amazon included the construction of roads, hydroelectric dams, and mining projects (Hecht and Cockburn, 2010). It also included the titling of occupied and, therefore, deforested plots (Pfaff, 1999). Environmental policies were non-existent in the region during this period. Indeed, population growth, road building, and the possibility of securing property rights by deforesting land have contributed to the escalation of deforestation in the region in this period (Pfaff, 1999; Pfaff, Robalino, Walker, Aldrich, Caldas, Reis, Perz, Bohrer, Arima, Laurance et al., 2007; Alston, Libecap and Mueller, 2000).

Policies to promote forest conservation began to earn prominence in the late 1980s with the creation of institutions like the Ministry of the Environment (MMA) and the Environmental Protection Agency (IBAMA). The *de jure* protection of forests increased in the following decade with the enactment of different pieces of legislation that increased the share within properties that farmers and ranchers were not allowed to deforest and established criminal and administrative penalties farmers and ranchers would receive in case they violate environmental law. Importantly, the legal framework established that any unauthorized deforestation in the Amazon was a crime and that the environmental police was allowed to seize the equipment (tractors, trucks, chainsaws etc.) found on site in any illegally cleared land. Nevertheless, the lack of coordination between agencies and tools to effectively monitor and punish individuals engaged in illegal deforestation severely limited the effectiveness of this legislation (Assunção, Gandour and Rocha, 2015; Burgess, Costa and Olken, 2018). Thus, forest clearing continued to grow with deforestation in the Brazilian Amazon peaking in the early 2000s.

This spurred the creation of the *Action Plan for the Prevention and Control of Deforestation in the Legal Amazon* (PPCDAM) in November 2004. From its beginning, the PPCDAM promoted a major change in monitoring policies with the adoption of the Real-Time Detection of Deforestation (DETER), a satellite-based monitoring of deforestation in the

Amazon. DETER uses geo-referenced images on Amazon forest cover in 15-day intervals to identify deforestation hot spots and target law enforcement efforts. This significantly increased IBAMA's ability to punish illegal deforestation and is considered responsible for the decrease in deforestation which occurred after 2004 (Nepstad, Soares-Filho, Merry, Lima, Moutinho, Carter, Bowman, Cattaneo, Rodrigues, Schwartzman et al., 2009; Assunção, Gandour and Rocha, 2015; Burgess, Costa and Olken, 2018). Evidence indicates that better monitoring decreased deforestation in the region by 60% (Assunção, Gandour and Rocha, 2019). Later, the PPCDAm led to institutional changes focused in sanctioning and increasing monitoring of municipalities with high deforestation, expediting the prosecution of environmental crimes, and restricting credit to producers non-compliant with the environmental legislation. These policies were implemented in 2007 and 2008, being responsible for further decreases in deforestation.[5]

Our work explores whether the PPCDAm influenced the way local officials promote or discourage deforestation. We are particularly interested in understanding the effects of better monitoring of deforestation on the behavior of these officials. To explain how this effect might operate, we next describe the incentives mayors of the municipalities in the Amazon might have to enact policies that influence deforestation.

2.2 Local Politics, Farmers, and Environmental Policies

Municipalities are the smallest administrative division in Brazil. Municipal governments are managed by a mayor elected using plurality rule in municipalities with less than 200,000 voters and majority rule in municipalities with more than 200,000 voters. May-

[5] The 'priority list' of municipalities facing economic sanctions and increased environmental monitoring was established by the Decree No. 6,321, enacted in 2007. See Assunção and Rocha (2019) and Sills, Herrera, Kirkpatrick, Brandão Jr, Dickson, Hall, Pattanayak, Shoch, Vedoveto, Young et al. (2015) for evidence of the effectiveness of the 'priority list' in reducing deforestation. Regulatory modifications facilitating IBAMA's law enforcement actions was established by Decree No. 6,514 enacted in 2008. See Assunção, Gandour and Rocha (2019) for a discussion of the impact of stricter environmental enforcement on deforestation. The restriction of credit for producers not compliant with the environmental legislation was instituted by Resolution 3,545 enacted in 2008 by the National Monetary Council. See Assunção, Gandour, Rocha and Rocha (2020) for evidence of the effects of this policy on deforestation.

ors serve a four-year term which can be renewed once.

The decentralization that followed the 1988 Federal Constitution transformed the municipalities in the main providers of public services in the country (Arretche, 1999). Municipal governments are responsible for managing childcare centers, primary schools and health centers, for improving and maintaining infrastructure, for commissioning the construction of housing projects, for selecting eligible households for a number of federal policies, etc.

Environmental policies do not fall under the jurisdiction of municipal governments, it being the responsibility of state and federal governments. This, however, does not preclude municipalities from indirectly influencing deforestation through their local policies. The consent of local governments is essential for the occurrence of activities like land grabbing or illegal logging.[6,7] Moreover, local governments might influence the incidence of federal policies. Bribes or lobbying might be used to reduce the enforcement of environmental regulations, to facilitate the disbursement of credit to local farmers and ranchers or to increase the number of agreements earmarking resources to promote agricultural activities in the municipality. The decisions to enact these policies will typically depend on the costs and benefits politicians obtain with encouraging deforestation. These costs and benefits, in their turn, might depend on the extent local politicians represent the interests of the farmers operating in their municipality.

Farmers and their associations exert a strong influence in politics in Brazil. The lobby of this sector influenced politics in Brazil since the country became independent in the 1800s. However, the sector became more politically organized during re-democratization in the 1980s due to fears that democratization would weaken property rights, promote land reform, and end the preferential access to credit the sector enjoyed since the dictator-

[6]See Fearnside (2001) and Ludewigs, Brondízio, Hetrick et al. (2009) for a discussion of land grabbing, land tenure and their likely impacts on deforestation and Chimeli and Boyd (2010) for a discussion of illegal logging in the Amazon.

[7]See Alston, Libecap and Mueller (2000) for a discussion of the impact of land tenure on deforestation.

ship (Helfand, 1999).

This reorganization of farmers' political interests created one of the most powerful lobbies in the country - one quarter of all members of Congress are members of the so-called rural caucus, which represents farmers and their interests.[8] In the 1990s, this lobby thrived in ensuring land distribution initiatives did not hurt farmers and in expanding farmers' access to credit from state-owned banks. In the 2000s, the tightening of the conservation policies brought this issue to the center of rural politics in Brazil (Richardson, 2012). Because these policies tighten land constraints, they suffer intense opposition from farmers and their representatives.[9]

At the national-level, politicians representing agricultural interests lobbied for undermining environmental regulations and for appointing bureaucrats aligned with their agenda for the ministries of agriculture and environment.[10] At the local-level, politicians representing agricultural interests might enact policies encouraging deforestation.

The incentives for politicians representing agricultural interests to encourage deforestation will depend rents policies which encourage illegal deforestation generate. In the absence of effective monitoring, the returns of deforesting will be high, which, in turn, will

[8]The coordinator of a presidential campaign told reporters of Revista Piauí in 2014 that "in thirty years doing political campaigns I have never seen someone be elected without the support (from agri-business)" (*Revista Piauí*, July 2014, p.22). Indeed, the rural caucus openly supported the winning bid of President Jair Bolsonaro in the 2018 presidential election.

[9]The position against anti-deforestation policies of the representatives of farmers interests in Brazil often receives attention in the international media. In 2012, The Economist reported the tension between farmers and environmentalists in the discussion of the reform of the country's Forest Code ("Environmental Law in Brazil: Compromise or Deadlock?", *The Economist*, June 2, 2012). In 2014, the National Public Radio reported how the growing power of the rural caucus could undermine environmental policies. It wrote that "the make up of Brazil's new legislative body will have a big impact on the world because of a surge in the so-called ruralist bloc and their track record on environmental protections in the Amazon" ("In Brazil, Conservationists Worried New Congress Could Harm Amazon", *National Public Radio*, October 17, 2014). Indeed, The Guardian recently described how the increasing power of farmers and their representatives is threatening conservation policies. It wrote that "beef and soy barons have strengthened their grip on power. (...) (President) Michel Temer appointed several ruralistas to his cabinet and moved to dismantle and dilute the institutions and laws that slowed forest clearance." ("Wild Amazon faces destruction as Brazil's farmers and loggers target national park", *The Guardian*, May 27, 2017).

[10]The current Ministry of the Agriculture, Ms. Tereza Cristina, is the former chair of the rural caucus in Congress while the current Ministry of the Environment, Mr. Ricardo Salles, is a former Secretary of the Environment of the state of São Paulo with known connections to agriculture whose appointment was supported by the main farmers' associations.

induce farmers to pressure politicians to encourage deforestation in their municipalities. To the extent that politicians connected to agriculture are more responsive to these pressures, they will be more likely to encourage deforestation in their municipalities for political reasons. Furthermore, if politicians connected to agriculture have economic interests aligned with those of this industry, they will also be more likely to encourage deforestation for personal reasons. However, in the presence of effective monitoring, the returns from deforesting will be lower which will reduce the political and personal incentives for politicians connected to agriculture get from promoting deforestation.

Therefore, we expect the real time remote-sensing monitoring system implemented in the first phase of the PPCDAm to differentially influence deforestation in municipalities governed and not governed by politicians connected to agriculture. Other policies implemented in the second phase of the PPCDAm might have a similar impact from the monitoring. By increasing the legal penalties from deforesting or restricting the access to credit to producers non-compliant with the environmental legislation, these policies might further lower the returns from deforesting. Furthermore, by punishing municipalities with high deforestation, these policies might induce competition between municipalities with the goal of leaving (or staying out) of the environmental blacklist.

Our empirical analysis combines data on local politicians, local elections, and forest cover to test the hypotheses laid out above. We specifically test two hypotheses. First, we test whether deforestation was different in municipalities governed and not governed by mayors connected to agriculture before the implementation of the PPCDAm. Second, we test whether this difference decreased after the implementation of the PPCDAm.

3 Conceptual and Empirical Frameworks

3.1 Conceptual Framework

To motivate our empirical framework, we build a model in which incumbents implement policies that increase deforestation to attract support from voters and donors who benefit from forest clearing, thereby increasing their likelihood of being reelected. Our model is in the spirit of the political agency literature (Besley and Case, 1995; Coate and Morris, 1995; Banks and Sundaram, 1998; Ashworth, 2005; List and Sturm, 2006; Besley, 2006; Ashworth, 2012). We follow closely the approach to modeling multiple policy issues proposed by List and Sturm (2006) and Besley (2006).

Environment. We consider a model with two periods denoted by $t = \{1, 2\}$. In each period, an incumbent politician chooses the level of taxes and expenditures ("government size") and whether or not to implement policies to promote deforestation ("deforestation").

There are two types of voters – *ordinary* and *pro-deforestation* – representing shares ω and $1 - \omega$ of the electorate. Ordinary voters derive utility solely from government size. Their utility is $|g - g^*|\Gamma$ in which g is their preferred government size and g^* is the government size implemented by the politician in office. Pro-deforestation voters derive utility solely from "deforestation". Their utility is Δ if the politician in office implements pro-deforestation policies and 0 if not. Besides their preferences on public policies, voters receive a popularity shock δ for the incumbent. We let δ be uniformly distributed in the support $[-1/2\epsilon, +1/2\epsilon]$. Voters discount the future with discount factor $\beta \in (0, 1)$.

There are two types of politicians – *ordinary* and *farmers* – denoted by $p \in \{O, F\}$. Politicians' preferences on government size are public information, while their preferences on deforestation are private information. Preferences on government size are identical regardless of the type of politician. However, preferences on deforestation are heterogeneous depending on the type of politician. There is a probability π^p a politician is pro-deforestation and a probability $1 - \pi^p$ it is not. In the former case, implementing pro-deforestation policies is not costly. However, in the latter it has a cost c drawn from a uniform distribution defined over the support $[0, C]$. We suppose $\pi^F > \pi^O$. This effectively means that being a farmer signals whether the politician is pro-deforestation. Both types of politicians receive a rent R from holding office and discount the future with a discount factor $\beta \in (0, 1)$.

Timing is as follows. In the beginning of period 1, nature draws the incumbent's type, her preferences regarding government size, and her cost shock c. The politician then decides which policies to implement and voters derive utility from them. At the end of period 1, politicians draw a popularity shock δ, and voters decide whether to reelect the incumbent or replace her by a randomly chosen opponent from the pool of politicians from the other type. In period 2, the politician in office decides which policies to implement, voters derive utility from them, and the game ends.

Equilibrium. We solve for the perfect Bayesian equilibrium of the game between voters and politicians. In this equilibrium, politicians and voters behave optimally in both periods. The politicians choose policies to maximize their expected utility given the reelection rule used by the voters. Voters decide whether to reelect the incumbent by comparing the expected utility from reelecting her conditional on the existing information with the expected utility of replacing her by a randomly chosen opponent of the other type. Voters use the policies implemented by the incumbent to infer their type (using Bayes' rule).

The decisions on government size are straightforward. Because the incumbent's preferences on government size are publicly known, ordinary voters decide whether to reelect her by checking whether the incumbent's preferences are closer to theirs than the preferences of a randomly chosen opponent. We denote the lead of the incumbent among ordinary voters by η.

The interesting behavior by politicians occurs regarding deforestation. In period 2, there is no strategic behavior and politicians implement their preferred policies. However, because the incumbent's preferences on deforestation are not publicly known, there are incentives for politicians to implement pro-deforestation policies in period 1 to attract pro-deforestation voters and increase her probability of reelection.

Let Π^p be the voters' belief that a politician of type p which implemented pro-deforestation policies in period 1 is pro-deforestation. Bayes' rule implies

$$\Pi^p = \frac{\pi^p}{\pi^p + (1-\pi^p)\lambda^p} \tag{1}$$

in which λ^p is the probability that a politician of type p chooses pro-deforestation policies in period 1 when it is costly to her.

Pro-deforestation voters use this posterior Π^p and the prior $\pi^{p'}$ to compare the expected utility of reelecting the incumbent with the expected utility of replacing him by an opponent of type p'. Note that $\Pi^p > \pi^p$ for all λ. This implies that politicians' build reputation among pro-deforestation voters by enacting policies that cater to their interests.

Because $\pi^F > \pi^O$, reputation building is more effective for farmers than for other politicians. Farmers always obtain an electoral advantage by enacting pro-deforestation policies because $\Delta\left(\pi^F - \pi^O\right) > 0$ regardless of λ^A. However, ordinary politicians only obtain an electoral advantage by enacting pro-deforestation policies if the following condition holds:

$$\lambda^O < \frac{\pi^0/(1-\pi^0)}{\pi^F/(1-\pi^F)}. \tag{2}$$

Equation (2) states that the signaling effect of enacting pro-deforestation policies for ordinary politicians must be strong enough to revert their disadvantage with pro-deforestation voters. If this does not occur, the reputational effect is negative, signaling is ineffective, and ordinary politicians do not implement pro-deforestation policies when it is costly for them.

Combining the decisions of the two types of voters, it is straightforward to see that an incumbent that implements pro-deforestation policies gets reelected if and only if $\omega\eta + (1-\omega)\Delta(\Pi^{p} - \pi^{p'}) + \delta > 0$. Conversely, an incumbent that does not implement these policies gets reelected if and only if $\omega\eta + \delta > 0$. Integrating over the distribution of δ, we find that the politician implements pro-deforestation policies if:

$$c < \beta R\epsilon(1-\omega)\Delta(\Pi^{p} - \pi^{p'}) \tag{3}$$

Integrating over the distribution of c, we obtain the following expression for the probability that a politician of type p chooses pro-deforestation policies when it is costly to her is:

$$\lambda^{p} = \left(\frac{\beta\epsilon R(1-\omega)\Delta}{C}\right)(\Pi^{p} - \pi^{p'}) = \Gamma(\Pi^{p} - \pi^{p'}), \tag{4}$$

Equation (4) states that the probability that a politician of type p chooses pro-deforestation policies when it is costly to her is the product of the share of pro-deforestation politicians, a measure of return of reelecting incumbent from the perspective of the voters ($\Delta(\Pi^{p} - \pi^{p'})$), and a measure of return being reelected from the perspective of the politicians ($\epsilon\beta R/C$).

Equations (1)-(4) enable us to characterize the equilibrium behavior of the politicians. Farmers implement pro-deforestation policies in period 1 if $c < \beta R\epsilon(1-\omega)\Delta(\pi^{F} - \pi^{O})$ and are reelected with probability $1/2 + \omega\eta(1-\omega)\Delta(\pi^{F} - \pi^{0})$. If condition (2) is satisfied, ordinary politicians opposed to deforestation do not implement pro-deforestation policies and are reelected with probability $1/2 + \omega\eta$. Conversely, if condition (2) is not satisfied, ordinary politicians opposed to deforestation implement pro-deforestation policies in period 1 if $c < \beta R\epsilon(1-\omega)\Delta(\Pi^{O} - \pi^{F})$ and are reelected with probability $(1 -$

$\omega)\Delta(\Pi^O - \pi^F)$.

Using these equilibrium conditions, we obtain the following result:

Result 1. *The probability of enacting pro-deforestation policies and being reelected is higher for farmers than for other politicians.*

Proof. See Appendix A. ■

Result 1 establishes that farmers will deforest more and be reelected more often than the other politicians. This result reflects two theoretical mechanisms: *preferences* and *incentives*. The *preferences* channel comes from the fact that farmers are more likely to be pro-deforestation, while the *incentives* channel comes from the fact the electoral return from implementing pro-deforestation policies is higher for farmers.

It is possible to use our model to evaluate the effects of the introduction of centralized conservation policies by the federal government. Conservation policies might reduce the returns from deforesting from the perspective of voters in the extensive margin through a decrease in the number of pro-deforestation voters ($\uparrow \omega$) and in the intensive margin through a decrease in the benefit these voters obtain from pro-deforestation policies ($\downarrow \Delta$). Furthermore, these policies might increase the costs of enacting deforestation ($\uparrow C$) or trigger penalties that decrease the returns from holding office ($\downarrow R$). Irrespective the mechanism, this implies the introduction of conservation polices reduces Γ. The following result establishes that the equilibrium effects of these policies.

Result 2. *The introduction of conservation policies influences the political equilibrium, reducing deforestation and reelection rates. Both effects are stronger in municipalities governed by farmers than in municipalities governed by ordinary politicians.*

Proof. See Appendix A. ■

Result 2 establishes that the introduction of conservation policies generates political spillovers. In terms of environmental outcomes, these spillovers reinforce the effects of conservation policies, further reducing deforestation, especially in municipalities governed by politicians connected to agricultural interests. In terms of political outcomes, these spillovers increase political turnover, in general, and reduce the competitiveness of politicians connected to agricultural interests, in particular. Our empirical framework uses rich data on politicians and deforestation to test these predictions.

3.2 Empirical Framework

To evaluate the effects of PPCDAm on the behavior and the electoral competitiveness of politicians connected to agriculture, we test whether the differences in environmental outcomes, government expenditures, and electoral outcomes between municipalities governed by pro-agriculture politicians and other municipalities are influenced by the implementation of the PPCDAm.

We begin by estimating differences in outcomes between municipalities governed by farmer politicians and municipalities governed by other politicians using the following empirical model:

$$Y_{it} = \alpha + \beta P_{it} + \gamma P_{it} Post_t + \delta(1 + \phi' X_{it}) Post_t + \epsilon_{it}, \tag{5}$$

in which Y_{it} is an outcome of interest of municipality i during term t, P_{it} is a dummy denoting whether the municipality i is governed by a farmer politician during term t, $Post_t$ indicates the term 2005-2008, X_{it} is a vector of controls, and ϵ_{it} is an idiosyncratic error term. The parameters of interest in Equation (5) are β and $\beta + \gamma$. These parameter capture the mean differences in Y between municipalities governed by farmer politicians and municipalities governed by other politicians, before and after the PPCDAm.

Because the PPCDAm was implemented in 2005, this implies these elections were held in comparable political environments but the mayors elected in these elections governed under different incentives to deforest. This enables us to estimate whether the change in incentives promoted by the PPCDAm affected the behavior of the politicians during their terms and their (or their group) performance future elections.

Following the theoretical discussion from Section 3.1, we focus on the effects of farmer politicians on environmental outcomes and on the electoral performance of their group in the following election. We expect farmer politicians to enact policies to promote deforestation and to benefit electorally from them in before the implementation of the PPCDAm, implying $\beta \geq 0$ for both outcomes. We further expect the incentives to enact policies that promote deforestation and the electoral benefits to diminish after the implementation of the PPCDAm, implying $\gamma < 0$ for both outcomes.

To better understand the politics of deforestation in the Amazon, we further estimate Equation (5) on government expenditures, land-related conflicts, and economic performance. These regressions enable us to better understand the both the tools used by local politicians to promote deforestation and who benefits from deforestation.

The fundamental challenge to recover the coefficients β and γ using Equation (5) is that municipalities in which farmer politicians win elections are likely to be different from municipalities in which other politicians win elections. This might be true both in observable and unobservable dimensions, implying the inclusion of controls in the vector X_{it} is unable to ensure identification.

We exploit close elections to deal with this identification issue. Under the hypothesis that the outcomes of close elections are "as good as random", it is possible to recover the effects of farmer politicians using regression discontinuity (RD) design which compares outcomes in municipalities in which farmer politician won the election by a small margin and municipalities in which a farmer politician lost by a small margin.

We use the following empirical model to obtain the RD estimates separately for each time period:

$$Y_i = \alpha + \beta P_i + g(M_i) + \gamma' X_i + \epsilon_i, \tag{6}$$

in which $g(.)$ is a flexible function and M_i is the margin of the farmer politician. We estimate Equation (6) separately for the elections of 2000 (pre) and 2004 (post), corresponding to the electoral terms of 2001-2004 and 2005-2008, respectively. We also compute a difference-in-discontinuities coefficient to estimate $\beta^{2004} - \beta^{2000}$ (Grembi et al., 2016). Our preferred specification uses a local linear regression with uniform weights using the optimal bandwidth computed using the approach proposed by Calonico et al. (2014). We report other specifications in robustness exercises.

The hypothesis that close elections is "as good as random" has two empirical implications. First, pre-determined outcomes ought to be balanced in both sides of the discontinuity. Second, the distribution of M_i should be continuous at the cutoff. We discuss the validity of these hypothesis in Section 4.2.

The two hypotheses discussed in the previous paragraph are sufficient to ensure the causal interpretation of each of the RD coefficients. However, one additional hypothesis is required to enable the comparison the RD coefficients. As Equation (6) is estimated using information of the municipalities in which farmer politicians were winners or runner-ups, the municipalities used to estimate the effects of farmer politicians in different periods are distinct. This implies that comparing the RD coefficients over time is possible only under the hypothesis the PPCDAm did not influence the occurrence of a close election involving farmer politicians. Otherwise, the differences in the RD coefficients might simply reflect heterogeneity in the effects of farmer politicians across different groups of municipalities. We provide evidence consistent with this hypothesis in Section 4.2.

4 Data

4.1 Data Sources

Our empirical investigation examines whether the introduction of a real-time remote-sensing monitoring of deforestation by the federal governmental influenced the behavior and the electoral competitiveness of politicians connected to agriculture (farmer). For this, we combine official electoral records, geo-referenced information on deforestation and land use, administrative data on public finances, survey information on land-related conflicts, and census data. We describe each of these sources in detail.

Elections. We obtain information on politicians and electoral outcomes using an administrative dataset of politicians running for office at the local level provided by the Brazilian Electoral Court (TSE) and pre-processed by *Base dos Dados* (Carabetta et al., 2020). Our dataset covers a total of two electoral terms (2001-2004 and 2005-2008). For each candidate for office, this data contains information on his/her electoral performance as well as information on his/her political party, gender, age, occupation, and educational level. We use this dataset to build a measure of candidates connected to agriculture (farmer). We define as farmers the politicians who self-reported an occupation related to agriculture in our data.[11] Farmer candidates amount to 18.5% of all candidates for mayor in the Amazon in 2000 and 16.9% in 2004.

Deforestation. We measure deforestation using geo-referenced data on "tree cover" and "tree cover loss" at 30m^2 resolution for the period 2001-2008 provided by the Global Forest Change v1.5 (Hansen et al., 2013). Tree cover is defined as all vegetation greater than 5 meters in height and tree cover loss (deforestation) is defined as the complete removal or significant disturbances of the forest canopy. We aggregate the pixel-level information to

[11] In particular, we encode an indicator for whether the candidate's occupation is "agricultor", "agronomo", "pecuarista", "produtor agropecuário", "técnico em agronomia e agrimensura", "trabalhador agrícola", "trabalhador da pecuária", and "trabalhador rural".

the municipality-level, resulting in a panel counting the number of deforestation events that are observed in each municipality at a given year. We convert the number of events to square kilometers to obtain a measure that is comparable to the other deforestation and land use measures used in the paper.

In robustness exercises, we use the municipality-level deforestation measure provided by the Project for Monitoring Deforestation in the Legal Amazon of the Brazilian Institute of Spatial Research (PRODES/INPE). Data is available at the municipality-level for the period 2001-2008. It includes information on forest cover, deforestation, cloud coverage, and unobserved areas.[12]

CO2e emissions. We collect data on CO2e emissions from the Greenhouse Gas Emissions Estimation System (SEEG)[13] promoted by the Climate Observatory (a network of 40+ NGOs working on climate change in Brazil).[14] Information is available at the municipality-year level, and contains details such as source of emissions, type of gas, and economic activity involved. For our purposes we restrict attention to years 2001-2008.

Land Use. We obtain information on land use using geo-referenced data on land use at 30m^2 resolution provided by the MapBiomas project (MapBiomas, 2018), also part of the SEEG platform. The data set is generated from Landsat 5, 7 and 8, spans 2001-2008, and covers all Brazilian biomes (Amazon, Atlantic Forest, Caatinga, Cerrado, Pampa and Pantanal). It classifies each pixel as being covered by forest, pasture, crops, non-forest, among others. We aggregate the data to municipality-level.

Public Finance. We obtain different indicators of revenues and expenditures at the municipality-level using two distinct sources of data. First, we use data on total revenues and expenditures provided by the National Treasury's Series on Local Public Finances (Finbra) and

[12]PRODES defines deforestation as the annual deforestation increment - the area of forest cleared over the 12 months leading up to August of a given year. The annual deforestation increment of year t therefore measures the area, in km2, deforested between 1 August of $t-1$ and 31 July of t.

[13]See http://seeg.eco.br/en/.

[14]See http://www.observatoriodoclima.eco.br/en/.

pre-processed by *Base dos Dados* (Carabetta et al., 2020). This dataset contains revenues and expenditures classified by type and source for the period 2001-2008. Second, we use data for matching grants between municipalities and the federal government ("convênios") collected from the Transparency Portal.[15] For each individual grant, this dataset contains information on value, date completed, category, originating institution, etc.

Land Conflict. We obtain indicators of land conflict using data provided by the *Comissão Pastoral da Terra* (CPT). This commission records all occupations, land conflicts, and violence connected to land conflicts occurring in Brazil since the 1980s. We constructed a municipality-year panel of conflicts, attempted assassinations, and assassinations for the period 2001-2008 from the commission's annual reports.

Other. We use data from the 2000 Census provided by the Brazilian Institute of Geography and Statistics (IBGE) to construct to construct municipality-level measures on income, education, health, infrastructure, and demography. We use these measures to test the validity of our empirical design.

4.2 Descriptive Statistics and Validity Tests

We set the unit of observation in our data as a municipality-election term, which accounts for four years each (between 2001-2004 and 2005-2008). A municipality-term enters our sample if (1) the municipality is not a state capital, (2) there was ever any deforestation in the municipality, and (3) there was a farmer candidate among the top two most-voted candidates in that election. Starting from the 772 municipalities in the Amazon, we end up with 502 municipalities never in our sample, 110 in the sample only in the pre-period, 96 in the sample only the post-period, and 64 in the sample in both periods. We plot the four groups in a map in Figure 1.

Table 1 reports baseline descriptive statistics of our sample. Columns (1) and (2) report

[15] Available at `http://www.portaldatransparencia.gov.br/convenios`.

statistics for municipality-terms in our sample, while Columns (3) and (4) report statistics for the rest of the Amazon in each period. We include data on municipality size, forestry and agriculture, and politics. For each outcome and group, we compute the mean and standard error in parenthesis.

We notice a few patterns. First, the municipalities in our sample, in both pre and post periods, are smaller in size when compared to the rest of the Amazon. They are also covered by less forest area, and have a lower proportion of forest covered by protected areas. Within our sample, municipalities present in the pre period are also smaller in size and with less forest area when compared to those in the post period. Along political characteristics, mechanically given our sample construction, we find that municipality-terms in our sample have more farmer candidates running for office than those outside our sample.

To validate our empirical strategy in Section 3.2, the RD design requires pre-determined covariates to be balanced at the cutoff. We estimate Equation (6) on pre-determined outcomes to examine this hypothesis. Table 7 reports the results. Most of the coefficients are close to zero and statistically insignificant. The RD design further requires the distribution of the running variable to be continuous at the cutoff. Appendix Figure B.1 reports the results of the density test proposed by Cattaneo et al. (2020). There is no evidence of discontinuous changes in the distribution of M_i in the cutoff.

As discussed before, a meaningful comparison of RD coefficients estimated using data from different elections requires the hypothesis the PPCDAm did not influence the occurrence of a close election involving farmer politicians. Because the political equilibrium in which the 2000 and 2004 elections occurred is comparable, we believe this hypothesis is likely to hold in our setting. Table B.1 provides indirect evidence supporting this assertion. We compare groups' averages before and after PPCDAm, and test each difference statistically with the $Post \times In\ Sample$ and $Post \times Close\ Election$ dummies. We find that none of selected list of covariates is statistically different across groups before and after the PPCDAm. These results are in line with the descriptive statistics presented in Table 1.

5 Results

5.1 Farmer Politicians and the PPCDAm

Table 2 tests the predictions of the theoretical model presented in section 3.1. Panel A reports estimates of (5) and Panel B reports estimates of (6). Columns 1 and 2 test the predictions on deforestation and Columns 3 and 4 the predictions on political outcomes. Odd columns report coefficients obtained not including controls and even columns the coefficients obtained including controls, which include population, area, tree cover area, whether the municipality is in the "agricultural frontier"[16], and whether the municipality was ever blacklisted[17]

We begin discussing the predictions on deforestation. Results 1 and 2 predict deforestation will be higher in municipalities governed by farmer mayors, in particular before the introduction of the PPCDAm (2001-2004). It further predicts this difference will decline after the introduction of this set of policies (2005-2008).

Panel A reports that municipalities governed by a farmer mayor had more deforestation in the 2001-2004 period but not on the 2005-2008 period. Column 1 and 2 report these municipalities deforested, on average, 52.65 km^2 more in the period 2001-2004 and 20.44 km^2 less in the period 2005-2008 (p-value = 0.19 and 0.24, respectively). Effects in the period 2001-2004 are significant with controls but not without it, while effects in the period 2005-2008 are not significant regardless of the specification. However, their difference (73.1 km^2 and 70.3 km^2) is statistically significant regardless of the specification (p-value =

[16]The agricultural frontier is the region in the Amazon's southeast, where most of the agricultural expansion historically happens.

[17]Blacklisting was a policy enacted in late 2008 that concentrated deforestation control efforts in a set of municipalities with high levels of deforestation in the decade. See (Assunção and Rocha, 2019) for a detailed discussion of this policy.

0.097 and 0.043, respectively). The relative decline of deforestation in municipalities governed by farmer mayors after the introduction of the PPCDAm is quantitatively important. It corresponds to about 60.3% of the mean ($\approx 70.3/116.4$) and 26.7% of the standard deviation ($\approx 70.3/262$).

Panel B provides evidence that the effects of farmer mayors on deforestation are robust to using close elections. The differences in deforestation between municipalities governed by farmer politicians and other politicians in the period 2001-2004 are larger and more significant than the ones obtained in Panel A. However, as documented in Panel A, these differences disappear in the period 2005-2008. Comparing the coefficients from both periods, we document a relative decline of deforestation in municipalities governed by farmer mayors after the introduction of the PPCDAm of 181.7km^2. This corresponds to roughly 155% of the standard deviation of deforestation.

Figure 2 provides graphical evidence of the results presented in Columns 1 and 2 of Panel B. The figures depict two main patterns. First, before the PPCDAm was implemented, we observe a large discontinuous increase in deforestation to the right of the cutoff. Second, after the PPCDAm was implemented, this difference disappears completely, with both sides of the cutoff having about 100 km^2 in deforestation.

We implement two sets of robustness checks to validate our results. First, we assess the robustness of our results to the choice of bandwidth. We re-estimate the RD model for periods pre and post with bandwidths varying from 5 to 25 percentage points. The results are presented in Figure 3. In the pre period (2001-2004), the coefficients are large and statistically different from zero at the 5% level up to a bandwidth of 18 percentage points. In the post period (2005-2008), the coefficients are close to zero and statistically insignificant regardless of the bandwidth.

Second, we re-estimate the RD model with alternative deforestation outcomes to evaluate whether our main results are robust to the measure used. Table B.2 reports the results. Columns 1 and 2 normalize deforestation by taking logs and dividing by the municipality's area, respectively. Both coefficients are large in magnitude. Columns 3 and 4 report coefficients obtained trimming and winsorizing deforestation at the 1% and 99% percentiles. The results are qualitatively identical to the ones obtained in the original RD model. We then address the worry that deforestation happens exclusively in the first or last year in the term. Columns 5 and 6 provide evidence that excluding these periods do not influence our results qualitatively. Column 7 uses a weighted measure of deforestation and find an even larger effect of farmer mayors on deforestation before the introduction of the PPCDAm.[18] Columns 8 and 9 report results using two alternative sources of deforestation data (PRODES and MapBiomas, respectively). Again, we find even larger coefficients using these measures.

All our findings for deforestation are echoed in terms of CO2e emissions. In Table 2, Columns 3 and 4 we report the effects of electing a farmer mayor on total CO2e emissions in tons per square kilometer. We find a large and significant effect before the PPCDAm, and a much lower, if not zero statistically, after it. Both in Panels A and B, the coefficient on the difference is negative. Figure 4 plots the findings from Panel B, and Figure 5 displays how the effect varies with different bandwidth choices.

We then discuss the predictions on political outcomes. Results 1 and 2 predict the probability of electing a farmer mayor in the subsequent election is higher in municipalities governed by farmer mayors, in particular before the introduction of the PPCDAm (2001-2004). It further predicts this electoral advantage will decline after the introduction of this set of policies (2005-2008).

Columns 5 and 6 of Panel A provide evidence consistent with these hypotheses. We document that farmer mayors increase the likelihood of election of a farmer mayor in the subsequent election, but that this effect declines with the introduction of the PPCDAm. Municipalities governed by farmer mayors in 2001-2004 were 22-24 p.p. to elect

[18] We construct this measure by weighing each pixel by the percentage of forest it contained in the original Hansen et al. (2013) data.

a farmer in the subsequent election (2004) while municipalities governed by farmer mayors in 2005-2008 were 12-13 p.p. more likely to elect a farmer in the subsequent election (2008). Coefficients are statistically significant regardless of the specification. Comparing these coefficients, we find that the effect of farmer mayors on the likelihood of electing a farmer politician declines in 10-11 p.p. with the introduction of the PPCDAm. This corresponds to 55-60% of the mean ($\approx$ 0.10-0.11/0.18) and 26-29% of the standard deviation ($\approx$ 0.10-0.11/0.38) of the likelihood of electing a farmer politician. However, this decline in the effect of farmer mayors is not statistically significant (p-value = 0.15).

However, the effects documented in Panel A disappear when we explore close elections in Panel B. The effects of farmer mayors become statistically insignificant and their difference is close to zero. We interpret this finding as suggesting that – at least in more competitive political environments – the political effects of enacting pro-deforestation policies is not strong enough to generate electoral advantages.

We also implement two sets of robustness checks to validate our results. First, we assess the robustness of our results to the choice of bandwidth in Figure 7 and find that the coefficients are close to zero and statistically insignificant regardless of the bandwidth for both periods. Second, in Appendix Table B.3 we re-estimate Equations (5) and (6) with other political outcomes of interest as motivated by our theory and show that the patterns from Table 2 are qualitatively similar across specifications. In the cross-section we find that electing farmer mayors increases the share of farmer candidates and farmer vote share in the next election (statistically significant at the 1% level) both in pre and post periods, but not mayors' reelection rates. The differences between periods are negative but insignificant. Similar patterns hold for the Regression Discontinuity, but with statistically insignificant coefficients.

5.2 How do local politicians influence deforestation?

Having established that farmer mayors caused more deforestation and had higher election rates prior to the PPCDAm, we now turn to shedding light on what exactly are the patterns of deforestation observed.

First, we are interested in whether it happens inside or outside protected areas. In Table 3 Columns (1) and (2) we show that deforestation happens almost exclusively outside protected areas. This result builds on the literature about the effects of protected areas on deforestation (Nepstad et al., 2006; Nolte et al., 2013), and is consistent with recent literature finding that protected areas in Colombia and Brazil successfully curb deforestation within their boundaries (Gandour, 2018; Bonilla-Mejía and Higuera-Mendieta, 2019; Baragwanath and Bayi, 2020). Second, in Columns (3), (4), and (5) we find that cleared land is mostly directly converted to pasture, and not croplands. This goes in line with the folk story of deforestation and land-grabbing dynamics in the Amazon, where cleared forest is first converted to extensive cattle farming pasture and later to crop plantations.

Our results on patterns of deforestation are corroborated by the effects farmer mayors have on agricultural outcomes. In Table 4 we estimate Equation (6) for area planted, total value produced, and the number of cattle raised, all normalized by the municipality's area. Prior to the PPCDAm, we find that farmer mayors had an important, albeit statistically insignificant, negative effect on the production crops and a positive effect on the number of cattle raised. The former is about 38%, while the latter is about 51% of the standard deviation. This is consistent with our findings on deforestation given that extensive cattle ranching in the Amazon is low productivity and uses land significantly. Additionally, we find that these effects reverse with the policy change: the coefficients on the difference are positive for crops, and negative for cattle. Farmer mayors appear to adjust their margin of action to less land-extensive practices when enforcement was higher.

5.3 Matching Grants and Mayoral Discretion

Politicians have a set of tools and policy options to influence deforestation and land dynamics. Some are less observable, such as illicit deals with state- and non-state-actors, and others are more, such as local spending patterns. In Brazil one lever requiring particularly high mayoral effort and discretion is called matching grants. Because the tax base of the municipalities is typically small, obtaining more resources from such grants is an important way mayors have of increasing spending in priority areas. Indeed, mayors put considerable effort in lobbying members of the congress and bureaucrats to obtain these resources (Azulai, 2017).

We exploit our data on every individual matching grant between 2001 and 2008 to test for whether farmer mayors direct a higher amount of revenue to agriculture. In Table 5 and Figure 8 we confirm that prediction. Electing a farmer mayor causes a statistically significant increase of about R$48 per capita spent on agriculture prior to the PPCDAm. An analogous effect does not exist for other areas, such as education or health, or for the post period, when incentives for deforestation had changed.[19]

Since the workers' party (PT) won the national election in 2002 and took office in 2003, it could be that this result is driven by farmer mayors differentially getting more matching grants after 2003 for political reasons. Restricting observations to years 2001-2004, we test for this possibility as a robustness check and estimate

$$grants_{it} = \alpha_i + \alpha_t + \beta Post_t PA_{it} + \gamma Post_t PT_{it} + \delta Post_t PA_{it} PT_{it} + \varepsilon_{it} \tag{7}$$

where *grants* stand for revenue in matching grants per capita for municipality i in year t, $Post_t$ is an indicator for years 2003 and 2004, PA_{it} indicates whether a municipality elected a farmer mayor, and PT_{it} indicates whether the elected mayor was affiliated to

[19] The money for matching grants is typically used to buy equipment or build infrastructure. In education these are typically used to refurbish buildings, build gyms, or buy equipment for labs. Grants in agriculture, on the other hand, are often used to buy tractors for cooperatives or farmers' associations.

the workers' party. Our main coefficient of interest is δ, which measures whether aligned farmer mayors received a different amount in matching grants. In Appendix Table B.4 we find that this is not the case. Our estimated coefficients are not statistically significant for agriculture or any other area.

5.4 Land-related conflict

As discussed in Section 2, deforestation in the Amazon happens amid an environment of weakly defined property rights (Alston, Libecap and Schneider, 1995, 1996; Chiavari, Lopes, Chiavari and de Araujo, 2021). Conflict between land owners and squatters is frequent and often results in violence. The election of a farmer mayor may further worsen that situation if these mayors, for example, impact land use dynamics or weaken local enforcement.

We test this idea with data covering events like conflicts, murders, and settlements. In Table 6 we re-estimate Equation (6) and find that electing a farmer mayor significantly raises the frequency of such events pre-PPCDAm, but not after it. In Column (1) we show that the number of conflicts increases by 3.38, accounting for 118% of the standard deviation in the data. In Columns (2) we find that the number of murders increase substantially as well. Yet, we find no effects on the number of settlements itself. We present the corresponding graphical results in Figure 9.

6 Conclusion

This paper documents that the government policy effectiveness depends on its influence on local politics. We exploit the implementation of the *Action Plan for the Prevention and Control of Deforestation in the Legal Amazon* (hereafter, PPCDAm) in November 2004, which synced a real-time remote-sensing system for environmental monitoring with anti-deforestation enforcement on the ground, to provide evidence that it reduced the incentives of farmer politicians to promote local deforestation. Our results are fully explained by changes in the conversion of forests into pastures outside protected areas, and seem to be explained by declines in the amount of resources politicians connected to agriculture channel to this sector. We further show evidence that these politicians become less electorally attractive after the policy when returns to deforestation were lower. We interpret our findings as indicating that, by improving monitoring and later increasing legal penalties associated with illegal deforestation outside protected areas, this reduced the rents from illegal deforestation, thereby reducing the incentives for farmers cater to local special-interest groups and to enact pro-deforestation policies.

Our findings have important policy implications. First, given the impact farmer mayors have on deforestation and land use, federal policy may need to directly oversee this group's access to policy levers. Second, conservation policy may be under-provided if government does not incorporate its indirect effects on local politics. Moreover, our findings may imply a political double reversal in the Amazon if federal government undermines its environmental enforcement capacity, as witnessed in recent years (Burgess et al., 2019).

This paper leaves various avenues open for future research. For example, it would be important to further characterize the political careers of farmer politicians. Understanding to what extent mayoral performance leverages them to positions in state and federal politics, or how they consolidate regional interests into national policy are largely unexplored questions.

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7 Tables and Figures

Table 1: Descriptive Statistics

	In Sample		Rest	
	Pre	Post	Pre	Post
	(1)	(2)	(3)	(4)
Size				
Population (000's)	15.70	16.56	31.05	33.14
	(15.39)	(17.04)	(99.45)	(106.43)
Area (km2 000's)	5.16	5.86	6.93	6.71
	(5.71)	(11.02)	(15.13)	(14.21)
Forestry and Agriculture				
Tree Cover (km2 000's)	3.31	4.24	5.56	5.27
	(4.86)	(10.51)	(14.61)	(13.69)
% Protected Area	7.04	7.07	11.56	11.45
	(17.69)	(19.14)	(25.96)	(25.54)
Ever a Priority Municipality	0.09	0.07	0.06	0.07
	(0.28)	(0.26)	(0.24)	(0.25)
Agricultural Frontier	0.82	0.81	0.77	0.78
	(0.38)	(0.40)	(0.42)	(0.42)
Amazon Biome	0.67	0.74	0.64	0.62
	(0.47)	(0.44)	(0.48)	(0.48)
Cerrado Biome	0.32	0.26	0.35	0.37
	(0.47)	(0.44)	(0.48)	(0.48)
Politics				
Candidates Mayor	2.54	2.77	2.78	2.81
	(0.93)	(0.90)	(1.10)	(1.05)
Farmer Candidates Mayor	1.16	1.12	0.32	0.31
	(0.45)	(0.35)	(0.64)	(0.64)
Candidates Council	55.02	53.37	65.52	62.32
	(26.29)	(23.90)	(51.64)	(52.57)
Farmer Candidates Council	18.89	15.23	13.50	12.30
	(13.00)	(10.55)	(10.48)	(10.09)
Council Seats	9.85	9.09	10.34	9.31
	(1.45)	(0.31)	(2.50)	(1.82)
Observations	174	160	598	612

Notes: This Table presents descriptive statistics at the municipality level. Sample is defined as in Section 4.2. A municipality-term enters our sample if (1) the municipality is not a state capital, (2) there was ever any deforestation in the municipality, and (3) there was a farmer candidate among the top two most-voted candidates in that election.

Table 2: Effect of farmer mayors on main outcomes

	Deforestation (km2)		CO2 Emissions (t/km2)		Farmer Next Term	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Cross-section						
Pre	52.65	73.14**	664.49***	771.83***	0.24***	0.22***
	(40.28)	(31.76)	(225.30)	(237.93)	(0.05)	(0.05)
Post	-20.44	2.84	153.23	355.53***	0.13***	0.12***
	(17.52)	(14.09)	(148.85)	(136.59)	(0.04)	(0.04)
Difference	-73.09*	-70.30**	-511.26*	-416.30	-0.11	-0.10
	(43.92)	(34.74)	(270.03)	(274.33)	(0.07)	(0.07)
Total observations	1185	1185	1185	1185	1185	1185
Controls	-	✓	-	✓	-	✓
Mean Pre	116.42	116.42	2010.40	2010.40	0.18	0.18
SD Pre	262.05	262.05	2187.92	2187.92	0.38	0.38
Panel B: Regression Discontinuity						
Pre	312.88***	169.99**	2470.69	3526.52**	-0.10	-0.07
	(112.16)	(78.00)	(1611.14)	(1505.97)	(0.22)	(0.22)
Post	-16.97	-30.11	-802.09	-361.64	-0.11	-0.05
	(51.38)	(40.90)	(719.81)	(644.06)	(0.18)	(0.18)
Difference	-219.71	-181.73*	-3428.43	-2841.09	-0.01	0.00
	(151.96)	(102.41)	(2133.42)	(1950.82)	(0.33)	(0.33)
Effective Observations Pre	29	35	56	50	74	63
Effective Observations Post	57	57	67	60	73	70
Effective Observations DD	85	85	132	132	158	158
Optimal BW Pre	5.92	6.84	10.63	9.94	15.10	11.49
Optimal BW Post	7.77	7.89	9.53	8.45	10.76	10.27
Optimal BW DD	7.32	7.32	10.97	10.97	13.37	13.37
Controls	-	✓	-	✓	-	✓
Mean Pre	66.91	57.63	1892.37	1929.86	0.27	0.25
SD Pre	130.94	117.18	1662.34	1719.39	0.45	0.44

Notes: This Table presents results from Equations (5) and (6) estimated for deforestation, CO2e emissions, and whether a farmer mayor was elected next term. The number of effective observations for each column is the number of observations within the bandwidth used. Controls include population, area, tree cover area, and indicators for the municipality ever being in the PPCDAm blacklist and being in the agricultural frontier. Robust standard errors in parenthesis. p<0.01 ***, p < 0.05 **, p < 0.1 *.

Table 3: Effect of farmer mayors on patterns of deforestation

	Outside PA	Inside PA	To Pasture	To Crops	To Other
	(1)	(2)	(3)	(4)	(5)
Pre	189.35***	8.04*	122.30***	-6.46	36.27
	(62.10)	(4.14)	(40.33)	(6.59)	(36.81)
Post	-18.60	-8.34*	31.82	1.66	-67.95
	(44.29)	(4.66)	(25.65)	(1.41)	(44.46)
Difference	-273.01***	-19.91***	-94.86	5.76	-71.66
	(91.36)	(7.38)	(75.62)	(7.58)	(56.43)
Effective Observations Pre	56	73	64	68	81
Effective Observations Post	45	78	46	39	49
Effective Observations DD	106	151	101	162	166
Optimal BW Pre	9.60	11.85	10.70	11.42	15.46
Optimal BW Post	5.58	11.49	6.04	4.77	7.17
Optimal BW DD	8.40	6.04	7.90	12.66	13.15
Controls	✓	✓	✓	✓	✓
Mean Pre	85.20	2.40	56.65	3.16	44.86
SD Pre	126.89	6.03	65.05	14.98	86.89

Notes: This Table presents results from Equation (6) estimated for patterns of deforestation. The number of effective observations for each column is the number of observations within the bandwidth used. Controls include population, area, tree cover area, and indicators for the municipality ever being in the PPCDAm blacklist and being in the agricultural frontier. Robust standard errors in parenthesis. $p<0.01$ ***, $p < 0.05$ **, $p < 0.1$ *.

Table 4: Effect of farmer mayors on agriculture normalized by area

	Area Planted	Value	Cattle
	(1)	(2)	(3)
Pre	-0.05	-0.89	18.35
	(0.05)	(6.70)	(12.20)
Post	0.11	13.30	-12.47
	(0.09)	(11.51)	(15.89)
Difference	0.15	11.88	-15.77
	(0.12)	(16.18)	(24.24)
Effective Observations Pre	56	64	56
Effective Observations Post	49	49	67
Effective Observations DD	111	95	128
Optimal BW Pre	9.84	10.79	9.99
Optimal BW Post	6.77	6.86	9.07
Optimal BW DD	8.68	9.07	10.24
Controls	✓	✓	✓
Mean Pre	0.07	8.78	36.87
SD Pre	0.13	17.25	35.79

Notes: This Table presents results from Equation (6) estimated for agricultural outcomes. The number of effective observations for each column is the number of observations within the bandwidth used. Controls include population, area, tree cover area, and indicators for the municipality ever being in the PPCDAm blacklist and being in the agricultural frontier. Robust standard errors in parenthesis. $p<0.01$ ***, $p < 0.05$ **, $p < 0.1$ *.

Table 5: Effect of farmer mayors on matching grants per capita

	Agriculture	Environment	Education	Health
	(1)	(2)	(3)	(4)
Pre	47.94**	-0.01	-0.19	-10.77
	(23.84)	(1.01)	(3.54)	(43.45)
Post	67.49	-0.47	62.42*	19.28
	(47.84)	(1.11)	(35.63)	(21.47)
Difference	50.70	-1.33	65.96	45.73
	(60.93)	(2.50)	(42.62)	(41.32)
Effective Observations Pre	38	71	61	49
Effective Observations Post	55	116	46	48
Effective Observations DD	100	177	87	82
Optimal BW Pre	6.66	11.72	10.52	8.69
Optimal BW Post	7.56	18.92	6.41	7.12
Optimal BW DD	7.75	6.41	6.81	6.44
Controls	✓	✓	✓	✓
Mean Pre	15.95	0.85	4.31	56.35
SD Pre	24.26	2.79	5.19	102.57

Notes: This Table presents results from Equation (6) estimated for matching grants outcomes. The number of effective observations for each column is the number of observations within the bandwidth used. Controls include population, area, tree cover area, and indicators for the municipality ever being in the PPCDAm blacklist and being in the agricultural frontier. Robust standard errors in parenthesis. $p<0.01$ ***, $p < 0.05$ **, $p < 0.1$ *.

Table 6: Effect of farmer mayors on land conflict

	Conflicts	Murders	Settlements
	(1)	(2)	(3)
Pre	3.38**	1.34***	-0.02
	(1.63)	(0.30)	(0.05)
Post	0.49	-0.11	-0.22**
	(1.02)	(0.21)	(0.10)
Difference	-1.48	-1.24**	0.10
	(2.15)	(0.50)	(0.31)
Effective Observations Pre	44	36	31
Effective Observations Post	56	52	71
Effective Observations DD	124	107	124
Optimal BW Pre	8.17	6.38	5.79
Optimal BW Post	7.57	7.38	10.31
Optimal BW DD	9.73	10.31	9.93
Controls	✓	✓	✓
Mean Pre	1.78	0.00	0.07
SD Pre	2.86	0.00	0.27

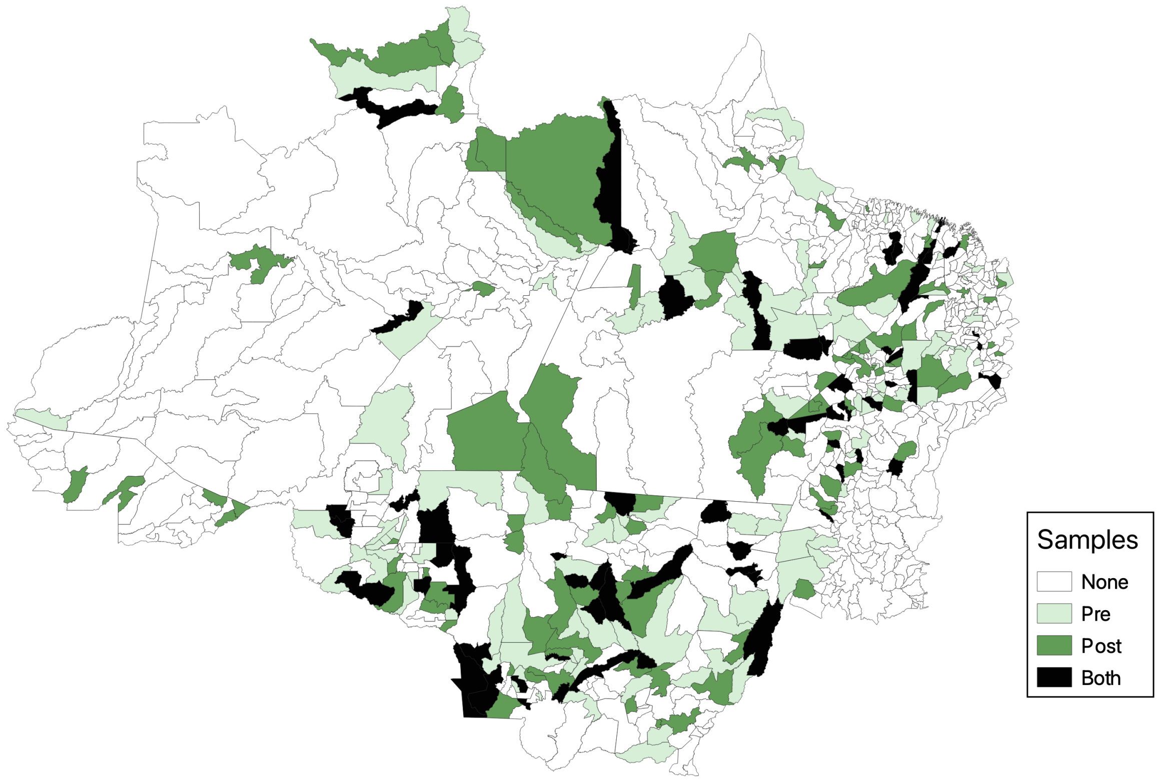
Notes: This Table presents results from Equation (6) estimated for land conflict outcomes. The number of effective observations for each column is the number of observations within the bandwidth used. Controls include population, area, tree cover area, and indicators for the municipality ever being in the PPCDAm blacklist and being in the agricultural frontier. Robust standard errors in parenthesis. $p<0.01$ ***, $p < 0.05$ **, $p < 0.1$ *.

Table 7: Testing continuity of covariates

	Population	Area	Agr. Frontier	Ever Priority	% Protected Area	Forest Area
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Pre						
Elected Farmer	9,467.35	-297.47	0.21	0.10	7.48	1,213.13
	(6,628.80)	(2,306.15)	(0.23)	(0.12)	(7.75)	(1,490.79)
Municipality FE	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓
Optimal Bandwidth	17.38	11.57	12.63	12.50	13.65	11.36
Effective Observations	88	71	76	76	77	67
Mean	13982	4642	0.820	0.0300	7.030	2488
SD	10143	4375	0.390	0.160	13.96	3021
Panel B: Post						
Elected Farmer	-2,943.35	2,926.03	0.01	-0.14	-6.42	2,447.16
	(8,695.76)	(4,216.84)	(0.20)	(0.09)	(8.87)	(3,008.95)
Municipality FE	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓
Optimal Bandwidth	12.99	10.13	8.348	8.489	12.04	15.66
Effective Observations	88	68	61	62	82	103
Mean	15295	5233	0.660	0.0700	10.62	3884
SD	13575	4823	0.480	0.260	21.48	4944

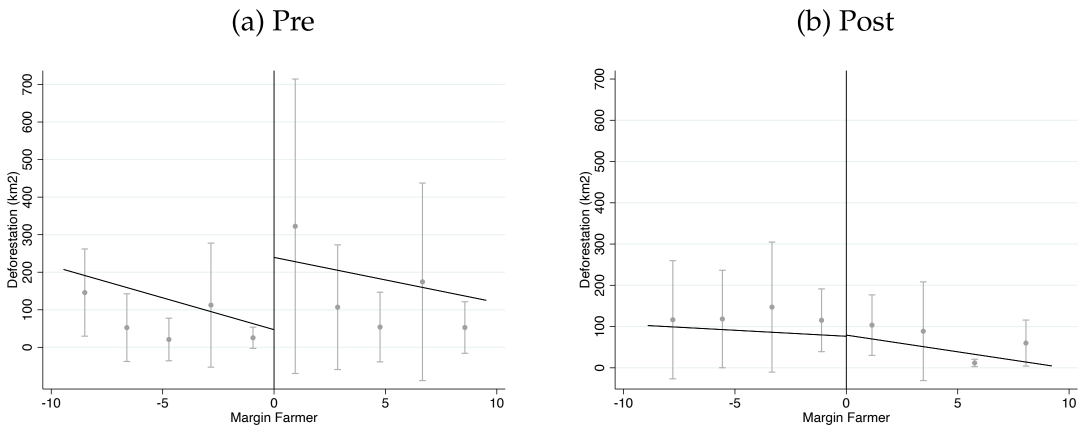
Notes: This Table presents results from Equation (6) estimated for covariates as discussed in Section 4.2. The number of effective observations for each column is the number of observations within the bandwidth used. Robust standard errors in parenthesis. p<0.01 ***, p < 0.05 **, p < 0.1 *.

Figure 1: Sample municipalities



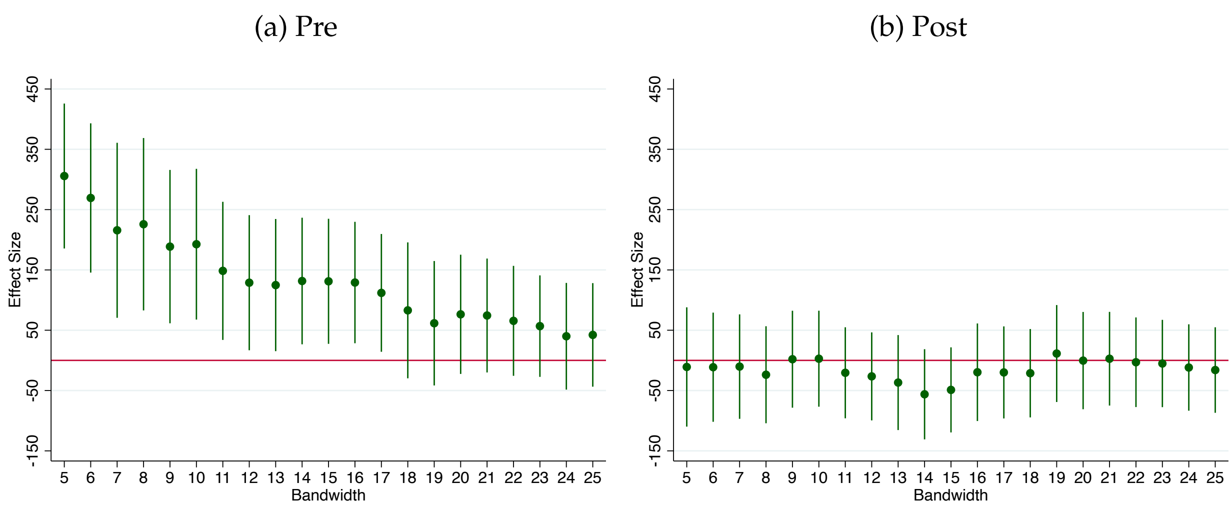
Notes: This map shows municipalities in the Brazilian Amazon divided into four sample groups, as defined in Section 4.2: those never in our sample, in our sample in the pre-period, in our sample in the post-period, and in our sample in both periods. A municipality-term enters our sample if (1) the municipality is not a state capital, (2) there was ever any deforestation in the municipality, and (3) there was a farmer candidate among the top two most- voted candidates in that election.

Figure 2: Effect of electing a farmer mayor on deforestation



Notes: This figure plots the Regression Discontinuity results of deforestation on the margin of victory of farmer candidates from Equation (6) for the pre and post periods. Controls include population, area, tree cover area, and indicators for the municipality ever being in the PPCDAm blacklist and being in the agricultural frontier. Bands plot the 95% confidence intervals.

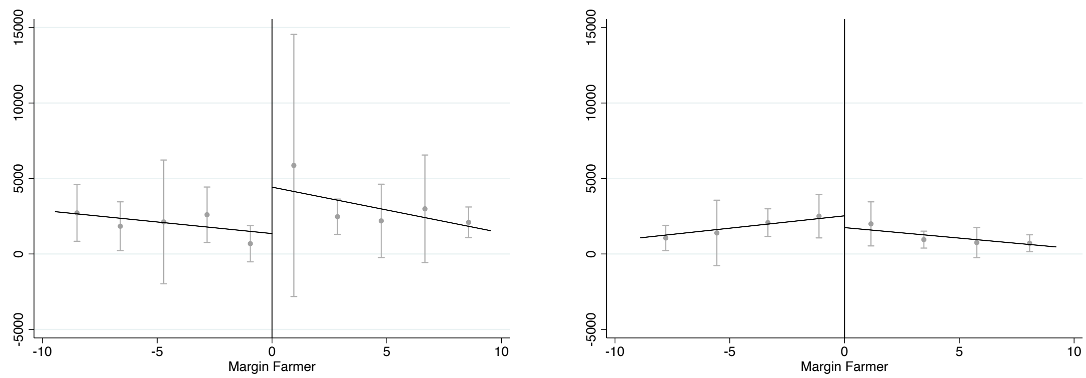
Figure 3: Effect of farmer mayors on deforestation with varying bandwidths



Notes: Each point and its associated 95% confidence interval in this Figure represents a Regression Discontinuity estimate from Equation (6) with varying bandwidths in periods pre (2001-2004) and post (2005-2008), as discussed in Section 5.1.

Figure 4: Effect of electing a farmer mayor on CO2e emissions (t/km^2)

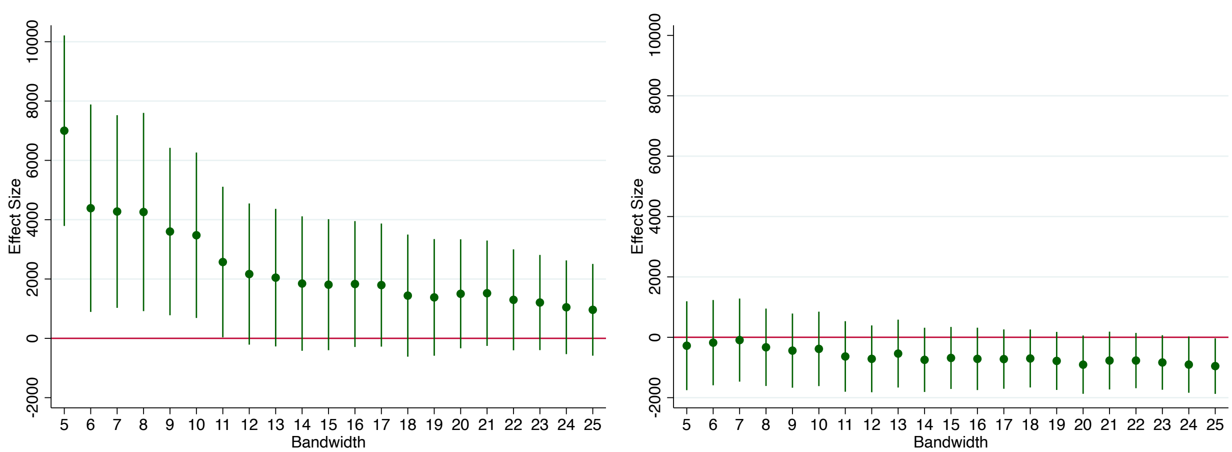
(a) Pre (b) Post



Notes: This figure plots the Regression Discontinuity results of CO2e emissions in tons per km^2 on the margin of victory of farmer candidates from Equation (6) for the pre and post periods. Controls include population, area, tree cover area, and indicators for the municipality ever being in the PPCDAm blacklist and being in the agricultural frontier. Bands plot the 95% confidence intervals.

Figure 5: Effect of farmer mayors on CO2e emissions (t/km^2) with varying bandwidths

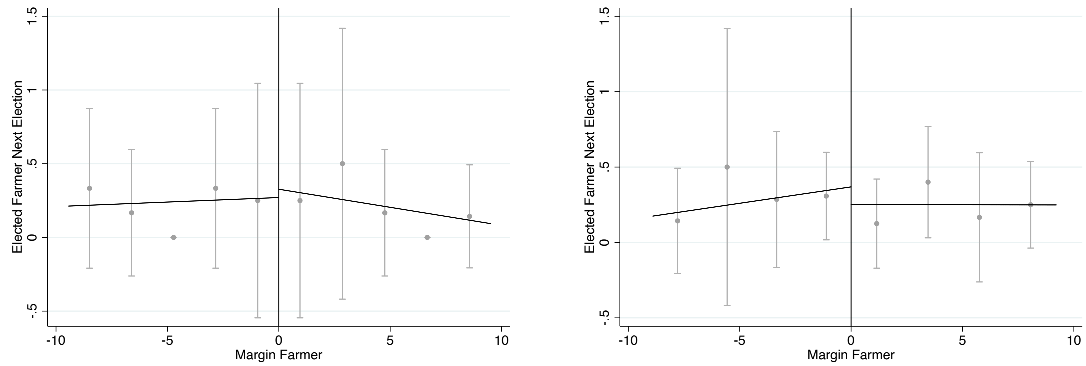
(a) Pre (b) Post



Notes: Each point and its associated 95% confidence interval in this Figure represents a Regression Discontinuity estimate from Equation (6) with varying bandwidths in periods pre (2001-2004) and post (2005-2008), as discussed in Section 5.1.

Figure 6: Effect of electing a farmer mayor on a farmer mayor being elected next term

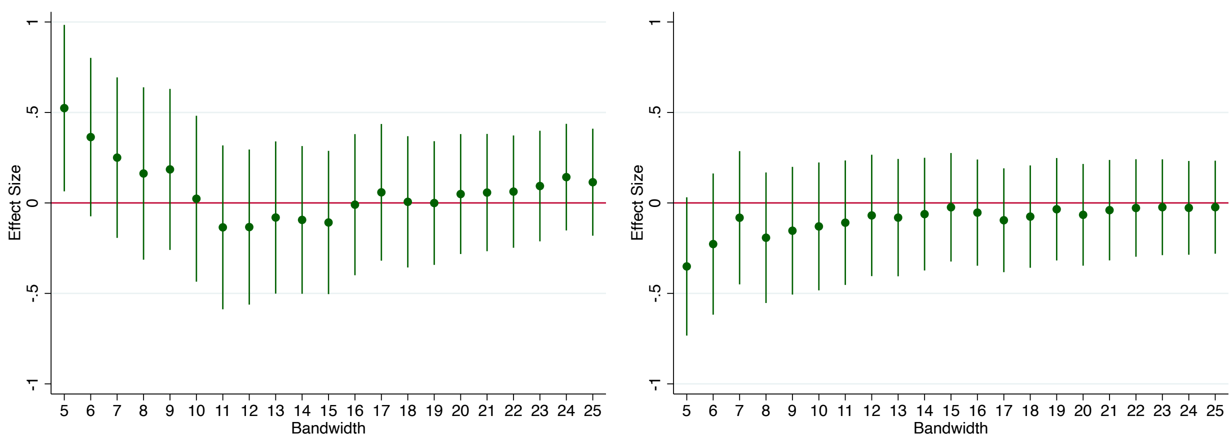
(a) Pre (b) Post



Notes: This figure plots the Regression Discontinuity results of a farmer mayor being elected next term on the margin of victory of farmer candidates from Equation (6) for the pre and post periods. Controls include population, area, tree cover area, and indicators for the municipality ever being in the PPCDAm blacklist and being in the agricultural frontier. Bands plot the 95% confidence intervals.

Figure 7: Effect of farmer mayors on subsequent election with varying bandwidths

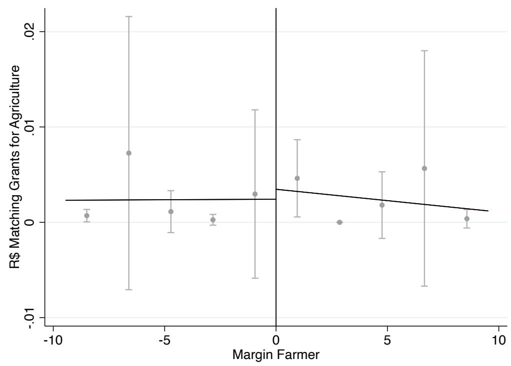
(a) Pre (b) Post



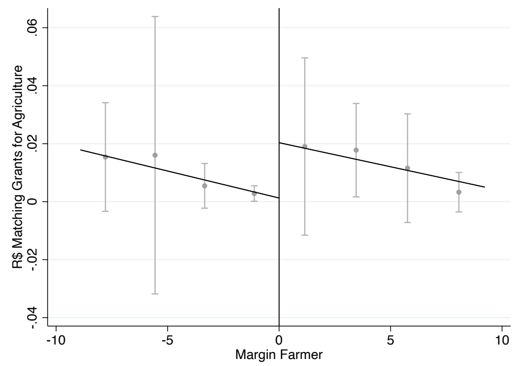
Notes: Each point and its associated 95% confidence interval in this Figure represents a Regression Discontinuity estimate from Equation (6) with varying bandwidths in periods pre (2001-2004) and post (2005-2008), as discussed in Section 5.1.

Figure 8: Effect of electing a farmer mayor on matching grants per capita

(a) Agriculture - Pre

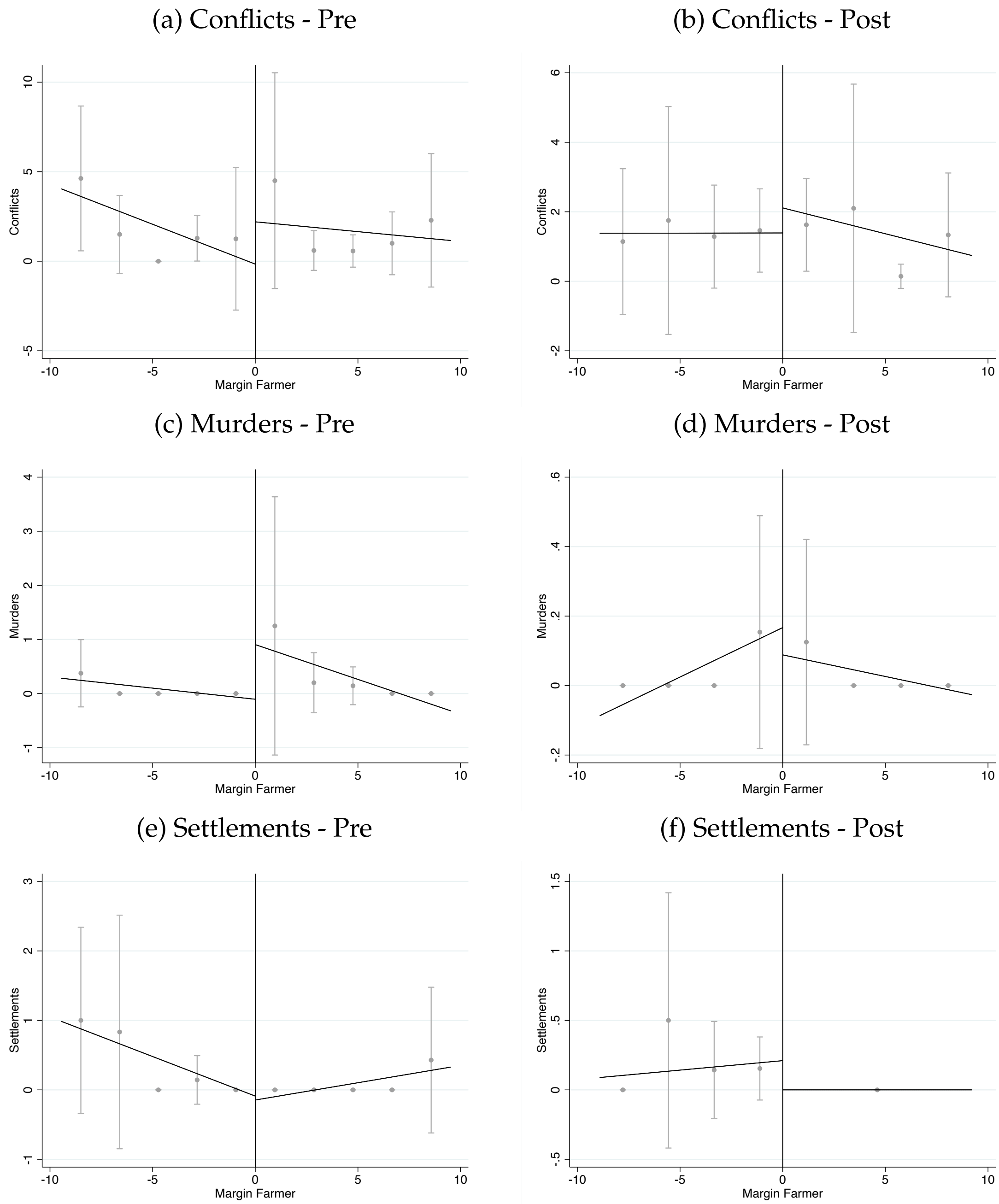


(b) Agriculture - Post



Notes: This figure plots the Regression Discontinuity results of matching grants per capita on the margin of victory of farmer candidates from Equation (6) for the pre and post periods as estimated in Table 5. Controls include population, area, tree cover area, and indicators for the municipality ever being in the PPCDAm blacklist and being in the agricultural frontier. Bands plot the 95% confidence intervals.

Figure 9: Effect of electing a farmer mayor on land conflict



Notes: This figure plots the Regression Discontinuity results of land conflict on the margin of victory of farmer candidates from Equation (6) for the pre and post periods as estimated in Table 6. Controls include population, area, tree cover area, and indicators for the municipality ever being in the PPCDAm blacklist and being in the agricultural frontier. Bands plot the 95% confidence intervals.

Online Appendix to "The Political Effects of Curbing Deforestation: Evidence from Brazil"

A Proofs

A.1 Result 1

The probability a politician of type p chooses deforestation is:

$$p\left(D|p\right) = \pi^p + (1 - \pi^p)\lambda^p \tag{A.1}$$

We will prove that $p\left(D|F\right) > p\left(D|O\right)$, that is, that farmers are more likely to enact pro-deforestation policies.

In the main text, we derived the following expression for λ^p:

$$\lambda^p = \Gamma(\Pi^p - \pi^{p'}), \tag{A.2}$$

in which $\Gamma = \left(\beta\epsilon R(1-\omega)\Delta\right)/C$.

Define $x^p = \pi^p - \pi^{p'}$ as the difference between the probabilities of politicians of types p and p' being pro-deforestation. This difference is a sufficient statistic for the difference between politicians of types F and O. Using this definition and the definition of Π^p, it is possible to re-write (A.2) as

$$\lambda^p - \Gamma\left(\frac{\pi^p(1-\pi^p)(1-\lambda^p)}{\pi^p + (1-\pi^p)\lambda^p} + x^p\right) = 0 \tag{A.3}$$

Using the implicit function theorem, we obtain:

$$\frac{\partial\lambda^p}{\partial x^p} = \frac{\Gamma}{1 + \frac{\Gamma\pi^p(1-\pi^p)\lambda^p}{\left(\pi^p+(1-\pi^p)\lambda^p\right)^2}} > 0 \tag{A.4}$$

This implies that the share of politicians of type p who chooses pro-deforestation policies when it is costly to them is increasing in the difference in the probability politicians of groups p and p' are pro-deforestation. Because $x^F > 0 > x^O$, this implies $\lambda^F > \lambda^O$. Thus,

$$\begin{aligned} p\left(D|F\right) - p\left(D|O\right) &= \pi^F + (1-\pi^F)\lambda^F - \pi^O + (1-\pi^O)\lambda^O \\ &= \underbrace{x^F}_{>0}(1-\lambda^F) + (1-\pi^0)\underbrace{(\lambda^F - \lambda^O)}_{>0} > 0, \end{aligned} \tag{A.5}$$

Equation (A.5) completes the proof. This result reflects two theoretical mechanisms: *preferences* and *incentives*. The *preferences* channel comes from the fact that farmers are more likely to be pro-deforestation, while the *incentives* channel comes from the fact the electoral return from implementing pro-deforestation policies is higher for farmers politicians.

A.2 Result 2

We begin proving that the tightening (loosening) of conservation policies decrease (increase) deforestation. In our model, changes in conservation policies corresponds to changes in Γ. Thus, we will prove that

$$\frac{\partial p\left(D|p\right)}{\partial \Gamma} = (1-\pi^p)\frac{\partial \lambda^p}{\partial \Gamma} > 0 \tag{A.6}$$

Thus, it suffices to prove that λ^p is increasing in Γ. Differentiating λ^p with respect to Γ, we obtain:

$$\frac{\partial \lambda^p}{\partial \Gamma} = \frac{\Pi^p - \pi^{p'}}{1 + \frac{\Gamma \pi^p (1-\pi^p)\lambda^p}{(\pi^p + (1-\pi^p)\lambda^p)^2}} > 0 \tag{A.7}$$

The intuition of this result is straightforward. Tightening (loosening) conservation policies reduces (increases) the electoral incentives and increases (decreases) the costs of enacting pro-deforestation policies.

Notice that the fact that tightening (loosening) of conservation policies decreases (increases) deforestation in general implies directly that it reduces reelection rates. This comes from the fact that, in our model, reelection rates are a function of the extent of signaling using pro-deforestation policies. Thus, a reduction in the number of politicians signaling using pro-deforestation policies reduces reelection rates.

We then prove that the tightening (loosening) of conservation policies decreases (increases) deforestation more in municipalities governed by farmers. Because x^p is a sufficient statistic of the politician type, this is equivalent to proving that the effect of Γ on deforestation is increasing in x^p:

$$\frac{\partial^2 p\,(D|p)}{\partial\Gamma\partial x^p} > 0 \tag{A.8}$$

Using the Chain rule, it is possible to write the derivative above as:

$$\frac{\partial^2 p\,(D|p)}{\partial\Gamma\partial\lambda^p} = (1-\pi^p)\left(\frac{\partial^2\lambda^p}{\partial\Gamma\partial x^p}\right) \tag{A.9}$$

Using the implicit function theorem, it is straightforward to show that

$$\frac{\partial^2\lambda^p}{\partial\Gamma\partial x^p} = \frac{1}{\left(\pi^p+(1-\pi^p)\lambda^p\right)^4} > 0 \tag{A.10}$$

Thus, the effect of Γ on deforestation is increasing in x^p. This establishes that the tightening (loosening) of conservation policies decreases (increases) deforestation more in municipalities governed by farmers. The intuition for this result is straightforward. Farmer politicians are more responsive to changes in the returns of enacting pro-deforestation policies because a larger fraction of these politicians use deforestation to build reputation and increase their reelection odds.

Notice that the fact that the stronger effect on deforestation of tightening (loosening) on municipalities governed by farmers than in municipalities governed by other politicians implies that these municipalities experience a stronger reduction in reelection rates. As mentioned earlier, this comes from the fact that, in our model, reelection rates are a function of the extent of signaling using pro-deforestation policies.

B Additional Results

B.1 Tables

Table B.1: Sample selection

	Population	Area	Agr. Frontier	Ever Priority	% Protected Area	Forest Area
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A						
Post * In Sample	-1,234.96	924.87	-0.02	-0.01	0.14	1,227.82
	(6,185.84)	(1,289.17)	(0.05)	(0.03)	(2.50)	(1,221.52)
In Sample	-15,348.30***	-1,771.94**	0.05	0.02	-4.52***	-2,248.99***
	(4,233.08)	(755.58)	(0.03)	(0.02)	(1.71)	(702.47)
Post	2,096.51	-222.91	0.01	0.00	-0.11	-294.05
	(5,922.99)	(844.80)	(0.02)	(0.01)	(1.48)	(814.70)
Observations	1,542	1,542	1,544	1,544	1,544	1,542
R-squared	0.01	0.00	0.00	0.00	0.01	0.00
Mean	32715	7318	0.750	0.0700	12.12	5950
SD	100000	15633	0.430	0.250	26.52	15092
Panel B						
Post x Close Election	-4,688.49	1,763.77	-0.01	-0.06**	0.04	1,939.46
	(5,201.13)	(1,793.65)	(0.07)	(0.02)	(3.44)	(1,705.28)
Close Election	-11,635.12***	-2,594.02***	0.02	-0.02	-4.14**	-2,846.53***
	(4,008.08)	(557.42)	(0.04)	(0.02)	(1.68)	(490.13)
Post	2,435.79	-79.04	0.00	0.00	-0.01	-95.00
	(4,887.35)	(715.07)	(0.02)	(0.01)	(1.28)	(688.07)
Observations	1,534	1,534	1,534	1,534	1,534	1,534
R-squared	0.00	0.00	0.00	0.00	0.00	0.00
Mean	34336	7053	0.760	0.0700	11.97	5614
SD	110000	14672	0.430	0.260	26.16	14137

Notes: This Table presents results on how sample selection changes before and after the PPCDAm as discussed in Section 4.2. Robust standard errors in parenthesis. p<0.01 ***, p < 0.05 **, p < 0.1 *.

Table B.2: Robustness Deforestation

	ln(·)	% Area	Trimmed	Winsorized	W/o 1st Year	W/o 4th Year	Weighted	PRODES	MapBiomas
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: Cross-section									
Pre	-0.06	0.34	29.65*	46.09***	55.22**	52.97**	79.82**	56.16	92.95**
	(0.22)	(0.29)	(17.36)	(17.35)	(24.18)	(22.27)	(33.08)	(45.38)	(38.33)
Post	0.22	0.28	15.05	10.33	0.32	3.43	8.18	4.66	-1.33
	(0.19)	(0.22)	(10.15)	(10.92)	(9.32)	(11.22)	(13.95)	(12.33)	(16.74)
Difference	0.28	-0.06	-14.60	-35.76*	-54.90**	-49.55**	-71.64**	-51.51	-94.28**
	(0.29)	(0.36)	(20.11)	(20.50)	(25.92)	(24.94)	(35.90)	(47.03)	(41.82)
Total observations	1185	1185	1185	1185	1185	1185	1185	1185	1185
Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mean Pre	3.08	2.16	95.78	108.38	94.75	80.30	139.05	205.91	193.63
SD Pre	2.12	2.62	161.38	199.47	214.69	173.17	286.88	392.97	348.24
Panel B: Regression Discontinuity									
Pre	1.47	3.15**	184.85**	169.99**	160.88***	121.78*	221.93**	525.17***	355.77**
	(0.91)	(1.54)	(75.15)	(78.00)	(50.27)	(65.40)	(90.73)	(111.22)	(144.09)
Post	-0.16	-1.70	-11.40	-20.06	-1.21	-10.47	-24.59	-34.09	-19.97
	(0.77)	(1.23)	(46.45)	(40.65)	(26.41)	(41.43)	(43.60)	(43.53)	(60.91)
Difference	-0.83	-5.07**	-203.11**	-185.26*	-113.21	-137.30	-241.94**	-581.56***	-352.92*
	(1.44)	(2.33)	(90.37)	(102.85)	(76.14)	(85.26)	(113.97)	(137.12)	(188.90)
Effective Observations Pre	43	47	40	35	32	34	35	36	41
Effective Observations Post	67	60	45	62	51	39	57	44	49
Effective Observations DD	84	120	105	87	84	83	91	84	85
Optimal BW Pre	8.67	8.93	7.94	6.84	6.56	6.65	6.76	7.20	8.45
Optimal BW Post	9.87	8.26	6.15	8.54	7.36	5.08	7.86	5.77	7.34
Optimal BW DD	7.12	8.56	8.56	7.37	7.23	6.83	7.53	7.06	7.34
Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mean Pre	2.82	1.40	82.45	57.63	48.46	46.88	78.45	79.07	165.27
SD Pre	2.14	1.67	132.66	117.18	95.42	96.41	151.34	133.53	194.79

Notes: This Table presents results from Equation (6) estimated for different measures of deforestation, as discussed in Section 5.1. Controls include population, area, tree cover area, and indicators for the municipality ever being in the PPCDAm blacklist and being in the agricultural frontier. p<0.01 ***, p < 0.05 **, p < 0.1 *.

Table B.3: Robustness Politics

	% Farmer Cand. Next Term	% Vote Farmer Next Term	Farmer Next Term	Mayor Reelected
	(1)	(2)	(3)	(4)
Panel A: Cross-section				
Pre	14.29***	15.75***	0.22***	0.03
	(3.34)	(3.57)	(0.05)	(0.05)
Post	12.33***	12.92***	0.12***	-0.04
	(2.87)	(3.17)	(0.04)	(0.05)
Difference	-1.95	-2.84	-0.10	-0.07
	(4.40)	(4.77)	(0.07)	(0.07)
Total observations	1170	1170	1185	1185
Controls	✓	✓	✓	✓
Mean Pre	17.21	17.70	0.18	0.23
SD Pre	25.66	27.49	0.38	0.42
Panel B: Regression Discontinuity				
Pre	3.14	1.32	-0.07	-0.04
	(12.55)	(14.21)	(0.22)	(0.18)
Post	-4.60	-4.06	-0.05	0.23
	(11.51)	(13.17)	(0.18)	(0.19)
Difference	-9.36	-5.33	0.00	0.30
	(20.83)	(20.54)	(0.33)	(0.35)
Effective Observations Pre	68	61	63	50
Effective Observations Post	58	65	70	60
Effective Observations DD	115	156	158	115
Optimal BW Pre	12.13	11.16	11.49	9.72
Optimal BW Post	8.37	10.10	10.27	8.43
Optimal BW DD	9.57	13.37	13.37	9.31
Controls	✓	✓	✓	✓
Mean Pre	23.53	25.69	0.25	0.20
SD Pre	28.54	31.80	0.44	0.41

Notes: This Table presents results from Equation (6) estimated for different measures of political performance, as discussed in Section 5.1. The number of effective observations for each column is the number of observations within the bandwidth used. Controls include population, area, tree cover area, and indicators for the municipality ever being in the PPCDAm blacklist and being in the agricultural frontier. p<0.01 ***, p < 0.05 **, p < 0.1 *.

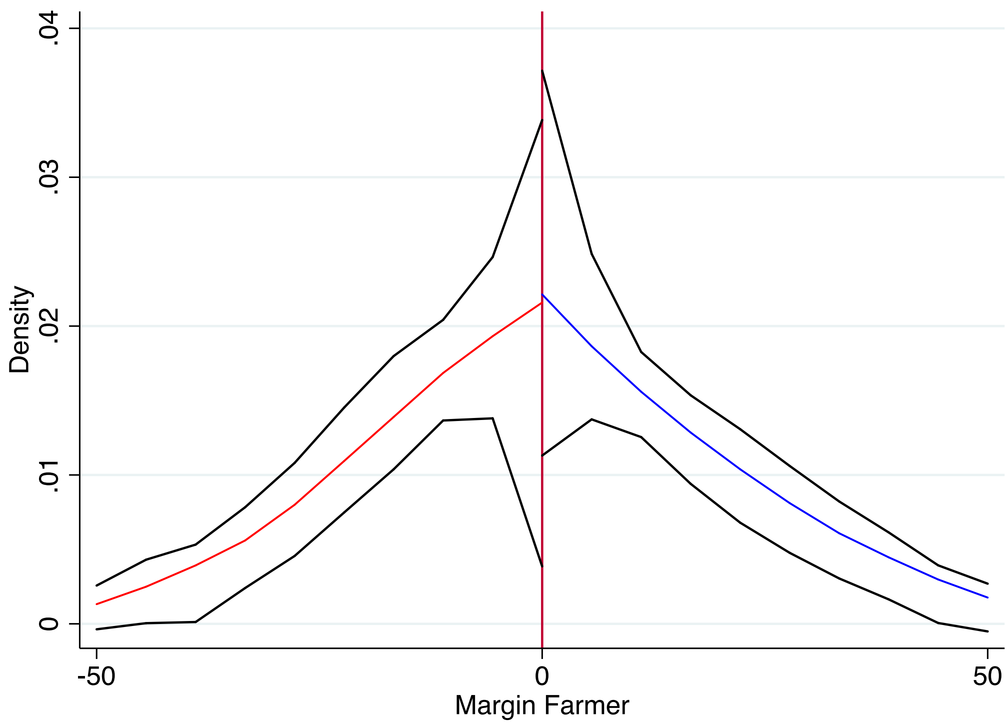
Table B.4: Robustness of matching grants with *Partido dos Trabalhadores* entering power in 2003

VARIABLES	(1) Agriculture	(2) Environment	(3) Education	(4) Health
Post PT x PT Mayor x Farmer Mayor	-3.87	1.49	-0.19	-5.00
	(10.63)	(1.17)	(1.91)	(13.60)
Post PT x PT Mayor	2.61	-0.53	0.39	14.31*
	(8.16)	(0.92)	(1.36)	(7.63)
Post PT x Farmer Mayor	0.49	-0.94	0.80	0.06
	(3.04)	(0.86)	(0.59)	(5.47)
Observations	648	648	648	648
R-squared	0.51	0.30	0.24	0.35
Municipality FE	✓	✓	✓	✓
Controls	✓	✓	✓	✓
Mean	7.380	0.650	1.350	12.54
SD	22.53	5.600	3.650	35.62

Notes: This Table presents results from Equation (7). Controls include population, area, tree cover area, and indicators for the municipality ever being in the PPCDAm blacklist and being in the agricultural frontier. Robust standard errors in parenthesis. p<0.01 ***, p < 0.05 **, p < 0.1 *.

B.2 Figures

Figure B.1: Farmer vote share density test



Notes: This figure plots the density test proposed by Cattaneo et al. (2020) estimated on farmer candidates' vote share discussed in Section 4.2.