Green Mandates and the Politics in the Jungle: Do Leftist Mayors Curb Amazon Deforestation? [1]

Marislei Nishijima (University of Sao Paulo, Brazil)
Email: marislei@usp.br
and
Sarmistha Pal (University of Surrey, UK)
Email: s.pal@surrey.ac.uk

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Abstract: The paper argues that Brazil's political left, traditionally aligned with various workers' groups, tends to prioritise environmental protection and the rights of Indigenous peoples, who are disproportionately represented among the poor in the legal Amazon. This inclination stems from the left's preference for state intervention to safeguard the poor indigenous population, which often conflicts with business interests in agriculture, cattle ranching, and mining in the legal Amazon. Using satellite monitoring data from 760 municipalities in the Brazilian legal Amazon region between 2000 and 2021, the study examines the influence of left-wing Mayors on levels and annual changes of deforestation, annual deforestation changes, reforestation initiatives, and local government spending on environmental management. Through a regression discontinuity approach, the study assesses the impact of left-wing Mayors who narrowly defeated right-wing rivals in close elections. RD robust results suggest that electing a leftist mayor in a tight race leads to significant reductions in deforestation and increase in environmental expenditures, particularly when the leftist mayors govern without a coalition. These effects persist regardless of whether the mayors belong to the left alone, or a left and centre-left coalition, with the strongest impact seen among mayors solely from the left in non-coalition governments. The study also documents that municipalities with larger indigenous populations and higher levels of deforestation are more likely to elect leftist mayors, resulting in increased leftist vote shares. This dynamic holds leftist mayors accountable to these voters and underscores the importance of a functioning local democracy.

Keywords: Political ideology; Leftist mayors; Deforestation; Reforestation; Close elections; Regression discontinuity design; Local democracy; Brazil.

JEL classifications: H77; Q56; R14; P44;

1. Introduction

Forest loss causes 12–20% of global greenhouse gas emissions due to the disruption of carbon storage when trees are cut down. In the Amazon, deforestation is driven by legal and illegal activities like farming, ranching, mining, and logging, making sustainable management crucial. This study focuses on Brazil, which holds 60% of the Amazon rainforest. Since the 2006 Forest Management Law, forest governance has been decentralised, giving mayors significant authority though President Bolsonaro (2019–2022) dismantled many environmental protections, raising concerns for deforestation.

The present study investigates whether leftist, as against right-wing, mayors are more effective in reducing deforestation, considering their ideology within this decentralised system. It argues that left-leaning mayors may be more effective at reducing deforestation, especially when governing independently without coalition constraints. In Brazil, industries like logging, soybean farming, cattle ranching, and mining disproportionately harm Indigenous and working-class communities. Leftist politicians, often supported by unions and grassroots movements, tend to favour state-led environmental protection, which contrasts with the pro-business stance of right-wing parties (Dunlap, Xiao, & McCright, 2001; Neumayer, 2003). Voters in environmentally affected areas are more likely to support leftist leaders seen as defenders of conservation (Papp, 2022; Cotofan et al., 2024). However, some local politicians may still exploit natural resources for political gain, such as promising land access to powerful groups. This study investigates how these dynamics play out in practice, focusing on the environmental impact of left-wing mayors.

We compiled municipality-level data for 760 municipalities in the Brazilian Legal Amazon, sourced from various official sources between 2000 and 2021, to examine whether leftist mayors are pro-environment. We consider the following outcomes: (i) deforested areas and annual changes (from PRODES/ National Institute for Space Research (INPE) satellite data), (ii) reforested area (from Terra Class/INPE-EMBRAPA, until 2015), and (iii) annual environmental spending (from municipal finance data). PRODES offers high spatial resolution (≥6.25 ha) but cannot detect secondary vegetation loss, which Terra Class partly addresses with biennial land-use maps (Almeida et. al. 2016). All areas are in km². For robustness, we also compute outcomes as shares of municipal area or total expenditure as appropriate.

We identify party ideology using sources such as BBC Brasil, the EU Manifesto Project (with limited coverage), and Bolognesi et al. (2023), classifying mayoral candidates as left- or

right-wing (see Appendix Table A6 and Section 2.2 for further details). Based on this, we define leftist mayors using three proxies: (i) mayors from left-only parties, (ii) mayors from left and centre-left parties, and (iii) mayors from workers' parties .

A key challenge in assessing whether electing a leftist mayor impacts environmental outcomes is that both may be shaped by the same community characteristics, whether observed or not. Following the literature, we address this by focusing on close elections between left- and right-wing candidates within a regression discontinuity (RD) framework. This approach leverages descriptive representation, meaning that the elected candidate (i.e., whether the electorate narrowly preferred a leftist or right-wing candidate) reflects the political preferences of the voters at the time of the election. We then assume substantive representation, where elected leftist candidates are expected to implement left-leaning policies—such as stronger environmental protection—while right-wing candidates prioritise different agendas.

However, winning an election by a small margin does not always translate into fully implementing the expected ideological agenda. Political constraints such as coalition governments (affecting 35% of elected mayors in our sample), legal disputes, or governance barriers may limit mayors from fully enacting their party's policies or even assuming office, thus justifying our focus on non-coalition governments.

We detect some manipulation near the zero winning margin, but it disappears when excluding the central observations around{-0.005, +0.005} range, using a 0.01 threshold, thus giving rise to donut RD (see Barreca et al., 2011). Accordingly, we adopt a sharp regression discontinuity design based on the following justifications: (i) the McCrary test indicates no evidence of manipulation around the revised threshold of the running variable at 0.01; (ii) there is an adequate density of observations near the 0.01 cut-off; and (iii) observable covariates appear balanced on either side of the threshold, reinforcing the assumption that units just above and below the cut-off are otherwise comparable.

Results show that close elections lead to leftist mayors (left plus centre-left taken together), confirming descriptive representation. These mayors significantly reduced deforestation and increased environmental spending, especially when not in coalitions. Effects persist even when comparing only left- vs. right-wing races. This likely reflects stronger accountability to their constituencies, including Indigenous groups. Additionally, we document a significant positive association between lagged deforestation and leftist vote share in the subsequent years, suggesting that voters also respond to deforestation by electing leftist mayors in a bid to save the rainforest.

We further observe that the influence of leftist mayors on selected environmental outcomes varies based on several additional factors. Notably, the impact of leftist mayors is more pronounced in municipalities that are farther from the Trans-Amazon Highway, when the mayor is not politically aligned with the President, and during municipal non-election years. While leftist mayors generally have a positive effect, these varied results underscore their limitations in fully protecting the Amazonian rainforests, thus requiring more focused attention to Amazon conservation efforts.

This study builds on literature about descriptive vs. substantive representation of minorities (Bratton and Ray, 2002) and class (Carnes, 2012, 2013; Carnes and Lupu, 2015), as well as the role of campaign dynamics (Campbell, 1992, 1996) and party platforms in addressing inequality (Schakel and Burgoon, 2022; Demange and Van der Straeten, 2020).

Deforestation in the Amazon is viewed as a tragedy of the commons (Stavins, 2011; Van der Ploeg, 2011; Brollo et al., 2013), driven by uncoordinated exploitation for profit through mining, logging, agriculture, ranching, and land speculation. This study builds on existing research in optimal forest management (Dasgupta and Heal, 1974; Samuelson, 1976; Dasgupta, 1982; Brown, 2000) and examines how political ideology, particularly that of leftist mayors, influences forest protection.

Bratton and Ray (2002) distinguish between descriptive and substantive representation, where diverse elected officials are expected to shape policies that benefit their constituents. Research shows that class strongly influences political attitudes (Korpi, 1983; Lupus et al., 2009; Brooks, 1994; Manza et al., 1995; Evans, 2000), with workers favoring state-led policies and elites supporting market-oriented ones Carnes and Lupu (2015). Studies (e.g., Schakel and Burgoon, 2022) also reveal inequality in political representation, especially between rich and poor. Building on this, the current study explores a new angle by examining whether leftist mayors in Brazil improve environmental outcomes, particularly in reducing deforestation—an area previously underexplored in this context.

Finally, campaign dynamics play a crucial role in informing voters, with candidates controlling the amount of information shared (Page, 1976; Campbell, 1992, 1996). Demange and Van der Straeten (2020) show that candidates highlight issues that align with their strengths and voter preferences, shaping perceptions based on assumptions about voter rationality. Recent studies note growing voter concern for the environment (Papp, 2022; Cotofan et al., 2024). This tension between ideology and voter demands explains our finding that leftist mayors' positive impact on the Amazon stems from accountability to voters, especially in highly deforested areas.

The paper is developed as follows. Section 2 discusses the history of public policy development in Brazil for the protection of the Amazon and then develops the hypotheses of interest. Section 3 explains the process of data collection and the empirical strategy. Section 4 describes the empirical findings. The final section concludes.

2. Background

Brazil consists of 26 states, a federal district, and over 5,590 municipalities. The study focuses on 760 municipalities in the Legal Amazon, which spans nine states and contains 60% of the Amazon rainforest. Although indigenous issues are federally legislated, strong indigenous land rights and protections only began with the 1988 Constitution. This Constitution formally defined protected indigenous lands, enabling legal land demarcation and granting Indigenous peoples legal representation and autonomy—rights not afforded under previous constitutions.

The 1988 Constitution also marked a shift toward decentralised governance, giving municipalities and states greater political, fiscal, and administrative roles, while the federal government remained responsible for national policy planning. Municipalities were tasked with executing these policies, supported financially by the federal and state governments.

The Amazon faces unique property rights challenges, often perceived as "no man's land," which has led to widespread deforestation and land grabbing. Past government land reform initiatives encouraged migration to the region by offering land to settlers, further complicating land ownership and environmental governance.

2.1. Recent interventions for the protection of the Amazon

In 2006, Brazil introduced a law requiring the legal registration of forested land, prompting rural property registrations across the country, including in the Amazon. However, this process exposed the lack of formal recognition for Indigenous Territories—about 63% remain unlegalized, with 821 out of 1,290 territories lacking official demarcation.

Successive governments have shown declining commitment to Indigenous land approvals:

- Fernando Henrique Cardoso (1995–2002): 145 approvals
- Luiz Inácio Lula da Silva (2003–2010): 79 approvals
- Dilma Rousseff (2011–2016): 21 approvals
- Michel Temer (2016): 1 approval
- Jair Bolsonaro (2019–2022): 0 approvals

This trend reflects increasing marginalization of Indigenous peoples, especially under Bolsonaro's pro-business, anti-Indigenous policies. Much of the Legal Amazon still lacks clear land ownership, making it susceptible to illegal occupation. Research shows that fully recognized Indigenous land rights can reduce deforestation by up to two-thirds.

The 2012 Forest Code introduced tools like the Rural Environmental Register (CAR) and the Environmental Regularization Program (PRA) to manage land use and promote sustainable agriculture. These initiatives aim to monitor deforestation, enforce environmental compliance, and incentivize sustainable practices. However, implementation has been slow, with many properties still pending verification and resolution.

2.2. Political representation of the left in Brazil

In Brazil, mayoral elections take place every four years, alternating with state and presidential elections that happen in between. Voting is mandatory for individuals aged 18 to 70, while illiterate, incapable persons, 16 and 17-year-olds, and those over 70 can choose to vote or not. In most municipalities with a population under 200,000, mayors are elected using a single-round voting system where the candidate receiving the most votes wins the election. However, in municipalities with populations exceeding 200,000, a candidate must secure an absolute majority to win. If no candidate achieves this, a second-round runoff election determines the winner. Over 99% of municipalities in the Legal Amazon area elected a Mayor in the first round. Only a minority of municipalities had gone to the second round of election to elect its Mayor.

There are various methods for measuring the ideology of political parties, such as analysing their party programs, observing the behaviour of party representatives, examining their electoral behaviour, considering the public perception of party representatives, and consulting experts in the field. To classify party ideology, we consulted BBC Brasil, and Bolognesi et al. (2023)[2]. The last relied on expert opinions to classify party ideology, while BBC Brasil analysed the results of ten recent and relevant votes in the Chamber of Deputies. Appendix 2 Table 2.1 details these two sources of party ideology classifications, which are generally consistent when classification exists for both. Based on these classifications, we classified the parties of elected municipal Mayors and runner-up candidates into broader categories as follows:

Ideology	Parties

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[2] We also consulted the EU Manifesto project, however, we were unable to use the Manifesto project extensively due to its limited coverage of Brazilian parties.

Left	PCB, PC do B, PCO, PDT, PMN, PSB, PSOL, PSTU, PT, PV
Centre-Left	AVANTE, CIDADANIA, PPS, PROS, REDE, SOLIDARIEDADE
Centre	PMDB
Centre-Right	DC, MDB, PMB, PRP, PSD, PSDB
Right	DEM, PL, PTB PATRIOTA, PODE, PP, PRTB, PSC, PTC, Republicanos, PPB, PR, PRB, PSC, PSL.

The study finds that **leftist parties in Brazil are closely linked to labor unions and often promote socialism and anti-capitalism to address poverty**. Key left-leaning parties include:

- **PT (Workers' Party)**, founded by labor unions, ruled Brazil from 2002 to 2016, and was a central player in national politics alongside **PSDB**.

- Other socialist or leftist parties include **PSTU**, **PSOL**, **PMN**, **PCO**, **PSB**, and **PV**, many advocating for reforms like shorter work hours, agrarian reform, public investment, and breaking ties with the IMF.

- **PV (Green Party)** emphasizes social equity and sustainability.

- **Rede** is an environmentalist party, while **AVANTE** is a centrist party formed by labor party dissidents.

- Many of these parties often formed coalitions with PT and shared socialist or anti-capitalist ideals.

These parties collectively promote policies favouring workers, environmental protection, and opposition to neoliberal economic models.

In contrast, centre and centre-right Brazilian parties are more allied with the businesses. Among them, PMDB and MDB are parties without a clear ideological program and have often allied themselves with the ruling executive to extract advantages through clientelist networks. PSB too has aligned with both the left and the right in recent years. PMB is the Brazilian Women's Party Known for its non-feminist and anti-abortion stance, while DC (Christian Democracy) is a small party supporting traditional Christian values.

Using this party ideology classification, we create several proxies for left-wing Mayors: (a) Mayors from the Left and Centre-Left parties taken together; (b) Mayors from the left parties only; (c) Further, we construct an index to identify the parties that best represent the workers' (as against business) interests. Most parties cite workers' rights as one of the key objectives. Thus, to disentangle the most prominent parties that defend workers' interests, we consider the ones that have "workers" (trabalhadores, colaboradores or operários in Portuguese) as one of the words in the party's acronym. (a)-(c) are the parties, who are generally

pro-workers, pro-poor and often pro-environment too. (d) Since the 2016 municipal elections, we have also been able to identify if the local government has any elected Indigenous members. The latter provides an alternative way to assess the role of leftist Mayors (a)-(c) in these municipalities with elected indigenous members. We find a high degree of correlation between the election of an indigenous member and that of the leftist Mayors.

***** Insert Figure 1 *********

Figure 1 displays the trend in the average share of leftist mayors in the sampled municipalities. Panel a depicts the trend for left and centre-left mayors, while panel b focuses specifically on left-only mayors. The data shows a rising share of leftist mayors in Amazonian municipalities from 2000 to 2012. However, this share declined after 2012, reaching a low point by 2015, and then stabilized, though it remained below the 2010 peak. This decline aligns with the gradual downfall of the PT government under President Lula, which was increasingly burdened by corruption scandals and economic crises. A similar downward trend is observed for mayors from workers' parties after 2010.

*** Insert Table 1 here ****

Table 1 reports the likelihood of having a leftist mayor- columns (1)-(2) show the estimates of left party (left plus centre-left), columns (3)-(4) those of left only party mayors and columns (5)-(6) those of mayors from workers' parties. Row (1) shows the estimate of Indigenous population (as a share of 10000), while row (2) shows that of Indigenous population as share of the municipality population. Evidently, there is a positive and significant association between the indigenous population (level or share) in a municipality and the likelihood of having a leftist Mayor. Consequently, election of a leftist mayor can be taken as indicative of the indigenous population's representation in that municipality.

In view of the local election data from 2016 onwards, we also consider the likelihood of a municipality with elected indigenous members. Note that this information is not available for prior elections. Our analysis shows that the likelihood of having an Indigenous person elected member is significantly higher (0.12 as against 0.066 with a t-statistic of 6.3830) when the mayor is from a left-leaning parties (left or centre-left in our classification). This positive association is also confirmed in Table 2 where we regress the number of elected Indigenous members on the likelihood of having a mayor from left only, left and centre-left or workers' parties. This evidence further strengthens the significant association between political representation of the Indigenous peoples and election of leftist Mayors in our sample.

Coalition governments are very common in Brazilian municipalities due to the great number of parties in the country. The likelihood of having a coalition government is about 0.36 when the mayor represents the left or a centre-left party. We also note that many mayors are aligned with the President in terms of their party affiliation and this likelihood (0.26 as against 0.06 for others with a t-stat of 35.5624 for testing the mean difference) is significantly higher among left-led municipalities in Brazil. The latter can probably be attributed to the fact that the centre-left Workers' Party (PT), under the Presidents Lula and Dilma Rousseff, had ruled for much of the sample period (2003-16).

2.3. Are leftist Mayors necessarily pro-environment?

Indigenous communities in the Amazon have historically lived in harmony with nature, acting as effective stewards of the forest. In the Bolivian Amazon, Indigenous land ownership is strongly linked to forest conservation, while private settler and bushman holdings are associated with old-growth forest loss (Webb 2019).

Earlier waves of deforestation (1960s–2000s) were driven by government-led development through road construction, land incentives, and agricultural settlement programs. In Brazil, political shifts have, however, significantly influenced Amazon conservation. The centre-left Workers' Party (PT), in power from 2003 to 2016, introduced impactful environmental regulations like the 2006 land registration law and the 2012 New Forest Code. These policies reduced deforestation through measures such as protected areas, monitoring systems, and incentives for municipalities. However, under far-right President Jair Bolsonaro (elected in 2018), many of these protections were rolled back, thus promoting deforestation, weakening environmental enforcement and supporting illegal activities like mining and logging, and dismissing Indigenous concerns. His presidency ended with deforestation levels 66% higher than in previous years (Lima et al., 2020).

We argue that left-leaning mayors are more inclined than their right-wing counterparts to implement environmentally protective policies. This tendency stems from three key factors: environmental protection often requires state intervention; leftist parties in Brazil, largely supported by the working class, generally favor government action over market solutions (Carnes & Lupo, 2015); and such interventions typically benefit Indigenous communities, who are disproportionately affected by environmental degradation (Dunlap et al., 2001; Neumayer, 2004). As a result, left-wing mayors are more likely to pursue environmental regulations, even

when these may conflict with local business interests, in order to support their core constituents—workers and the poor.

However, evidence also shows that local politicians can exploit natural resources for electoral gain. For instance, during Brazil's 2018 presidential election, deforestation spiked amid promises to weaken environmental protections (Abessa et al., 2019). Similarly, U.S. governors adjust environmental policies based on voter preferences—tightening in environmentally conscious ("green") states and loosening in industrial ("brown") states (List & Sturm, 2006). While there's no definitive evidence of an anti-environment agenda within Brazil's left, factions within Lula's Workers' Party have varied in their stance. Nonetheless, Lula's recent return to office is seen as a positive development for Amazon preservation, with a pledge to achieve zero deforestation and halt further agricultural expansion by 2030.

We weigh these two sets of arguments and use our data to explore the role of leftist mayors on outcomes related to Amazon deforestation. Some further considerations are in order here. Left-leaning mayors may struggle to implement environmental policies if their governing coalitions include parties with opposing interests, or if economic incentives tied to business interests in the rainforest dominate local priorities. The study also investigates the varied impact of leftist leadership based on: (a) proximity to the Transamazônica Highway, which can facilitate illegal logging; (b) election years, when environmental issues are often deprioritized in favor of economic concerns; and (c) political alignment with the President, which can affect policy implementation. These factors are empirically tested using available data.

3. Data and Empirical Strategy

3.1. Data Description

We compile a unique municipality level data covering 760 Legal Amazon municipalities over 2000-2021 from various official main sources. Deforestation data primarily comes from satellite monitoring from PRODES, a project in the National Institute for Space Research (INPE) with the goal of monitoring and controlling deforestation, among others. Prodes has better spatial resolution than other monitoring systems, e.g., DETER and can identify areas of size 6.25 ha or above annually. Since the mask is a blind spot for both PRODES and DETER, any changes to secondary vegetation in the Amazon remain invisible to both systems, and consequently, to Brazilian environmental authorities. The Terra Class project (Almeida et. al. 2016), a joint effort between INPE and EMBRAPA, partially addressed the problem of the

invisibility of secondary vegetation in the Amazon by creating biennial maps of land use and cover within the PRODES deforestation mask, with secondary vegetation as one of the categories monitored.

In addition, we collect data on Legal Amazon over 2000-2021 from another variety of official sources: IBGE- Brazilian Institute of Geography and Statistics, Water Agency, DNIT - Infrastructure, MMA – Ministry of Environment, TSE – Superior Electoral Court, IPEA- Institute of Applied Economic Research, SUS- National Health Service, CPT- Pastoral Land Commission, Tesouro Transparente - Transparency National Treasure. This is summarised in Appendix ` Table A1.

The key outcome variables of our interest are: (i) area deforested (PRODES); (ii) change in area deforested in square km (PRODES); (iii) area reforested (From Terra Class available only until 2015); (iv) expenditure on environment management. All areas are measured in square kilometers. For robustness, we also consider the area deforested as share of total municipality area, annual changes in area deforested as share of total deforested area as well as total expenditure on environmental management as share of total municipality expenditure. In general, mechanical clearance using bulldozers and other heavy equipment is estimated to cost 44-70% more than using fire (Simorangkir, 2007). MODIS satellite data for detecting all fires across the world for the period 2003-2018 suggests that the incidence of fires is concentrated heavily in forested low-income countries and is about four times higher than that in forested high-income countries. Appendix 1 Table A2 summarises the means and standard deviations of all regression variables.

*****Insert Figure 2 *****

Panels a-b of Figure 2 show the trends in deforested areas, the levels and annual changes in our sample. Between 2000-2004, there was a high degree of deforestation in Brazil (see panel a); however, deforestation started falling sharply (see panel b) from 2005 onwards as the Lula government initiated several policies to conserve the Amazon. However, there was a reversal of the policies to tackle deforestation as the country entered a period of economic crisis after 2014, which was further bolstered by the election of Bolsonaro in 2018 to govern between 2019-2022. This is further corroborated in the panel c of Figure 2, which shows the trend in local government expenses on environmental management: it grew steadily until about 2014 and then started falling.

3.2. Comparison of municipalities ruled by leftist and non-leftist mayors

Using a broad definition of leftist mayors (including both left and center-left), Appendix 1 Table A3 compares key characteristics across municipalities and highlights the following:

1. Left-led municipalities are larger in both area and population.
2. They have higher Indigenous populations, both in absolute terms and as a share of the total.
3. Voter turnout is significantly greater in these areas.
4. Business taxes (ISS revenues) are higher, enabling more spending on Indigenous support and environmental initiatives (e.g., land use, mining control, water management).

These findings inform the next stage of the analysis, which seeks to estimate the causal impact of leftist mayors on deforestation outcomes.

3.3. Empirical Strategy and Identification

The main empirical challenge has been that the election of a leftist mayor in a municipality is unlikely to be random. It is likely to depend on the same municipal characteristics that also influence the deforestation or reforestation outcomes of interest. To address this issue, we employ close elections between left-wing (left and centre-left) and right-wing mayoral candidates within a regression discontinuity (RD) framework, see Appendix Table 2 for basic statistics of variables in the regressions. The underlying assumption is that close elections effectively randomise the selection of a leftist versus a right-wing mayor, thereby allowing us to estimate the causal effect of electing left-wing mayors in local municipal elections on various outcomes related to conflict and deforestation.

The RD design is one of the most credible non-experimental identification strategies used in the literature. It relies on weak and easy-to-interpret nonparametric identifying assumptions, which permit flexible and robust estimation and inference for local treatment effects. The key feature of the design in our case relies on the winning margin of a left-wing candidate against a right-wing one, which is used as the key running variable for each Amazon municipality in the sample. This determines the treatment assignment via hard-thresholding around the cut-off winning margin of 0 to characterise a close election. Close elections are defined as those in which the winner and the runner-up are of opposite ideologies and the margin of victory is so small (very close to the cut-off threshold of 0) that the ideological identity of the winner of a close election turns out to be quasi-random. All municipalities that elect a left-wing candidate against a right-wing one with a winning margin above the cut-off 0 are offered the treatment, while all municipalities whose score is below this cut-off 0 (i.e.,

where a left-wing candidate loses against a right-wing one) are treated as the control units. Identification is then done by comparing the responses of treated units just above the cut-off of 0 winning margin with those below (control group) as counterfactuals.

The probability of a leftist mayor being elected is a function of the vote difference between the winner and the runner-up and this function has a discontinuity at zero. As the vote difference approaches discontinuity, constituencies in which a left candidate wins by a small vote margin are increasingly similar to constituencies in which a right-wing individual wins by a small margin (Lee 2001; Pettersson-Lidbom 2001), making the experimental framework quasi-random.

3.3.1. Identification

Before proceeding with the RD robust estimates of the selected outcomes, we first test that the RD identifying assumptions hold in our sample.

3.3.1.1. McCrary (2008) test

First, we check whether the running variable, i.e., the winning margin, is continuous at the cut-off point 0. To do this, use McCrary test (McCrary 2008) for all three possible left winning margins, named *wmw*, *wmw_leftonly* and *wmw_workers*, in our full sample using a cut-off value 0. The McCrary test was, however, statistically significant ($p=0.0000$), suggesting possible manipulation of the running variable at the cut-off. The binomial test does not show a significant imbalance in observations near the threshold, so the issue may not be due to sample imbalance but rather the distribution's shape. Accordingly, we inferred that this RDD may be compromised due to potential manipulation at the threshold value 0. If individual units can manipulate the forcing variable winning margin to end up just above or below the threshold, the key RD assumption of local random assignment fails. This is possible because of the strategic voting, especially if the voting goes to the second round. Donut RD removes observations near the cut-off, where manipulation is most likely.

Following Barreca et al. (2011), we next exclude observations with winning margins above -0.005 and below 0.005, and adopt a cut-off value of 0.01 to implement a donut regression. We then rerun the McCrary density test, which does not indicate manipulation at the cut-off: the p-values are 0.8422 and 0.12 for *wmw_leftonly* and *wmw*, respectively, both exceeding the 0.05 threshold level of significance. This suggests no statistically significant discontinuity in the density of the running variable at the cut-off of 0.01, indicating the absence

of manipulation for these two running variables. Furthermore, the binomial test does not reveal significant sorting around the cut-off. Overall, the RDD appears valid, with no evidence of manipulation at the threshold, allowing us to proceed confidently with the regression discontinuity design analysis. However, we discard the running variable *wmw_workers*, as the McCrary test yields a p-value below 0.05 in this case, indicating potential manipulation at the 0.01 cut-off too—although the binomial test does not detect significant sorting in this case. We also run the rddensity test for mayors in non-coalition governments, after excluding winning margins below 0.005 and above -0.005, and adopting a 0.01 cut-off for both left only mayors and left plus centre left mayors. These tests too confirm the validity of the RDD, with no significant manipulation detected at this threshold 0.01.

****Insert Figure 3 *******

Figure 3 (panels A1-A6) shows the histograms of the running variable after excluding the winning margin above -0.005 and below 0.005 (positive when a left party (left and centre-left or left only) mayoral candidate winning against a non-left party candidate and negative otherwise) in bins of 2 per cent. Panels A1, A3 and A5 show the cases of left plus centre-left Mayoral candidates, while panels A2, A4 and A6 show those for left only mayors. Taken together, Figure 3 seems to support the continuity of the left party (left plus centre-left taken together) candidate's winning margin at the cut-off 0.01.

3.3.1.2. RD plots of outcome variables

Secondly, Figures 4a (panels A1–A4) and 4b (panels B1–B4) present the RD plots for the selected outcome variables: total area deforested (in square kilometres), annual change in deforested area (in square kilometres), total area reforested (in square kilometres), and annual environmental expenditure. The plots are based on left-only and leftist (left plus centre-left) winning margins, using the revised cut-off value of 0.01 and a quadratic polynomial specification. We plot left-wing win margin on the horizontal axis. Positive win margin above 0.01 indicates that a left-wing mayoral candidate wins against a right-wing one; negative win margin below -0.01 indicates the opposite, i.e., a left-wing mayoral candidate loses against a right-wing one. We plot a lowess smoothing line for each of the selected outcomes on each side of the cut-off (indicated by the variable c) win margin 0.01 in each panel using quadratic polynomials.

****** Insert Figure 4a ******

****** Insert Figure 4b ******

In general, we observe a small increase in area deforested (level or share) at c=0.01 when a left-wing mayoral candidate wins against a right-wing one in panels A1 and B1 in close elections. In contrast, there is a small reduction in area deforested (level or share) from last year when a left-wing mayoral candidate wins against a right-wing one (see panels A2 and B2) in close elections. Further, there is a small positive effect on area reforested (panels A3 and B3), but considerable increase in environmental expenses (panels A4 and B4) when a left-wing mayoral candidate wins against a right-wing one in close elections. Later we shall use RD robust estimates method to identify the impact of leftist mayor on these outcomes after controlling for all other factors.

3.3.1.3. Political fragmentation and win margin

A useful attribute of the RD design applied to Amazonian municipalities is that voter fragmentation across different candidates up for election leads to close elections over a wide range of underlying left party vote shares. This is illustrated in the first column of Figure 5, which shows the left party winning margin (the difference between the vote share for a left-wing mayoral candidate winning against a non-left runner-up candidate) against left party vote share on the horizontal axis. Observations within 2 percentage points of the winning margin threshold at zero are shown in red. The diagonal line shows the hypothetical one-to-one relationship between the two variables. Observations close to the horizontal line marking the winning margin cut-off 0.01 vary from just under 2 per cent (with votes split across many candidates up for election) up to 50% (with votes more concentrated across fewer candidates up for election) of the total votes cast for a left party candidate. We get a very similar picture even when we consider mayoral candidates from left only parties winning against right-wing ones, as shown in the second column of Figure 5. We, therefore, conclude that the RD treatment effect is not singular to a specific preference point, but it is representative of a more heterogeneous constellation of political circumstances in our sample. This explicitly demonstrated an additional benefit pertaining to a core assumption of the RD design: left party preferences are continuous over the threshold defined by c=0.01.

****** Insert Figure 5 ******

3.3.1.4. Balancing of the covariates

For the RD robust model with covariates, we also check that the treatment has no effect on the covariates at the cut-off winning margin 0.01, and that the conditional expectations of potential outcomes and covariates are continuous at the cut-off.

The chosen covariates are the municipality's log(population), log(area in square kilometres), illiteracy rate among those aged 15 and over, share of Indigenous population, share of male population, distance to the nearest highway, and whether the municipality receives any oil royalties. We test the balance of these covariates around the cut-off at $c = 0.01$. Figures 6a and 6b (panels A–G) present these tests using quadratic polynomials, respectively, for left-only mayors winning or losing against right-wing candidates. Each panel plots a lowess smoothing line for each covariate on either side of $c = 0.01$, after excluding observations within the range [-0.005, 0.005], where evidence of manipulation was found. We consider both left-only mayors and the broader group of left plus centre-left mayors. Overall, the results confirm that the selected covariates are balanced around the cut-off at $c = 0.01$, regardless of the polynomial specification, except for indigenous population share and distance to the Transamazônica Highway. These two covariates are therefore excluded from the RD robust regressions discussed below.

****** Insert Figure 6a ******
****** Insert Figure 6b ******

Since the McCrary test indicates no significant manipulation of the running variable—winning margin—at the 0.01 threshold, any observed discontinuity in outcomes can be attributed to the treatment (i.e., the election of a leftist mayor in narrowly decided contests against right-wing opponents). Additionally, there is a sufficient number of observations near the cut-off, and observable covariates are well balanced on either side, supporting the assumption that units just above and below the threshold are otherwise comparable. Therefore, we adopt a sharp regression discontinuity design for our analysis.

3.2. RD Robust estimates

Having established that the identification conditions hold in our sample, we argue that the election of a leftist (against a rightist) mayor in a close election is likely to be random around the cut-off of 0.01 winning margin. The latter is guided by the McCrary test, which does not hold for the winning margin cut-off 0. Hence, we exclude observations above -0.005 and below 0.005, creating a "donut hole" and use a cut-off value 0.01 (see Barreca et al., 2011).

We obtain the robust Regression Discontinuity (RD) estimates (see Appendix 2 for further details) proposed by Calonico et al., (2014a; 2014b) that implements local polynomial RD point estimators with robust bias-corrected confidence intervals and inference procedures. The advantage here is that these estimates are robust to "large" bandwidth choices. This programme reports three different procedures: i) conventional RD estimates with a conventional variance estimator; ii) bias-corrected RD estimates with a conventional variance estimator; and iii) bias-corrected RD estimates with a robust variance estimator. Option (iii) remains our preferred estimates. Given that McCrary test does not hold for the winning margin cut-off 0, we exclude observations above -0.005 and below 0.005, creating a "donut hole" and use a cut-off value 0.01. Barreca et al. (2011) demonstrate that excluding a narrow band of data around the cut-off point 0 can reduce bias from sorting or heaping, provided sufficient bandwidth remains for estimation.

4. Empirical Findings

4.1. Effects of leftist mayors on deforestation outcomes

Below we analyse the RD robust estimates of selected outcome variables pertaining to deforestation with and without covariates, which are balanced at the cut-off threshold 0.01. For each selected outcome, we provide estimates for mayors from left and centre left parties as well as those when mayors belong to left parties only. All estimates use optimal bandwidth only.

4.1.1. Effects on outcome levels

Appendix 1 Table A4 shows the RD robust estimates of area deforested (panel a), annual change in area deforested (panel b), area reforested (panel c) and also the annual environmental expenses (panel d) without any covariates for close elections of leftist Mayors (various proxies) using optimal bandwidth after dropping the observations in the neighbourhood [-0.005, +0.005]. Columns (1)-(3) show estimates for left and centre left parties taken together while column (4)-(6) show those for left only parties respectively using linear, quadratic and cubic polynomials. Including higher-order polynomials ensures that the functional form is flexible enough to capture any nonlinear trends near the cutoff and also that the estimates are robust. Evidently, leftist mayors are associated with a significant drop in area deforested, annual drop in area deforested as well as an increase in the annual environmental expenses, but no significant effect on the reforested area is noted.

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*** Insert Table 3 here ****

Table 3 estimates, different from Table A4, include the covariates, which help control for observable characteristics, increasing the efficiency and potentially reducing bias. The included covariates are: population size, geographic area, 15+ illiteracy rate, male population share, if it is a protected indigenous land, if receives oil royalty share and if it is an election year. We drop the covariates that do not satisfy the balancing condition. At the cut-off 0.01 for left only mayors, there is a statistically significant drop in area deforested, annual changes in area deforested and also an increase in the expenditure on environment management, named *ln(envexptot)*, for units just to the right of the cut-off compared to just to the left of the cut-off. The estimated effect on area deforested appears approximately three times the mean of deforested area (2918.7/935.7224), while the effect on annual changes in area deforested is around 0.42 (=7.4068/17.53) of the mean value of annual changes in area deforested in the sample at the threshold value 0.01. The coefficient of 2.133 for determining environmental expenditure means a 213% increase in environmental expenditure (since it is log-transformed), assuming the treatment assignment happens at the threshold. The robust confidence interval ([0.69, 3.80]) confirms the precision of the estimate even after adjusting for potential bias and heteroskedasticity. We get similar results for left party in which case the coefficient estimate is 2.01 or 201% increase in environmental expenditure with a quadratic polynomial. The corresponding coefficient for area deforested is -194.97 (relative to a mean 935.7224) and this is also significant. However, the treatment effect of a leftist mayor from left and centre left parties taken together remains statistically insignificant for annual changes in area deforested in this case. No significant effect is, however, found on reforestation, regardless of the mayor's party affiliation. Overall, mayors from purely leftist parties have a stronger impact on reducing deforestation than those from broader left or centre-left coalitions, likely due to fewer policy compromises.

4.2. Effects of leftist mayors in non-coalition governments on deforestation outcomes

4.2.1. Effects on outcome levels

About 37% of municipal governments in the dataset are governed by coalitions, which can blur the true impact of leftist mayors due to internal disagreements on issues like deforestation. To better assess the effect of leftist leadership, the study focuses only on municipalities led by non-coalition mayors, where leftist leaders are more likely to implement their policies without compromise.

*** Insert Table 4 here ****

Evidently, the treatment effect of a leftist mayor is negative for all columns 1-6, but statistically significant only for left only mayors in columns (4)-(6), indicating a drop in area deforested at the threshold. In contrast, this effect is positive and statistically significant for annual environmental expenses irrespective of whether a left only or left plus centre-left mayor is in power. In other words, the treatment effects on area deforested and environmental expenses at the threshold are more pronounced for left only mayors where they are more likely to pursue left-leaning policies. Considering the quadratic polynomial and left only mayoral cases, the size of the estimated coefficient is -519.34 for area deforested, which is around 0.55 of the mean area deforested. In contrast, the treatment effect is around 1.747 for annual environmental expenses, indicating a 174.7% increase in environmental expenses (since the outcome variable is measured in natural logarithm) at the threshold when a leftist mayor wins against a right wing candidate in close elections. Treatment effects, however, remain statistically insignificant for annual change in area deforested and also for area reforested in this case.

Estimates for round 1 elections only: Given that some mayoral elections go to second round, there may be more strategic voting at the second round. Hence, we also consider the treatment estimates for election round 1 only for non-coalition cases as a robustness test. This case satisfies the RD density test as per McCrary (2008). The corresponding RD robust estimates of selected outcomes are summarised in Appendix 1 Table A5. Evidently, these estimates are rather similar to those shown in Table 4 – a significant drop in total area deforested is noted only for left only mayors at the threshold while a significant increase in environmental expenses are noted at the threshold irrespective of whether a leftist or left only mayor is selected.

4.2.2. Effects on outcome shares

In addition, we construct the outcomes as share variables to check the robustness of the estimates of the outcomes measured in levels in Tables 3 and 4. In particular, we construct area deforested as share of total municipality area, annual change in deforested area as share of total deforested area, area reforested as share of total deforested area and also environmental expenses as share of total municipality expenses. RD robust estimates of the impact of leftist mayor on outcome shares for non-coalition cases are summarised in Appendix 1 Table A6.

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We do not find any statistically significant effect of leftist mayors on share of annual changes in area deforested or share of environmental expenses; but election of left only mayors is associated with a significant drop in area deforested by around 6% though no effect on share of environmental expenses. We do not observe any effect on share of area reforested either.

Further Appendix 1 Table A7 shows the estimates of selected outcome shares for election round 1 in non-coalition cases. As before, these estimates are similar to those shown in Appendix 1 Table A6: significant negative treatment effects are only observed for area deforested when a left only mayor is elected in close elections. No significant effect is observed for annual environmental expenses shares, as before.

Overall, leftist mayors are linked to reduced deforestation and increased environmental spending, especially when governing alone. However, the impact is generally weaker when measured as a proportion of total outcome levels.

4.3. Effect of leftist mayors in municipalities without a budget deficit

Some suggest that budget deficits may push municipalities to weaken anti-deforestation rules to attract business. In the sample, about 8% of municipalities face such deficits. Due to limited data, robust estimates are calculated only for municipalities without a deficit, allowing the study to test if the positive effects of leftist mayors are stronger when financial pressure is absent.

Appendix 1 Table A8 shows that in close elections, non-coalition municipalities without budget deficits led by leftist mayors see the strongest positive environmental effects. The most notable impact is a significant increase in environmental spending (log scale), observed for both left-only and combined left/centre-left mayors. However, only left-only mayors show a significant reduction in deforested area. These results highlight that left-only mayors, especially in fiscally stable municipalities, are more effective in advancing environmental policies.

4.4. Treatment Effects when a leftist Mayor wins/loses against right-wing one

So far, we have considered the estimates for all candidates in the full sample or the non-coalition sample. We now re-estimate all the outcomes for the subsample where a leftist mayoral candidate wins/loses against a right-wing candidate. Naturally, the sample size drops here. Appendix 1 Table A9 shows these RD robust estimates. Panel a shows the estimates for left only mayors while the panel b shows those for left and centre-left mayors taken together. Even when the sample size falls significantly, there is confirmation from Appendix Table A9

that the close election of a left only mayor is associated with statistically significant increases in environmental expenses. The effect on area deforested, although still negative, fails to be statistically significant in this smaller sample. As before, these observed effects are more pronounced among mayors from left only parties.

4.5. Underlying mechanisms

In this section, we explore the possible mechanisms in operation to explain the key results.

4.5.1. Mechanism 1

Typically, municipalities governed by the left tend to have a notably higher percentage of indigenous population, who are more likely to care about conserving the Amazon. Referring to Table 1, it is possible to verify a significant positive association between the presence of an Indigenous population (level or share) and the share of votes for left-only (column 1), left and centre-left (column 2) and workers' (column 3) parties. Table 2 further shows the positive and statistically significant association between the share of elected *indigenous* members and the likelihood of having a leftist mayor. Finally, panel a of Table 5 shows a positive and significant association between voter turnout and leftist vote share, highlighting that leftist electoral success is closely tied to higher voter participation, possibly arising from leftist campaign strategies and/or redistributive or progressive policies, often associated with leftist platforms, especially in areas dominated by an Indigenous population. All this evidence underscores the importance of accountability of leftist Mayors in meeting the needs of their constituents, especially the indigenous ones, in the legal Amazon region of the country.

*** Insert Table 2 here ****
*** Insert panel a Table 5 here ****

4.5.2. Mechanism 2

Appendix Figure A1, panel a, illustrates a strong correlation between the level of lagged deforestation and the support for leftist (left and centre-left) candidates. This relationship is reaffirmed in Table 5, panel b estimates, indicating that voters react to deforestation by favouring leftist mayoral candidates, thus resulting in higher vote shares of leftist parties in the following round as in columns 1-3. In essence, electoral democracy serves as a potential

mechanism through which leftist mayors are more likely to be elected in regions with higher levels of deforestation in the legal Amazon area with a greater share of the Indigenous population.

*** Insert panel b of Table 5 here ****

As the Chief Executives of their municipalities, elected leftist mayors can serve their constituents in multiple ways. Beyond adopting redistributive policies, they can actively foster deforestation-free practices among local businesses by enforcing strict sourcing guidelines that require suppliers to demonstrate sustainable practices. This not only enhances corporate responsibility but also aligns with growing consumer demands for ethical and environmentally friendly products. Furthermore, they can invest in reforestation initiatives, supporting tree planting and ecosystem restoration projects that are essential for mitigating deforestation and its harmful effects.

4.6. Heterogeneous impact

The study explores whether the impact of left-only mayors on deforestation and environmental spending varies across different contexts. It analyzes differences based on election years, proximity to the Transamazônica Highway, and political alignment with the President. Results (summarized in Table 6) cover deforested area, annual changes in deforestation, and environmental expenses using various polynomial models. Reforestation is excluded due to insignificant effects. All estimates follow the same methodology as the baseline analysis.

*** Insert panels a and b of Table 6 here ***

A comparison between panels a and b of Table 6 underscores the differing impacts of left-only mayors on specific outcomes. During election years, the treatment effects on area deforested are consistently positive and statistically significant across all columns. However, in non-election years (columns 1–3), these effects turn negative and statistically insignificant. This aligns with findings from electoral studies (e.g., List and Sturm, 2006), which suggest that populist leaders may offer or promise forested land to gain the support of influential stakeholders during campaigns. On the other hand, the coefficients for environmental expenses remain positive and statistically significant in both election and non-election years.

The Transamazônica Highway is a long highway that connects the Amazon rainforest and enables one to transport products from the Amazon rainforest in Brazil.

Insert panels c and d of Table 6 here *

Panel c shows estimates for municipalities located farther from the highway (>median distance), while panel b shows those located near the highway (being less than or equal to the median distance).

These robust estimates reveal that the presence of a leftist Mayor at the winning margin threshold leads to a statistically significant reduction in deforested area, but only in municipalities located farther from the Transamazônica Highway (i.e., beyond the median distance). Conversely, for municipalities situated closer to the highway (within the median distance), the treatment effects are positive and statistically significant, indicating a higher likelihood of encroachment in these municipalities, which are easily accessible. However, no notable difference is observed in the impact of left-only mayors on environmental spending across these distance-based subsamples.

*** Insert panels e and f of Table 6 here ***

Panels e and f of Table 6 show the RD robust estimates of selected outcomes for close elections of leftist Mayors in aligned (panel e) and non-aligned (panel f) municipalities. In aligned municipalities (panel e), the mayor and the President are from the same party, which does not hold for non-aligned municipalities. The underlying idea is to test whether alignment with the President strengthens the leftist mayors' attitude towards tackling deforestation at the local level. Here no significant effect is observed for area deforested in either panel. However, a significant negative effect is observed for annual change area deforested (columns 4-6) while a positive effect is observed for environmental expenses (columns 7-9). This suggests that aligned leftist mayors are more successful in curbing deforestation, while non-aligned leftist mayors are more inclined to boost environmental expenditures.

5. Concluding comments

The article argues that Brazil's political left is better positioned than the right to address deforestation and protect the climate in the legal Amazon, due to its historical advocacy for workers, Indigenous peoples, and the poor. Using data from 760 municipalities and a regression discontinuity (RD) design focused on close elections, the study finds that leftist mayors significantly reduce deforestation and increase environmental spending, though they do not

significantly impact reforestation. These effects are strongest when leftist mayors govern without coalition partners or budget constraints.

The influence of leftist mayors is especially pronounced in municipalities farther from the Transamazônica Highway, in non-election years, and when aligned with the federal government. Electoral democracy plays a key role—areas with higher Indigenous populations or greater deforestation tend to vote more for leftist candidates, which incentivizes them to act on environmental issues.

Overall, leftist mayors are more inclined to implement pro-environment policies, especially when not limited by political alliances. They can drive sustainable development by regulating supply chains, promoting corporate accountability, and investing in ecosystem restoration. Despite setbacks under President Bolsonaro, the return of Lula and Brazil's democratic resilience offer renewed promise for rainforest conservation and sustainable growth. Although it is a study of Brazil, it has implications for countries beyond the Brazilian border.

References

Abessa, D., A. Fama and L. Buruaem. (2019) The systematic dismantling of Brazilian environmental laws risks losses on all fronts, Comment, Nature ecology & evolution Vol 3: 510–511 .

Almeida, C. A. D., Coutinho, A. C., Esquerdo, J. C. D. M., Adami, M., Venturieri, A., Diniz, C. G., ... and Gomes, A. R. (2016). High spatial resolution land use and land cover mapping of the Brazilian Legal Amazon in 2008 using Landsat-5/TM and MODIS data. Acta Amazonica, 46, 291-302.

Baragwanath, K., and Bayi, E. (2020). Collective property rights reduce deforestation in the Brazilian Amazon. Proceedings of the National Academy of Sciences, 117(34), 20495-20502.

Barreca, A. I., M. Guldi, J. M. Lindo, and G. R. Waddell (2011): "Saving babies? Revisiting the effect of very low birth weight classification," Quarterly Journal of Economics, 126, 2117–2123.

Bolognesi, Ribeiro, Codato (2023) A New Ideological Classification of Brazilian Political Parties, DADOS, Rio de Janeiro, vol.66 (2): e20210164, 2023.

Bratton, K. A., and Ray, L. P. (2002). Descriptive representation, policy outcomes, and municipal day-care coverage in Norway. *American Journal of Political Science*, 428-437.

Brollo, F., T. Nannicini, R. Perotti and G. Tabellini. 2013. The Political Resource Curse, *American Economic Review* 103(5)

Brooks, Clem. 1994. Class Consciousness and Politics in Comparative Perspective. *Social Science Research* 23(2): 167–95

Brown, Gardner M. Renewable Natural Resource Management and Use without Markets. *Journal of Economic Literature* 38, no. 4 (2000): 875–914.

Burgess, R., M. Hansen, B. Olken, P. Potapov and S. Sieber. (2012) The Political Economy of Deforestation in the Tropics, *Quarterly Journal of Economics*.

Calonico, S., M. Cattaneo and R. Titunik. (2014a). Robust nonparametric confidence intervals for regression-discontinuity designs. *Econometrica* 82: 2295–2326.

Calonico, S., M. Cattaneo and R. Titunik. (2014b) Robust data-driven inference in the regression-discontinuity design, *The Stata Journal* 14(4): 909–946

Campbell, J. E. (1992). Forecasting the presidential vote in the states. American Journal of Political Science, 386-407.

Campbell, J. E. (1996). Polls and votes: the trial-heat presidential election forecasting model, certainty, and political campaigns. American Politics Quarterly, 24(4), 408-433.

Carnes, Nicholas. 2012. Does the Underrepresentation of the Working Class in Congress Matter? *Legislative Studies Quarterly*37(1): 5–34.

Carnes, Nicholas. 2013.White-Collar Government: The Hidden Role of Class in Economic Policy Making. Chicago: University of Chicago Press.

Carnes, N. and N. Lupu. (2015) Rethinking the Comparative Perspective on Class and Representation: Evidence from Latin America, *American Journal of Political Science* 59(1): 1-18.

Cisneros, E., Zhou, S. L., & Börner, J. (2015). Naming and shaming for conservation: evidence from the Brazilian Amazon. PloS one, 10(9), e0136402.

Cotofan, M., Kuralbayeva, K., and Matakos, K. (2024). Global warming cools voters down: how climate concerns affect policy preferences.

Cunha, Manuela Carneiro da. Índios na Constituição. (2018) Novos estudos CEBRAP 37, no. 3: 429-443. http://dx.doi.org / 10.25091/S01013300201800030002

Dasgupta, Partha, and Heal, G. (1974) The Optimal Depletion of Exhaustible Resources. *The Review of Economic Studies* 41: 3–28. https://doi.org/10.2307/2296369.

Dasgupta, P. (1982) The Control of Resources (Cambridge, MA: Harvard University Press).

Demange, G., and Van der Straeten, K. (2020). Communicating on electoral platforms. Journal of economic behavior & organization, 174, 402-419.

Dunlap, R. E., Xiao, C., & McCright, A. M. (2001). Politics and environment in America: Partisan and ideological cleavages in public support for environmentalism. Environmental politics, 10(4), 23-48.

Evans, Geoffrey. (2000) The Continued Significance of Class Voting. *Annual Review of Political Science* 3: 401–17.

Gelman, A. and G. Imbens. (2018) Why High-Order Polynomials Should Not Be Used in Regression Discontinuity Designs, *Journal of Business and Economics Statistics*: 447-456. https://doi.org/10.1080/07350015.2017.1366909

Korpi, Walter. (1983) The Democratic Class Struggle, London: Routledge.

Lima M., Vale J.C.E., Costa G.M., Santos R.C., Correia Filho W.L.F., Gois G., Oliveira-Junior J.F., Teodoro P.E., Rossi F.S., and C.A. Silva Junior (2020). The forests in the indigenous lands in Brazil in peril, *Land Use Policy*, v.90, 104258, ISSN 0264-8377, https://doi.org/10.1016/j.landusepol.2019.104258.

Lee, D. S. (2001). The Electoral Advantage to Incumbency and Voters' Valuation of Politicians' Experience: A Regression Discontinuity Analysis of Elections to the US..

List, J.A., D.M. Sturm. (2006) How elections matter: theory and evidence from environmental policy, Quarterly Journal Economics, 121: 1249-1281.

Lupu, Noam, and Susan C. Stokes. (2009) "The Social Bases of Political Parties in Argentina, 1912–2003." *Latin American Research Review* 44(1): 58–87.

Manza, Jeff, Michael Hout, and Clem Brooks. (1995) Class Voting in Capitalist Democracies since World War II: Dealignment, Realignment, or Trendless Fluctuation? *Annual Review of Sociology* 21: 137–62.

McCrary, J. (2008) Manipulation of the Running Variable in the Regression Discontinuity Design: A Density Test, Journal of Econometrics 142: 698-714.

Medina, S., G. Moromizato and M. Barron. 2020. Deforestation and Re-elected Local Authorities: Evidence from Peru, paper presented at the NEUDC 2020.

Neumayer, E. (2004). The environment, left-wing political orientation and ecological economics. Ecological economics, 51(3-4), 167-175.

Pailler, S. (2018) Re-election incentives and deforestation cycles in the Brazilian Amazon, J. Environ. Econ. Manag., 88 : 345-365.

Papp, Z. (2022). Environmental attitudes, environmental problems and party choice. A large-N comparative study. Political Geography, 97, 102652.

Pettersson-Lidbom, P. (2008). Do parties matter for economic outcomes? A regression-discontinuity approach. Journal of the European Economic Association, 6(5), 1037-1056.

Rodrigues-Filho,S, R. Verburg, M. Bursztyn, D. Lindoso, N. Debortoli, A.M.G. Vilhena. (2015) Election-driven weakening of deforestation control in the Brazilian Amazon, Land Use Policy, 43 : 111-118

Samuelson, Paul. (1976) Economics of forestry in an evolving society. *Economic Inquiry*, 14 (Dec), pp. 466–492.

Stavins, Robert N. (2011) The Problem of the Commons: Still Unsettled after 100 Years. *American Economic Review*, 101 (1): 81-108.DOI: 10.1257

Schakel, W., and Burgoon, B. (2022). The party road to representation: Unequal responsiveness in party platforms. European Journal of Political Research, 61(2), 304-325.

Simorangkir, D. (2007). Fire use: is it really the cheaper land preparation method for large-scale plantations?. Mitigation and adaptation strategies for global change, 12(1), 147-164.

West, T. A., and Fearnside, P. M. (2021). Brazil's conservation reform and the reduction of deforestation in Amazonia. Land use policy, 100, 105072.

Van der Ploeg, F. (2011) Natural Resources – Curse or Blessings, *Journal of Economic Literature* 49(2).

Webb, J. (2019) "Indigenous led conservation in the Amazon- A win-win solution", Amazon Frontlines https://amazonfrontlines.org/chronicles/indigenous-conservation-amazon/

Tables

Table 1. Association between Indigenous population and the likelihood of a leftist mayor

VARIABLES	(1) Left+centreleft	(2)	(3) Leftonly	(4)	(5) Workers'party	(6)
Indig pop/10000	0.100***		0.0750***		0.0253	
	(0.0218)		(0.0212)		(0.0191)	
Share of indig pop		0.00108**		0.000847**		0.000606
		(0.000434)		(0.000421)		(0.000390)
Constant	0.236***	0.238***	0.193***	0.195***	0.164***	0.164***
	(0.00361)	(0.00364)	(0.00337)	(0.00340)	(0.00315)	(0.00317)
Observations	15,160	15,160	15,160	15,160	15,160	15,160
R-squared	0.002	0.000	0.001	0.000	0.000	0.000

Note: The table reports the likelihood of having a leftist mayor- columns (1)-(2) show the estimates of the likelihood of having a mayor from left plus centre-left (leftparty) parties, columns (3)-(4) that of left only party and columns (5)-(6) those from workers' parties. Row (1) shows the estimate of indigenous population (as a share of 10000), row (2) shows that of indigenous population as share of total municipality population. Standard errors are clustered at the municipality level and shown in the parentheses. Significance levels: ***,**,* denote significance at the 1, 5 and 10 percent levels, respectively.

Table 2. Association between elected indigenous members and the likelihood of leftist Mayor

VARIABLES	(1) Leftonly	(2) Left+centre-left	(3) Workers' party
Elected indigenous members 2016	0.0450***	0.0482***	0.0260***
	(0.00701)	(0.00755)	(0.00656)
Intercept	0.193***	0.237***	0.163***
	(0.00327)	(0.00352)	(0.00306)
Observations	15,200	15,200	15,200
R-squared	0.003	0.003	0.001

Note: The table reports the likelihood of having a leftist mayor as function of number of elected indigenous members - columns (1)-(3) respectively show the estimates of the likelihood of having a mayor from left only, left plus centre-left and worker's party. Standard errors are clustered at the municipality level and shown in the parentheses. Significance levels: ***,**,* denote significance at the 1, 5 and 10 percent levels, respectively.

Table 3. RD robust estimates of outcomes using optimal bandwidth- <u>with covariates</u>

	Left+centre-left			Left only		
	(1)	(2)	(3)	(4)	(5)	(6)
Polynomial	Linear	Quadratic	Cubic	Linear	Quadratic	Cubic
Panel a	Area deforested in sq km (Mean: 935.7224)					
Robust	-93.862	-194.97**	-129.39	-188.17**	-2918.7***	-1268.4***
(t-stat)	(-1.5600)	(-2.1602)	(-1.5118)	(-2.1364)	(-5.3089)	(-4.1112)
Panel b	Annual change in area deforested in sq km (Mean: 17.93427)					
Robust	0.4847	2.2032	-3.7051	-1.1019	-7.4068*	-10.356*
(t-stat)	(0.5332)	(0.3827)	(-0.8924)	(-0.0872)	(-1.6370)	(-1.7255)
Panel c	Area reforested in sq km (Mean: 0.6437755)					
Robust	2.114	2.3653	2.7047	2.7066	3.4936	3.7596
(t-stat)	(0.8434)	(0.7667)	(0.7503)	(0.8898)	(0.7328)	(0.6858)
Panel d	Log(Annual environmental expenses) (Mean: 5.012348)					
Robust	1.6809***	2.0082***	2.2681***	1.7122***	2.1334***	2.0915***
(t-stat)	(3.3282)	(3.0352)	(2.6228)	(3.2778)	(2.8350)	(2.8583)
Other covs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8751	8751	8751	8751	8751	8751

The table shows the weighted RD robust estimates of area deforested (panel a), annual change in area deforested (panel b), area reforested (panel c) and also the annual environmental expenses (panel d) for close elections of leftist Mayors (various proxies) using optimal bandwidth for -0.005<winning margin>0.005. Columns (1)-(3) show estimates for left and centre left party taken together, column (4)-(6) show those for left only parties respectively using linear, quadratic and cubic polynomials. Included covariates are: population size, geographic area, 15+ illiteracy rate, male population share if it is a protected indigenous land, if receives oil royalty share and if it is an election year. Standard errors shown in parentheses. Significance levels: ***,**,* denote significance at the 1,5 and 10 percent levels, respectively.

Table 4. RD robust estimates of selected outcomes using optimal bandwidth, non-coalition cases with covariates

	Left+centre-left			Left only		
	(1)	(2)	(3)	(4)	(5)	(6)
Polynomial	Linear	Quadratic	Cubic	Linear	Quadratic	Cubic
Panel a	Area deforested in sq km (Mean: 936.4862)					
Robust	-45.294	-52.17	-1.2681	-123.66*	-519.34***	-1.7251
(t-stat)	(-0.5428)	(-0.7300)	(0.0531)	(-1.7602)	(-7.0736)	(-0.0668)
Panel b	Annual change in area deforested in sq km (Mean: 17.9351)					
Robust	5.8885	11.273**	5.6071	2.531	-3.8908	-1.3159
(t-stat)	(1.5429)	(2.0612)	(0.7436)	(0.8236)	(-0.7923)	(-0.3432)
Panel c	Area reforested in sq km (Mean: 0.642066)					
Robust	2.3531	3.3058	3.6909	3.151	4.1962	4.4577
(t-stat)	(0.9706)	(0.8576)	(0.8360)	(1.0010)	(0.8667)	(0.8589)
Panel d	Log(Annual environmental expenses) (Mean: 5.0138)					
Robust	1.3352***	1.6017**	1.6265**	1.4615**	1.7147**	1.6808**
(t-stat)	(2.5506)	(2.4798)	(2.1446)	(2.5398)	(2.2170)	(2.1363)
Other covs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6667	6667	6667	6667	6667	6667

The table shows the RD robust estimates of area deforested (panel a), annual change in area deforested (panel b), area reforested (panel c) and also the annual environmental expenses (panel d) for close elections of leftist Mayors (various proxies) using optimal bandwidth for -0.005<winning margin>0.005 after dropping the cases of coalition governments. Columns (1)-(3) show estimates for left and centre left party taken together, column (4)-(6) show those for left only parties respectively using linear, quadratic and cubic polynomials. Included covariates are: population size, geographic area, 15+ illiteracy rate, male population share if it is a protected indigenous land, if receives oil royalty share and if it is an election year. Standard errors shown in parentheses. Significance levels: ***,**,* denote significance at the 1,5 and 10 percent levels, respectively.

Table 5. Underlying Mechanisms

Panel a: Mechanism 1	(1)	(2)	(3)
VARIABLES	voteshare_leftparty	voteshare_leftonly	voteshare_workers
ln(turnout)	0.0581***	0.0521***	0.128***
	(0.00722)	(0.00449)	(0.0185)
Year dummies	Yes	Yes	Yes
Observations	13,804	14,188	14,188
R-squared	0.028	0.036	0.084
Panel b: Mechanism 2	(1)	(2)	(3)
VARIABLES	voteshare_leftparty	voteshare_leftonly	voteshare_workers
lag(lndeforested)	0.00466***	0.00495***	0.00513***
	(0.00178)	(0.00174)	(0.00174)
Intercept	0.0410***	0.0242**	0.0519***
	(0.0103)	(0.00950)	(0.0104)
Observations	14,312	14,188	14,188
R-squared	0.025	0.029	0.051

This table shows the results in favour of Mechanism 1 and Mechanism 2. Columns (1)-(3) of the upper panel show the estimates of ln(turnout) on the likelihood of having a leftist mayor while columns (1)-(3) of the bottom panel show the estimates of one period lagged value of log(deforested area) on leftist vote shares. Leftparty is a binary variable indicating if the mayor is from left and centre-left parties; leftonly is a binary variable indicating if the mayor is from left parties only while worker's party is another binary variable indicating if the mayor is from the workers' parties. These binary variables are 0 otherwise. Standard errors shown in parentheses. Significance levels: ***, **, * denote significance at the 1, 5 and 10 percent levels, respectively.

Table 6. Heterogeneous impact of left only Mayors

VARIABLES	(1)	(2) Area deforested	(3)	(4)	(5) Annual change in area deforested	(6)	(7)	(8) Ln(environmental expenses)	(9)
Polynomial	Linear	Quadratic	Cubic	Linear	Quadratic	Cubic	Linear	Quadratic	Cubic
(a) elec_year=1									
Robust	326.2**	494.0***	546.7**	-3.956	-17.11	-19.91	1.509**	2.447**	1.562
	(138.4)	(181.9)	(237.3)	(6.430)	(10.54)	(12.34)	(0.709)	(1.199)	(1.148)
Observations	6,382	6,382	6,382	6,382	6,382	6,382	6,382	6,382	6,382
(b) elec_year==0									
Robust	-99.98	48.73	-26.25	-20.40**	-17.02	-10.55	3.047**	3.841*	4.050
	(228.4)	(359.8)	(388.7)	(8.729)	(16.22)	(19.59)	(1.460)	(2.271)	(2.862)
Observations	2,369	2,369	2,369	2,369	2,369	2,369	2,369	2,369	2,369
(c) distance from transamazon highway>Q2									
Robust	-218.8**	-166.6	-178.0	-9.215	-13.49	-12.29	2.568***	2.418***	2.149*
	(104.8)	(110.2)	(133.6)	(6.764)	(9.227)	(10.87)	(0.672)	(0.923)	(1.271)
Observations	4,381	4,381	4,381	4,381	4,381	4,381	4,381	4,381	4,381
(d) distance from transamazon highway<=Q2									
Robust	646.4***	881.2***	1,025***	-0.000396	-12.79	-19.40*	1.651**	2.946**	3.783***
	(84.61)	(117.1)	(176.4)	(6.677)	(11.02)	(11.14)	(0.746)	(1.290)	(1.350)
Observations	4,370	4,370	4,370	4,370	4,370	4,370	4,370	4,370	4,370
(e) Mayor & President from same party									
Robust	187.7	215.8	-1.706	-30.38***	-36.34***	-37.21**	2.946**	2.955**	1.863
	(124.1)	(156.4)	(241.6)	(9.603)	(13.74)	(14.52)	(1.177)	(1.226)	(1.858)
Observations	976	976	976	976	976	976	976	976	976

(f) Mayor & President from different parties

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Robust	57.36	209.2	-61.60	-1.379	-28.76**	-26.47*	1.528**	3.036**	3.733**
	(112.7)	(224.8)	(194.9)	(6.434)	(14.22)	(14.73)	(0.734)	(1.427)	(1.641)
Observations	7,775	7,775	7,775	7,775	7,775	7,775	7,775	7,775	7,775
Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The table shows the RD robust estimates of area deforested, annual change in deforested area since last year and environmental expenses for close elections of left only mayors. The table shows the estimates for election year (panel a), non-election years (panel b), distance from the TransAmazon highway being greater than median (panel c), distance from the TransAmazon highway being less than or equal to median (panel d), mayor's party is aligned/non-aligned with the President's party (panel e) and mayor's party non-aligned with President's party (panel f). Columns (1)-(3) show estimates for area deforested, columns (4)-(6) show estimates for annual changed in area deforested and columns (7)-(9) show those for ln(environmental expenses) respectively using linear, quadratic and cubic polynomials . All estimates use optimal bandwidth. All regressions also include covariates: population size, geographic area, 15+ illiteracy rate, male population share if it is a protected indigenous land, if receives oil royalty share and if it is an election year (the latter is dropped in panels c and d). Standard errors shown in parentheses. Significance levels: ***, **, * denote significance at the 1, 5 and 10 percent levels, respectively.

Figure 1. Trend in the share of left-leaning Mayors

a. Trend in mean share of left & centre-left Mayors

b. Trend in mean share of left only Mayors

c. Trend in mean share of workers' party Mayors
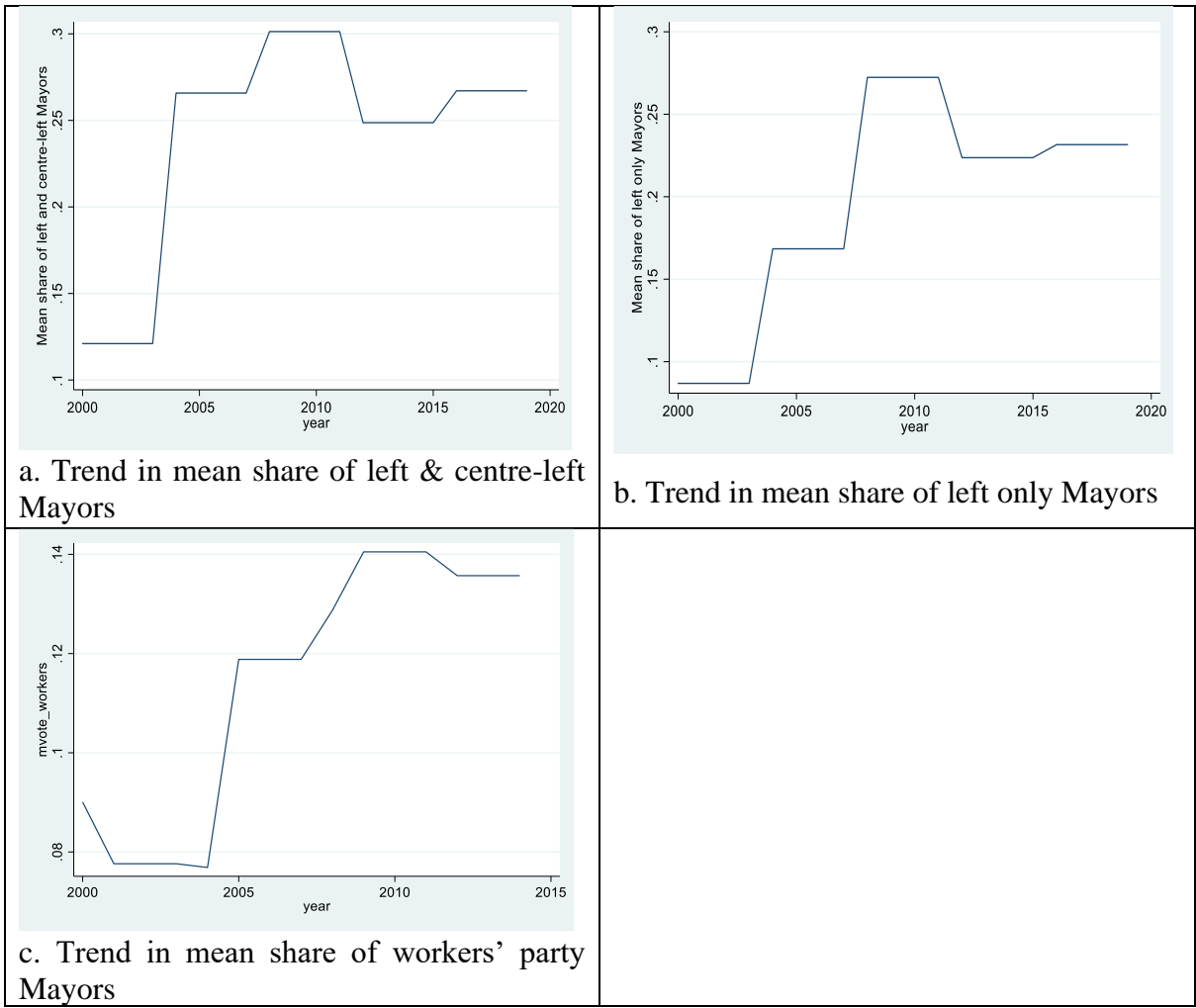
Figure 2. Trends in deforested area, change in deforested areas and environmental expenses in the Brazilian Amazon

a.   Trend in deforestation in the sample

b.   Trend in change in deforestation

c.   Trend in environmental expenses
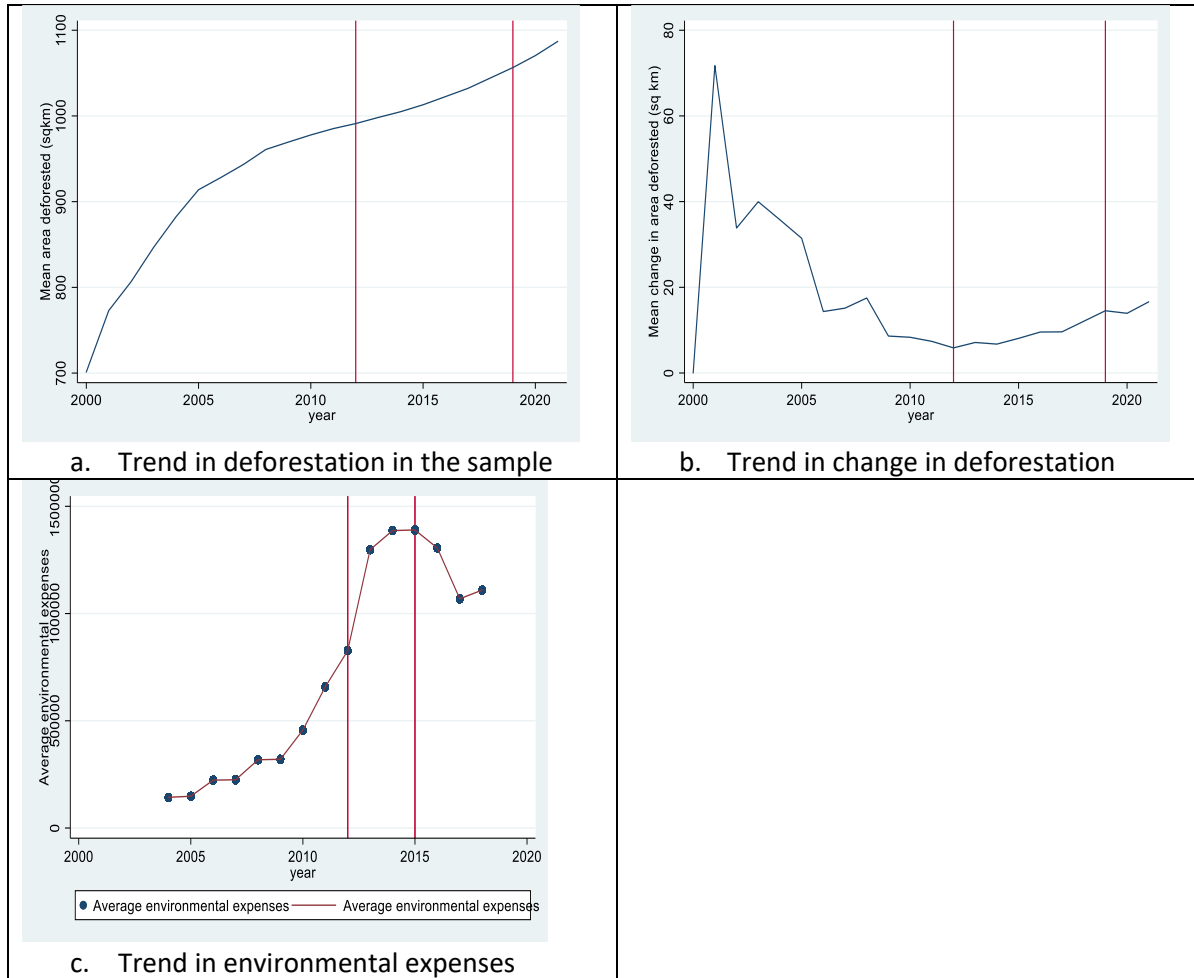
Figure 3. Distribution of leftist Mayoral winning margin, full sample

A1. Left party win margin (donut))
A2. Left only win margin (donut)
A3. Left party win margin (donut) & round
A4. Left only win margin (donut) & round
A5. Left party win margin(donut) & no coa
A6. Left only win margin(donut) & no coalitio
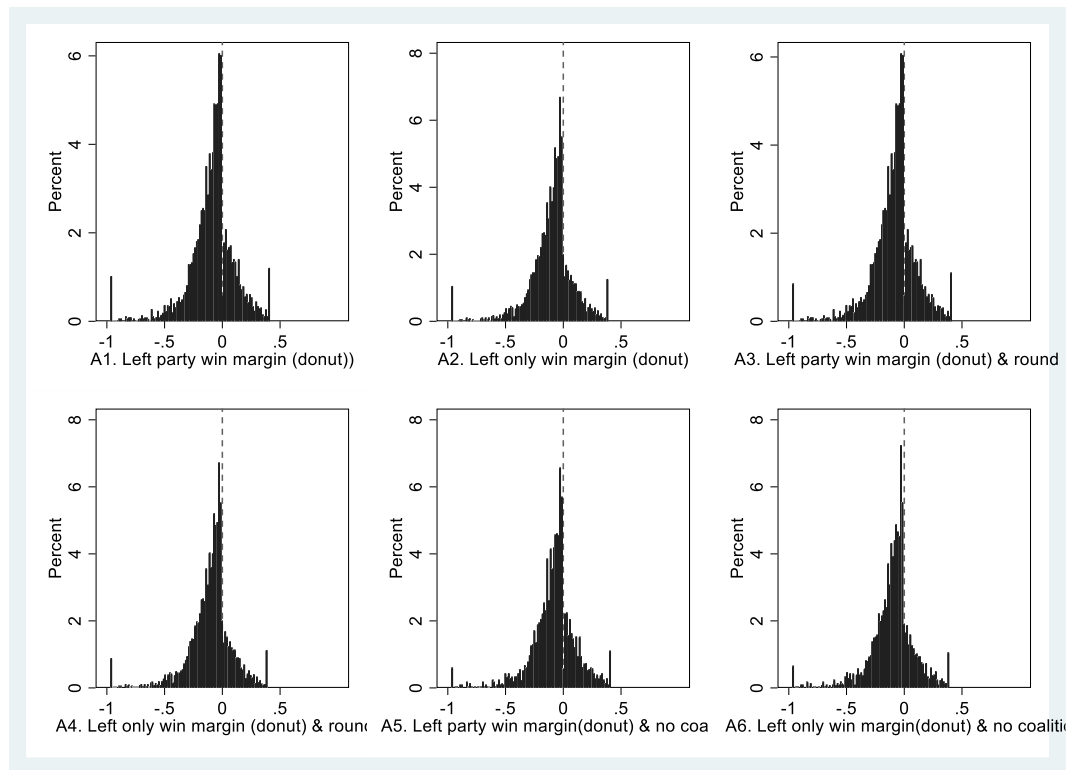
Figure 4a. RD plot of deforestation/reforestation outcomes – left only Mayors
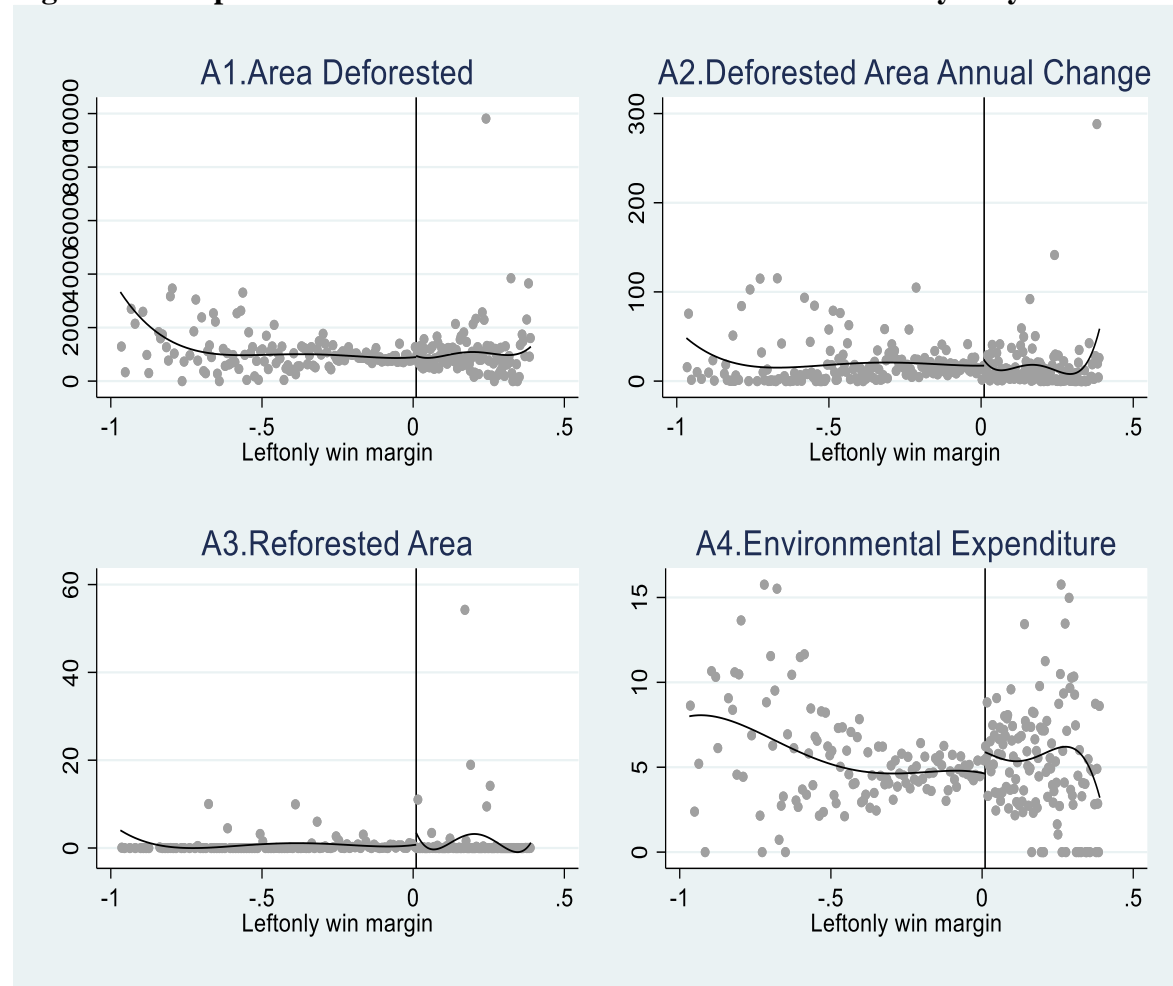
Figure 4b. RD plot of deforestation/reforestation outcomes – left plus centre-left Mayors
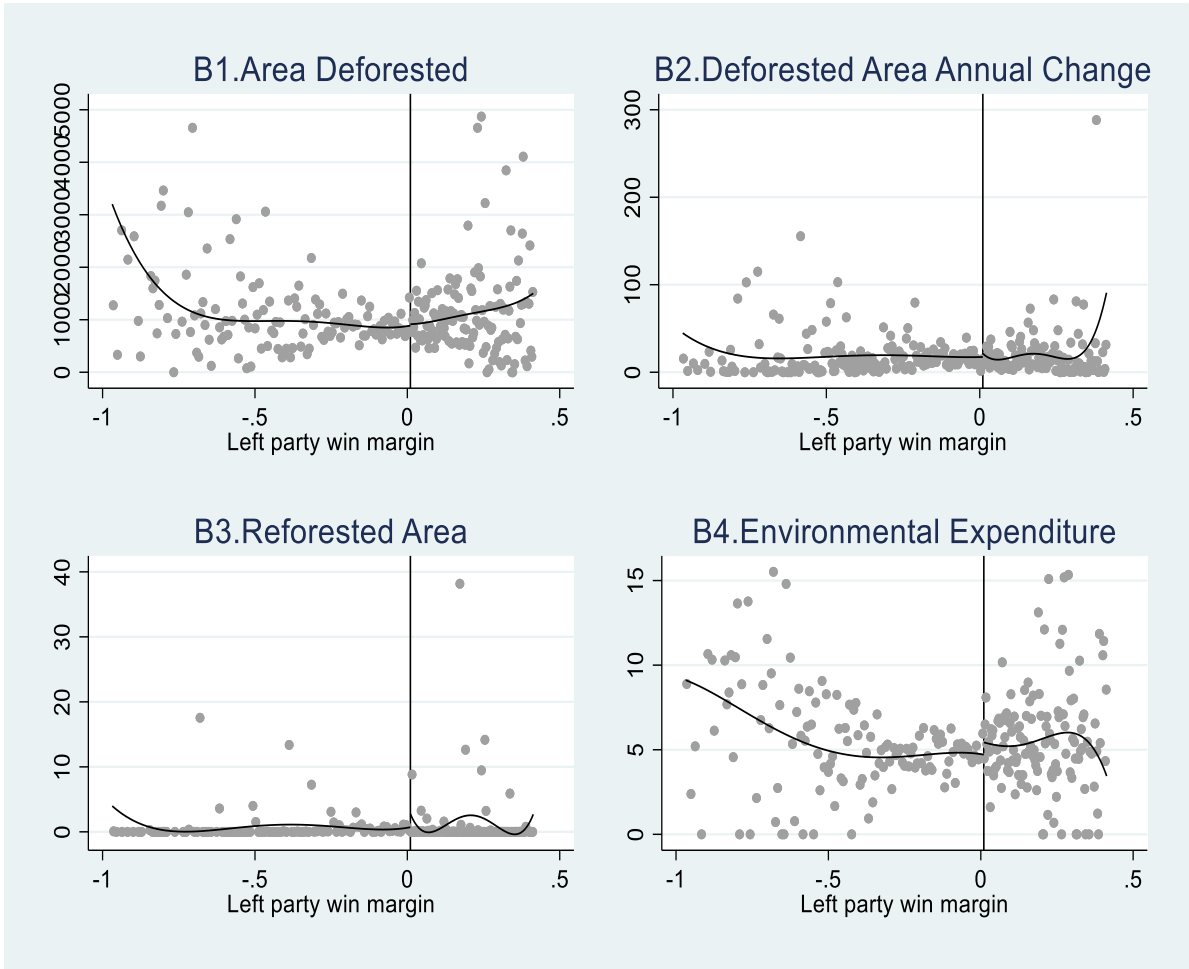
Figure 5. Political fragmentation and win margin
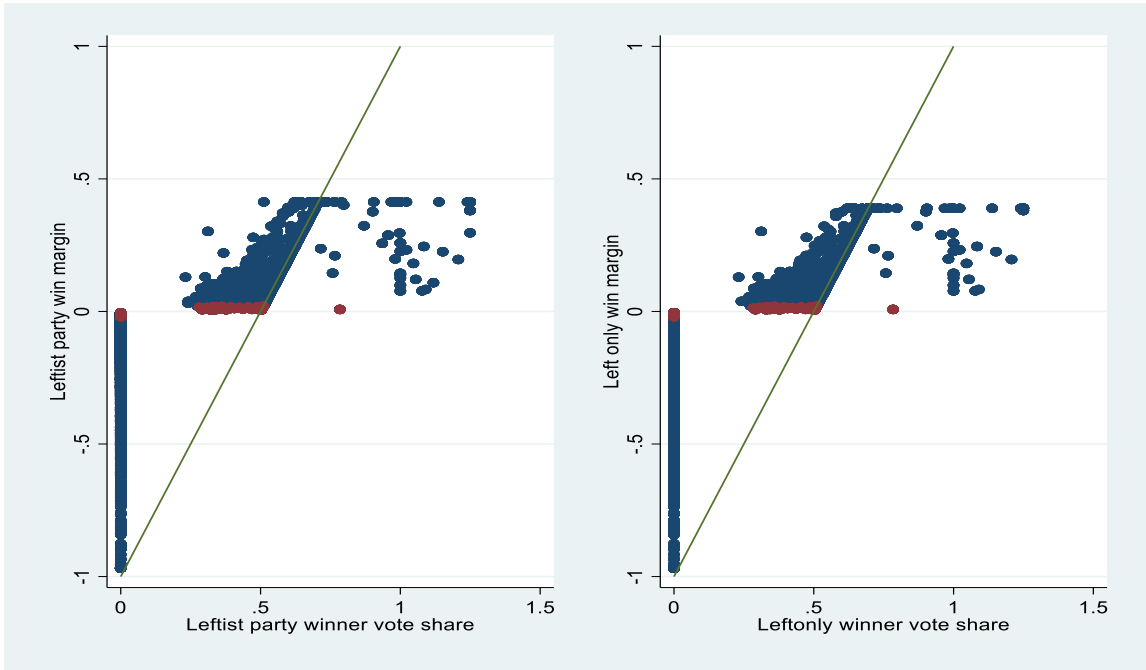
Figure 6a. Balancing of the covariates around the cut-off – left only winning margin

Figure 6b. Balancing of the covariates around the cut-off (0.01)– left plus centre-left winning margin

A. log(Population)

B. log(area in km)

C. 15+ illiteracy rate

D. Indigenous pop share

E. Male pop share

F. If receives oil royalty

G. Distance from highway

Appendix 1 – Additional results

Table A1. Data sources

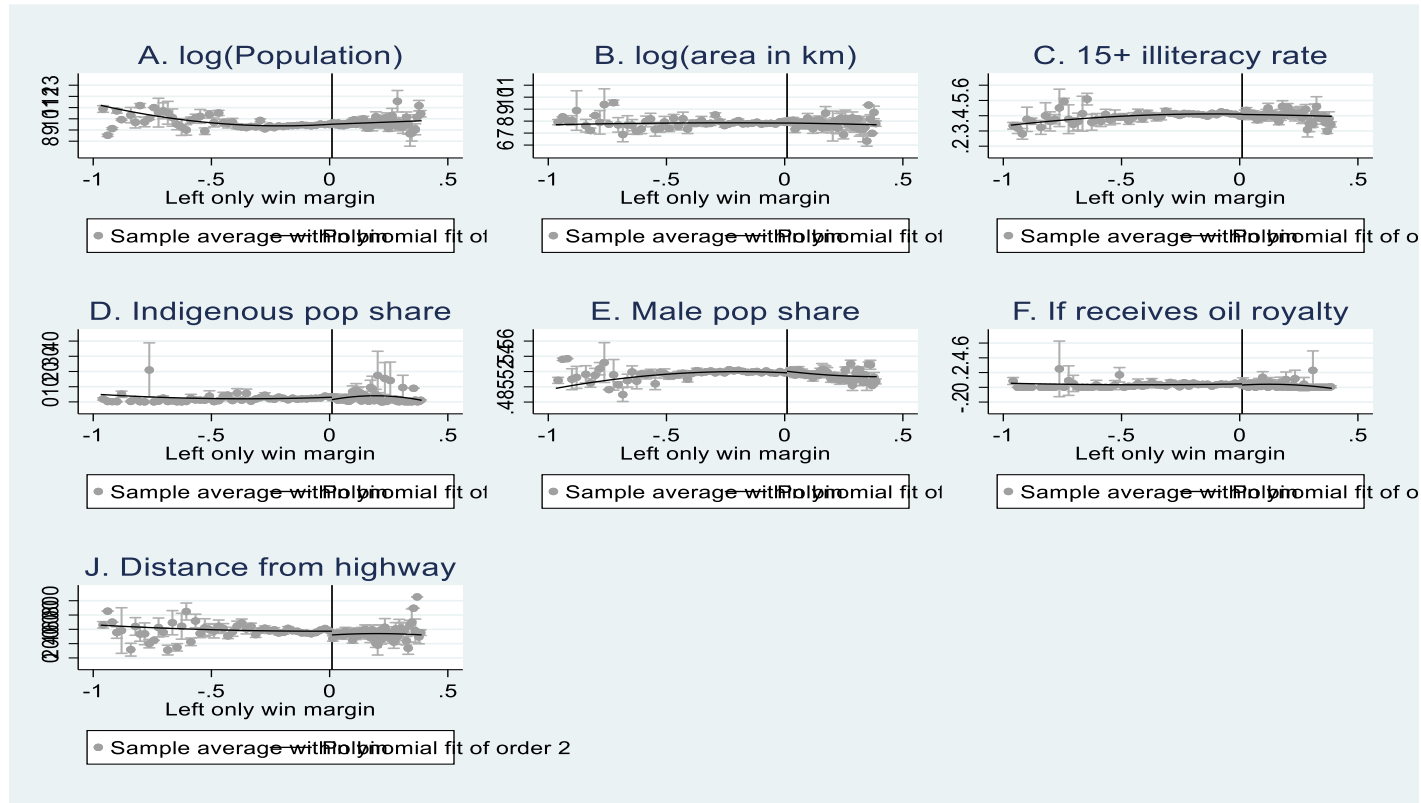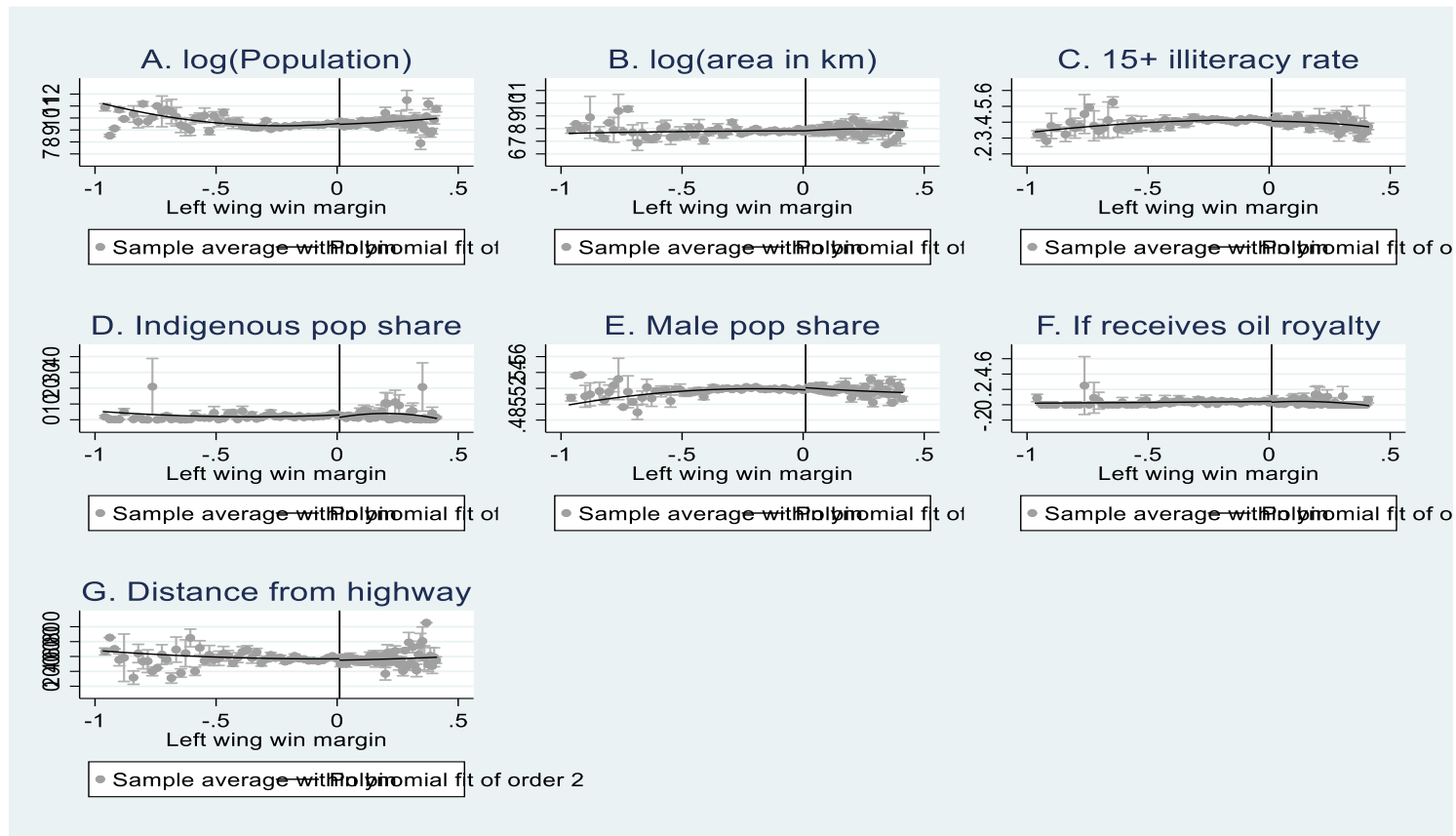| Variables	Source	Method
Deforestation	PRODES – National Institute for Space Research (INPE) https://www.gov.br/inpe	Satellite-based annual monitoring of clear-cut deforestation. High spatial resolution (6.25 ha or larger).
Deforestation	TerraClass – INPE and EMBRAPA (Almeida et al. 2016)	Biennial land use and land cover mapping within the PRODES mask, including secondary vegetation areas not captured by PRODES or DETER.
Transamazônica Highway (BR-230)	DNIT - https://www.gov.br/infraestrutura/pt-br/assuntos/dados-de-transportes/bit/bitmodosmapas#maprodo	Distance tool calculating nearest point of the municipality polygon to the highway and centroid distance to highway.
Blacklist	MMA – Ministry of the Environment https://www.gov.br/mma/pt-br/assuntos/servicosambientais/controle-de-desmatamento-e-incendios-florestais/pdf/Listagemmunicpiospriorritriosparaaesdepreveno2021.pdf	Official list of municipalities with highest deforestation rates subject to restrictions.
Elections	TSE – Superior Electoral Court https://www.tse.jus.br	Electoral data at the municipal level for elections from 1998 to 2018.
Homicides	IPEA – Atlas da Violência https://www.ipea.gov.br/atlasviolencia	Municipal-level homicide rates.
Other crime indices	SUS – National Health Service http://www2.datasus.gov.br/DATASUS/index.php?area=0205&id=1878964	Mortality and violence-related health data from DATASUS.
Conflict with Indigenous peoples	CPT – Comissão Pastoral da Terra https://www.cptnacional.org.br/downlods/category/4-areas-em-conflito	Data on land conflicts involving Indigenous peoples.
Municipality finances	Tesouro Nacional – https://www.tesourotransparente.gov.br	Financial data from 2000 to 2018 from FINBRA and SICONFI.
Demographics	IBGE Census 2000 & 2010	Population and demographic characteristics at the municipal level.

Table A2: Summary statistics of key regression variables

Variable	Obs	Mean	Std. Dev.
Area Deforested (sq km)	15,200	942.4842	1347.288
Deforested change (sq km)	15,200	17.7649	67.09414
Area reforested (sq km)	`12160	0.7625	13.0048
Environmental expenses (Real)	15,200	641481.5	4418154
Winning margin	14,148	-0.0874255	0.2058052
Leftparty (left & centre-left)	15,200	0.2407895	0.4275768
Leftonly (left only)	15,200	0.1965789	0.3974243
Workers' party	15200	0.1654605	0.3716079
Indigenous elected in 2016	3040	0.0460526	0.209606
Ln(population)	13,433	9.536831	1.102628
Ln(Size)	15,200	7.830709	1.355557
15+ illiterate rate	10,516	0.4077388	0.0877455
Indigenous pop share	15,160	2.644885	8.719648
Male pop share	15,179	0.5178572	0.0150216
Poor pop share	15,200	0.2947368	0.4559394
If has oil royalty	15,200	0.0373684	0.1896692
Distance from Transamazônica Highway	14,440	368.6225	258.1701

Note: The table shows the means and standard deviations of the key regression variables in our sample

Table A3. Comparison of municipalities governed by leftist and non-leftist Mayors

	Muni with leftist Mayor	Muni with non-leftist Mayor	T-stat
Geographic size (sq km)	7097	6533	2.1469**
Population	36099	32503	2.9015**
Indigenous population	629	459	5.0921***
Indigenous population %	2.98	2.54	2.7191**
Indigenous politician elected	0.07	0.04	6.7835***
Voter turnout	10951	10290	2.7876***
Voter turnout rate	0.57	0.55	2.2568**
Mayor turnover	0.52	0.55	2.2651**
Mayor female	0.07	0.11	- 5.5084***
Mayor graduate & more	0.44	0.41	2.5317**
Mayor from Pres. party (align)	0.18	0.11	10.2698***
Coalition govt	0.36	0.37	-1.8367
Ln(GDP)	11.6	11.3	13.0867***
GDP per capita 2000 prices	1.46	1.30	9.1706***
Receiving oil royalty	0.068	0.018	15.8639***
ISS tax revenue	3416064	2592650	1.9714*
Total tax revenue	5447116	290430	2.3374**
Exp-revenue ratio	0.70	0.75	-10.9577***
Spending on indigenous assist.	8023	4022	1.9044*
Spending on environ management	530722	325997	2.9744***

Note: In this table leftist mayors refer to mayors from left and centre-left parties. These statistics are generated from our estimation sample. ***,**,* denote significance at the 1, 5 and 10 percent levels, respectively.

Table A4. RD robust estimates of outcomes without covariates using optimal bandwidth

	Left+centre-left		Left only			
	(1)	(2)	(3)	(4)	(5)	(6)
Polynomial	Linear	Quadratic	Cubic	Linear	Quadratic	Cubic
Panel a	Area deforested in sq km (Mean: 936.4862)					
Robust	-170.57***	-620.9***	-621.48***	7.8931	-23.362	-536.69
(t-stat)	(-3.2559)	(-6.1680)	(-6.2511)	(0.0799)	(-0.6831)	(-5.6118)
Panel b	Annual change in area deforested in sq km (Mean: 17.9351)					
Robust	3.3701	-0.1453	-8.5951***	-5.6692*	-1.9114	-5.7926*
(t-stat)	(1.2903)	(-0.3059)	(-2.8566)	(1.7457)	(-0.7986)	(-1.6988)
Panel c	Area reforested in sq km (Mean: 0.642066)					
Robust	0.9165	1.1743	0.9116	1.6053	1.9068	1.9435
(t-stat)	(0.3586)	(0.4023)	(0.2515)	(0.5455)	(0.5796)	(0.5442)
Panel d	Log(Annual environmental expenses) (Mean: 5.0138)					
Robust	0.6590**	0.8395*	0.9203	1.1675***	1.3161**	1.2173**
(t-stat)	(1.9758)	(1.8385)	(1.2302)	(3.0125)	(2.3167)	(1.9769)
Other covs	No	No	No	No	No	No
Observations	12987	12987	12987	12987	12987	12987

The table shows the RD robust estimates of area deforested (panel a), annual change in area deforested (panel b), area reforested (panel c) and also the annual environmental expenses (panel d) for close elections of leftist Mayors (various proxies) using optimal bandwidth for -0.005<winning margin>0.005. Columns (1)-(3) show estimates for left and centre left party taken together, column (4)-(6) show those for left only parties respectively using linear, quadratic and cubic polynomials. Standard errors shown in parentheses. Significance levels: ***,**,* denote significance at the 1,5 and 10 percent levels, respectively.

Table A5. RD robust estimates of level outcomes with covariates, election round 1, non-coalition govts only

	Left+centre-left			Left only		
	(1)	(2)	(3)	(4)	(5)	(6)
Polynomial	Linear	Quadratic	Cubic	Linear	Quadratic	Cubic
Panel a	Area deforested in sq km (Mean: 933.209)					
Robust	-19.975	-35.908	-1.8583	-108.46	-608.84***	-3.6206
(t-stat)	(-0.1920)	(-0.5342)	(-0.0367)	(-1.4879)	(-8.1845)	(-0.0320)
Panel b	Annual change in area deforested in sq km (Mean: 19.64812)					
Robust	5.9516	10.222**	5.4853	2.9314	-3.1008	-1.5846
(t-stat)	(1.6131)	(2.1228)	(0.7206)	(0.8669)	(-0.6514)	(-0.3778)
Panel c	Area reforested in sq km (Mean: 0.4101)					
Robust	2.3742	3.2994	3.6906	3.163	4.2239	4.4633
(t-stat)	(0.9714)	(0.8591)	(0.8361)	(1.0007)	(0.8659)	(0.8595)
Panel d	Log(Annual environmental expenses) (Mean: 4.4691)					
Robust	1.3359**	1.603**	1.6175**	1.4626**	1.7152**	1.6409*
(t-stat)	(2.5490)	(2.4787)	(2.0928)	(2.5485)	(2.2168)	(1.9660)
Other covs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6643	6643	6643	6643	6643	6643

The table shows the RD robust estimates of area deforested (panel a), annual change in area deforested (panel b), area reforested (panel c) and also the annual environmental expenses (panel d) for close elections of leftist Mayors (various proxies) using optimal bandwidth for -0.005<winning margin>0.005. Columns (1)-(3) show estimates for left and centre left party taken together, column (4)-(6) show those for left only parties respectively using linear, quadratic and cubic polynomials. Covariates included are the same as in Table 4. Standard errors shown in parentheses. Significance levels: ***,**,* denote significance at the 1,5 and 10 percent levels, respectively.

Table A6. RD robust estimates of Outcomes as Shares with Covariates for Non-coalition Cases– (optimal bandwidth)

Full sample	Left+centre-left		Left only			
	(1)	(2)	(3)	(4)	(5)	(6)
Polynomial	Linear	Quadratic	Cubic	Linear	Quadratic	Cubic
Panel a	Share of Area deforested in sq km (Mean:0.35)					
Robust	-0.0337**	-0.02873	-0.03467	-0.0008	-0.0646***	-0.05858***
(t-stat)	(-2.3175)	(-1.2502)	(-1.2567)	(0.5391)	(-2.8815)	(-2.9760)
Panel b	Rate of annual change in area deforested in sq km (Mean: 0.02)					
Robust	0.0021	0.005	0.0065	0.004	0.0037	-0.0004
(t-stat)	(0.4583)	(0.5816)	(0.6628)	(0.5525)	(0.2137)	(-0.2091)
Panel c	Share of area reforested in sq km (Mean: 0.00017)					
Robust	-0.0007	-0.0008	-0.0009	-0.0005	-0.0007	-0.0008
(t-stat)	(-0.9951)	(-1.0261)	(-1.0767)	(-0.7814)	(-0.8795)	(-0.9670)
Panel d	Share of Annual environmental expenses (Mean: 0.009)					
Robust	-0.0027	-0.0032	-0.0029	-0.0017	-0.0033	-0.0043
(t-stat)	(-0.6303)	(-0.2519)	(-0.1557)	(-0.3067)	(-0.2449)	(-0.4215)
Other covs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6667	6667	6667	6667	6667	6667

The table shows the RD robust estimates of shares of area deforested (panel a), annual change in area deforested (panel b), area reforested (panel c) and also the annual environmental expenses (panel d) for close elections of leftist Mayors (various proxies) using optimal bandwidth for -0.005<winning margin>0.005 after dropping the cases of coalition governments. Columns (1)-(3) show estimates for left and centre left party taken together, column (4)-(6) show those for left only parties respectively using linear, quadratic and cubic polynomials. Included covariates are: population size, geographic area, 15+ illiteracy rate, male population share if it is a protected indigenous land, if receives oil royalty share and if it is an election year. Standard errors shown in parentheses. Significance levels: ***,**,* denote significance at the 1,5 and 10 percent levels, respectively.

Table A7. RD robust estimates of outcomes as shares with covariates for non-coalition cases, election round 1

	Left & centre-left parties			Left only parties		
	(1)	(2)	(3)	(4)	(5)	(6)
Polynomials	Linear	Quadratic	Cubic	Linear	Quadratic	Cubic
Panel a	Share of Area deforested in sq km (Mean:0.35)					
Robust	-0.0332***	-0.0287	-0.0346	-0.0008	-0.0646***	-0.0586***
	(0.012)	(0.018)	(0.021)	(0.012)	(0.022)	(0.022)
Covariates	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6,643	6,643	6,643	6,667	6,667	6,667
Panel b	Rate of annual change in area deforested in sq km (Mean: 0.02)					
Robust	0.0017	0.0050	0.0065	0.0040	0.0037	-0.0004
	(0.006)	(0.009)	(0.010)	(0.008)	(0.010)	(0.012)
Covariates	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,725	5,725	5,725	5,749	5,749	5,749
Panel c	Share of area reforested in sq km (Mean: 0.00017)					
Robust	-0.0006	-0.0008	-0.0009	-0.0005	-0.0007	-0.0008
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Covariates	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6,643	6,643	6,643	6,667	6,667	6,667
Panel d	Share of Annual environmental expenses (Mean: 0.009)					
Robust	-0.0025	-0.0037	-0.0029	-0.0017	-0.0033	-0.0043
	(0.005)	(0.008)	(0.010)	(0.007)	(0.009)	(0.010)
Covariates	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,627	4,627	4,627	4,647	4,647	4,647

The table shows the RD robust estimates of area deforested (panel a), annual change in area deforested (panel b), area reforested (panel c) and also the annual environmental expenses (panel d) for close elections of leftist Mayors (various proxies) using optimal bandwidth for -0.005<winning margin>0.005. Columns (1)-(3) show estimates for left and centre left party taken together, column (4)-(6) show those for left only parties respectively using linear, quadratic and cubic polynomials. Covariates included are the same as in Table 4. Standard errors shown in parentheses. Significance levels: ***,**,* denote significance at the 1,5 and 10 percent levels, respectively.

Table A8. RD robust estimates of selected outcomes without budget deficit (non-coalition municipalities)

|	Left+centre-left			Left only		
	(1)	(2)	(3)	(4)	(5)	(6)
Polynomial	Linear	Quadratic	Cubic	Linear	Quadratic	Cubic
Panel a	Area deforested in sq km (Mean: 936.4862)					
Robust	-49.493	-34.097	-14.015	84.9	-308.91**	-49.856
(t-stat)	(-0.5812)	(-0.0949)	(0.1143)	(-0.7471)	(-2.4124)	(-0.4640)
Panel b	Annual change in area deforested in sq km (Mean: 17.9351)					
Robust	3.2589	5.7795	6.2343	-3.0869	-4.4604	-4.1375
(t-stat)	(1.2523)	(1.3183)	(1.1048)	(-0.5248)	(-0.7705)	(-0.6986)
Panel c	Area reforested in sq km (Mean: 0.642066)					
Robust	2.5673	3.535	3.9245	3.3723	4.525	4.7679
(t-stat)	(0.9692)	(0.8440)	(0.8164)	(1.0043)	(0.8629)	(0.8564)
Panel d	Log(Annual environmental expenses) (Mean: 5.0138)					
Robust	1.1863*	1.3809*	1.4039	1.4447**	1.5677*	1.5266
(t-stat)	(1.9377)	(1.7169)	(1.3680)	(2.1726)	(1.6474)	(1.5805)
Other covs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6039	6039	6039	6039	6039	6039

The table shows the RD robust estimates of area deforested (panel a), annual change in area deforested (panel b), area reforested (panel c) and also the annual environmental expenses (panel d) for close elections of leftist mayors (various proxies) using 3% bandwidth after dropping the cases of coalition governments and governments with budget deficit. Columns (1)-(3) show estimates for left and centre left party taken together, column (4)-(6) show those for left only parties respectively using linear, quadratic and cubic polynomials. Included covariates are: population size, geographic area, 15+ illiteracy rate, male population share if it is a protected indigenous land, if receives oil royalty share and if it is an election year. Standard errors shown in parentheses. Significance levels: ***,**,* denote significance at the 1,5 and 10 percent levels, respectively.

Table A9. RD robust estimates for leftist candidates winning against right wing ones (non-coalition governments)

Panel a: Left only Mayors winning against right candidates								
Polynomials:	Linear	Quadratic	Linear	Quadratic	Linear	Quadratic	Linear	Quadratic
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	deforested	deforested	deforested_change	deforested_change	Reforested	Reforested	lenvexp	lenvexp
Robust	-197.1960	-134.5976	-1.2199	-0.2358	0.0861	0.0249	4.2498**	4.7443**
	(434.010)	(674.102)	(12.345)	(16.903)	(0.064)	(0.031)	(2.105)	(2.494)
Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	295	295	295	295	295	295	295	295
Panel b: Left plus centre left Mayors winning against right-wing candidates								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	deforested	deforested	deforested_change	deforested_change	Reforested	Reforested	lenvexp	lenvexp
Robust	-174.1610	-254.2857	12.3247	11.0453	0.0071	0.0104	0.5000	1.0616
	(291.504)	(464.695)	(9.059)	(12.344)	(0.012)	(0.014)	(1.616)	(2.892)
Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	532	532	532	532	532	532	532	532

The table shows the weighted RD robust estimates of all outcome variables, area deforested in columns 1-2, annual change in area deforested in columns 3-4, area reforested in columns 5-6 and ln(environmental expenses) in columns 7-8 in close elections of leftist Mayors winning against right-wing ones and vice-versa. We show estimates using linear and quadratic polynomials and optimal bandwidth. Panel a shows the estimates for left only Mayors while the panel b shows those for left and centre left Mayors. All regressions include covariates: population size, geographic area, 15+ illiteracy rate, male population share if it is a protected indigenous land and if receives oil royalty share and if it is an election year. Standard errors shown in parentheses. Significance levels: ***, **, * denote significance at the 1, 5 and 10 percent levels, respectively.

Figure A1. Association between indigenous population, deforested area and leftist vote share - Binscatter plots of outcomes
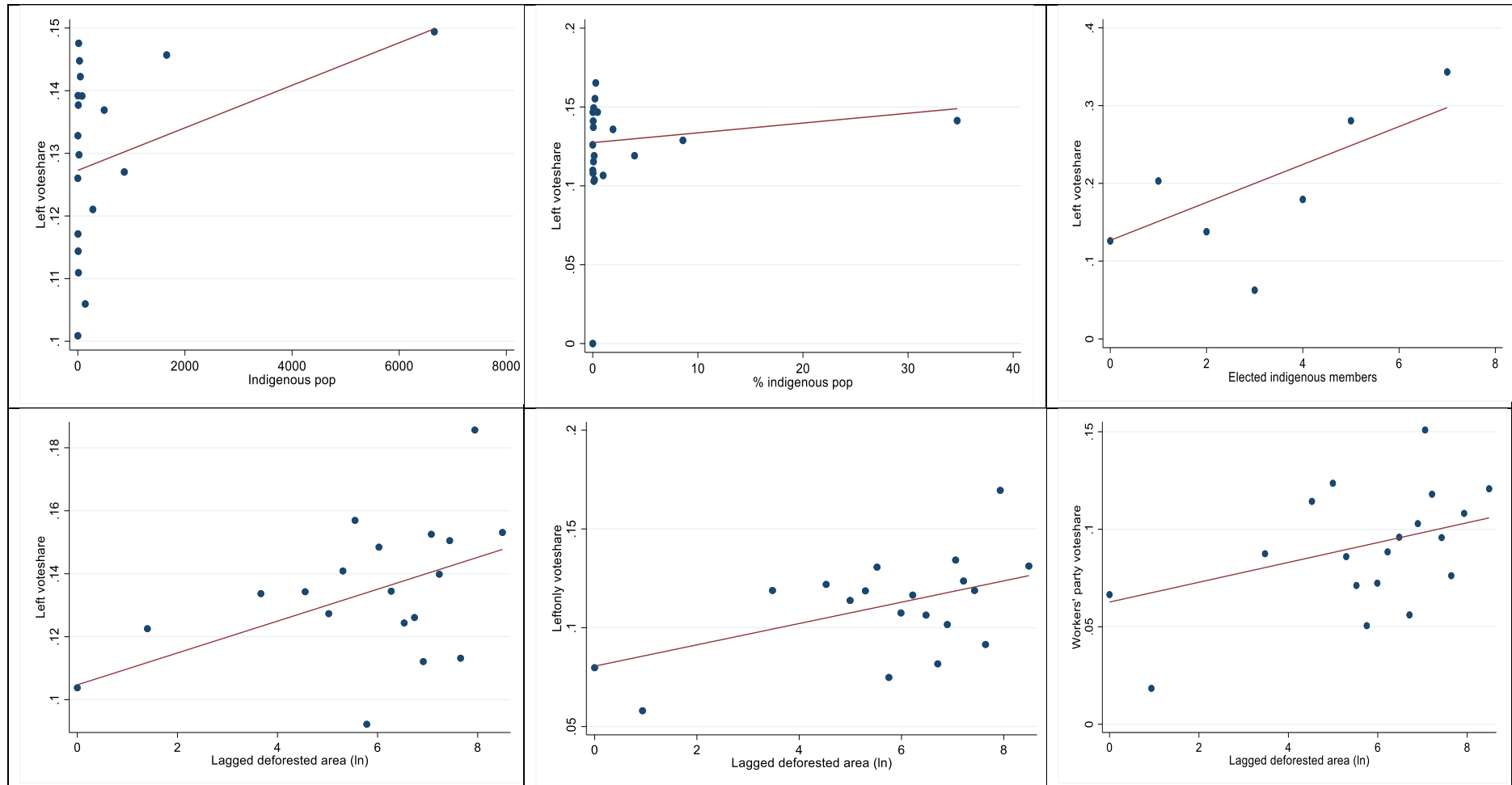
Appendix 2. Additional Materials

Table A2.1. - Classification of party ideology

					Party ideology	
Party Anacronym	*Full Name*	*Originated from previous party*	*Year of creation/Year of official registration*	*Details*	*BBC Brasil*	*Bolognesi et al. 2023*
PL	Partido Liberal		2005/2006	2006	Right	NC
PATRIOTA	Patriota		2011/2012	2012	Right	Extreme-Right
PODE	Podemos	Partido Trabalhista Nacional (PTN)	1995/1995	1995	Right	Right
PP	Progressistas	Partido Progressista (PP)	2017/2017	Changes in the party name: Partido Progressista Brasileiro (PPB) 1995–2003; Partido Progressista (PP) 2003–2017; and Progressistas (PP) 2017–present	Right	Extreme-Right
PRTB	Partido Renovador Trabalhista Brasileiro		1990/1997		Right	Right
PSC	Partido Social Cristão		1985/1990		From Right to Extreme Right	Right
PTB	Partido Trabalhista Brasileiro		1979/1981	It incorporated PSD (Partido Social Democrático) in 2002 and PAN (Partido dos Aposentados da Nação) in 2007.	From Right to Extreme-Right	Centre-Right
PTC	Partido Trabalhista Cristão		1989/1989		Right	Right

DEM	Democratas	PFL (Partido da Frente Liberal). Changed its name to DEM in 2007.	1985/1986	In 2021 DEM split and generated PDS (Partido Democrático Social) and UB (União Brasil) joint to PSL (Partido Social Liberal)	Centre-Right	Extreme-Right
Republicanos	Republicanos	Partido Municipalista Renovador (PMR)	2003/2005	Partido Municipalista Renovador (PMR) had its name changed to Partido Republicano Brasileiro (PRB) in 2005 and to Republicanos in 2019	From Centre-Right to Right	NC
PPB (also PP)	Partido Progressista Brasileiro		1995/1995	In 2003 it was extinct to generate Partido Progressista (PP)	Right	Extreme-Right
PR	Partido Liberal	Partido de Reedificação da Ordem Nacional (PRONA) and Partido Liberal (PL)	2006/2006	It was generated by the merger of PRONA and PL	From Right to Extreme Right	Right
PRB	Partido Republicano Brasileiro	Partido Municipalista Renovador (PMR)	2005/2005	In 2019 had its name changed to Republicanos (Republicanos)	From Centre-Right to Right	Right
PSL	Partido Social Liberal		1994/1998	Extinct in 2022. Bolsonaro was elected in 2019 by this party	From Right to Extreme Right	Right
PSDB	Partido da Social Democracia Brasileira	-	1988/1989	Created from a dissidence from the Partido do Movimento Democrático Brasileiro (PMDB)	From Centre to Centre-Right	Right
PMB	Partido da Mulher Brasileira		2008/2015	It was renamed to Brasil 35 in 2021	Centre-Right	Right
PSD	Partido Social Democrático	-	2011/2011		Centre	Right
DC	Democracia Cristã	-	1995/1997	Party connected to religion	From Centre to Centre-Right	Right

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PRP	Partido Republicano Progressista	-	1989/1991	Party finished in 2019	Centre-Right	Right
PT	Partido dos Trabalhadores	-	1980/1982	Party of the former president Lula	From Centre-Left to Left	Left
PCB	Partido Comunista Brasileiro	-	1993/1996		Extreme-Left	Extreme-Left
PC do B	Partido Comunista do Brasil	Created from Partido Comunista (PC) dissidents	1962-1988		From Centre-Left to Left	Left
PCO	Partido da Causa Operária	Created from Partido dos Trabalhadores (PT) dissidents	1995/1997		Extreme-Left	Extreme-Left
PDT	Partido Democrático Trabalhista		1979/1981		From Centre-Left to Left	Centre-Left
PMN	Partido da Mobilização Nacional		1984/1990		Centre-Left	Centre-Right
PSB	Partido Socialista Brasileiro		1985/1988		Centre-Left	Centre-Left
PSOL	Partido Socialismo e Liberdade	Created from Partido dos Trabalhadores (PT) dissidents	2004/2005		From Left to Extreme-Left	Left
PSTU	Partido Socialista dos Trabalhadores Unificado	Created from Partido dos Trabalhadores (PT) dissidents	1994/1995		Extreme-Left	Extreme-Left
PV	Partido Verde		1986/1993		Centre-Left	Centre-Left
AVANTE	Avante	Created from Partido Trabalhista Brasileiro (PTB) dissidents	1989/2004	The original name of the party was Partido Trabalhista do Brasil (PTdoB). Changed to AVANTE in 2017	Centre-Left	Centre-Left
CIDADANIA (also PPS)	Cidadania		1992/1992	Initital name was Partido Popular Socialista (PPS), changed to Cidadania in 2019	Centre-Left	Centre-Left
PROS	Partido Republicano da Ordem Social		2010/2013		Centre-Left	NC
SOLIDARIEDADE (also SDD)	Solidariedade		2012/2013		Centre-Left	Right

PPS (also CIDADANIA)	Partido Popular Socialista		1992/1992	Former name of the current Cidadania	Centre-Left	Centre-Left
REDE	Rede Sustentabilidade		2013/2015	Marina Silva is the founder	From Centre-Left to Centre-Right	Centre-Left
PMDB	Partido do Movimento Democrático Brasileiro	Partido do Movimento Democrático Brasileiro (PMDB) of 1966-1979	1980/1981	Changed its name to MDB in 2017	Centre	NC
MDB	Movimento Democrático Brasileiro	Partido Movimento Democrático Brasileiro (PMDB of 1980-2017)	1980/1981	Named PMDB until 2017	Centre	Centre-Left
PTB	Partido Trabalhista Brasileiro		1979/1981	It incorporated PSD (Partido Social Democrático) in 2002 and PAN (Partido dos Aposentados da Nação) in 2007.	From Right to Extreme-Right	Centre-Left

Note: NC stands for no classification. Source: BBC Brasil and Bolognesi et al. (2023)

Appendix 2 (continued): RD Robust estimates

We assume that the treatment assignment, m_{it}, for the i-th municipality in t-th election year is determined solely based on a cut-off score, c, on an observed forcing variable, x_i. We take the forcing variable x to be the winning margin for a leftist mayor relative to a non-leftist one; the cut-off is c = 0.01 as we consider close elections after excluding the central observations in the neighbourhood {-0.005, 0.005}. The municipalities that fall below the cut-off (c = 0.01), constitute the control group (m_i =0) that elects a non-leftist mayor who ran against a leftist mayoral candidate. Those above the cut-off, the treatment group ($m_i = 1$), elect a leftist mayor who ran against a non-leftist candidate. The assignment follows a known deterministic rule, m_i = 1 {$x_i \geq$ c}, where 1{•} is the indicator function. Accordingly, we consider the following specification for estimating the fuzzy RD estimates of the selected outcomes Y_{it} of the i-th municipality in t-th election cycle in response to the treatment m:

(Equation 1) $Y_i = \alpha \beta m_i + f(x_i) + \varepsilon_i \ \forall \ x_i \ \varepsilon \ (c - h, c + h)$

where Y_i is the selected outcome in question, m_i is the treatment (when a leftist mayoral candidate wins against a right-wing candidate), x_i is the forcing variable (i.e., winning margin), and h is the neighbourhood around the cut-off c of the forcing variable x, referred to as the bandwidth in the literature. We use the optimal bandwidth to indicate close elections, as commonly used in existing literature. The control function $f(x_i)$ is some continuous function, usually, a n-th degree polynomial in the forcing variable on each side – we consider linear, quadratic and cubic polynomials in our regressions.