Eco-annoying or unscrupulous ruralist? The role of parties ideology on deforestation in the Amazon[1]

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Abstract

There are a lot of discussion around the role of ideology on environmental conservation. Anecdotal evidence has been presented to show that left-wing politicians worries more about the environment and right-wing politicians concerns more about economic growth. This paper uses RDD in the margin of victory of Brazilian mayors to calculate the impact of mayor parties ideology on deforestation in the Amazon. Results show that left-wing Mayors do not have any effect on deforestation in the Amazon when compared with non left-wing mayors. Deforestation is smaller in left-wing mayor municipalities, but this correlation is completely driven by voter preferences. When the election is close, deforestation is the same regardless the mayor ideology.

Key words: Ideology, deforestation, parties.

Há muita discussão em torno do papel da ideologia na conservação ambiental. Evidências anedóticas são em geral apresentadas para mostrar que os políticos de esquerda se preocupam mais com o meio ambiente e os políticos de direita se preocupam mais com o crescimento econômico. Este trabalho utiliza o método de Regressão Descontínua na margem de vitória dos prefeitos brasileiros para calcular o impacto da ideologia dos partidos do prefeito sobre o desmatamento na Amazônia. Os resultados mostram que prefeitos de esquerda não têm nenhum efeito sobre o desmatamento na Amazônia quando comparados com prefeitos que não são de esquerda. O desmatamento é menor nos municípios onde o prefeito é de esquerda, mas essa correlação é totalmente impulsionada pelas preferências dos eleitores. Quando a eleição é apertada, o desmatamento é o mesmo, independentemente da ideologia do prefeito.

Palavras-Chave: Ideologia, desmatamento, partidos.

JEL codes: Q14, Q23, Q28.

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1. Introduction

Deforestation in the tropics has been one of the hottest topics in the environmental economics literature. According to FAO (2020), the global vegetation cover rate reduced annually by 5.17 and 4.74 million hectares between 2000 and 2010 and between 2010 and 2020, respectively. However, the loss of vegetation cover is not homogeneous. South America and Africa were by far the ones that had the greatest loss in these two decades. Specifically, South America lost more than 5 million hectares per year of vegetation cover between 2000 and 2010 and about 2.6 million hectares per year between 2010 and 2020 (FAO, 2020; Forgas and Jolliffe, 1994).

In Brazil, deforestation was high in the beginning of the 2000s, but it had an important reduction since 2005, with the policies linked to a great plan to combat deforestation implemented by the federal government. As of the mid-2010s, deforestation began to escalate again and became a major concern for environmental specialists.

Several studies have investigated the reasons for the reduction in deforestation and the subsequent reversal of this reduction. Federal conservation policies (Assunção and Rocha, 2019; Assunção et al., 2020, 2022), reduction in agricultural commodity prices (Assunção et al., 2015), market arrangements such as the soy moratorium and the G4 agreement of slaughterhouses (Moffette et al., 2021) were identified as some of the drivers for reducing deforestation between 2005 and 2012.

The relaxations foreseen in a new forest code that was approved in the national congress in 2012 (Sant'Anna and Costa, 2021) and the dismantling of some environmental policies by federal governments of the center-right and extreme right (Abreu et al., 2022; Burgess et al., 2019) have been pointed out as responsible for the recent increases.

These studies investigate centralized policies, whether from the federal government or from companies that have national operations. On the other hand, they do not focus on the possible effects of local actors, whether public or private. Recent studies have discussed the role of local politicians and politics on deforestation in the Amazon. Mayor reelection incentives (Abman, 2014; Pailler, 2018), state, federal and municipal electoral years (Ruggiero et al., 2021), and mayors previous profession (Bragança and Dahis, 2021) has been showed important aspects to explain deforestation. Particularly, using regression discontinuity design, Bragança and Dahis (2021) show that mayors whose original profession was related to agriculture, increased deforestation in the Amazon until 2004. However, from 2004 onwards, with the creation of the satellite deforestation monitoring system, DETER, which was a centralized system controlled by the federal government, the agricultural mayors no longer have any effect on deforestation.

Therefore, having been stablished that local politicians and politics can affect deforestation in the Amazon, this paper contributes to this literature investigating the effect of mayors ideology on deforestation. We use regression discontinuity design to analyze whether municipalities governed by left-wing mayors deforest less than muncicipalities governed by non left-wing parties. We found that the mayor's ideology is indeed correlated with deforestation, but that correlation disappears when discontinuous regression is used. This suggests that the correlation comes from voter preferences and not from the ideology of the elected mayors themselves. Following Bragança and Dahis (2021), we also break the sample into before and after DETER, to understand if the result holds when we use in the sample only the years before the creation of the system that largely federalized monitoring against deforestation. We find that even before the creation of DETER, mayors' ideology does not

affect deforestation. We also investigate the impact of mayors' ideology on variables such as public credit, enforcement and agricultural GDP. Mayors' ideology does not affect these variables either.

Our paper is linked to the literature that discusses the ideological correlation with pro-environmental policies. Usually, the studies in this area show that left-wing people have higher willingness to pay (WTP) for environmental public policies than right-wing individuals. The idea is that compared to the rightist counterparts left-wing individuals are more supportive to government interference in general, including the interference on environmental issues. Right-wing viewers are more in favour of market based solutions for the environmental problems, and than, less supportive to policies such as the increase in taxes to control pollution, policies to environmental protection and obligations that increase industrial costs, for example (Hammar and Jagers, 2006; Harring and Jagers, 2013; Jagers et al., 2017; McCright et al., 2016b; Neumayer, 2004). They also find a correlation between environmental concerns and ideological spectrum, with leftist answering to be worrier with the environment (Dunlap et al., 2001; Hamilton and Saito, 2015; McCright et al., 2016a).

However, recent studies have shown that the fact that leftists are more pro-environmental policies depends on country characteristics. In fact in developed countries and in countries with high quality of government, the correlation holds. However, these studies point out that in less developed countries (Nawrotzki, 2012), in countries characterized by poor environmental quality (Nawrotzki, 2012), by the lack of trust in the government (Fairbrother, 2016), and by poor quality of government (Davidovic et al., 2020), the conservatives could be more supportive to environmental policies than the liberal and the leftists. The idea is that people with equalitarian view usually are supportive to increase taxes to receive more benefits, but if individuals have doubts about the government's effectiveness in transferring these benefits, they would become less supportive of this type of policy. In this case, they could become even less supportive than the conservatives, because they would have to pay to the increase in taxes (and have a worse financial condition to bear these costs) and have nothing back.

The literature cited above discusses the correlation between voters or individuals preferences and support to environmental policies. However, is the politicians ideology also important? Or politicians action only reflect voters preferences? The literature assumes that the competition to votes could make politicians only reflect the demand of voters preference (Downs, 1957), or, in the other hand, voters only choose political platforms already establisehd (Alesina, 1988). In any case, places with the same political preferences would see political convergence (either because voters do not affect the political choices of elected officials, or because elected officials only express voters' preferences in their policies). Some effort has been made to find the correlation between politicians ideology and pro-environmental policies, with mixed results. Leftists national leaders are pointed out to be working to pro-environmental international agreements (Bohmelt, 2022), to not have any effect on policies related to renewable energy (Thonig et al., 2021) and to be against command and control policies that could result in a negative relationship between leftists government and stringency in environmental policies (Tawiah, 2022).

The literature cited in the above paragraph does not worried much on causal impact. The papers are not concerned with where the correlation between ideology and pro-environment policies comes from, whether from the politicians' own ideology, whether from voters' demands or from other variables that are correlated with both things at the same time.

The advantage of RDD regressions on the margin of victory, like ours, is that you can

campare very similar places in terms of preferences and other characteristics and identify if there is an impact of the politician ideology and the outcome of interest. Then, our paper is also linked to the literature that investigates the effects of mayors characteristics on various socio-economic variables. This literature studies how traits such as gender (Chattopadhyay and Duflo, 2004; Beaman et al., 2009; Brollo and Troiano, 2016), ethnicity (Franck and Rainer, 2012), ideology (Gouvea and Girardi, 2021; Pettersson-Lidbom, 2008; Ferreira and Gyourko, 2009), religion (Meyersson, 2014), age (Alesina et al., 2018), education (Besley et al., 2011), and previous profession (Bragança and Dahis, 2021) affect choices related to public policies.

Particularly important to our case, Pettersson-Lidbom (2008) estimates the causal effect of party ideology on economic outcomes (government spending, taxes, unemployment) in Sweden. They find that left-wing parties spend more, tax more, and employ more than right-wing local governments. On the other hand, Ferreira and Gyourko (2009) estimate the causal effect of Democratic mayor being elected in the United States on outcomes such as government size, public spending etc. The paper finds no evidence of a difference between Democrats and Republicans at the municipal level , with respect to none of these outcomes, arguing that a possible explanation would be the fact that the party logic in economic policies could theoretically be different at the municipal level than at more aggregated levels (regional, state, federal), since cities could have more homogeneous constituencies and, therefore, not differ so much in this regard. Finally, Gouvea and Girardi (2021) show that Brazilian mayor's ideology does not affect the size of the government, but in some cases, could affect the composition of the expenditure, with a grater fraction coming for social expenditures. Our paper contributes to this literature showing the impact of mayor ideology on another dimension, environmental policies and deforestation in Brazilian Amazon.

The rest of this paper is organized in the following way: Section 2 discusses the Brazilian deforestation context and defines our aggregation of left parties; Section 3 presents the data used in the paper; Section 4 describes the methodology used to identify the causal impact of mayor ideology on deforestation; Section 5 presents the results and discusses the interpretation and possible reasons for the lack of the effect of ideology on deforestation; finally, Section 7 concludes the paper.

2. Institutional Context

2.1. Deforestation and Conservation Policies in Brazil

In 1965, first year of military dictatorship government, which would persist until 1985, Brazil released its first completed forest code. The law reserved 50% of land located at private property for forest conservation in the North and Midwest regions, where is located the Amazon forest. However, the time of military government was also the time of the colonization plans, that aimed to populate the most remote regions of the country, including the Amazon region. Some incentives to that were created, such as the construction of roads, hydro-power plants,credit to agricultural production, and land title to occupied and deforest plots. There existed few or none structure to enforce the legislation mentioned above.

In the mid of the 1980s some institutions to protect the environment started to appear. It was created the Ministry of Environment (MMA) and the Natural Resources and Environmental Brazilian Institute (IBAMA), which is the equivalent to the Environmental Protection Agency (EPA) in US. In the future decade, conservation policies were a more frequent concern, and a series of laws were enacted, including the one that increased to 80% the land within private

property that has to be preserved in the Amazon Biome. Some improvement on the instruments to sanction and impose penalties to farmers that committed environmental infractions also takes place.

However, the incentives to deforest the Amazon were still large and deforestation climb until the beginning of the 2000's. The lack of coordination and tools to effectively monitoring and applied sanctions avoid the legislation to be, in fact, accomplished. In 2004, year in which deforestation reached 27 thousand square kilometres, the Brazilian Federal Government launched the Action Plan for the Prevention and Control of Deforestation in the Legal Amazon (PPCDAM). The plan was an integrated policy, a joint effort of several ministries to prevent and combat deforestation in the Amazon. The first phase of the PPCDAM had as its major innovation, the creation of the DETER, a monitoring system based on satellite geo-referenced images that were sent to Ibama in daily base by the Spacial Research National Institute (INPE). With the posse of these images, IBAMA was able to carry out mega operations in partnership with the federal police and federal highway police to monitoring and sanction farmers engaged in illegal activities, seize and in some cases destroy agricultural instruments, apply administrative fines, embargoed private areas and national ids, and in mostly serious cases, arrest the farmer who committed some environmental crime.

This innovation in the monitoring system of deforestation in the Amazon was really a revolution. What used to depend on voluntary reports and constant inspection in territories where there was suspicion that deforestation could be happening, was now done quickly and with precision and prior knowledge of the location of illegal activities. Assunção et al. (2022) show that deforestation was 60% smaller than would be in the absence of the DETER between 2007 and 2016.

Another type of policy implemented by the PPCDAM was the creation of many forest protected areas, such as Conservation Units managed by federal, state, or municipal governments, and the demarcation of indigenous lands, which created some barrier to the expansion of deforestation and land used to agricultural production (Gandour, 2018).

In the second phase of PPCDAM, which began in 2008, two other policies were implemented. First, Resolution 3,545 from Brazilian Central Bank establishes that only farmers complying with environmental legislation could have access to subsidized rural credit in the Amazon Biome. Second, the Federal Government released a decree establishing a list of municipalities where the combat to deforestation should be targeted, which become know as the priority municipalities. Assunção et al. (2020) and Assunção and Rocha (2019) have shown that these policies were also very important to reduce deforestation in the Amazon after 2008.

Since 2012, deforestation has increased again in the Amazon and some studies have concentrated on the reasons for this climb. The relaxation of legal reserve requirements and permanent protection areas in the new forest code (Sant'Anna and Costa, 2021) and right-wing federal governments less concerned with environmental conservation have been pointed out as some of the reasons for this increase (Abreu et al., 2022; Burgess et al., 2019).

Our work contributes to these finds calculating the causal impact of local left-wing governments on deforestation in the Amazon.

2.2. Electoral Brazilian System and the Ideology Classification

Elections in Brazil are held every two years. The terms are for four years, but Brazil intersperses federal and state elections (which are held jointly) and municipal elections (held two years after federal and state elections). Municipal elections are held every 4 years. In

municipalities with more than 200,000 voters, they are held in two rounds and in municipalities with less than 200,000 voters in just one round. We use only municipalities with one round elections.

The municipality is the smaller Brazilian administrative jurisdiction. Although the mayor is not directly responsible to monitoring deforestation, the mayor can affect deforestation for example by using his influence to facilitate the possession of environmental permits, to resolve administrative and judicial problems over land disputes and to facilitate public credit, through the use of public banks. The mayor can also make deforestation more difficult by working together with IBAMA in the monitoring and application of sanctions for illegal activities.

To define the political-ideological orientation of the mayor in Brazil, we use a sort of articles that classify these ideologies in some groups. Defining ideological orientation in Brazil is a challenge, because, unlike other countries where there are few parties and often these parties have better defined political orientations, Brazil aggregates a large number of parties that have been changing and, sometimes, changing its name or becoming extinct. There are a set of articles that provide a ideological classification dealing with several years and different orientation scales. Tarouco and Madeira (2013), for example, classifies parties as Left, Center and Right, while Mainwaring et al. (2000) classify them as Left, Center-Left, Center, Center-Right and Right. There are also articles such as Zucco and Power (2009) that classify parties on a scale from 1 to 10. To obtain a final classification, data were aggregated in Center, Right and Left and parties defined as an aggregate of articles. It should be noted that the articles did not differ in classification when considering the same parties, but no article encompassed all Brazilian parties.

It was consider leftist the following parties: PCB/PPS, PCdoB, PDT, PMN, PSB, PSOL, PT, REDE, and PV.

3. Data

The main data source used in this paper comes from the Brazilian Electoral Superior Court (TSE). The database provides information about all mayor elections (which happen each four year) from 2000 to 2016. It brings information about candidate characteristics, such as party, sex, race, education and about election outcomes of first and second rounds, such as vote percentages, winners and losers. In Brazil, few municipalities have second round (only the ones with population larger than 200 thousand voters). We construct our database keeping municipalities with less than 200 thousand voters and elections with a left wing party won and a non-left wing party achieved the second place or a non-left wing party won and a left wing party achieved the second place.

Another important data source used in this paper is the deforestation database. We use satellite processed PRODES deforestation data from Spacial Research National Institute (INPE) from 2001 to 2020. PRODES is a INPE project that processes satellite deforestation data in the Legal Amazon since 2001. Is the more reliable deforestation data in the country.

We also test the influence of politicians ideology on different type of policies that could impact deforestation. To do that, we use credit data from the Brazilian Central Bank. This database provides information about rural credit by municipality from 2001 to 2020 (value and number of contracts). It has information separated by the finality of the credit (for example separating credit for cattle and for crop production and also for investment, operational use and commercialization). Previous research has shown that command and control policies are very

important do combat deforestation (Assunção et al., 2015, 2022). We use data from Brazilian Institute of Environment and Natural Resources (IBAMA) on issued fines for environmental infractions to identify the effect of mayor ideology on the number of fines applied by the Amazon municipalities. IBAMA also provides data about the private land that is embargoed by the agency in consequence of some environmental infraction. We use this data to test another possible effect of ideology on monitoring policies. Data from IBAMA is from 2001 to 2020. Gandour (2018) shows that protected areas serve as a barrier to deforestation spread. We use data from Ministry of Environment with information about the area covered by protected areas in each municipality from 2001 to 2020.

Finally, we use data from National Bureau of Geography and Statistics (IBGE) to test the validity of our RDD regressions. We get information about population from 2000 to 2020, as well as information about municipalities GDP and municipality agricultural GDP.

4. Empirical Strategy

We use Regression Discontinuity Design (RDD) to infer the impact of mayor ideology on deforestation and some other outcomes. The idea behind the RDD strategy is to solve the endogeneity problems related measuring this impact using OLS or fixed effect regressions comparing municipalities where mayors are from a party with a specific ideology versus municipalities where mayors from a party with some other ideology. The main problem of this type of regressions is that is impossible disentangle the part of the effect that comes from the mayor ideology and the part of the effect that comes from population preferences (which is correlated with mayor party).

Pettersson-Lidbom (2008) solve this problem using RDD to compare economic outcomes of left-wing local governments in Sweden who won by a small margin of victory with economic outcomes of non left-wing local government who won by small margin of victory. In both case, the second place in the run should be a candidate from the opposite ideology. In that cases, the difference in vote percentages is so small that the city is governed by one or another ideology not because of population preferences, but for some aleatory reason. Cities in the right side of the discontinuity (the margin of victory of zero percentage points) are, in average, very similar to the ones in the left side of the discontinuity. Ferreira and Gyourko (2009) use the same strategy to compare outcomes in cities governed by Democratic mayors with outcomes in cities governed by republican mayors in the United States.

The strategy uses the following regression:

$$y_{it} = \alpha + \beta Left_{it} + f(LeftMargin)_{it} + \lambda_t + \epsilon_{it} \tag{1}$$

Where y_{it} is the outcome of municipality i in year t (deforestation, rural credit, agricultural GDP, etc), $Left_{it}$ is a dummy that assumes value equal to one if the municipality i is governed by a left mayor in year t, $f(LeftMargin)_{it}$ is a polynomial function of the margin of victory of the left mayor candidate in the last election previous to year t (is negative in the case of left candidate lost), and λ_t is year fixed effects to capture time changes in the outcome common to all municipalities. We also include cluster in municipalities to make standard errors robust to municipal autocorrelation.

We present the results using different windows in margin of victory. We test for a five percentage points window, besides a non-parametric window chosen by the method described by Calonico et al. (2014), which became known as CCT method. We also provide some usual

robustness tests in RDD regression, such as verify whether the characteristics of municipalities that should not be affected by mayor ideology are balanced in both treatment and control groups (the right and the left side of discontinuity) and do the density discontinuity McCrary test (McCrary, 2008) to show that there are no discontinuity in the running variable, the margin of victory. The McCrary test is usually used to verify if there manipulation in the running variable. In our context, the reason we do the test is not manipulation, but to verify if some of the ideologies win by a small difference disproportionately more often than the other (in that case, be at one side and not in the other side of the cut-off point would be less random).

5. Results

This section presents the results found by the study. First, we analyze the effect of mayor ideology on deforestation running a municipality fixed effect model to show that there is correlation between mayor ideology and deforestation. However, as argued in the previous sections, this correlation could be resulted by voters preferences, a problem that we solve further using RDD regressions. We run a fixed effects model explained in the following equation:

$$y_{it} = \alpha + \beta Left_{it} + \gamma_i + \lambda_t + \epsilon_{it} \tag{2}$$

where y_{it} is deforestation in municipality i in year t, $Left_{it}$ is a dummy which assumes value equal to one if the mayor of municipality i in year t is from a left party, γ_i is a muncipality fixed effect and λ_t is a year fixed effect. We use cluster in the municipalities to make standard errors robust to municipal autocorrelation.

The results are presented in Table 1. Column 1 shows the effect of a left mayor on deforestation normalized by the municipality area. Result shows that in municipalities where the mayor is from a left party there are less deforestation than in municipalities governed by a non-left mayor and it is significant at a 5% level of significance. Column 2 shows the same correlation when deforestation divided by the forest area in municipality (the area that is still possible to be deforested) is used as dependent variable. Column 3 presents the results on deforested area within protected areas and no correlation is found.

In general, results show that there is a negative correlation between deforestation and left mayor, which could reinforce the literature that point out that there is an ideology effect on environmental conservation. However, as previous explained, the fixed effect model is not the model indicated to measure this effect. Voters preferences could be driven these results and not the ideology of the mayor. Therefore, it is important running RDD regressions to compare municipalities with similar preferences to isolate the impact of mayor ideology on deforestation.

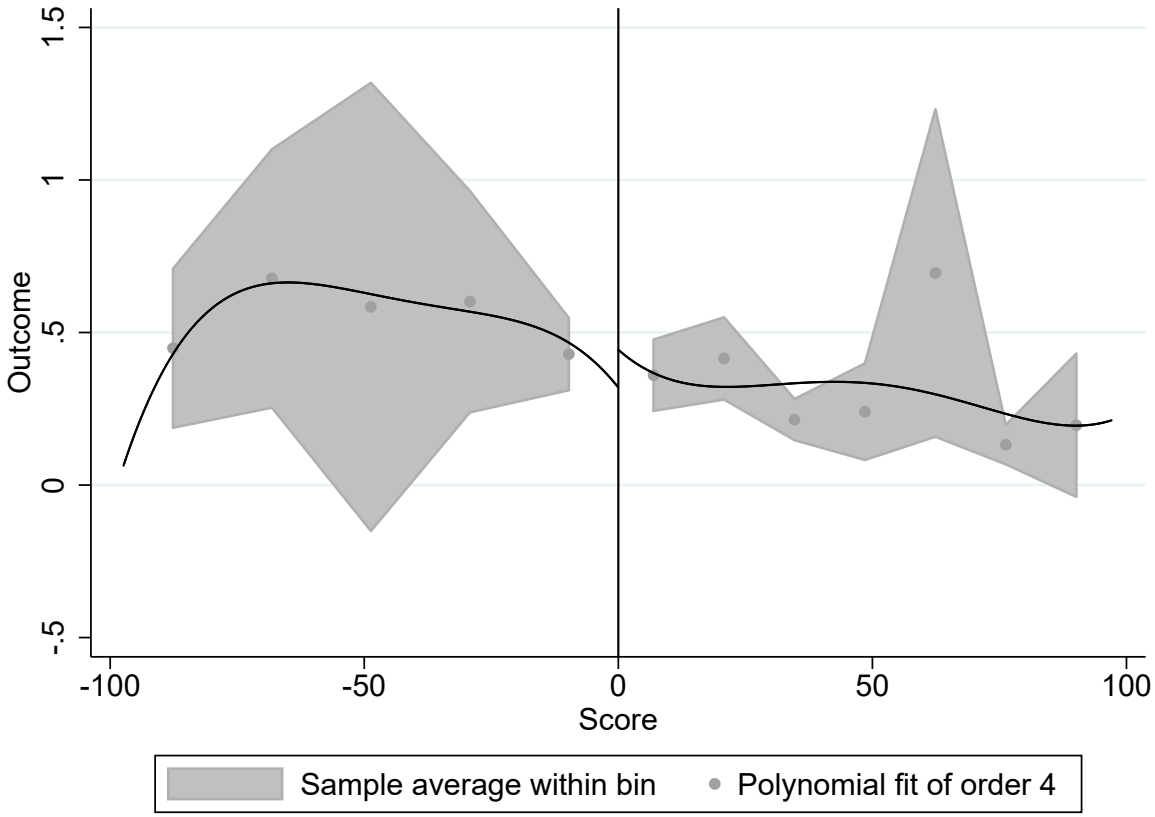
We begin by showing the typical RDD graphic using our main measure of deforestation (divided by municipal area). Figure 1 presents the relationship between the margin of victory of a left wing mayor candidate and deforestation in the Amazon. A polynomial fit of order 4 and the CCT bandwith are used to draw the figure. Results show that there is no jump in deforestation around the zero margin of victory indicating that the ideology of the mayor is not important to deforestation when we take into account municipalities with similar preferences (then ones that are placed near to the zero margin of victory).

Table 1: Correlation of Ideology - Fixed Effects Regressions

VARIABLES	(1) Deforestation Divided by Municipal Area	(2) Deforestation Divided by Forest Area	(3) Deforestation in Protected Area
Left Mayor	-0.145	-0.223	0.399
	(0.069)**	(0.132)*	(2.256)
Observations	14,230	14,230	15,212
Number of mun	760	760	772
Municipality FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Notes: The table presents results on the effect of mayor ideology on deforestation using a municipality fixed effect model. The dependent variable is deforestation measure in three different ways. Column 1, presents the result for deforested area divided by municipality size, column 2 uses deforestation divided by forest area and column 3 use total deforestation within protected areas. *** p<0.01, ** p<0.05, * p<0.10.

Figure 1: Margin of Victory and Deforestation in the Amazon



Notes: The figure presents the relationship between the margin of victory of left wing mayor candidate and deforestation in the Amazon. A polynomial fit of order 4 and the CCT bandwith are used to draw the figure.

To verify if these results are, in fact, robust, we run a series of RDD regressions as specified in Equation 1. We begin with the regressions on deforestation measured in different ways. Table 2 presents the results. Column 1 presents the result of the regression explained in equation 1 using deforestation divided by the municipal area as dependent variable. Column 2 uses deforestation divided by municipal forest area as dependent variable and column 3 uses deforestation within protected areas as dependent variable. Columns 1 to 3 present the results using a 5 p.p. window and columns 4-6 reproduce the same regressions using a window chosen by CCT non parametric method. All results show that mayor ideology does not affect deforestation in the Amazon, meaning that the results found by the fixed effect model comes only by voters preference.

Table 2: The Effect of Ideology on Deforestation

VARIABLES	(1) Deforestation Divided by Municipal Area	(2) Deforestation Divided by Forest Area	(3) Deforestation in Protected Area	(4) Deforestation Divided by Municipal Area	(5) Deforestation Divided by Forest Area	(6) Deforestation in Protected Area
Left Mayor	-0.094	-0.410	13.426	0.113	-0.005	-9.667
	(0.222)	(0.617)	(17.338)	(0.179)	(0.378)	(14.473)
Observations	5,039	5,039	5,416	5,039	5,039	5,416
Window	5 p.p.	5 p.p.	5 p.p.	CCT Optimal	CCT Optimal	CCT Optimal

Notes: Regressions are the same type as in equation 1. Each column presents the RDD regression using as dependent variable the one described in the column title. The three first columns present the results using a 5 p.p. margin of victory window and the last three columns presents results using the window chosen by the CCT non-parametric method. *** p<0.01, ** p<0.05, * p<0.10.

Bragança and Dahis (2021) show that mayor linked to agricultural professions had effect on deforestation before the implementation of the PPCDAM, which was a huge centralized effort to reduce deforestation in the Amazon and which created the monitoring system through satellite images, the DETER. After the creation of this system and the implementation of this huge and centralized plan to combat deforestation, mayor linked to agricultural professions do not have effect any more on deforestation. To verify if this is the case also in terms of mayor ideology we restrict our sample only to years before 2005 and run the same regressions as in Table 2. The results show that there are no impacts of mayor ideology on deforestation even before 2005. For the sake of space we omit the table with this results, as it was very similar to Table 2.

To investigate the reasons why mayor ideology does not affect deforestation we test the effect of ideology on a series of policies that could affect deforestation. Several times, mayors invest in some type of policies that could increase or decrease deforestation. Despite we did not find any effect of mayor ideology on deforestation there is a possibility that we find some effect on these policies. If this last sentence is true, this indicates that mayor of some ideology are trying to reduce (increase) deforestation facilitating the policies that help this reduction (increase), but are not in the end affecting deforestation. For example, it is possible that left wing mayors are trying to restrict credit for farmers who are not complying with environmental legislation and this restriction is affecting credit concessions, but the effect is not large enough to affect deforestation. If this is true, we learn something about how ideology affects environmental conservation policies, even that the final result is still not a decreasing on deforestation.

We then, first, analyze the impact of deforestation on credit concessions to crop production and to livestock. The idea is that mayors favourable to agricultural activities could facilitate the access to credit for this type of use, which in turn could affect deforestation (Assunção et al., 2020). Therefore, it is important to know if mayor ideology causes changes on credit concessions. We run regressions as the one explained in equation 1 where the dependent variables are credit concessions for crop production and credit concessions for livestock. We also test the effect on agricultural GDP, since agriculture is an economic activity that competes with keeping the forest standing. Table 3 presents the results. Columns 1 and 4 show the results on credit for crop production, columns 2 and 5 on credit for livestock, and columns 3 and 6 on agricultural GDP. In the first three columns is used the 5 p.p. window and in the last three columns is used the CCT window. All results confirm that mayor ideology does not have any effect on credit concessions, neither to crop production nor to livestock. It also does not affect agricultural GDP.

Table 3: The Effect of Ideology on Credit Concessions and Agriculture

VARIABLES	(1) Ln Financing Crops	(2) Ln Financing Cattle	(3) Agricultural GDP	(4) Ln Financing Crops	(5) Ln Financing Cattle	(6) Agricultural GDP
Left Mayor	0.704	1.578	-49.47	-0.509	0.020	-16.57
	(2.385)	(2.530)	(35.11)	(1.395)	(1.448)	(13.45)
Observations	4,308	4,308	3,823	4,308	4,308	3,823
Window	5 p.p.	5 p.p.	5 p.p.	CCT Optimal	CCT Optimal	CCT Optimal

Notes: Regressions are the same type as in equation 1. Each column presents the RDD regression using as dependent variable the one described in the column title. The three first columns present the results using a 5 p.p. margin of victory window and the last three columns presents results using the window chosen by the CCT non-parametric method. *** p<0.01, ** p<0.05, * p<0.10.

Besides credit, environmental monitoring and law enforcement has been shown important tools to combat deforestation in the Amazon (Assunção et al., 2015, 2022). We investigate whether mayor ideology affects the intensity of this kind of policy. Also, the creation of new protected areas was one of the instruments brought by the PPCDAm to combat deforestation, as argued in Section 2. Gandour (2018) shows that protected areas serve as a barrier to the expansion of deforestation to remote places where the presence of forest is abundant and where deforestation is still far from that place but in the way to arrive there. Therefore, we also investigate whether left mayors create more (or less) protected areas than non-left mayors in municipalities governed by them.

Table 4 presents the results. In columns 1 and 3 we calculate the effect of mayor ideology on the number of fines issued by IBAMA in each municipality to sanction environmental violations. In columns 2 and 4, the area embargoed because of environmental crimes is used as dependent variable. And in columns 3 and 6, the area of new protected areas created in the municipality is the dependent variable. We use a 5 p.p. window in columns 1-3 and a CCT window in columns 4-6. Again, the results show that there is no effect of mayor ideology on environmental policies.

We calculate the impact of mayor ideology on several policies that affect deforestation and do not find any effect. As mayor ideology has no effect on policies used to combat deforestation in the Amazon it is expected that it does not have effect on deforestation either. If some

Table 4: The Effect of Ideology on Policies

VARIABLES	(1) Number of Fines	(2) Embargoed Area	(3) Created Protected Area	(4) Number of Fines	(5) Embargoed Area	(6) Created Protected Area
Left Mayor	2.648	-6.758	295.770	1.008	-8.311	-53.524
	(2.803)	(4.887)	(221.513)	(2.146)	(10.494)	(177.751)
Observations	4,232	3,600	1,058	4,232	3,600	1,058
Window	5 p.p.	5 p.p.	5 p.p.	CCT Optimal	CCT Optimal	CCT Optimal

Notes: Regressions are the same type as in equation 1. Column 1 presents the results of mayor ideology on the number of fines punishing environmental violations issued by the municipality. Column 2 does the same for embargoed areas. And column 3 shows the impact of mayor ideology on the creation of protected areas in the municipality. The three first columns present the results using a 5 p.p. margin of victory window and the last three columns presents results using the window chosen by the CCT non-parametric method. *** p<0.01, ** p<0.05, * p<0.10.

ideologies increased the probability of implement more stringent environmental policies we should expect the ideologies to have some effect on deforestation. But, this is not the case and then, the results on deforestation are consistent with this find.

Finally, we investigate if the lack of effects of mayor ideology on deforestation is because of the kind of aggregation of ideology that we are making, which could be cancelling off the effect of some parties. We then run an empirical test using the larger Brazilian parties separately. For example, we run a regression with municipality governed by a PT mayor as treatment group and governed by a non-PT mayor as a control group and do the same for PDT, PSDB, MDB, PP, and DEM. Again, we use RDD methodology and keep in the sample only the municipalities where the party treated was first place or second place in the election and choose 5 percentage points window or the CCT window to compare similar municipalities. The dependent variable is deforestation normalized by the municipality size. Results are presented in Table 5. They show that there is no effect of any party on deforestation. The regression using the sample with PP party suggests some effect on increasing deforestation, but it is not robust to the choice of the window size. In general, no party facilitates deforestation or makes deforestation more difficult in the Amazon.

We present strong evidence that mayor party ideology does not affects deforestation in the Amazon. We also show other studies showing that some other mayor characteristics, such as their original profession, has impact on deforestation, as pointed out by Bragança and Dahis (2021). Also, some other studies show the importance of mayors or political situation on deforestation in the Amazon municipalities. Abman (2014) show that, after the 2008 Federal Government decree that stablish the list of priority municipalities to combat deforestation, which could have some bad reputation consequences to mayors of municipalities on the list, eligibility to a new mandate started to have effect on deforestation in the Amazon. Mayors eligible to a new mandate reduced more deforestation than mayors not eligible to new mandates after the decree is released. Pailler (2018) also find that municipalities with mayors running for reelection deforest more than the other ones. Finally, Ruggiero et al. (2021) find that municipalities with higher deforestation increase deforestation in federal and state year elections and municipalities with lower deforestation increase deforestation in municipal year elections.

But, if mayor original profession and mayor incumbency has impact on deforestation, and electoral year are important to changes in deforestation, why mayor party has no effect? We

Table 5: The Effect of Parties on Deforestation

VARIABLES	(1) PT	(2) PDT	(3) MDB	(4) PSDB	(5) PP	(6) DEM
			Panel A - Regressions using 5 p.p. window			
Mayor Party	-0.056	-0.303	0.033	-0.090	0.465	-0.506
	(0.401)	(0.415)	(0.328)	(0.521)	(0.271)*	(0.678)
Observations	2,178	1,386	5,023	3,484	1,675	3,049
Window	5 p.p.	5 p.p.	5 p.p.	5 p.p.	5 p.p.	5 p.p.
			Panel A - Regressions using CCT window			
Mayor Party	-0.005	0.213	0.368	-0.549	-0.367	0.084
	(0.235)	(0.511)	(0.287)	(0.341)	(0.508)	(0.412)
Observations	2,178	1,386	5,023	3,484	1,675	3,049
Window	CCT Optimal	CCT Optimal	CCT Optimal	CCT Optimal	CCT Optimal	CCT Optimal

Notes: Regressions are the same type as in equation 1. The dependent variable is normalized deforestation. Each column presents the RDD regression using as variable of interest the information about the party of the mayor, which appears in the column title. Panel A presents the results using a 5 p.p. margin of victory window and panel B presents results using the window chosen by the CCT non-parametric method. *** p<0.01, ** p<0.05, * p<0.10.

speculate that parties in Brazil are very fragmented, and at municipal levels this fragmentation is even higher. In fact, Zucco and Power (2021) show that polarization and ideology convergence have few importance on party fragmentation in Brazil. Politicians create new parties and migrate from one to another party glimpsing become a leader of the party in local levels. In that case, the politician does not choose the party that converge more with his/her ideas, but the one that will bring him/her more electoral benefits and greater chances of becoming a local leader. Gouvea and Girardi (2021) show that mayor ideology has no effect on the size of government, suggesting ideological convergence on the main parties in Brazil. This ideological convergences at the local level could be an explanation to the results presented above.

6. Robustness Tests

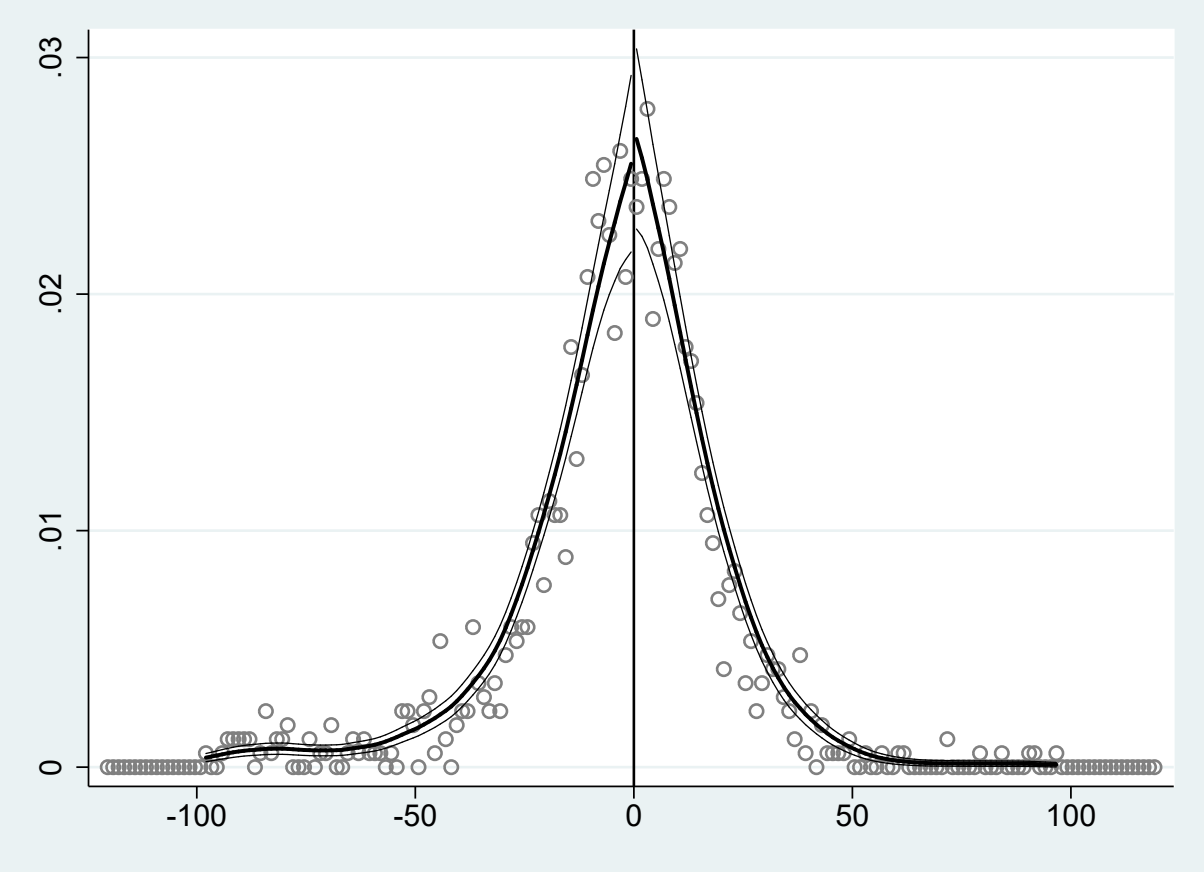
After calculate the impact of mayor ideology on deforestation in the Amazon, and show that the first does not affect the last, it is important to verify is the conditions needed to run discontinuity regressions hold for our case. We do the three robustness tests that are common in RDD regressions. First we run the McCrary density test to show that there are no discontinuity in margin of victory around the zero cut off point; second, we test if there are discontinuity on co-variables that should not be affected by mayor ideology; and finally we run RDD regressions using margin of victory function with different functional forms and choosing different windows for the bandwith.

To do that, we start by doing the McCrary test to verify if there is manipulation on the margin of victory. In this case, manipulation is very difficult and we do not believe on it. However, it is possible that, for example, left parties, when they win, do so consistently by a very small margin, while right-wing parties always win by large margins. The opposite could also be true. If something like this is happening in the elections in the Amazon, the RDD results are not valid, because the treatment and control groups are not being chosen by an aleatory process, but by something that consistently happens. McCrary density test verifies

if there is some discontinuity on margin of victory density around the cut-off point (the zero margin). If there is no such discontinuity around zero, then RDD regressions are valid.

Figure 2 shows the result for this test. It is possible to see that there is no discontinuity on margin of victory density around the zero cut-off point, which guarantee the possibility to use RDD regressions.

Figure 2: Margin of Victory Density and the McCrary Test



Notes: The figure presents the margin of victory density and the McCrary test to verify if there is a discontinuity on the density around the zero margin (McCray, 2008).

Another important robustness test for RDD regressions is to verify if the method produces balanced treatment and control groups. That is, to verify if municipalities on the right side of the discontinuity are similar to municipalities on the left side of discontinuity. To do that, usually the researchers run the same regressions they run to calculate the effects they are looking for, but now with some municipality characteristics that have no chance to be affected by the treatment (in our case municipal characteristics not affected by mayor ideology). This test is known as the test with the co-variables, which means that the co-variables should be balanced in treatment and control groups. We run this test for 6 municipal characteristics, population, municipal area, if the municipality is on the Amazon Biome, if the incumbent is running for re-election, the total of valid votes and the municipal GDP. We use the same regressions explained in Equation 1, changing only the dependent variable.

Table 6 presents the results. Panel A presents the results using a 5 p.p. window and Panel B presents results using the CCT window. Results show that none of this variables are correlated with municipalities governed by left-wing mayors, as is expected if RDD regressions are doing a good job in comparing similar groups of municipalities.

Table 6: Correlation of Ideology with Municipal Chacteristics

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Ln pop	Municipal Area	Amazon Biome	Incumbent Running	Valid Votes(p.p.)	Ln GDP
			panel A - Using a 5 p.p. window			
Left Mayor	-0.104	0.089	-0.067	-0.098	-0.443	-0.408
	(0.247)	(0.315)	(0.115)	(0.121)	(0.638)	(0.327)
Observations	1,353	1,354	1,354	1,332	1,354	917
Window	5 p.p.	5 p.p.	5 p.p.	5 p.p.	5 p.p.	5 p.p.
			panel B - Using CCT window			
Left Mayor	-0.236	0.178	-0.075	0.010	-0.757	-0.244
	(0.153)	(0.205)	(0.064)	(0.073)	(0.686)	(0.188)
Observations	1,353	1,354	1,354	1,332	1,354	917
Window	CCT	CCT	CCT	CCT	CCT	CCT

Notes: Regressions are the same type as in equation 1. Each column presents the RDD regression using as dependent variable the one described in the column title. Panel A presents the results using a 5 p.p. margin of victory window and panel B presents results using the window chosen by the CCT non-parametric method. *** p<0.01, ** p<0.05, * p<0.10.

Finally, we run robustness tests using margin of victory function with different functional forms. We test the same regressions as in our main specification using a degree 3 polynomial function, and using different slopes on both side of the discontinuity. We also test the mayor ideology effect choosing a 3 p.p. window and a 10 p.p. window. For this tests, we use our main deforestation measure, the deforested area divided by municipality area.

Table 7 presents the results. In columns 1-3, we use a degree 3 polynomial function on the margin of victory. In Column 1, the window is 5 p.p., in columns 2 we use CCT window and in column 3, the window is 50 p.p. (the whole sample). In columns 4 and 5 we control for an interaction between the margin of victory and the dummy of left mayor. That means, we allow the both sides of discontinuity to have different slopes. We do that for the 5 p.p. window (column 4) and for the CCT window (column 5). In columns 6 and 7 we use a bandwith window of 3 and 10 p.p., respectively.

Again, all results show that the mayor ideology does not affect deforestation in the Amazon. In general, the evidence shows that ideology has no effect on deforestation and that this result is robust to different specification.

7. Conclusion

In this paper we show that mayor political ideology it is not a trait that affects deforestation. We did several robustness tests and did not find any impact of mayor ideology neither on deforestation nor on policies that could impact deforestation, such as the concession of public credit, the environmental command and control policies, and the creation of new protected

Table 7: The Effect of Ideology on Deforestation - Different Functional Forms

VARIABLES	(1) Degree 3 5 p.p. window	(2) Degree 3 CCT window	(3) Degree 3 50 p.p. window	(4) Different Slopes 5p.p. window	(5) Different Slopes CCT window	(6) 3 p.p. window	(7) 10 p.p. window
Left Mayor	-0.450	-0.004	0.155	-0.094	0.113	-0.319	0.114
	(0.330)	(0.238)	(0.214)	(0.222)	(0.179)	(0.270)	(0.207)
Observations	5,039	5,039	5,039	5,039	5,039	5,039	5,039
Window	5 p.p.	CCT Optimal	50 p.p.	5 p.p.	CCT Optimal	3 p.p.	10 p.p.
polynomial	degree 3	degree 3	degree 3	degree 1	degree 1	degree 1	degree 1

Notes: Regressions are the same type as in equation 1. Each column presents the RDD regression using as dependent variable the one described in the column title. Panel A presents the results using a 5 p.p. margin of victory window and panel B presents results using the window chosen by the CCT non-parametric method. *** p<0.01, ** p<0.05, * p<0.10.

areas. The results are consistent with Zucco and Power (2021) finds, which show that Brazilian political system is very fragmented and other mayor traits seem to import more than party ideology. We then conclude that neither left-wing mayors are Eco-annoying nor right-wing mayors are unscrupulous ruralists.

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