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Cavalcanti, Francisco

Barcelona Economics Institute (IEB), University of Barcelona (UB)

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Francisco Cavalcanti [†]

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Abstract

Citizen assessment of government performance is a cornerstone of the successful functioning of democracy. However, accountability is a double-edged sword. When voters misunderstand the stakes and provide the wrong incentives to elected officials, political accountability leads to an implementation of suboptimal welfare policies. This paper reveals that an electorate can demand clientelism. I find evidence that after a drought, voters increase the vote share of local incumbent parties that are politically aligned with the central government to ensure the inflow of partisan government aid relief. Such behavior reinforces the central government's incentives to bias policies in favor of politically aligned municipalities to influence elections. Consequently, the circle of distortion of aid relief allocation is perpetuated. The data cover the Brazilian democratic elections from 1998 to 2012. I use fixed effects models with panel data and a regression discontinuity design with heterogeneous treatment effects. The results resemble a long-run patronage equilibrium.

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[†]Barcelona Economics Institute (IEB) & University of Barcelona (UB). Address: c/ J.M. Keynes, 1-11, 08034 Barcelona, Spain. E-mail: f.cavalcanti@ub.edu.

"*The new question is not whether voters are responding to government performance but whether they are responding in the right manner.*"
– Healy and Malhotra (2013)

1 Introduction

Democratic systems based on free elections are commonly accepted as one of the most efficient means to form welfare-enhancing governments. A wide range of models (Ferejohn, 1986; Persson et al., 1997) suggest that public officers implement optimal policies when they are selected and sanctioned through universal suffrage. In this process, voters retrospectively evaluate the performances of incumbents and punish or reward them in subsequent elections. If one assumes that voters' preferences are tied to honesty, competence, and effort and that voters hold politicians accountable for those attributes, politicians have the incentive to behave accordingly. Democracy can produce inefficient policies, however, if voters' choices provide misleading incentives for elected officials. In this case, accountability plays a detrimental role and weakens the motives to implement optimal welfare policies. For instance, in a context where a narrow elite controls economic institutions and persists in power through patronage by distorting the allocation of public resources, retrospective voting could slide society into a slow-developing course (Acemoglu and Robinson, 2008). Understanding the circle that connects retrospective voting behavior with policy outcomes is a major line of research (Healy and Malhotra, 2013).

This study addresses this research topic by showing that voters could demand clientelism.[1] I find empirical evidence that an electorate rewards partisan alignment between different tiers of the government in order to ensure the inflow of public funds. A partisan alignment between the central government and local politicians is a strong determinant of intergovernmental transfers. Voters may decide to settle this connection to take advantage of the short-run benefits of patronage politics. However, this relationship comes at the cost of encouraging the government to bias the distribution of public resources toward party labels. Such behavior could be translated as a failure of government efficiency and might lead to a long-run sub-optimal equilibrium (Healy and Malhotra, 2009). In a desirable situation, voters in such environments should condemn individualistic transactions that are more costly than socially beneficial (Hicken and Simmons, 2008; Shin, 2015). However, if voters demand it, elections could fall into a vicious circle of clientelism in which voters from different localities do not cooperate and in which everyone ends up worse off, similar to a Bertrand trap (Cabral and Villas-Boas, 2005).

The paper demonstrates such a relation by empirically studying voters' reaction to droughts, the government's accountability when assigning drought mitigation policies, and voters' responses to this (perverse) accountability in a vote-buying context known in Brazil as the *drought industry*.[2] Investigating voters' choices that undermine social welfare is suitable in contexts where there are frequent natural catastrophes because these events could lead to a

[1] Defined as large-scale exchanges of targeted goods and favors between patrons and client with a hierarchy of intermediaries (Fukuyama, 2014).

[2] The *drought industry*, or *indústria da seca*, is an expression used to refer to the clientelism relationship between the elite (*coronéis*) and the peasants (*flagelados*) who exploit the humanitarian collapse driven by droughts in Brazil to obtain electoral influence in exchange for votes for water distribution. This term was first mentioned by Callado (1960). More details in Appendix A.

situation where voters must make a difficult decision. More specifically, considering a scenario in which political alignment between tiers of government is already in place, voters face the following dilemma after a shock of drought. Although getting rid of incumbent politicians in elections should discipline governments into good performance, thereby blaming the incumbent for a lack of policies that have resulted in permanent solutions, voting for these incumbents may guarantee partisanship in the provision of palliative policies from other governmental levels. If citizens in vulnerable conditions who have their standards of living diminished by natural disasters still show increased support for politicians in power because of political alliances, then this finding would indicate a decision in favor of patronage politics rather than disciplining welfare-enhancing governments. This dynamic is exactly what the paper shows; droughts drive voters to plead for even more political alignment.

The dilemma faced by voters is based on three premises: 1) whether voters punish incumbents because of natural disasters, 2) whether voters reward governments because of aid relief, and 3) whether governments bias the allocation of aid relief. More precisely, the first hypothesis is that droughts alter political preferences as voters blame politicians for worsening living conditions (Gasper and Reeves, 2011; Bruckner and Ciccone, 2011). This willingness to blame the political class may arise either because governments have not implemented adaptation policies to mitigate the effects of droughts or because governments are responsible for some of the vulnerable social conditions exacerbated by this kind of natural disaster (Quiroz Flores and Smith, 2013; Heersink et al., 2017). I analyze two types of Brazilian elections at the municipality level: presidential (1998, 2002, 2006, 2010) and mayoral (2000, 2004, 2008, 2012). Implementing a fixed effects panel data analysis, I find that voters indeed punish the incumbent party for droughts in elections. On average, the president's party vote decreases by five percentage points, and the mayor's party vote decreases by seven percentage points.

The second hypothesis is that central governments are electorally rewarded for distributing mitigation policies that aim to alleviate the misery triggered by water scarcity. An increase in the public supply of water and food and infrastructure investment in the affected areas may reduce economic losses and relieve the pain of the population. Consequently, voter's angriness against the political class could be attenuated or even converted into popularity (Healy and Malhotra, 2010; Bechtel and Hainmueller, 2011). In the same line, the paper shows that the adverse impact of drought is, on average, completely compensated by the provision of palliative and prevention policies in presidential elections but not in mayoral elections. The results also indicate that voters are keenly aware that it is the central government that grants the droughts aid relief and that voters react more positively to palliative rather than preventive policies.

The third hypothesis is that governments tend to allocate intergovernmental transfers strategically. If the central government has strong opportunistic electoral objectives, the government may distort the provision of aid relief in order to maximize its chances of re-election (Arulampalam et al., 2009). Indeed, the nature of disaster relief as an emergency expenditure creates room for discretionary allocations, and disaster relief is frequently associated with misuse of public spending (Garrett and Sobel, 2003; Cole et al., 2012). The capture of drought mitigation policies by the government as a tool to influence electoral outcomes is at the heart of inefficient resource allocation. Applying a more flexible version of the regression disconti-

nuity design (RDD) with heterogeneous effects proposed by Becker et al. (2013), I show that before presidential elections, any aligned municipality is more likely to receive palliative policy than the non-aligned ones. The effect is enormous and reaches almost 74 percentage points for droughts categorized as extremes. I do not find similar opportunistic behavior with the provision of preventive policies or when the target elections are for mayors.

The dynamics between the negative shock of droughts on elections and the political use of mitigation policy converges to a predicament for the electorate, which in turn allows for the assessment of voters' choices. In one regard, disciplining government performance implies punishing politicians in power after a serious drought. However, in the circumstance where there is already party symmetry between local politicians and central government, punishing incumbents would extinguish the political alignment. In this case, changing the incumbent party for the opposition parties would result in fewer chances for intergovernmental transfers coming from the central government. If voters acknowledge the political alignment advantage to the extent that they reward it or are even aware that it is a bias, incumbents have no incentive to change the way they operate, which will perpetuate the problem. As a result, disaster relief could become an institutionalized form of clientelism between governments and citizens, which in turn prevents the implementation of more sustainable adaptation policies against droughts, as denounced in Nelson and Finan (2009).

The main analysis adopts as empirical strategies both the fixed effects panel data model and also the RDD with heterogeneous treatment effects in order to ensure both causal interpretations and external validation. The study reveals that voters reward party alignment in mayoral elections but that there is no evidence of strategic voting during presidential elections. The reward for the partisan alliance rises after the shock of a drought. I find that droughts increase the effect of political alignment by approximately 8 percentage points in the vote share of the mayor's party. In presidential elections, however, voters do not seek alignment, and after a severe drought, the vote share of the president's party decreases by 12 percentage points in aligned municipalities. This behavior may be explained by the fact that voters care about their mayor being aligned with the president before presidential elections (when this may be beneficial by enhancing the chances of obtaining a palliative policy), but voters do not seem to care about the president being aligned with the mayor in the period before mayoral elections (when the central government seems to act less opportunistically).

The paper contributes by showing that voters can provide the wrong incentives. The findings complement the existing literature on patronage politics (Shin, 2015; Anderson et al., 2015). In particular, in a randomized control trial, Bobonis et al. (2017) show that citizens granted a residential water cistern in drought-prone areas of Northeast Brazil are less likely to ask politicians for private benefits. This paper supports their most important conclusion but differs in at least two important aspects. First, while the above experiment is based on an intervention from an international development agency, which means a third party that is independent from the government-voter relationship, my analysis takes into account policies financed by Brazilian governments. This difference is crucial because politicians claim credit, which is a relevant intrinsic feature of the political economy of the *drought industry*. Otherwise, there would be no incentive for discretionary resource allocation, and government inefficiency

would not exist. Distinct from Bobonis et al. (2017) who, unsurprisingly, do not find that the delivery of cisterns directly benefits politicians and conclude that political alignment plays no role, my findings show that voters reward central governments for the provision of drought policy and that the political alignment advantage is considerable in mayoral elections. In this sense, the findings of this paper are closer to those of Martinez-Bravo (2014), who shows that villages in Indonesia with a village head who is prone to clientelism experience a stronger electoral alignment with the district-level government. Second, this paper provides a notion of long-run patronage equilibrium. Instead of analyzing a single electoral period for mayor, my data extend over a period that captures four national elections and four municipal elections.

The paper is related and contributes to several branches of the literature. First, I use an innovative measure of drought, the *aridity index*, which performs better than the measures used in previous studies in Brazil (Rocha and Soares, 2015; Larreguy and Monteiro, 2014). This measure is already commonly used in the hydrology literature (Wolfe, 1997; Arora, 2002). Second, this work contributes to the voter responsiveness literature by adding evidence that voters punish incumbents because of natural disasters (Barnhart, 1925; Achen and Bartels, 2004; Gasper and Reeves, 2011; Cole et al., 2012; Fair et al., 2015) and reward them because of aid relief (Healy and Malhotra, 2010; Fuchs and Rodriguez-Chamussy, 2014). However, this paper opposes the previous work showing that the effect of aid relief is not strong enough for a net increase in popularity (Bechtel and Hainmueller, 2011; Gasper and Reeves, 2011; Lazarev et al., 2014). Third, this paper extends the literature that studies the strategic allocation of resources by central governments that intend to maximize their electoral support (Downton and Pielke Jr, 2001; Solé-Ollé and Sorribas-Navarro, 2008; Cohen and Werker, 2008; Brollo and Nannicini, 2012; Larreguy and Monteiro, 2014). Furthermore, this work provides evidence that the type of election matters for discretionary bias. Lastly, the paper contributes to the emerging literature that explores how retrospective voting influences policy outcomes (Healy and Malhotra, 2013).

The remainder of the paper proceeds as follows. Section 2 gives a conceptual framework. Section 3 presents the data. Sections 4, 5, and 6 show the results of the empirical analysis. Section 7 concludes. Appendix A gives an overview of the institutional setting and explains the roots of the political anecdote *drought industry* and its transition to the current situation. Appendix B shows the robustness checks of the main analysis. Appendix C shows the RDD validation graphs. Appendix D provides the data sources.

2 Framework

Consider a setting in which there are three agents: voters, the mayor, and the president. Voters are subject to two types of time-separated elections: mayoral contests and presidential contests. In every election year, voters observe the past and make a judgment related to government performance (retrospective voting) (Nordhaus, 1975), build expectations on what could maximize future benefits (forward-looking voting) (Drazen and Eslava, 2010), and then decide to vote against or in favor of the incumbent party. Retrospective voting depends on two observed events: drought and mitigation policies against droughts. Politicians, in turn, study

voter decisions and adjust their objective function (Persson and Tabellini, 2002).

Voters blame incumbents for droughts

An extended period of water scarcity in a region affects local communities through economic and health mechanisms (Girma Kebbede, 1988; Felbermayr and Gröschl, 2014; Rocha and Soares, 2015). In these communities, voters, who see themselves in a worsened condition, are more likely to infer a low effort from incumbents and blame them for the increase in population vulnerability.

One can argue that drought is an event that is beyond the influence of politicians and that it is illogical to expect a voter to punish incumbents for reasons other than government performance. However, the willingness to blame incumbents for natural disasters is valid under both of the following assumptions of voter information about drought as an exogenous event from political decisions: fully aware and insufficiently aware. In the case in which voters are fully aware that politicians in power do not influence the incidence of droughts, voters may still blame incumbents for the lack of preparation for negative shocks. In the case in which voters are insufficiently aware, voters may vote against the politician in office in subsequent elections as the result of linking their lower standard of living to the performance of the incumbent.

The economic literature suggests that there are at least two reasons, not mutually exclusive, why voters may not disentangle economic outcomes originating from exogenous shocks, such as droughts, from those resulting from political decisions. The first reason entails a context with asymmetric information, where voters observe the economic condition and mistakenly infer politicians' quality and effort. The second reason is *attribution errors*, where voters might be wrong about the causes of economic conditions (Nordhaus, 1975; Wolfers, 2011; Bagues and Esteve-Volart, 2016). Along the same line of reasoning, one arrives at the following hypothesis to be tested:

- Hypothesis 1: droughts have a negative impact on incumbents in elections.

The economic literature on natural disasters has previously addressed this issue. For instance, by analyzing extreme weather events in India to examine the hypothesis that voters respond to events that are beyond a government's control, Cole et al. (2012) show that on average, incumbent parties that run for re-election lose approximately three percent of the vote per one-standard deviation change in district-level rainfall from the optimum level. Similar evidence of adverse effects on incumbent re-elections due to droughts can be found for the U.S. (Barnhart, 1925; Achen and Bartels, 2004) and for Sub-Saharan African countries (Bruckner and Ciccone, 2011). Evidence for such adverse effects can also be found for other types of natural disasters, such as floods (Arceneaux and Stein, 2006; Fair et al., 2015), tornadoes (Healy and Malhotra, 2010), hurricane (Abney and Hill, 1966), and others (Ahlerup, 2013; Quiroz Flores and Smith, 2013; Lazarev et al., 2014).

Voters reward incumbents for aid relief

In contrast to droughts, the aid relief from governments may ease public dissatisfaction. Households that experience thirst and hunger have their living conditions ameliorated when external agents send supplies of water and food. Consequentially, voters might reward politicians in power (or just not punish them) because of the responsiveness of politicians after natural catastrophes. Even if the mitigation policy does not come directly from a policy sphere that is controlled by the politician in office, voters may infer that good politicians are better able to capture extra resources from distinct government tiers to reduce drought consequences. Thus, aid relief from a specific level of government may indirectly affect elected officials at other levels of government. In the same logical line, the next hypothesis to be tested is as follows:

- Hypothesis 2: mitigation policies have a positive impact on incumbents in elections.

Earlier works have addressed the reward that voters grant politicians in elections for responsiveness to natural disasters. For instance, Healy and Malhotra (2010) study the effect of tornadoes on U.S. elections when disaster declarations are made and show that the incumbent party's presidential vote share receives an almost four-percentage point increase. Notably, this study suggests that the benefit of such declarations mostly outweighs the electoral cost of severe weather. Other studies that show that aid relief converts a negative shock of natural disasters into popularity can be found for droughts (Gasper and Reeves, 2011; Fuchs and Rodriguez-Chamussy, 2014), floods (Bechtel and Hainmueller, 2011), and fires under a non-democratic regime (Lazarev et al., 2014). I do not find studies showing that governments fail to convert the negative shock of a natural disaster into a net increase in popularity with disaster response.

Aid relief bias

In the Brazilian context, mayors have limited available resources, and most of the local public revenues come from transfers from higher levels of government. The president controls the greatest share of public resources and has more decision-making power to allocate them.[3] When there is a drought shock, mayors alone are incapable of properly responding to citizen demands. Mayors are constrained by the small level of fiscal capacity to deal with unexpected events. Thus, mayors have to beg the central government for help. In turn, the central government takes into account two elements when deciding where to send resources for mitigation policies. The first is the severity of the drought. High levels of water scarcity lead to a high probability of federal intervention. The second is political alignments, meaning the mayors in the same party as the president have higher chances of receiving aid interventions than mayors in the opposition party.

There could be two types of political bias experienced by the central government in sending aid relief, namely, opportunistic and partisan bias (Arulampalam et al., 2009). Assuming that mitigation policies affect voters' perceptions of politician quality, this distortion could

[3]The most important source of municipal revenues is represented by federal transfers, which account for 65% of the municipal budget on average (Brollo and Nannicini, 2012).

be used as an instrument to influence electoral outcomes. An upcoming presidential election could increase the incentives for the central government to prioritize the allocation of public resources when there is a political alliance with local politicians in office. In this case, voters might easily assimilate central government action and reward the president's party directly in the voting booth. There will be a political bias, then, if the central government has a sufficiently opportunistic electoral motivation. For instance, when studying the U.S. presidential discretion in disaster declarations involving floods, Downton and Pielke Jr (2001) find that presidents tend to issue disaster declarations more generously in years when they are facing re-election.

If the central government has a partisan performance motivation, then one should observe similar behavior before local elections. Furthering the allocation of mitigation policies to aligned municipalities just before the mayoral elections would boost the re-election performance of local politicians. On the one hand, the mitigation policies could help maintain the political alliance with municipalities; however, the central government has low autonomy in the extraction of rent from municipal governments. In this sense, for instance, if the central government is relatively more opportunistic than partisan, one would expect a greater impetus from the party of the president to favor aligned municipalities just before the presidential elections (Arulampalam et al., 2009). Hence, under municipal election circumstances, the central government might exhibit comparatively less biased behavior.

Government efficiency is guaranteed if the central government is fully benevolent. In this desirable situation, elected officials pursue neither opportunistic nor partisan electoral objectives. Thus, aid delivery policies are orthogonal to party labels, and no bias occurs. Otherwise, the discretionary of allocation of public funds for the purpose of influencing incumbent electoral performance rather than enhancing general public welfare would be a failure in the optimal public provision (Healy and Malhotra, 2009). These discussions call for testing the following hypothesis:

- Hypothesis 3: the central government biases the allocation of mitigation policies in favor of aligned municipalities.

The determinants of intergovernmental transfers have been exhaustively studied, and there is a convincing set of results indicating that party alignment plays a significant role in the allocation of public resources in various institutional contexts. Such evidence can be found for the U.S (Downton and Pielke Jr, 2001; Garrett and Sobel, 2003), Spain (Solé-Ollé and Sorribas-Navarro, 2008), India (Arulampalam et al., 2009), and Brazil (Brollo and Nannicini, 2012). In the closest work that addresses droughts and declarations of states of emergency in Brazil, Larreguy and Monteiro (2014) find that non-aligned municipalities are 5 percentage points less likely to receive drought relief from the central government. The characteristics of the mitigation policy might also impact the government's incentive to bias its allocation. For instance, the temporal effect of the policy as palliative or preventive, the degree of voter awareness of each policy, and the bureaucratic rigidity of policy implementation might enhance or decrease government strategic behavior (Cohen and Werker, 2008).

Political alignment advantage

Prolonged droughts can also affect strategic voting. Citizens affected by water shortages could adjust their expectations regarding the persistence and recurrence of these events.[4] An increase in vulnerability increases the marginal utility of consumption such that poverty-stricken citizens may also shift preferences toward private target goods and away from the provision of public goods (Bardhan and Mookherjee, 2013; Bobonis et al., 2017). In aggregate force, the voters may demand more targeted mitigation policies for droughts. Considering that households acknowledge that mitigation policies are also a function of political alignment (Larreguy and Monteiro, 2014), as in a long-run patronage system equilibrium (Nelson and Finan, 2009), the electorate might ascribe even more weight to the alignment between the incumbent parties at the national and municipal levels when deciding how to vote. Thus, voters could be induced to vote for an incumbent who is politically aligned to increase their chance of receiving future government assistance.

The impact of drought-based voter incentives on the inference of the quality of incumbents and the shift in preferences toward mitigation policies is unclear. Although sanctioning politicians in power after a drought could discipline the government's accountability by signaling for more sustainable adaptation policies, the ouster of a politically aligned incumbent after a serious drought will extinguish political alignment. The final behavior of the voters will determine what they find to be most relevant, and in this way, will influence the actions of policy makers. If voters are perishing from a drought and deliberately support the incumbent because of a political alliance, this behavior would be characterized as a demonstration of support for patronage among the levels of government. This is the last hypothesis to test.

- Hypothesis 4: droughts have a positive impact on the re-election of incumbents if they are politically aligned with other levels of government.

The exact answer to the above hypothesis suggests that the effect of droughts on the vote share of an incumbent who is politically aligned would be distinct for each type of election depending on whether the central government is essentially opportunistic, partisan, or benevolent. For instance, if the central government is opportunistic, political alignment is more relevant for the allocation of mitigation policies when presidential elections are approaching. Then, one would expect that considering a municipal election, voters ascribe more weight to party alignment in their voting decision. This behavior would be the case since in the years following mayoral elections, the central government is more prone to send government aid to the aligned municipalities to increase their electoral performance in the forthcoming presidential election. In any case, if voters value the chance of receiving targeted mitigation policies to the extent that the party alignment effect is positive, then the impact of a drought will further exacerbate this advantage if voters demand clientelism.

As voters in elections hold politicians accountable by selecting and sanctioning politicians according to voter preferences, politicians are induced to behave accordingly. If voters signal

[4]Lichand and Mani (2016), when studying 47 municipalities in Ceará, Northeast Brazil, show that uncertainty about future rainfall affects farmers' decision-making through cognitive load leading to a variety of behavioral biases.

that they want aid relief with partisan bias, politicians strive to deliver it. This behavior connects the dots of a clientelism circle. The final outcome is to some extent similar to a Bertrand supertrap (Cabral and Villas-Boas, 2005). If all municipalities were to cooperate, the welfare-maximizing strategy would be to cease the patronage politics that cause an inefficient redistribution of resources and to demand unbiased policies with an emphasis on long-term prevention. However, rejecting patronage politics implies bearing an immediate cost to citizens that materializes in the form of less aid for droughts. This dynamic could mean that the rational response of individual municipalities may to favor rather than oppose patronage.[5]

The voter rationality assumption is what connects all the hypotheses above and is the most significant shortcoming in the democratic accountability dynamic. The behavioral response that allows assessing voter preferences requires that they have a sufficient cognitive capacity to evaluate government performance and form an expectation of future actions. Thus, if this assumption does not hold, the theory that justifies the central hypothesis of the paper might generate different predictions.

3 Data

The empirical analysis exploits Brazilian data on mayoral elections, presidential elections, municipality characteristics, the incidence of droughts, and mitigation policies against droughts. In the following subsections, I show the sources and explain how I constructed the variables used.

3.1 Elections

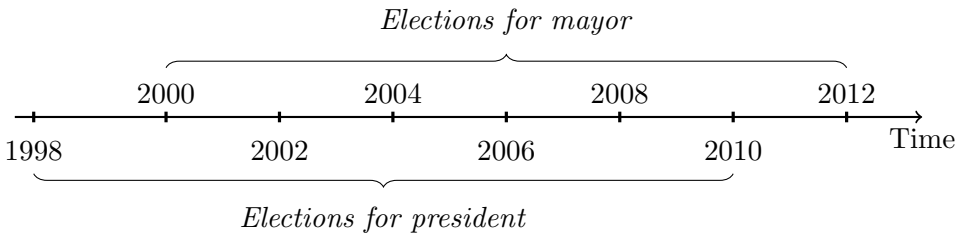
The 1988 Brazilian constitution enabled free and universal elections after more than 20 years of military dictatorship. The contemporaneously constituted democracy follows elections with a majority rule in which voters elect the candidate with the most votes for each of the three levels of government executive power: the central government (president), state government (governor) and municipal government (mayor). Elected officials have a four-year term in office. However, election years are different for mayors and the governor/president. The central government and state governments are decided together in elections in the same year, but municipal governments have a specific election, and the timing difference between these two elections is always two years, as described in Figure 1. I extracted data on mayoral elections (years 2000, 2004, 2008, and 2012) and presidential elections (years 1998, 2002, 2006, and 2010) from *Tribunal Superior Eleitoral*.

Two key variables are used in this analysis. The first variable is the vote share of the incumbent party running for re-election. I construct this variable for the mayor's party and the president's party at the municipality level for both cases. These variables are implemented as dependent variables throughout the investigation.[6]

[5] Redding (1996) and a series of academic works had studied individual behavior as interdependent on what individuals expect other agents to do. The optimal individual behavior in the presence of this interdependence between agents drives multiple outcomes. Although these outcomes can differ in their implications for social welfare, each is a rational equilibrium.

[6] It is worth mentioning that for the executive branch in Brazil, re-election has been permitted only since 1997

Figure 1: Timing of elections



The second variable is the previous margin of victory for the mayor's candidate who is affiliated with the same party as the Brazilian president if the candidate is one of the two candidates who receive the most votes. For this variable, I also need to extract information related to the 1996 mayoral elections. The previous margin of victory is used as a running variable for regression discontinuity design (Lee and Lemieux, 2010). Margins of victories above zero determine whether politically aligned candidates with the incumbent president were elected. The previous margin of victory, which is used as a forcing variable, changes with the type of election analyzed. For municipal elections, I use the margin of victory in the last municipal election, which is exactly four years before. For federal elections, the margin of victory used is from the municipal election two years earlier. The difference stems from the fact that for the outcomes of both the 2002 federal elections and the 2004 municipal elections, the previous margins of victory for candidates in the same party as the incumbent president are drawn from the 2000 mayoral elections. However, the incumbent presidential party in the federal election in 2002 was PSDB, and the incumbent party in the mayoral election in 2004 was PT.

During the period for which I test the presence of the *drought industry*, two parties with different political preferences ruled the Brazilian central government. Fernando Henrique Cardoso from PSDB, a right-wing party, won the election in 1994. He was re-elected in 1998 and stayed in office until December of 2002. The presidential election of 2002 was won by Luiz Inácio Lula da Silva from PT, a left-wing party. Lula started his term in January of 2003, was re-elected in 2006, and stayed in office until December of 2010. Dilma Rousseff, who is also affiliated with PT, replaced Lula in January of 2011 after winning the presidential election in October of 2010.

3.2 Droughts

Droughts in the Brazilian territory are extreme cases of water shortages that provoke negative consequences that go beyond of merely harvest losses. The effects of drought have historically been associated with the disappearance of lakes, streams, and vegetation, leading to the death of cattle, goats, and other livestock, which in turn increases malnutrition and thirst and often leads to humanitarian crisis (Guilhoto et al., 2011). Thus, these extreme events are better

(*Emenda Constitucional* n. 16, 4th of June) but is still limited to two terms. This restriction means that once a politician with executive power is re-elected, he becomes a lame duck and cannot be eligible for re-election again. Thus, the vote share of the incumbent politician seeking re-election is truncated, and using this value in the analysis means losing observations. Using the vote share of the incumbent party appears to be a better option since these parties can seek re-election as many times as they try.

explained as a matter of water balance than simply the level of rainfall. The economic literature that addresses droughts across large areas in Brazil using only episodes with a lack of rainfall is vulnerable to misidentifying extreme water scarcity in locations that have an abundance of groundwater as they ignore geographical, vegetation, and soil characteristics. As a matter of fact, it is very unlikely that a period of little rain in the Amazon rainforest would trigger similar consequences as a similar period in areas that are susceptible to desertification (PAN-BRASIL, 2004). Thus, using variations in rainfall could incorrectly suggest that there is water scarcity in highly humid areas.

In order to overcome the above caveat, I propose an improved measure of the severity of droughts in relation to those used in Larreguy and Monteiro (2014), Rocha and Soares (2015), and Bobonis et al. (2017).[7] Instead of only using levels of rainfall, I propose using the ratio between evaporation and rainfall. This procedure of measurement is similar to those used in studies focused specifically on hydrology (Wolfe, 1997; Arora, 2002). I define the *aridity index* as the ratio between the accumulated months of evaporation and the accumulated months of rainfall, as follows:

$$AI_{t,m} = \frac{\sum_1^t Evaporation_{t,m}}{\sum_1^t Precipitation_{t,m}}. \tag{1}$$

The term AI represents the *aridity index*. The subscript t represents the month of the observation for each variable, and the subscript m represents the municipality. Throughout the paper, I will use a time window of two years, i.e., $t = 24$.[8] This index gives an idea of how much water is stored in a municipality during the time window adopted. Higher values of this index indicate that the environment is arid.

I extract monthly precipitation and evaporation data from ground weather stations from INMET, the Brazilian Institute of Meteorology.[9] Figure 2a depicts the location of the 180 ground stations. The monthly level of precipitation and evaporation for every Brazilian municipality is extrapolated as follows. I first locate the closest ground meteorological station in each quadrant to the north-east, north-west, south-east, and south-west of every municipality. Then, I compute the distance between the municipality's centroid and the ground station. The inverse square of this distance is used as a weight to proxy weather variables for each municipality.

Since elections regularly occur in October, I account for the level of rainfall and evaporation prior to this month. I sum the weather data for the 24 months preceding a specific election. For example, the *aridity index* of the 2010 presidential election takes into account the sum of the monthly levels of evaporation and precipitation from November 2008 (exactly one month after the mayoral election in 2008) through October 2010 (the month of the presidential election).

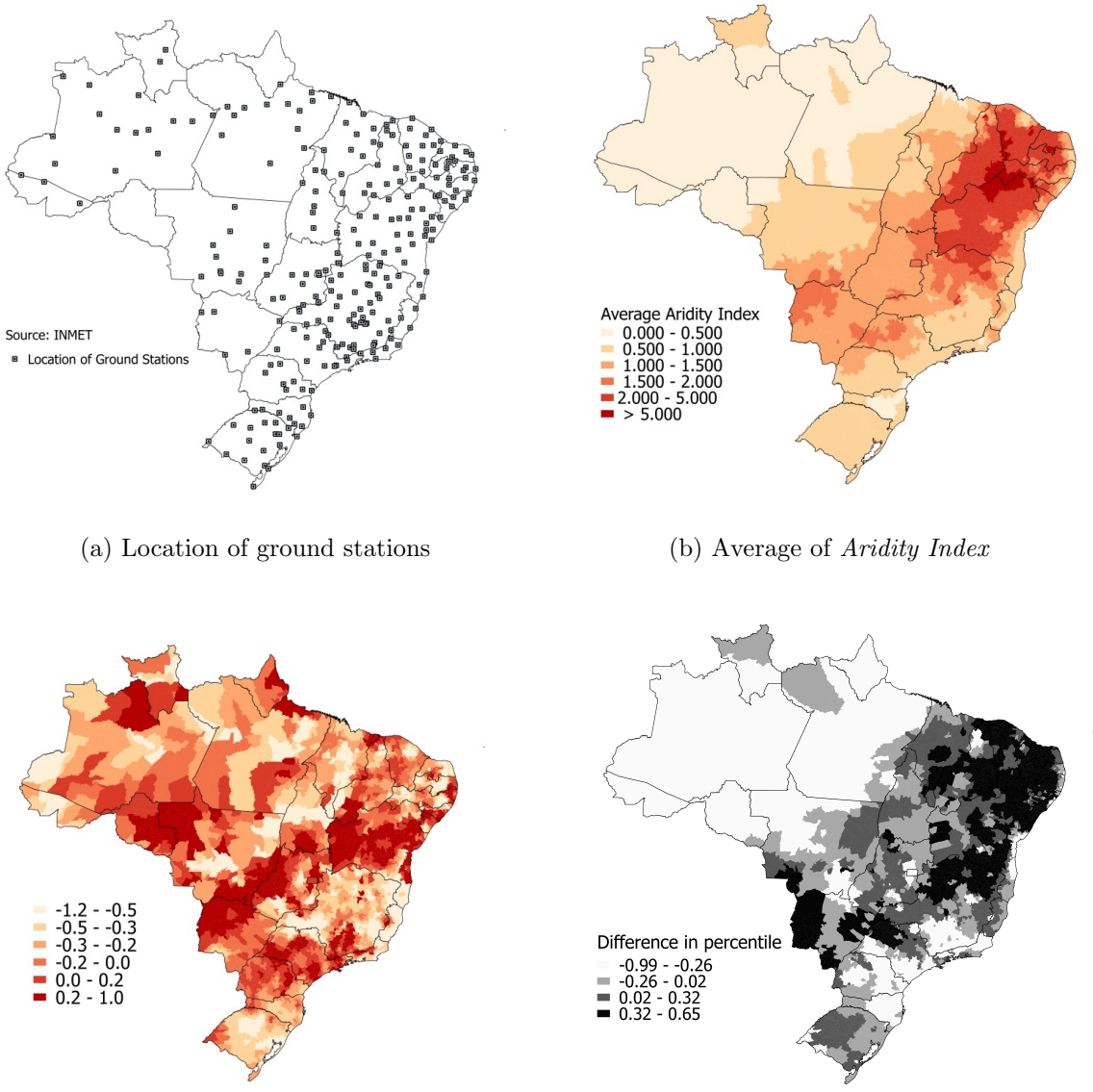
There are three significant advantages of this measure compared with the standard vari-

[7]The measure of drought in the studies of Larreguy and Monteiro (2014) and Bobonis et al. (2017) is the municipal rainfall z-score, i.e., the deviation from the historical mean normalized by the historical standard deviation. The measure of drought in the study of Rocha and Soares (2015) is a dummy variable that indicates that rainfall over 12 months was more than one standard deviation below the historical average.

[8]Since the timing difference between mayoral elections and presidential elections is always two years, the adoption of this time window of 24 months is convenient.

[9]This dataset contains an extensive list of weather variables in the period between 1963 to 2013.

Figure 2



(a) Location of ground stations

(b) Average of *Aridity Index*

(c) Average of Z-score of rainfall

(d) Difference in percentile

Note: maps of Brazil divided by states. Figure 2a depicts the location of the INMET ground stations. Figure 2b represents the average *Aridity Index* in the period of analysis. Figure 2c depicts the average Z-score of rainfall during the period of analysis. Figure 2d illustrates the difference of percentile of average Z-score of rainfall and percentile of average of *Aridity Index* in the period of study. Municipalities in color white represent areas where the Z-score of rainfall infer higher propensity of drought compared with the *Aridity Index*, and cities in black the other way around.

ables used for drought in the literature. First, the measure relies on two indicators of water availability, namely, how much it rains and how much it evaporates. These features are important because they depict the water storage capacity. Using levels of precipitation alone provides incomplete information about the soil moisture balance. Second, the measure gives an intensity indicator that captures how arid a municipality is during a certain period and distinguishes high humidity areas from desertification areas. Third, the measure is constructed using ground station data, which provide objective weather information. Rainfall levels are recorded with a pluviograph, and levels of evaporation are recorded from a Piche evaporimeter. These data collection instruments provide meteorological observations that are superior to widely used satellite data because satellites do not directly measure precipitation and evaporation but rather make inferences (Dell et al., 2014).[10]

Figure 2b depicts the average *aridity index* from 1998-2012 for the Brazilian territory. The map confirms that the proposed measure of drought overcomes the problem of misidentifying water scarcity for areas where such scarcity is unlikely to occur. In fact, a significant part of the northern region, which is mostly covered by the Amazon rainforest, has an average *aridity index* below 0.5. However, the inland regions of the northeast, an area that is commonly associated with humanitarian crisis because of droughts, has the highest index in the territory. The north of the southeast region and the south of the center-west region exhibit a high average aridity. For comparison, Figure 2c shows the average Z-score of rainfall during the period of analysis, similar to Larreguy and Monteiro (2014) and Bobonis et al. (2017).[11] The map indicates the dispersion of drought propensity throughout the territory, including that in highly humid areas such as the Amazon rainforest. Figure 2d compares the difference in the percentiles of average *aridity index* and average rainfall Z-score for municipalities during the study period. White areas show the municipalities where the Z-score of rainfall suggests a higher incidence of drought in comparison to the measure of the *aridity index*. Black areas indicate otherwise. In summary, while the *aridity index* identifies more drought incidence in the Brazilian region known as semi-arid, the Z-score of precipitation identifies more drought incidence in extremely humid areas.[12]

Figure 3 shows how levels of aridity have evolved in time. The positive trend raises concern about the growth of drought incidence and the spread to areas that never suffered from this natural disaster before.

For the empirical analysis, I compute the incidence of drought following the generalized climate classification scheme for values of the global aridity index proposed by Middleton et al. (1997).[13] In the simplest definition, I assume that the variable *drought* takes a value of one if

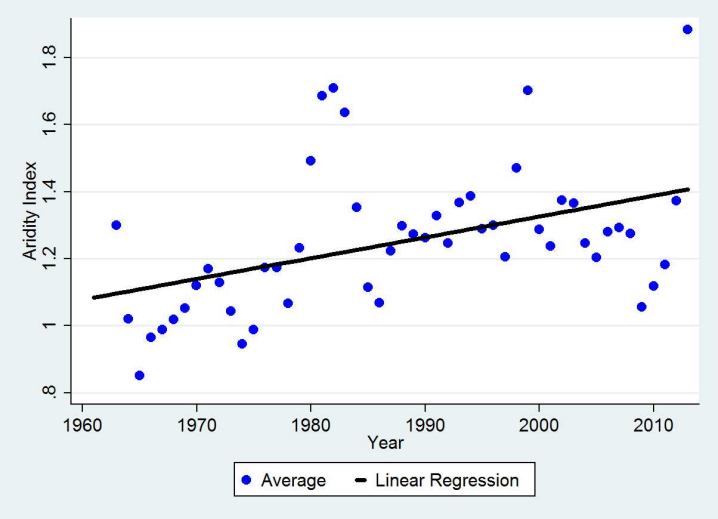
[10]Indeed, the *aridity index* outperformed the prediction of states of emergency because of drought compared with measures of drought using satellite datasets such as NOAA's PRECipitation REConstruction Dataset (PREC) (Chen et al., 2002) and Terrestrial Precipitation - 1900-2010 Gridded Monthly Time Series (Matsuura and Willmott, 2013). These results are available upon request.

[11]High values indicate low precipitation.

[12]Note that using the Z-score of the *aridity index* would encounter the same problem described if one uses the Z-score of rainfall only. That is, the measure could infer that there is a high incidence of drought in highly humid areas in Brazil.

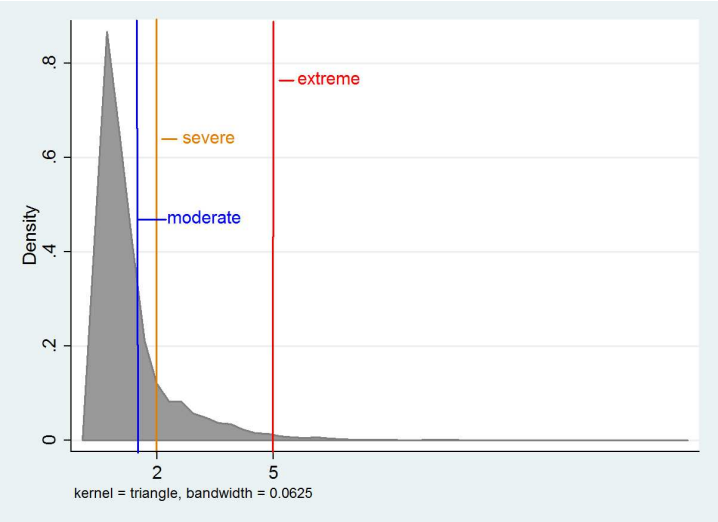
[13]Note that my index is equivalent to the inverse of the index of aridity in Middleton et al. (1997). The reason for this transformation is the ease of interpreting of results. The idea is to make the measurement positively monotonic with drought.

Figure 3: Historical Evolution of Average of *Aridity Index* in Brazil



during the two years preceding each election the *aridity index* is equal to or higher than 2.[14] That is, evaporation was at least twice as large as rainfall. In order to account for nonlinear effects among different levels of droughts and ensure that a few extreme cases do not drive the primary results, I split the drought variable into categories. The category *extreme* takes a value of one if the index is equal to or higher than 5 and is zero otherwise. The category *severe* takes a value of one if the index is equal to or greater than 2 and lower than 5 and is zero otherwise. Finally, the category *moderate* takes a value of one if the index is equal to or higher than 1.59 and lower than 2 and is zero otherwise. In this sense, the measure of water scarcity informs gradual levels of droughts. Figure 4 shows the kernel density of the *aridity index* and presents the drought classification scheme.

Figure 4: Kernel Density of *Aridity Index*



[14]The purpose is to make the empirical analysis as readable as possible. The interpretation and statistical significance of the results are the same if one uses levels of the *aridity index*.

3.3 Drought Mitigation Policies

The government's methods of dealing with the consequences of drought can be assigned into the following two groups: palliative policies and preventive policies (Cohen and Werker, 2008; Neumayer et al., 2014). Essentially, palliative policies are designed to serve citizens after an incidence of drought and have an immediate but short-term effect. In contrast, prevention policies are intended to mitigate the impact of the future conditions and usually have a long-term benefit.

In the context of this study, palliative and preventive policies also have different bureaucratic rigidities. Palliative policies are more bureaucratically loose to carry out, and therefore to bias, than prevention policies. Additionally, palliative policies are more easily manageable to promote vote buying. For instance, in addition to instantly diminishing the suffering of the poor, politicians can also use these palliative grants to buy voter support by sending water trucks to the appropriate places and by making food distribution conditional on voting for the national incumbent or at least on turning out on the day of the election. Infrastructure investments, in turn, are more immobile in space and are thus less flexible for discriminatory purposes.

Concerning electoral results, both methods may have distinct implications. Palliative policies may be more salient for voters than prevention policies since the absence of the latter diminishes voters' counterfactual perceptions of their situation. From a political economy perspective, these implications could distort the optimal balance between these policies. For instance, studying natural disasters in the U.S., Healy and Malhotra (2009) show that voters reward ruling parties in elections for spending on disaster relief but not for investing in disaster prevention, leading governments to spend less on the preparation for disasters, thus causing substantial public welfare losses.

Although the objective of this study is not to determine the best balance between prevention and palliative policies, I aim to identify how these policies are allocated among municipalities and how their effects are associated with elections given their different properties. Below, the construction of proxies for both policies is detailed.

Palliative policy

When a municipality suffers from an extended period of water scarcity that damages the economy of the locality, the mayor may request emergency aid from higher levels of public administration (i.e., the state and central governments). To be accepted by the central government, this request has to pass through a public administrative bureaucracy. The mayors of the affected municipalities need to declare a state of emergency because of drought and send documents and reports to the Ministry of National Integration of Brazil.[15] The National Secretariat of Civil Defence is the agency within the ministry that has the designation of analyzing the gravity of the drought. This agency comprises a commission that decides whether the mayor's request for aid relief is reasonable. All these institutions are politically subordinate to the

[15]For example, some of these documents are preliminary notifications of disaster, detailed damage reports, and action plans.

president. If these institutions agree that providing aid to the municipality is necessary, the central government publishes an ordinance recognizing the declaration of a state of emergency or public calamity.[16]

From this moment, the municipalities for which the state of emergency was recognized become eligible to receive several types of financial support and bureaucratic relief. In cases of drought, federal aid relief may arrive in the form of emergency funding through so-called mandatory transfers, the supply of water trucks, food distribution, the waiver of legal bureaucratic procedures for public spending, the renegotiation of agriculture debts, and permission for citizens withdraw money from labor insurance (FGTS).

I extract from *Sistema Integrado de Informações sobre Desastres Naturais* (S2ID) the central government ordinances recognizing the declaration of the state of emergency by drought for the period 1993 - 2013. Unfortunately, there is no information available on the monetary amount disbursed for each instance of emergency aid.

I use in my analyses a dummy variable that is a proxy for palliative policy. This variable takes a value of 1 if there was a recognition of the state of emergency because of drought for up to two years before the specific election in question (mayoral election or presidential election) and is 0 otherwise.

Prevention policy

One of the principal forms of transferring resources for infrastructure investments between the central government and municipal governments is through the so-called *Convênios*. These plans function as agreements between different levels of public administration and usually serve as a means of promoting the decentralization of public expenditure on projects related to physical facilities and structures. This modality of intergovernmental transfer is the most commonly adopted to implement long-lasting public policies to fight the effects of droughts.

I gather detailed data from $461,958$ *Convênios* projects that were implemented between the years 1995 and 2014. Among these projects, I identified 2,023 that have included in their project scopes the construction or maintenance of water dams, barrages for lakes, cisterns, and water distribution systems. These types of public works have minimal effects in situations where drought is already present but are intended to relieve the aftermath of future droughts.

The average execution time on these kinds of projects is one year and six months, and the average amount of money spent is US $120,000.00$, an increase of approximately 9% in the annual budget of a medium-sized municipality.[17]

I use in my analyses a dummy variable that is a proxy for prevention policy. This variable takes a value of 1 if one such project was implemented up to two years before the specific election in question and is 0 otherwise. It is reasonable to suppose that prevention policies are likely to provide spillover effects on neighboring municipalities. After all, in times of crisis, people can commute a short distance to the nearest source of water. To take into account this possibility, I also expand my definition of municipalities that have benefited from drought

[16] A state of emergency because of drought was first proposed in 1962 by Celso Furtado, at the time the chair of SUDENE (Superintendência do Desenvolvimento do Nordeste), in Resolution No: 453.

[17] Prices deflated by the IPCA (IBGE) with the base year 2000, which represents approximately R$ $380,000.00$.

prevention policies to include those localities that are located at a maximum distance of 30 km from the centroid of the municipality in which the project was originally addressed.[18]

3.4 Municipality Characteristics

To ensure that the effect of droughts does not incorporate time-varying characteristics of municipalities, I gather information from the 1991, 2000 and 2010 population censuses conducted by the Brazilian Bureau of Statistics (IBGE), and then, I extrapolate these data to election years. More specifically, I control for production structure by introducing variables such as the share of workers in the agricultural sector and the industrial sector. The average income controls the welfare of a municipality. The GINI coefficient controls the inequality. The proportion of graduates controls the level of human capital.

Additionally, I also gather information on the size of the municipal population from *Tesouro Nacional FINBRA* and the share of voters below 18 years old from *Tribunal Superior Eleitoral*.[19] The average temperature is collected from INMET. For these variables, extrapolations are not needed. In the empirical analyses, the control variables used are lagged for two years (the initial condition before drought shock) and log transformed. Because state capital cities have special political designations, these cities are dropped from the database. Table 1 depicts the summary statistics.

Table 1: Summary statistics

Dependent variable:	**Mean**	**Std. Dev.**	**Min**	**Max**	**N**
Vote share of mayor's party	0.268	0.271	0.000	1.000	22,099
Vote share of president's party	0.500	0.192	0.022	0.950	21,712
Palliative policy before presidential elections	0.189	0.391	0	1	50,436
Palliative policy before mayoral elections	0.264	0.441	0	1	50,436
Prevention policy before presidential elections	0.104	0.306	0	1	50,456
Prevention policy before mayoral elections	0.144	0.351	0	1	50,446
Weather variables:	**Mean**	**Std. Dev.**	**Min**	**Max**	**N**
Aridity Index (AI)	1.305	1.043	0.133	15.625	50,436
Drought	0.153	0.360	0	1	50,436
Categories:					
Extreme drought	0.013	0.113	0	1	50,436
Severe drought	0.140	0.347	0	1	50,436
Moderate drought	0.083	0.276	0	1	50,436
Temperature	23.164	3.055	13.299	29.737	50,436
Forcing variables:	**Mean**	**Std. Dev.**	**Min**	**Max**	**N**
Margin of victory before presidential elections	0.003	0.247	-0.988	0.938	2,549
Margin of victory before mayoral elections	-0.029	0.257	-0.988	0.938	2,018
Municipalities characteristics	**Mean**	**Std. Dev.**	**Min**	**Max**	**N**
Share of workers in agriculture sector	16.227%	9.355	0%	72.294%	44,314
Share of workers in industry sector	4.764%	4.580	0%	40.880%	44,314
Population	24,693	56,820	163	1,251,831	47,536
Average income	R$ 660.01	R$ 358.37	R$ 29.84	R$ 7,726.86	44,314
Share of graduated citizens	2.228%	1.944	0%	24.212%	44,314
GINI coefficient	0.528	0.066	0.261	0.880	47,285
Share of voters below 18 years old	3.337%	1.455	0.059%	11.355%	49,645

[18]The results do not change when using a maximum distance of either 10 km or 50 km.
[19]Voting is optional for Brazilians between 16 and 18 years.

4 Droughts, Mitigation Policies, and Electoral Results

To demonstrate why politicians should be concerned about the incidence of natural disasters and how voters react to the actions of central government, I investigate in this section the relationship between droughts, mitigation policies, and electoral outcomes in presidential and mayoral elections in Brazil, both at the municipality level. More specifically, I test the hypotheses that severe droughts adversely affect the parties in office in subsequent elections and that mitigation policies, conditioned on drought, have a positive influence on the re-election performance of incumbents.

Methodology

To adequately address the first hypothesis, I propose the following econometric specification:

$$SV_{t,m} = \alpha D_{t,m} + \gamma X_{t-2,m} + f_m + f_t + \epsilon_{t,m}. \tag{2}$$

where SV_{tm} represents the share of the vote for the incumbent party in election t and in municipality m. The term D indicates the set of variables that reflect water scarcity during the two years prior to the election. X represents a number of control variables lagged two years before the corresponding election. The terms f_m and f_t are a municipality fixed effect and year fixed effect, respectively. The term ϵ is the error.

Such specification captures the effect of droughts using within-municipality variation. The underlying assumption here is that weather conditions over two years preceding an election are exogenous to the political dispute. This assumption is reasonable because it is hard to argue that there is an omitted factor that could drive the vote share of the incumbent party and the levels of rainfall and evaporation simultaneously. Indeed, several studies relied on a similar assumption to identify the causal effect of natural disasters on economic outcomes (Kahn, 2005; Strömberg, 2007; Yamamura, 2014; Felbermayr and Gröschl, 2014; Neumayer et al., 2014).

Subsequently, I examine the hypothesis that the promulgation of public policies to fight droughts would reduce the negative impact these natural events may have on re-election. If voters indeed punish incumbent political parties because of droughts, it is to be expected that this effect will be exacerbated in places that have not received government assistance. Therefore, I introduce interaction variables in the previous econometric model as follows:

$$SV_{t,m} = \alpha D_{t,m} + \delta P_{t,m} + \beta(D_{t,m} * P_{t,m}) + \gamma X_{t-2,m} + f_m + f_t + \epsilon_{t,m}. \tag{3}$$

Where $P_{t,m}$ expresses whether a municipality has received a drought mitigation policy. I study the palliative policies and prevention policies separately. β is the coefficient of interest that expresses the heterogeneous correlation of the impact of drought on the municipalities benefiting from each type of public policy.[20]

[20] One could be concerned as to whether drought and palliative policies suffer from multicollinearity. However, this is not the case because there is no particular rule for the recognition of a state of emergency, and the conditions for this declaration turn out to be subjective. The pairwise correlation between palliative policies and the aridity index is only 0.36, so estimations should not suffer from multicollinearity. Still, my measure of drought has the highest correlation between palliative policies compared to other indexes of droughts. For

This coefficient must be interpreted with care. Although the estimation extracts the coefficient from the within-municipality variation and controls for the common yearly shocks as well as a set of covariates, it is still unable to rule out the hypothesis that there is an unobservable time-variant characteristic that drives the allocation of these public policies. The results should be taken only as suggestive rather than causal. For instance, it is well documented that political alignment is a determinant of the allocation of public policy, and this dynamic may also influence election results, which in turn may bias the coefficient (Solé-Ollé and Sorribas-Navarro, 2008; Brollo and Nannicini, 2012). I will address this issue explicitly later in the paper. However, it would be informative to construct a horse race for the effects of policy design on election results and make a comparative analysis.

Results

There are four takeaways from the analyses. First, the results confirm that droughts have an adverse impact on incumbent parties in elections. Moreover, the findings suggest that voters are likely to blame the local politicians and the central government alike for water shortages. In a way, this result could enigmatically stem from a voter rationality perspective since mayors have less decision-making power than presidents to implement preparedness policies and immediate aid relief in the aftermath of a drought. Nevertheless, this evidence could be explained by the citizen's perceptions of their proximity to public agents. An uprising against local politicians could be more effective since they usually live in the same city and are more tangible, whereas bureaucrats in higher levels of public administration usually live in capital cities that are generally distant.

Second, voters reward the incumbent party for the delivery of mitigation policies. Such a reward seems to be more sensitive to short-term relief spending than investments in drought preparedness spending. This finding suggests that if the central government has opportunistic and partisan motivations and selects policies so as to maximize electoral outcomes, it would be wise to focus more on palliative policies when allocating strategically among municipalities.

Third, the effectiveness of the use of drought mitigation policies as a strategic tool to reduce voter dissatisfaction in certain municipalities appears only for presidential elections, whereas this effect is absent in municipal elections. One could expect that the mayor's party might reap some electoral benefit from an additional expenditure financed by higher levels of public administration if voters are unsure about the source of the government spending. As this is not the case, an alternative explanation may be that citizens are sufficiently able to disentangle the provision of public goods by the central government from that by the municipal government. Reconciling these findings with the assumption that voters are irrational is difficult.

Fourth, the findings demonstrate that the effect of aid relief is not high enough for a net increase in popularity. Previous works have shown that the government's responsiveness implies a gain in voter gratitude to the extent that negative shocks from natural disasters disappear completely until these events become beneficial for the incumbent (Bechtel and Hainmueller,

instance, the pairwise correlation with the Z-Score of rainfall is 0.08, and the correlation with rainfall that is one standard deviation below the mean precipitation is 0.02.

2011; Gasper and Reeves, 2011; Lazarev et al., 2014). This dynamic does not apply for droughts in Brazil. The provision of palliative and prevention policy compensates for the negative shock of droughts, but this compensation is not enough to result in an increase in the vote share.[21]

Table 2

Dependent variable:	vote share of president's party				
	(1)	(2)	(3)	(4)	(5)
Drought	-0.052***			-0.049***	
	(0.007)			(0.009)	
Categories of drought:					
Extreme		-0.209***	-0.131***		-0.251***
		(0.014)	(0.015)		(0.021)
Severe		-0.059***	-0.012		-0.036***
		(0.008)	(0.008)		(0.009)
Moderate		-0.011**	0.011**		0.013**
		(0.005)	(0.005)		(0.005)
Interactions between policies and drought:					
Palliative x Drought				0.065***	
				(0.008)	
Prevention x Drought				0.021**	
				(0.010)	
Interactions between policies and categories of drought:					
Palliative x Extreme					0.114***
					(0.019)
Palliative x Severe					0.063***
					(0.009)
Palliative x Moderate					0.008
					(0.010)
Prevention x Extreme					0.133***
					(0.020)
Prevention x Severe					0.008
					(0.011)
Prevention x Moderate					-0.016
					(0.012)
Observations	21,712	21,712	19,343	19,343	19,343
R-squared	0.447	0.455	0.503	0.504	0.511
Controls	No	No	Yes	Yes	Yes

Note: the analyses use data for presidential elections of 1998, 2002, 2006, and 2010. Municipalities and years fixed effects included in all specifications. Controls variables are lagged two years before each election and include population, average income, GINI coefficient, the share of graduated citizens, the share of voters below 18 years old, the proportion of workers in agriculture and industry sector, palliative policy, and prevention policy. Standard error clustered at municipality level in parentheses. *** p-value < 0.01, ** p-value < 0.05, * p-value < 0.10.

Interpreting the results in detail, Table 2 depicts the findings using the vote share of the incumbent party in presidential elections as the dependent variable. Column (1) shows that a drought decreases the vote share of the incumbent party by an average of five percentage points. Column (2) suggests that such an effect is nonlinear regarding the intensity of water scarcity. While extreme droughts decrease the vote share of the presidential party by an average of twenty percentage points, severe droughts and moderate droughts result in a six percentage points and one percentage point decrease, respectively. Column (3) confirms that the nonlinear effect holds even when including time-varying covariates. Column (4) includes interactions between the incidence of drought and policies aimed at mitigating the consequences of drought. The results

[21] This conclusion holds even for municipalities that have received the palliative and preventive policies simultaneously. The triple interaction between drought and the two type of policies is statistically insignificant. The results are available upon request.

show that such policies indeed, on average, counteract the adverse impact that an incumbent party in central government would face if voters suffered from water shortages. Column (5) shows that even though voters experiencing an extreme drought react positively to the delivery of palliative and prevention policies by eleven and thirteen percentage points, respectively, the overall impact is still negative. When voters are subjected to a severe drought, only palliative policies appear to be relevant to the electoral outcome. In the case of moderate droughts, mitigation policies do not appear to be relevant at all. These findings suggest that from the perspective of the central government, the allocation of palliative policy against drought is potentially more rewarding with respect to electoral outcomes than preventive policy, which is in line with the results in Healy and Malhotra (2009).

Table 3

Dependent variable:	vote share of mayor's party				
	(1)	(2)	(3)	(4)	(5)
Drought	-0.070***			-0.065***	
	(0.015)			(0.018)	
Categories of drought:					
Extreme		-0.131***	-0.100***		-0.039
		(0.032)	(0.033)		(0.072)
Severe		-0.080***	-0.070***		-0.071***
		(0.017)	(0.018)		(0.021)
Moderate		-0.011	-0.007		-0.008
		(0.010)	(0.011)		(0.012)
Interactions between policies and drought:					
Palliative x Drought				0.001	
				(0.015)	
Permanent x Drought				0.012	
				(0.018)	
Interactions between policies and categories of drought:					
Palliative x Extreme					-0.008
					(0.071)
Palliative x Severe					0.008
					(0.016)
Palliative x Moderate					0.008
					(0.016)
Prevention x Extreme					-0.143***
					(0.053)
Prevention x Severe					0.019
					(0.020)
Prevention x Moderate					-0.015
					(0.025)
Observations	22,099	22,099	19,585	19,585	19,585
R-squared	0.020	0.020	0.019	0.020	0.021
Controls	No	No	Yes	Yes	Yes

Note: the analyses use data for mayoral elections of 2000, 2004, 2008, and 2012. Municipalities and years fixed effects included in all specifications. Controls variables are lagged two years before each election and include population, average income, GINI coefficient, the share of graduated citizens, the share of voters below 18 years old, the proportion of workers in agriculture and industry sector, palliative policy, and prevention policy. Standard error clustered at municipality level in parentheses. *** p-value < 0.01, ** p-value < 0.05, * p-value < 0.10.

Regarding municipal elections, Table 3 shows the results using the vote share of the mayor's party as the dependent variable. Column (1) confirms that drought is harmful to the re-election efforts of the party of the mayor. The incidence of drought decreases, on average, the vote share of the mayor's party by seven percentage points. Although this negative shock seems

to grow according to drought levels, the hypothesis that the effect is linear cannot be ruled out, as observed in column (2). Column (3) reaches a similar conclusion once time-varying covariates are included. Concerning the allocation of mitigation policies, column (4) provides different evidence from what was found in presidential elections. Neither palliative policies nor prevention policies appear to deter voter anger in local elections. Surprisingly, column (5) exhibits a negative correlation between the provision of prevention policies and the vote share of the incumbent in municipalities that suffer from extreme drought. This result could be explained by the electorate believing that the prevention policies implemented were useless given the scale of the environmental catastrophe.

In sum, these findings are in line with those in the economics and political science literature. The results of this work reinforce and extend the validity of previous work by showing that there is gratitude from the electorate for the government's response following natural disasters, and by showing that the reaction of voters is nonlinear in the severity of natural disasters.

5 Allocation of Drought Mitigation Policies

In the structure of Brazilian federalism, the central government has the greatest decision-making authority to intervene in areas devastated by drought. Given that high levels of water scarcity are also bad news for the electoral future of politicians in office, the central government could bias particular policies towards aligned municipalities. There may be different impetuses in mayoral compared to presidential elections. The discretionary allocation of public resources can be accomplished through the recognition of a state of emergency or an agreement through *Convênios* for investment in infrastructure. The distortion in these policies in favor of specific political parties penalizes the efficient provision of public goods. To rigorously investigate the veracity of the aforementioned assertion, I examine the effect of political alignment on the provision of drought mitigation policies.

Methodology

The methodological challenge comes from the fact that political preferences could be associated with several confounding factors that would bias the analysis. Thus, the most appropriate way to extract the causal impact of political alignment is to analyze the municipalities that met the following condition in the previous municipal elections: the two candidates with the most votes are from the party of the president and a party in the opposition coalition, as in Brollo and Nannicini (2012).[22] The underlying assumption is that in elections where the margin of victory is very small, the only difference between the treatment groups and control groups is party alignment with the central government, and all the confounding factors are randomly assigned around the threshold of winning an election.[23] More specifically, I implement the

[22] An alternative condition is a restriction of the sample to municipalities in which only two candidates ran in the previous municipal election, one of whom is in the same party as the incumbent president. The results are qualitatively and statistically the same, and they are available upon request.

[23] The validity of such an assumption could be tested using municipality characteristics as dependent variables. Appendix C shows the graphs of this test.

following regression discontinuity design (RDD):

$$P_m = \beta + \gamma \sum_{p=1}^{p} (MV_m)^p + T_m * [\alpha + \lambda \sum_{p=1}^{p} (MV_m)^p] + \epsilon_m. \quad (4)$$

Where P_m represents whether a municipality m received palliative or prevention policies during the two years before an election. The term MV is the forcing variable that represents the margin of victory of the candidate for mayor of the president's party in the previous mayoral election. The term T accounts for the treatment effect to be aligned with the central government. Naturally, T assumes a value of one if and only if $MV > 0$. Such specification allows for local or global polynomial order (p) in the forcing variable on both sides of the threshold 0. The coefficient α gives the local average treatment effect (LATE) of political alignment on receiving federal drought relief (Lee and Lemieux, 2010).

I implement two criteria to deal with the traditional trade-off between the size of bandwidth around the threshold and the polynomial order of the forcing variable when executing the RDD. First, I select arbitrarily elections in which the margin of victory is between -50% and 50% (excluding cases where the margin of victory is extremely high). Then, I regress for different degrees of polynomial order of the forcing variable, allowing different shapes on both sides of the threshold. I use first-, second-, third-, and fourth-order polynomials and select the one that minimizes the AIC criteria (Akaike, 1974). Second, I use the bandwidth selectors proposed by Imbens and Kalyanaraman (2012) and Calonico et al. (2014) and use the local polynomial with a rectangular kernel.

Additionally, I investigate whether politically-motivated allocation is heterogeneous across levels of water scarcity. Depending on the type of election that is approaching, the drought may exacerbate or reduce the central government bias. Put another way, the effect of political alignment could be directed towards a particular set of municipalities depending on the magnitude of the drought. I implement an RDD with heterogeneous treatment effects that provide a heterogeneous local average treatment effect (HLATE) but with a less conservative specification proposed by Becker et al. (2013). Instead of just allowing different shapes on both side of the threshold of the forcing variable regarding the treatment effect, I also allow different shapes for the heterogeneous treatment effect. More specifically, I implement the following econometric specification:

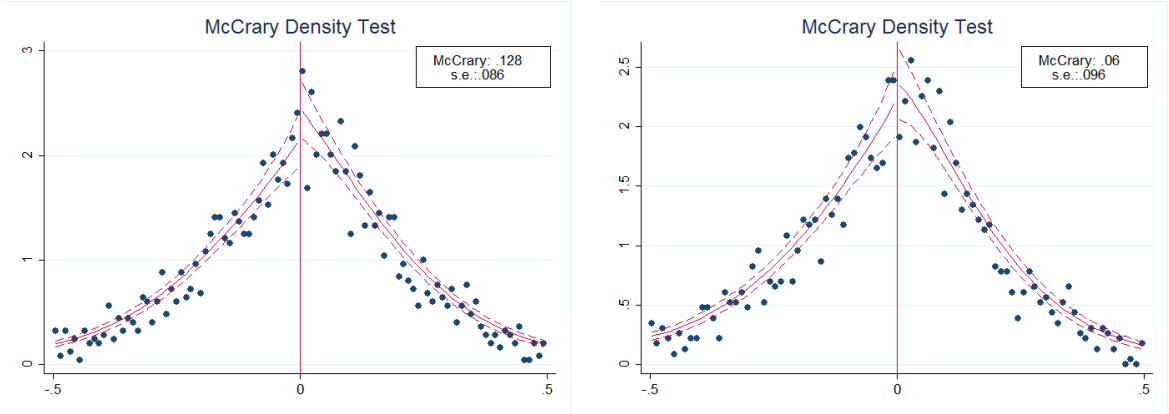
$$P_m = \beta + \sum_{p=1}^{p} (\gamma_p + \eta_p D_m) * (MV_m)^p + \vartheta D_m + T_m * [\alpha + \theta D_m + \sum_{p=1}^{p} (\lambda_p + \delta_p D_m) * (MV_m)^p] + \epsilon_m. \quad (5)$$

Where the coefficient ϑ indicates the local probability of receiving mitigation policy if a municipality suffers a certain degree of drought. The coefficient θ represents the heterogeneous local average treatment effect (HLATE) of party alignment when a municipality experiences a certain degree of drought. The linear combination of coefficients ϑ, α, and θ informs the local probability of receiving drought mitigation policy when a municipality suffers a certain degree of drought, and the incumbent mayor is in the same party of the current president of Brazil.[24]

[24]The results are equivalent in terms of sign and have more statistical power if we strictly follow the econometric

There are three important underlying assumptions required to implement this identification strategy. First, the covariates are continuous, and there is no jump at the threshold. Second, there is continuity in the probability of the degree of droughts at the threshold to capture genuine variation in the interaction with party alignment. Third, the interactions between the degree of drought and party alignment are not correlated with the error term, conditional on the margin of victory (Becker et al., 2013). The first two assumptions are tested in Appendix C. The latter assumption relies on the exogenous characteristic of weather variables and the fact that the electoral victory of aligned parties is controlled by the forcing variable margin of victory. The McCrary (2008) test of the forcing variables depicted in Figure 5. It can be seen that for both forcing variables, there is a smooth distribution around the threshold of zero, which rules out sorting concerns.

Figure 5



(a) Before presidential elections (b) Before mayoral elections

Note: The x-axis is the forcing variable margin of victory of mayor candidate in the president's party in the previous municipal election.

Results

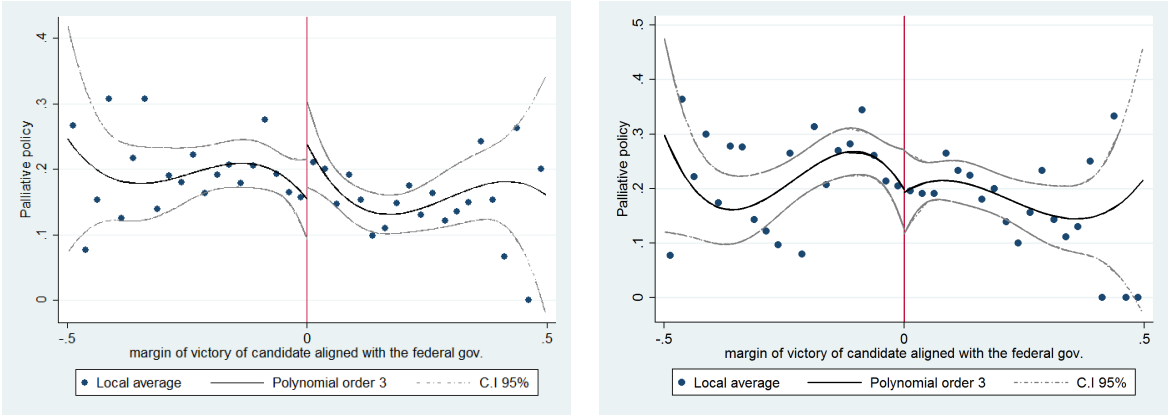
The analyses prove that there is a tremendous advantage for voters that experience a water shortage in having an incumbent mayor who is aligned with the central government. Such a feature is strikingly important for receiving palliative policies. However, the same is not applicable for policies that have long-run effects and is less immediately noticeable for the poor. In short, when water scarcity reaches a critical level in which thirst and famine forces citizens into extreme attitudes, such as blocking roads to plunder necessary supplies, the marginal effect of government assistance makes a big difference. Hence, a political alliance between the levels of government becomes a strong factor. The patronage relationship in the provision of drought palliative policies seems to persist.

Demonstrating the interpretation of the results, Figure 6 provides a graphical analysis of the effect of party alignment on the provision of palliative policy against droughts. Although

specification proposed in Becker et al. (2013). However, their specification is rigid in the sense that they do not admit the margin of vote share to have a distinct prediction for municipalities that suffered from droughts and municipalities that did not.

the coefficient for party alignment is larger when the election following the delivery of palliative policy is the presidential election, the effect for both types of electoral contest is not statistically significant at usual standards. Figure 7 shows similar results for the case of prevention policy.

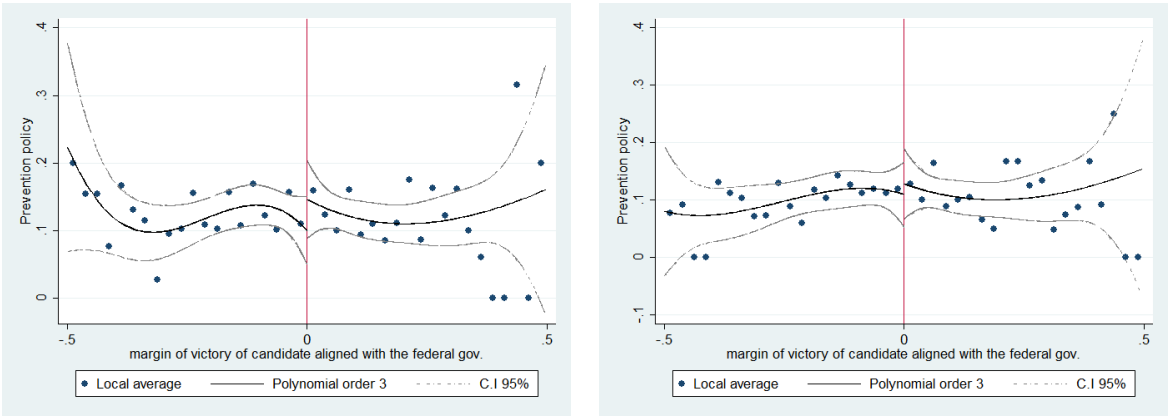
Figure 6: Graphical Analysis of RDD: Alignment on Palliative Policy



(a) Before presidential elections (b) Before mayoral elections

Note: The x-axis is the margin of victory of mayor candidate in the president's party in the previous municipal election. The y-axis of Figure 6a is the probability of receiving palliative policy before presidential elections. The y-axis of Figure 6b is the probability of receiving palliative policy before mayoral elections.

Figure 7: Graphical Analysis of RDD: Alignment on Prevention Policy



(a) Before presidential elections (b) Before mayoral elections

Note: The x-axis is the margin of victory of mayor candidate in the president's party in the previous municipal election. The y-axis of Figure 7a is the probability of receiving prevention policy before presidential elections. The y-axis of Figure 7b is the probability of receiving prevention policy before mayoral elections.

In order to dig a little more into whether there is a political bias towards a set of areas depending on the level of water scarcity, Table 4 shows the results of the heterogeneous treatment effects of political alignment. Panel A depicts the results for palliative policy before presidential elections. Columns (1), (2), and (3) use the three proposed criteria for the simplest definition of drought. The results indicate that the central government distributes palliative policy opportunistically following a pattern. The president prioritizes aligned municipalities in the event that the environmental condition is acute. Given a drought, an aligned city has an approximately 18 - 36 percentage points greater chance of receiving assistance from the

Table 4: Palliative Policies Before Elections

Panel A

Dependent variable:	palliative policy before election for president					
	(1)	(2)	(3)	(4)	(5)	(6)
Party alignment	-0.032	0.013	0.016	-0.013	-0.010	-0.007
	(0.025)	(0.042)	(0.043)	(0.035)	(0.044)	(0.044)
Party alignment x Drought	0.181**	0.343**	0.358**			
	(0.087)	(0.145)	(0.147)			
Drought	0.196***	0.109	0.083			
	(0.060)	(0.103)	(0.103)			
Categories of drought:						
Party alignment x Extreme				0.519**	0.738***	0.736***
				(0.259)	(0.273)	(0.273)
Party alignment x Severe				0.236*	0.287*	0.300*
				(0.135)	(0.163)	(0.165)
Party alignment x Moderate				0.192	0.239	0.237
				(0.134)	(0.155)	(0.155)
Extreme				0.162	-0.014	-0.012
				(0.200)	(0.209)	(0.209)
Severe				0.137	0.112	0.085
				(0.093)	(0.112)	(0.114)
Moderate				-0.071	-0.077	-0.075
				(0.082)	(0.088)	(0.088)
Observations	2,395	1,165	1,152	2,395	1,165	1,152
R-squared	0.104	0.089	0.093	0.121	0.097	0.101
Polynomial order	1	1	1	2	1	1
Bandwidith	0.500	0.120	0.118	0.500	0.120	0.118
Procedure		CTT	IK		CTT	IK
AIC	1943.09			1920.045		

Panel B

Dependent variable:	palliative policy before election for mayor					
	(7)	(8)	(9)	(10)	(11)	(12)
Party alignment	-0.031	-0.009	0.018	-0.017	0.005	0.025
	(0.040)	(0.039)	(0.052)	(0.040)	(0.039)	(0.052)
Party alignment x Drought	0.100	-0.018	0.139			
	(0.151)	(0.143)	(0.189)			
Drought	0.316***	0.390***	0.432***			
	(0.095)	(0.093)	(0.127)			
Categories of drought:						
Party alignment x Extreme				-0.516	-0.633	-0.707
				(0.640)	(0.461)	(0.674)
Party alignment x Severe				0.108	0.011	0.161
				(0.156)	(0.148)	(0.193)
Party alignment x Moderate				-0.102	-0.141	-0.024
				(0.154)	(0.150)	(0.202)
Extreme				0.690	0.544*	0.360
				(0.463)	(0.328)	(0.527)
Severe				0.328***	0.405***	0.450***
				(0.097)	(0.096)	(0.130)
Moderate				0.155	0.159	0.145
				(0.104)	(0.105)	(0.131)
Observations	1,868	1,327	838	1,868	1,327	838
R-squared	0.160	0.158	0.123	0.188	0.185	0.141
Polynomial order	1	1	1	1	1	1
Bandwidith	0.500	0.197	0.104	0.5	0.197	0.104
Procedure		CTT	IK		CTT	IK
AIC	1673.608			1636.946		

Note: forcing variable is the vote margin of victory of the candidate for mayor in the president's party in the previous municipal election. In columns (1), (4), (7) and (10) the bandwidth is chosen arbitrarily and the polynomial order of forcing variable is chosen by AIC criteria. The columns (2), (5), (8) and (11) use bandwidth selector proposed by Calonico et al. (2014) (CTT). The columns (3), (6), (9) and (12) use the bandwidth selector proposed by Imbens and Kalyanaraman (2012) (IK). Robust standard error in parentheses. *** p-value < 0.01, ** p-value < 0.05, * p-value < 0.10.

Table 5: Prevention Policies Before Elections

Panel A

Dependent variable:	prevention policy before election for president					
	(1)	(2)	(3)	(4)	(5)	(6)
Party alignment	0.019	0.036	0.036	0.025	0.034	0.038
	(0.018)	(0.028)	(0.030)	(0.017)	(0.025)	(0.026)
Party alignment x Drought	-0.052	-0.075	0.017			
	(0.086)	(0.136)	(0.146)			
Drought	0.397***	0.428***	0.382***			
	(0.060)	(0.097)	(0.105)			
Categories of drought:						
Party alignment x Extreme				0.229	0.028	0.299
				(0.199)	(0.291)	(0.307)
Party alignment x Severe				-0.107	-0.080	-0.030
				(0.094)	(0.150)	(0.160)
Party alignment x Moderate				-0.040	0.022	-0.023
				(0.098)	(0.164)	(0.181)
Extreme				0.131	0.206	0.081
				(0.139)	(0.195)	(0.210)
Severe				0.464***	0.494***	0.468***
				(0.065)	(0.106)	(0.113)
Moderate				0.203***	0.259**	0.296**
				(0.072)	(0.121)	(0.131)
Observations	2,395	1,393	1,240	2,395	1,393	1,240
R-squared	0.172	0.164	0.165	0.195	0.189	0.192
Polynomial order	1	1	1	1	1	1
Bandwidth	0.500	0.151	0.129	0.500	0.151	0.129
Procedure		CTT	IK		CTT	IK
AIC	1041.097			1002.844		

Panel B

Dependent variable:	prevention policy before election for mayor					
	(7)	(8)	(9)	(10)	(11)	(12)
Party alignment	0.016	0.033	0.036	0.025	0.032	0.038
	(0.020)	(0.026)	(0.031)	(0.019)	(0.024)	(0.028)
Party alignment x Drought	-0.121	-0.043	-0.021			
	(0.104)	(0.142)	(0.166)			
Drought	0.419***	0.450***	0.451***			
	(0.065)	(0.090)	(0.107)			
Categories of drought:						
Party alignment x Extreme				-0.024	-0.028	-1.286**
				(0.394)	(0.467)	(0.628)
Party alignment x Severe				-0.122	-0.045	-0.017
				(0.108)	(0.148)	(0.171)
Party alignment x Moderate				-0.060	0.018	-0.003
				(0.088)	(0.119)	(0.144)
Extreme				-0.119	0.333	0.524
				(0.282)	(0.310)	(0.525)
Severe				0.463***	0.481***	0.480***
				(0.066)	(0.093)	(0.110)
Moderate				0.204***	0.139*	0.117
				(0.061)	(0.080)	(0.090)
Observations	1,868	1,361	1,064	1,868	1,361	1,064
R-squared	0.126	0.138	0.141	0.152	0.165	0.171
Polynomial order	1	1	1	1	1	1
Bandwidth	0.500	0.207	0.143	0.500	0.207	0.143
Procedure		CTT	IK		CTT	IK
AIC	718.4768			688.3544		

Note: forcing variable is the vote margin of victory of the candidate for mayor in the president's party in the previous municipal election. In columns (1), (4), (7) and (10) the bandwidth is chosen arbitrarily and the polynomial order of forcing variable is chosen by AIC criteria. The columns (2), (5), (8) and (11) use bandwidth selector proposed by Calonico et al. (2014) (CTT). The columns (3), (6), (9) and (12) use the bandwidth selector proposed by Imbens and Kalyanaraman (2012) (IK). Robust standard error in parentheses. *** p-value < 0.01, ** p-value < 0.05, * p-value < 0.10.

central government. This effect is more than 70 percent greater than the average probability of receiving a palliative policy. Columns (4), (5), and (6) show the results once the drought variable is decomposed into categories. The sizes of the effects are astonishing. Aligned municipalities experiencing an extreme case of drought have an approximately 51 - 73 percentage points greater chance of receiving immediate relief compared to municipalities where the incumbent mayor is in the opposition coalition. In the case of severe drought, the chances are approximately 23 - 30 percentage points higher. Moderate drought has similar coefficients, but these are not statistically significant. Panel B of the same table shows the results for palliative policy before mayoral elections. In this case, party alignment seems to not play a role in the allocation of instantaneous aid relief. The linear combination of the party alignment variable and its interaction with drought has no statistical significance in any specification. In fact, the drought variable alone seems to be responsible for a large part of the predictive power in the econometric model, which suggests that the behavior of the central government is responsible, as seen in columns (7), (8) and (9). The same conclusion is reached when the results are observed in the categories of droughts, in columns (10), (11) and (12).

The results of party alignment heterogeneous effects for droughts on prevention policy are depicted in the Table 5. For this kind of policy, the central government does not seem to have any partisan or opportunistic conduct. In both types of electoral contest, neither the party alignment variable nor the linear combination with its interaction with droughts have sizable or statistically significant impacts. The only exception is the interaction between extreme droughts and party alignment, which has an unstable coefficient and is likely to be dictated by a just few observations.

These findings corroborate the results of previous academic works supporting that political alignment is an important determinant in the allocation of targeted public good. What can also be learned from this exercise is that the government seems to be more opportunistic than partisan, and therefore, the type of election matters. In addition, governments are more likely to bias the distribution of more immediate and less bureaucratic spending than long-term and bureaucratically rigid spending.

6 Voters Sometimes Demand Clientelism

The two last sections have demonstrated that although high levels of water scarcity have adverse effects on incumbents, citizens living in areas in which the mayor and the president are aligned have a significant gain in terms of the probability of receiving immediate aid from the central government in times of drought. From the voters' point of view, this dynamic creates a situation that requires a decision between opposing alternatives. The failure to implement adaptive policies to mitigate the effects of droughts would be a motivation to punish the incumbent in the subsequent election. However, in a scenario in which there is already a party alignment between the two levels of government, punishing the incumbent, and thereby changing the party in power, would result in fewer chances to obtain palliative policies. I address the outcome of these two antagonistic motivations in this section. More specifically, the two key questions are as follows: do voters comprehend the benefit of political alignment

and vote in favor of this alignment in elections? Given a voter's perception of the political alignment advantage, what is the effect of actual drought on this perception? In the next two subsections, I address these points.

6.1 Voter Assessment of Political Alignment

Voters can appraise two kinds of political alignment. In municipal elections, voters evaluate whether to vote for the incumbent mayor who is aligned with the central government taking into account the expected benefit from such an action. Meanwhile, in presidential elections, voters evaluate whether the maintenance of the incumbent president's party is relevant given that their mayor is in the same party as the central government. The importance of party alliance may be different in each situation. In one case, the voter decides the party at the top of the state, and in the other circumstance, the voter chooses the party lower in the hierarchy. In this subsection, I first analyze whether party alignment per se is relevant to voter behavior.

Methodology

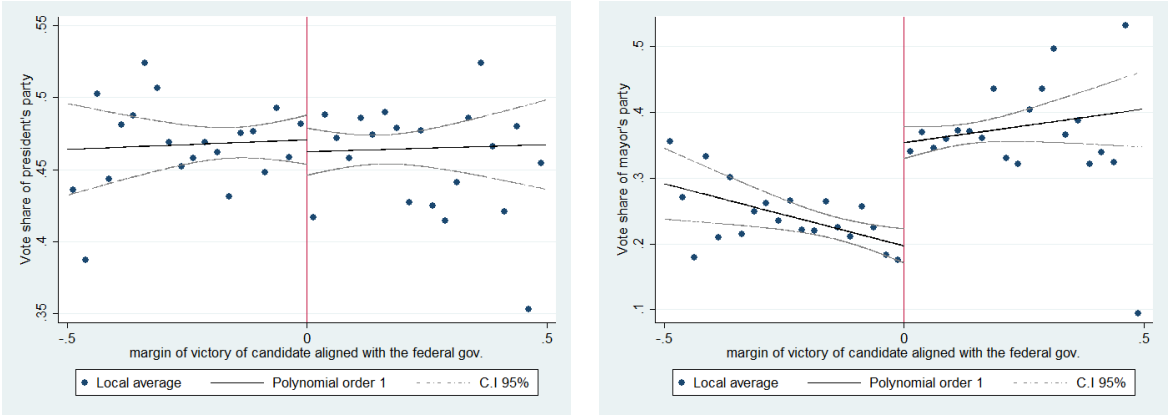
Similar to the previous section, I implement an RDD, as in equation 4. Nevertheless, the dependent variable in this empirical strategy is SV_m, which assumes the share of the vote for the mayor's party when analyzing municipal elections and the share of the vote for the president's party when analyzing federal elections. The rest of the approach remains the same.

Results

It could be inferred that voters assess political alignment positively in municipal elections but do not mind such alignment in presidential elections. Figure 8a gives a graphical analysis of the political alignment advantage for presidential elections. It can be seen that in this kind of election, party alignment does not seem to play any role. The predicted vote share of the president's party is flat across the threshold of the forcing variable. Voters are indifferent whether the incumbent president is in the same party as the mayor or not. A different conclusion is reached when I analyze the party alignment advantage for mayoral elections. The results can be examined graphically in Figure 8b. The upward jump in predicted vote share around the threshold suggests a large party alignment advantage. In this case, alignment between the local and federal parties increases the vote share of the incumbent party in the municipal contest by approximately 17 percentage points.

There are at least two possible explanations for the results. The first reason is related to the federative structure of Brazilian public administration. Since the municipal budget is mainly formed by transfers from the central government, mayors are dependent on higher levels of executive power. Therefore, the alliance with the central government in municipal elections is expected to have a significant advantage. This expectation is consistent with the system of patronage between different levels of public administration in order to ensure the flow of federal revenues (Brollo and Nannicini, 2012). The second possible explanation is related to group rule-utilitarian theory (Coate and Conlin, 2004), which suggests that in municipal elections,

Figure 8: Graphical Analysis of RDD: Alignment on Election



(a) Presidential elections

(b) Mayoral elections

Note: The x-axis is the margin of victory of mayor candidate in the president's party in the previous municipal election. The y-axis of Figure 8a is the vote share of president's party in federal elections. The y-axis of Figure 8b is the vote share of mayor's party in municipal elections.

individual voters can more easily identify themselves as members of a group of citizens, organize themselves strategically, and then do their part to help their group win. A strategic vote is less likely to happen in national elections because the heterogeneity of individuals is sufficiently large to prevent a voter bloc from forming in larger contests. Thus, voters might behave more strategically in municipal elections than in national elections, and the importance of political alignment for a group of citizens is taken into account in their voting decisions.

6.2 Droughts Impact on Voter Assessment of Political Alignment

Bearing in mind the assessment of party alignment, what would be the influence of the water shortage on the voting strategy of citizens and subsequently on the chances of re-electing the incumbent? As droughts expand economic vulnerability, voters might increase their demand for individualistic transactions and place even more value in the party alliance advantage. One possible way to test this hypothesis is to examine whether party alignment has a heterogeneous effect among municipalities regarding incidents of drought.

Methodology

Two feasible methodologies could provide both informative and distinct answers. The first is a fixed effects panel data model, similar to equation 2. The difference in this case is that the interactions are between levels of water scarcity and party alignment. Remember, the coefficients of such a specification should be interpreted as a global average correlation. Because political preferences are not randomly assigned, causal interpretation has to be avoided. Second, in order to employ political alignment as if this effect were exogenous, I implement a regression discontinuity design analysis with heterogeneous treatment effects, as in equation 5. The coefficients express the causal average local effect. However, since in this analysis, the impact extracted applies to a particular type of municipality that has the largest share of swing

voters, the results raise external validation concerns.

Results

There are three important conclusions from the findings. First, the results confirm that the effect of drought on the vote share of the politically aligned incumbent party would be different in each kind of election. An aligned mayor's party in a municipal election is rewarded, and an aligned president's party in a federal election is not. Second, voters act more strategically in mayoral elections than in presidential elections. Voters perceive that is important to maintain mayors who are aligned with the president to maximize their chances of being assisted with drought relief. Third, although both applied methodologies are based on completely different assumptions and provide a distinct interpretation of results, the global average effects, and the causal local average treatment effects are very similar, suggesting that both causal inference and external validation can be applied with some reasonableness. So, when there is an extended period of water shortage, voters might ponder the value of immediate aid relief, rewarding, even more, political alignment in the municipal contest. Thus, voters boost patronage relations by rewarding political linkages between levels of the state's hierarchy. In presidential elections, however, there is no clear incentive for voters to act strategically.

To be more precise, Table 6 shows the results for presidential elections. Columns (1) and (2) depict the results of the interaction between party alignment and drought extracted from the fixed effects panel data model with and without controls, respectively. As a global average, the correlation of party alignment in municipalities affected by drought decreases the vote share of the incumbent party by approximately 12 percentage points. Columns (5)-(7) depict the coefficients extracted from the regression discontinuity design analysis with heterogeneous treatment effects. The findings are very similar. The local causal impact of party alignment when there is a water shortage decreases the incumbent party vote share by approximately 9 to 12 percentage points. Splitting the drought variable into categories provides a coherent interpretation of what was found. Columns (3) and (4) suggest no differences in effects among extreme and severe droughts. The correlations account for approximately 11 to 13 percentage points of the incumbent party vote share. The moderate category has a tiny and insignificant effect. The effects are larger in columns (8)-(10), which depict the results from RDD. In the cities near the cut-off point of the previous margin of victory, the causal effect of drought combined with party alignment is negatively strong, approximately 30 and 32 percentage points for extreme droughts. However, the hypothesis of linearity between the categories cannot be rejected.

The results are inverted when I study the elections for mayor. Table 7 shows the results. Instead of punishing the incumbent party that is aligned with the president for the impacts of a drought, voters switch to voting for the re-election of this party. In other words, voters reward political alignment when they experience a drought. In the columns (1) and (2), the global average correlation of party alignment and drought increases the vote share of the mayor's party by approximately 7 percentage points. Columns (5)-(7) present the results of the RDD that deal with causality issues. The effects are slightly larger, 9 to 12 percentage points. When

Table 6

Dependent variable:	vote share of president's party									
	Fixed-effects model				RDD for HLATE					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Party alignment	0.038***	0.036***	0.039***	0.037***	-0.046**	-0.030	-0.023	-0.027	-0.015	-0.009
	(0.004)	(0.004)	(0.004)	(0.004)	(0.022)	(0.021)	(0.022)	(0.023)	(0.022)	(0.023)
Party alignment x Drought	-0.128***	-0.121***			-0.096	-0.109	-0.121*			
	(0.013)	(0.013)			(0.073)	(0.071)	(0.074)			
Drought	-0.034***	-0.003			0.001	0.023	0.032			
	(0.007)	(0.007)			(0.050)	(0.050)	(0.052)			
Categories of drought:										
Party alignment x Extreme			-0.112***	-0.129***				-0.322**	-0.300**	-0.296**
			(0.028)	(0.027)				(0.152)	(0.129)	(0.147)
Party alignment x Severe			-0.124***	-0.115***				-0.093	-0.094	-0.109
			(0.014)	(0.014)				(0.081)	(0.079)	(0.082)
Party alignment x Moderate			-0.017	-0.015				-0.203**	-0.161**	-0.145*
			(0.012)	(0.012)				(0.079)	(0.077)	(0.081)
Extreme			-0.187***	-0.109***				0.122	0.102*	0.100
			(0.014)	(0.015)				(0.077)	(0.061)	(0.061)
Severe			-0.042***	0.003				0.012	0.031	0.035
			(0.008)	(0.008)				(0.057)	(0.057)	(0.060)
Moderate			-0.008	0.013**				0.126**	0.125**	0.111*
			(0.005)	(0.005)				(0.057)	(0.057)	(0.059)
Observations	21,551	19,224	21,551	19,224	2,391	1,119	1,061	2,391	1,119	1,061
R-squared	0.455	0.504	0.463	0.509	0.017	0.011	0.009	0.026	0.025	0.021
Controls	No	Yes	No	Yes						
Polynomial order					1	1	1	1	1	1
Bandwidth					0.500	0.114	0.108	0.500	0.114	0.108
Procedure						CTT	IK		CTT	IK
AIC					-1389.1			-1377.86		

Note: fixed-effects model analyses in columns (1) - (4). The municipalities and years fixed effects included. Standard error clustered at municipality level in parentheses. Controls variables are lagged two years before each election and include population, average income, GINI coefficient, the share of graduated citizens, the share of voters below 18 years old, the proportion of workers in agriculture and industry sector, palliative policy, and prevention policy. RDD analyses in columns (5) - (10). Forcing variable is the vote margin of victory of the candidate for mayor in the president's party in the previous municipal election. In columns (5) and (8) the bandwidth is chosen arbitrarily and the polynomial order of forcing variable is chosen by AIC criteria. The columns (6) and (9) use bandwidth selector proposed by Calonico et al. (2014) (CTT). The columns (7) and (10) use the bandwidth selector proposed by Imbens and Kalyanaraman (2012) (IK). Robust standard error in parentheses. *** p-value < 0.01, ** p-value < 0.05, * p-value < 0.10.

I study the categories of drought, the analyses reach very similar conclusions. Columns (3) and (4) show that extreme droughts have a positive average correlation of 10 to 12 percentage points, severe droughts have a correlation of approximately 6 percentage points, and moderate droughts have a negative correlation. Columns (8)-(12) show the heterogeneous local causal effect of each category of drought. Although the extreme category yields unstable coefficients, in general, the findings are very similar in the sense that it seems that the causal effect is positive and linear.

Table 7

Dependent variable:	vote share of mayor's party									
	Fixed-effects model				RDD for HLATE					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Party alignment	0.081***	0.089***	0.087***	0.097***	0.143***	0.153***	0.157***	0.131***	0.131***	0.129***
	(0.007)	(0.008)	(0.008)	(0.009)	(0.019)	(0.027)	(0.031)	(0.021)	(0.030)	(0.033)
Party alignment x Drought	0.078***	0.075***			0.124**	0.099	0.125			
	(0.021)	(0.022)			(0.053)	(0.072)	(0.080)			
Drought	-0.079***	-0.071***			0.007	-0.017	-0.047			
	(0.015)	(0.016)			(0.038)	(0.053)	(0.059)			
Categories of drought:										
Party alignment x Extreme			0.126**	0.099*				0.084	-0.119	0.185
			(0.056)	(0.056)				(0.196)	(0.264)	(0.324)
Party alignment x Severe			0.068***	0.065***				0.147***	0.127*	0.154*
			(0.022)	(0.023)				(0.057)	(0.075)	(0.083)
Party alignment x Moderate			-0.045*	-0.055**				0.089	0.177**	0.214**
			(0.023)	(0.025)				(0.055)	(0.076)	(0.083)
Extreme			-0.155***	-0.120***				0.084	0.154	-0.148
			(0.033)	(0.034)				(0.190)	(0.261)	(0.321)
Severe			-0.090***	-0.078***				-0.003	-0.039	-0.063
			(0.017)	(0.018)				(0.039)	(0.054)	(0.060)
Moderate			-0.010	-0.004				-0.047	-0.087*	-0.099*
			(0.011)	(0.011)				(0.039)	(0.051)	(0.053)
Observations	21,888	19,466	21,888	19,466	1,864	1,191	973	1,864	1,191	973
R-squared	0.032	0.031	0.033	0.032	0.088	0.100	0.105	0.097	0.104	0.111
Controls	No	Yes	No	Yes						
Polynomial order					1	1	1	1	1	1
Bandwidth					0.500	0.168	0.124	0.5	0.168	0.124
Procedure						CTT	IK		CTT	IK
AIC					160.0612			167.6262		

Note: fixed-effects model analyses in columns (1) - (4). The municipalities and years fixed effects included. Standard error clustered at municipality level in parentheses. Controls variables are lagged two years before each election and include population, average income, GINI coefficient, the share of graduated citizens, the share of voters below 18 years old, the proportion of workers in agriculture and industry sector, palliative policy, and prevention policy. RDD analyses in columns (5) - (10). forcing variable is the vote margin of victory of the candidate for mayor in the president's party in the previous municipal election. In columns (5) and (8) the bandwidth is chosen arbitrarily and the polynomial order of forcing variable is chosen by AIC criteria. The columns (6) and (9) use bandwidth selector proposed by Calonico et al. (2014) (CTT). The columns (7) and (10) use the bandwidth selector proposed by Imbens and Kalyanaraman (2012) (IK). Robust standard error in parentheses. *** p-value < 0.01, ** p-value < 0.05, * p-value < 0.10.

7 Concluding Remarks

In Brazil, drought is the most common natural disaster and is a major cause of hunger, thirst, death, and forced migration. However, Nelson and Finan (2009) indicate that some people living in regions that have historically been devastated by these events in fact prefer periods of extreme water scarcity. In particular, they report that an elderly female goes so far as to pray for a drought. The suggested reason for someone to have such a desire is that the poor have become entirely dependent on government aid. As the arrival of the drought triggers the government aid relief mechanism, locals come to wish for it.

The above paper departed from this long debate suggesting that the high incidence of droughts in Brazil established the foundation for a long-run model of clientelism. For centuries, the rural households have traded their servility with large landowners by means of subsistence. In periods of severe water scarcity, people in extreme poverty face even higher welfare deterioration. Landlords, in turn, afforded them supplies food and water, among other necessities, but not without imposing rent extraction and patronage. This enforced social interaction becomes known as the *drought industry*.

A force that could detach the historical ties of rural households with their patrons would

be the insertion of a welfare-maximizing state, which would promote long-run investment in infrastructure to improve natural disasters preparedness and assist the most deprived. Instead, what is found is that the Brazilian government opportunistically captures the historical aid dependency of peasants in order to maximize re-election chances.

The high political turnover due to drought creates a unique scenario that encourages the central government to allocate aid relief strategically in order to assist politically aligned municipalities to the detriment of those governed by opposition parties. On the one hand, sending aid relief to aligned municipalities is a manner of forestalling the advance of opposition parties and maintaining incumbent party alignment between municipal and central governments. On the other hand, neglecting aid relief for non-aligned municipalities could guarantee municipal political turnover and make room for candidates allies.

This paper finds evidence suggesting that voters anticipate the opportunistic behavior by governments and therefore act strategically to maximize their future benefits. As political alignment plays a significant role in public resource allocation, citizens foster this alignment to increase their chances of being assisted in times of water crisis. Such voter behavior is boosted when voters are experiencing a drought, which confirms that increased vulnerability leads citizens to demand patronage politics in line with Bobonis et al. (2017). Politicians, for their part, assimilate the demand of voters and strive to give them what they want. This dynamic connects results in a long-run patronage equilibrium that leads to the sub-optimal provision of public goods and prevents the development of a region.

In conclusion, the continued absence of investments in drought preparedness infrastructure combined with the lack of responsibility in the allocation of immediate relief verifies the government's low willingness to promote the general welfare. In fact, the intrinsic motivation of landlords to take advantage of such degrading situations remains present in governmental actions. Therefore, the old clientelism system between landlords and peasants described as the *drought industry* did not vanish. Instead, this system was captured by the central government. A relevant follow-up research agenda would be to examine how to break such a clientelism cycle to ensure government efficiency in implementing welfare-enhancing public policies and in promoting resilience against droughts.

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Appendix A Institutional Setting

Drought is one of the most common natural disasters in the world, and this phenomenon is the most frequent disaster in Brazil and is both economically and environmentally destructive (Dai, 2011). In this scenario, the expression *drought industry* was invented from a singular observance of the long-term socioeconomic consequences that this natural event triggers (Callado, 1960). This catchphrase is regularly used in novels, song lyrics, and political debates (de Castro, 1967; Oliveira, 1977; Ribeiro, 1995; Silva, 2006; Matos, 2013) and refers to a complex process of distortions in government transfers that initially aimed to alleviate the drought's adverse effects but are instead used for political purposes. Although the *drought industry* has never been empirically tested, it is sustained by an informal rhetoric suggesting that the incidence of droughts and the Brazilian political economy are directly linked. In the following subsections, I first detail the background of the political anecdote, and I then describe the contemporary situation.

A.1 The Origins of the *Drought Industry*

The roots of the *drought industry* in Brazil originate in the Portuguese colonial period (1500 − 1815). To populate the Brazilian territory and extract its productive value, the Portuguese Crown granted vast areas of land to nobles, military officers, investors, and others loyal to Lisbon. This practice resulted in land being distributed to just a few people who had some prestige with the Crown. Because of this uneven distribution of land, large landholdings remained, through time, in the hands of a small group of privileged citizens, who we will call the elite.

Because the environment in drought-prone regions is characterized by very precarious conditions, agricultural workers and their families lived permanently on the edge of survivability (Guilhoto et al., 2011). In addition to facing extreme poverty and all social illnesses intrinsic to this condition, during periods of severe water shortages, rural households are fated to fight every day to find means to drink and to eat. Hunger and thirst reached their most drastic levels and often led to death. Rural families become dependent on external aid to stay alive.

In exchange for protection during periods of thirst and starvation, landlords extended to rural households a condition of servility, exploitation, and dependency. The characteristics of such social contract, which has close ties with the uneven land ownership regime, are usually associated with the "aristocratic mentality" that is characterized by values of obedience and loyalty and have built a set of social relations marked by despotism and violence (Matos, 2013).

The panorama of elite citizens running their landholdings as fiefdoms persisted for centuries throughout Brazilian history and underpinned a platform of unequal power of exchange between landlords and peasants. Such an relationship with landlords providing the means of survival and demanding loyalty in return become known as *coronelismo.*

A.2 The Contemporary *Drought Industry*

At the end of the nineteenth century, droughts began to receive public attention, and the Brazilian central government began to promote aid relief policies to assist rural households

suffering from this kind of natural disaster. Indeed, these governmental interventions reduced drought-related mortality, attenuated migration movements, and reduced the vulnerability of rain-fed farmers but did so at the expense of resilience to the weather perturbation. Families living in drought-prone regions remained dependent on external aid to deal with a crisis because aid relief policies are rarely designed for drought preparedness measures. Instead, these policies are mostly formulated in real time to attenuate the ongoing consequences of drought. This approach to humanitarian aid programs led peasants to long-run adaptations to weather shocks and has precluded these people from developing alternative adaptive mechanisms for survival. Thus, in the absence of landlord protection, rural households continued to rely solely on government actions for access to food, water, and necessary supplements during periods of drought.

In this new context of governmental intervention, the role played by landlords in protection for peasants did not vanish. Rather, quite the opposite occurred. Oligarchs captured the agencies responsible for the aid relief programs, and the access to public resources from the central government, in some way, was controlled by landlords (Silva, 2006). For instance, the locations chosen for the construction of water reservoirs with public funds were on the landlords' properties so they could charge exorbitant prices for water access. In addition, funding for public works was put directly into the hands of landlords, and thus, they had a stronger influence over the hiring of rural workers, thus expanding their patriarchal authority. In short, drought had become a large and prosperous business for this *sui generis* social class, the *industriais da seca* (industrials of drought) (Callado, 1960).

Farmworkers in drought-prone regions, regardless of whether they had been servile to landlords, are dependent on the political apparatus of the government, and thus to the local elite, during times of crisis. Since rural households face livelihood insecurity almost every year, there are some anecdotes suggesting that beneficiaries, who are not sponsored by landlords, actually prefer years of drought because government intervention brings a sense of security (Nelson and Finan, 2009). In the period before public assistance is mobilized, communities commonly invade local stores in search of food and block federal highways, stopping commercial food trucks to plunder their contents. This activity indicates that citizens have become accustomed to the dynamics between drought and governmental policies and have built expectations around future actions by government agencies.

In some sense, the direct patronage role of landlords was replaced by government actions, which is still an indirect patronage relationship between a political apparatus (landlords) and voters (peasants). Mitigation policies for drought started to be a political commodity between lower levels and higher levels of public administration. In order to guarantee the flow of public revenues, a coalition between politicians at the municipality level and the federal level began to be crucial. Municipalities where mayors were members of the opposition political party of the central government suffer from delays in emergency funds or even the denial of funds (Larreguy and Monteiro, 2014). Thus, the patronage system (*coronelismo*) also dominated the relationships between levels of government itself (Nelson and Finan, 2009).

Appendix B Robustness Checks of the Main Analysis

The main findings of the study are corroborated by two empirical strategies that are grounded in different assumptions: a fixed-effects model and a regression discontinuity design. However, there is still room to question potential flaws in the methodology. In order to address some possible flaws, this section proposes robustness checks that complement the main findings. Specifically, I reanalyze the two empirical strategies by 1) using a different technique for clustering the standard errors, 2) restricting the sample to municipalities with a higher propensity for drought, 3) decomposing droughts into cyclical and trend components, and 4) testing an alternative measure of aridity shocks. I report the results for mayoral elections given that this is the type of election where I find that voters rewarded political alignment and given that voters do not care about party alignment in the presidential election. Table 8 shows the results.

One concern might be how the standard errors are grouped. Although the technical procedure for clustering the standard errors does not affect the estimations, this procedure affects the statistical significance. For instance, it may be that the variance of the incidence of drought is correlated within municipalities that are geographically close to one another, that is, cities located in the same Brazilian federal state. To consider this potential flaw in the analyses, I cluster the standard errors at the state level instead of at the municipality level in Panel A. As it can be seen in columns (1) to (5), how standard errors are clustered is not of concern since the results maintain their statistical significance at the usual levels.

Given the extensive heterogeneity of Brazilian municipalities, one may be concerned about which cities are driving the results. In the fixed-effects models, the estimates are provided by the variation of droughts within the municipalities. However, some cities did not experience any droughts during the analysis period, and therefore, these municipalities are not adding information on the impact of droughts to the outcome variable apart from improving the accuracy of the prediction of the control variables. In the same vein, municipalities that have never experienced droughts may not be reasonable counterfactuals for the regression discontinuity design approach. To ensure that the effects found are not due to the presence of municipalities that have a very low likelihood of experiencing droughts, I restrict the sample to cities that have experienced at least one drought. The results are depicted in Panel B. The coefficient sizes remain similar to those in the primary analysis; however, for RDD, I probably lose statistical power due to the drastic reduction in sample size in columns (8) to (10).

Additionally, I deal with two crucial issues that can be raised from the analyses. First, an open question in the literature regarding the economic impacts of natural disasters is that what matters most is not clear: the intensity of a shock or the change in the level of a shock (Healy and Malhotra, 2013). It may be that voters living in a region that regularly experiences extreme droughts act differently from voters residing in an area that rarely faces these kinds of events and that between-municipality variation characteristics do not accurately capture these behavioral differences. Second, since voters' previous expectations are crucial in deciding who to vote for, and because both the level and level change shocks may have different implications for voter expectations, the electoral consequences may also be different. One way to address both of the issues referred to above is to decompose the drought measure into the following

Table 8: Robustness Checks

Panel A

	Fixed-effects model		RDD for HLATE		
	(1)	(2)	(3)	(4)	(5)
Party alignment	0.081***	0.089***	0.143***	0.153***	0.157***
	(0.013)	(0.013)	(0.024)	(0.030)	(0.035)
Party alignment x Drought	0.078**	0.075**	0.124**	0.099	0.125
	(0.033)	(0.036)	(0.057)	(0.112)	(0.093)
Drought	-0.079***	-0.071***	0.007	-0.017	-0.047
	(0.020)	(0.023)	(0.042)	(0.073)	(0.066)
Observations	21,888	19,466	1,864	1,191	973
R-squared	0.032	0.031	0.088	0.100	0.105

Panel B

	Fixed-effects model		RDD for HLATE		
	(6)	(7)	(8)	(9)	(10)
Party alignment	0.043*	0.050**	0.185*	0.183*	0.132
	(0.022)	(0.024)	(0.111)	(0.095)	(0.095)
Party alignment x Drought	0.101***	0.106***	0.071	0.071	0.122
	(0.030)	(0.032)	(0.139)	(0.118)	(0.119)
Drought	-0.072***	-0.066***	-0.091	-0.047	-0.099
	(0.015)	(0.016)	(0.100)	(0.090)	(0.090)
Observations	5,631	5,198	446	260	252
R-squared	0.071	0.065	0.136	0.156	0.171

Panel C

	Fixed-effects model		RDD for HLATE		
	(11)	(12)	(13)	(14)	(15)
Party alignment	0.074***	0.083***	0.101*	0.093**	0.085*
	(0.011)	(0.011)	(0.056)	(0.043)	(0.049)
Party alignment x Cyclical component (AI)	0.070***	0.056**	0.300**	0.219**	0.247**
	(0.023)	(0.023)	(0.125)	(0.096)	(0.106)
Party alignment x Trend component (AI)	0.016**	0.014**	0.079**	0.066**	0.079**
	(0.007)	(0.007)	(0.036)	(0.028)	(0.032)
Cyclical component (AI)	-0.066***	-0.057***	-0.241***	-0.119**	-0.169**
	(0.010)	(0.010)	(0.071)	(0.060)	(0.068)
Trend component (AI)	-0.019***	-0.015**	-0.056***	-0.029*	-0.051**
	(0.007)	(0.007)	(0.021)	(0.017)	(0.020)
Observations	21,888	19,466	1,864	1,191	973
R-squared	0.033	0.032	0.093	0.101	0.111

Panel D

	Fixed-effects model		RDD for HLATE		
	(16)	(17)	(18)	(19)	(20)
Party alignment	0.090***	0.098***	0.181***	0.157***	0.166***
	(0.007)	(0.008)	(0.032)	(0.026)	(0.029)
Party alignment x Zscore AI	0.009	0.010	0.086**	0.086***	0.075**
	(0.008)	(0.009)	(0.038)	(0.029)	(0.032)
Zscore AI	-0.021***	-0.021***	-0.049**	-0.046**	-0.052***
	(0.003)	(0.003)	(0.023)	(0.019)	(0.020)
Observations	21,888	19,466	1,864	1,191	973
R-squared	0.033	0.032	0.086	0.098	0.103

Note: no controls included in columns (1), (6), (11), and (16). Controls included in columns (2), (7), (12), and (17). In columns (3), (8), (13), and (18) the bandwidth are chosen arbitrarily and the polynomial order of forcing variable are chosen by AIC criteria. Columns (4), (9), (14), and (19) use bandwidth selector proposed by Calonico et al. (2014) (CTT). Columns (5), (10), (15), and (20) use bandwidth selector proposed by Imbens and Kalyanaraman (2012) (IK). Robust standard error in parentheses. *** p-value < 0.01, ** p-value < 0.05, * p-value < 0.10.

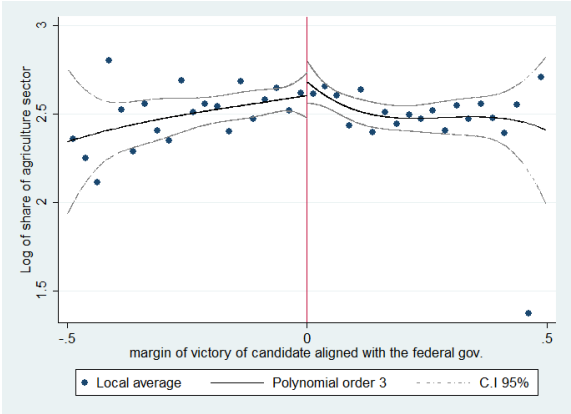
two components: the trend and the cycle. Municipalities that have A path dependence on droughts would exhibit high values of the trend variable, ensuring control of the difference in characteristics between drought-prone cities, and the cyclical component would capture an unexpected change in the level of aridity. Since I have time series data on aridity from 1963 to 2013, I decompose the trend and cyclical components following the procedure suggested by Hamilton (2017). This procedure calculates the trend and cycle components for each period as a simple prediction of linear regression taking into account only past observations. This approach is fundamental because a priori, voters have no information on future weather conditions and base all their beliefs solely on the past. Note that the trend component smoothly tracks the actual aridity index, while the cyclical component follows a random walk around zero and is arguably exogenous. Panel C depicts the results. The cyclical component seems to be the most determinant for the positive effect of drought and political alignment on the vote share of mayor's party. That is, both impacts on the level and level changes are important for voter behavior. However, the change in level has a stronger consequence. This finding may be because an unexpected change leads to a reordering of the beliefs of voters. That is to say, voters alter their predictions of the trajectory of the level of aridity drastically, and thus, they react more forcefully in their voting strategies.

Finally, to ensure meaningful comparisons across municipalities with different water scarcity conditions, aridity shocks are measured as the Z-score of the aridity index. More specifically, I calculate the difference between the current period's aridity and the historical mean of aridity in the municipality during the same two years divided by the municipality's historical standard deviation. Such a measurement is regularly used in studies that analyze droughts only taking into account precipitations (Rocha and Soares, 2015; Bobonis et al., 2017). The results presented in Panel C are robust to this aridity shock measurement choice and confirm that the party alignment effect increases when municipalities suffer a more significant water shortage than their historical average.

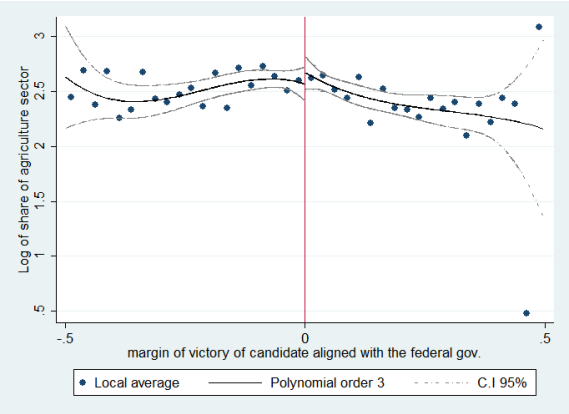
Appendix C RDD Validity

In this appendix, I graphically show the validity of the Regression Discontinuity Design (RDD) using covariates as dependent variables.

Figure 9: share of workers in agriculture sector

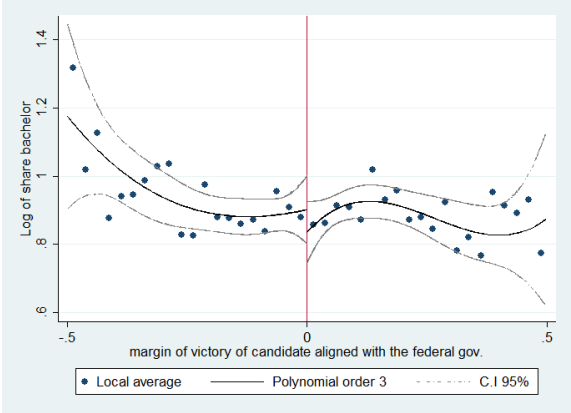


(a) Presidential elections

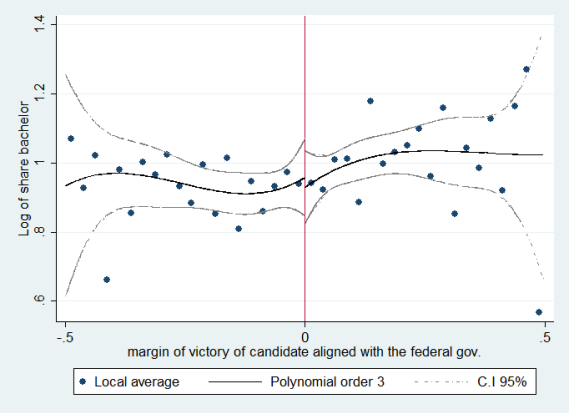


(b) Mayoral elections

Figure 10: share of graduated citizens

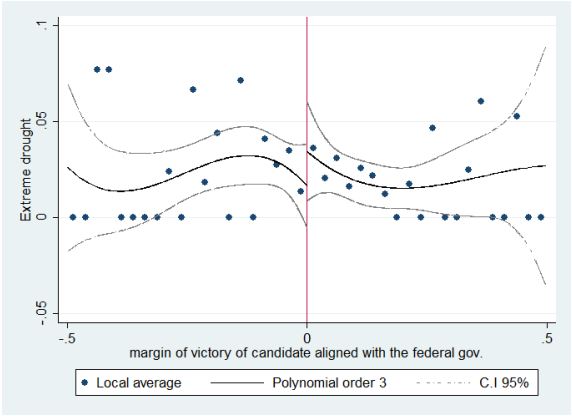


(a) Presidential elections

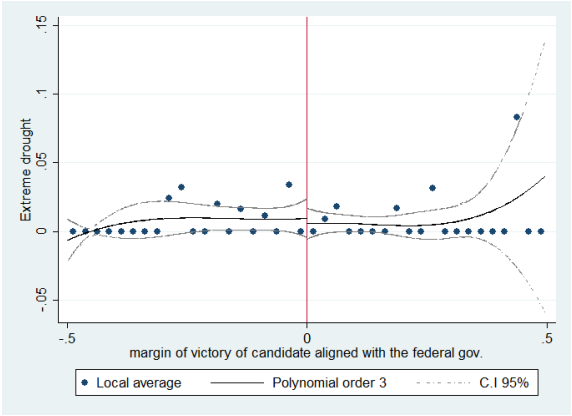


(b) Mayoral elections

Figure 11: extreme drought

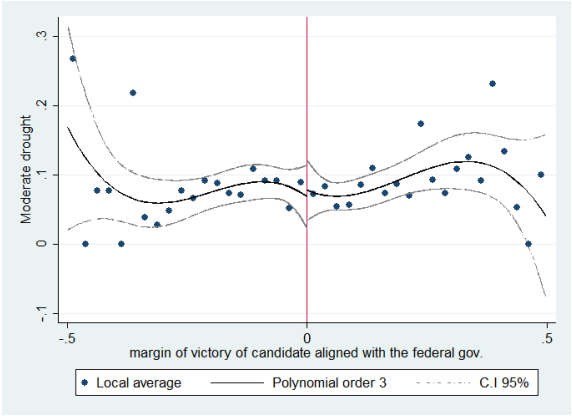


(a) Presidential elections

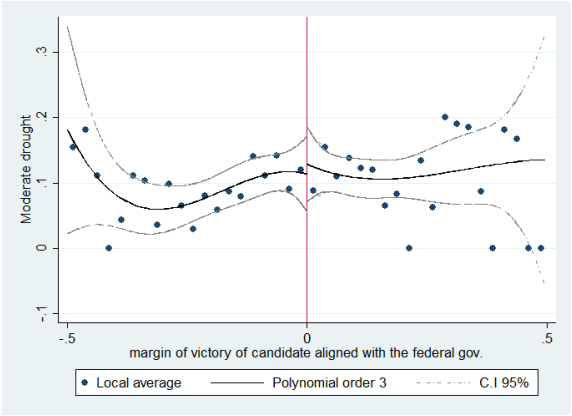


(b) Mayoral elections

Figure 12: moderate drought

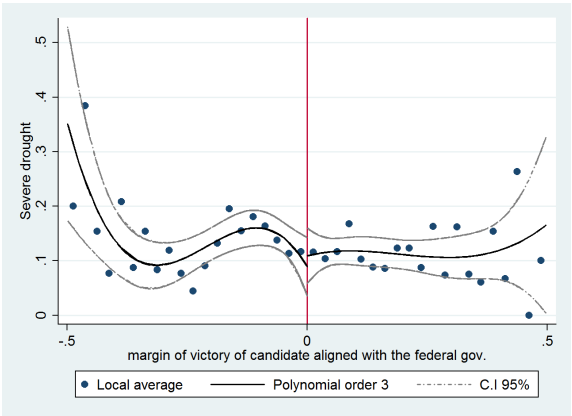


(a) Presidential elections

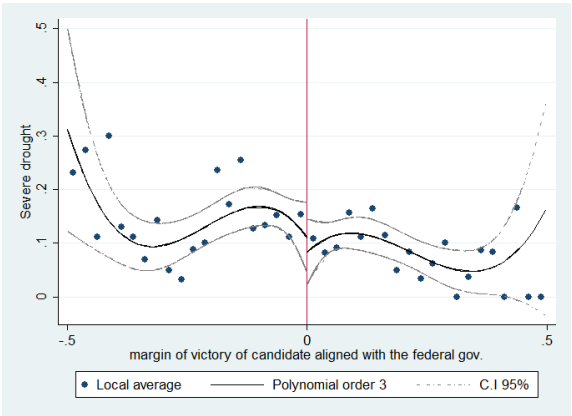


(b) Mayoral elections

Figure 13: severe drought

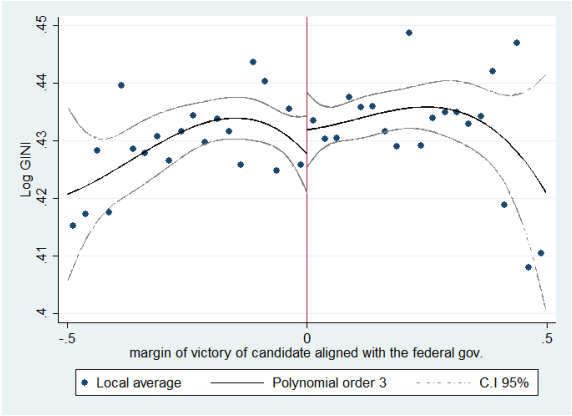


(a) Presidential elections

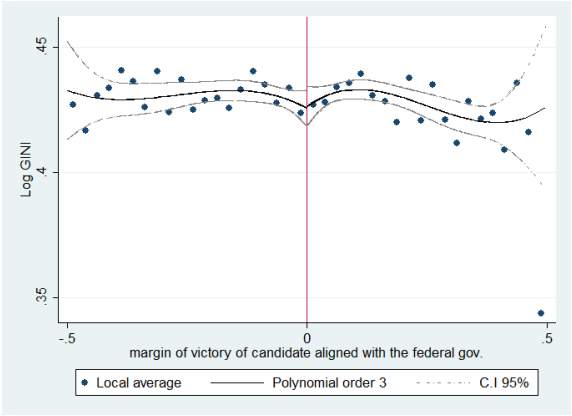


(b) Mayoral elections

Figure 14: GINI coefficient

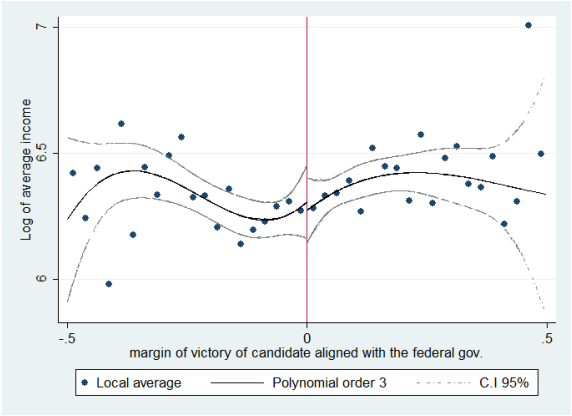


(a) Presidential elections

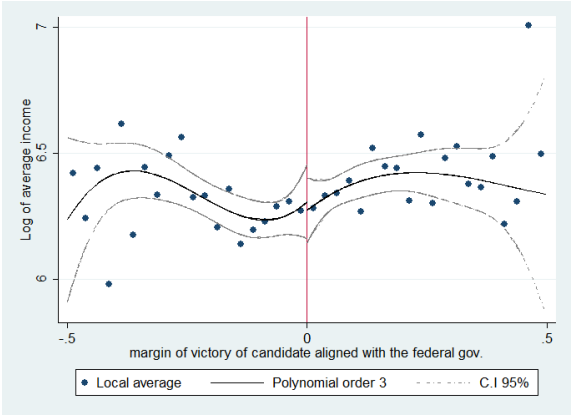


(b) Mayoral elections

Figure 15: average income

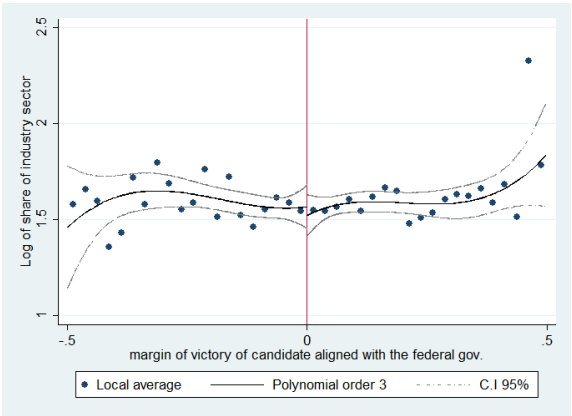


(a) Presidential elections

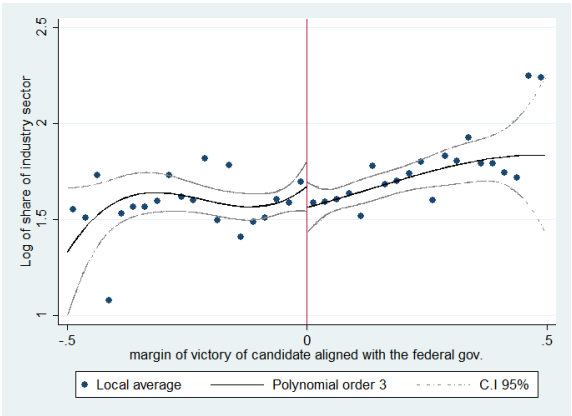


(b) Mayoral elections

Figure 16: share of workers in industry sector

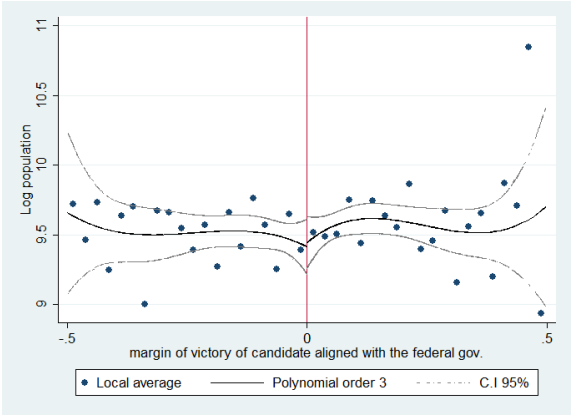


(a) Presidential elections

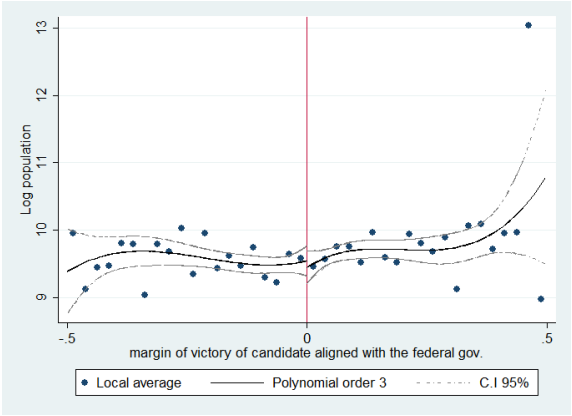


(b) Mayoral elections

Figure 17: population

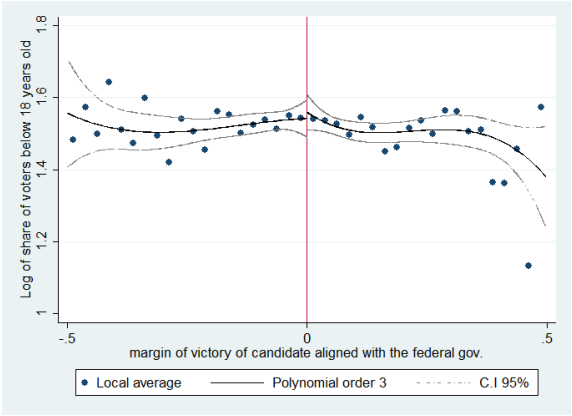


(a) Presidential elections

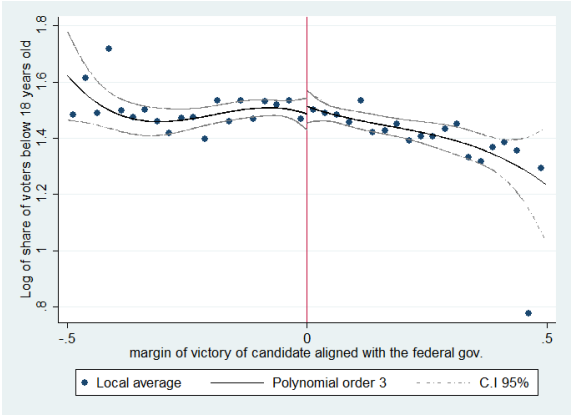


(b) Mayoral elections

Figure 18: share of voters below 18 years

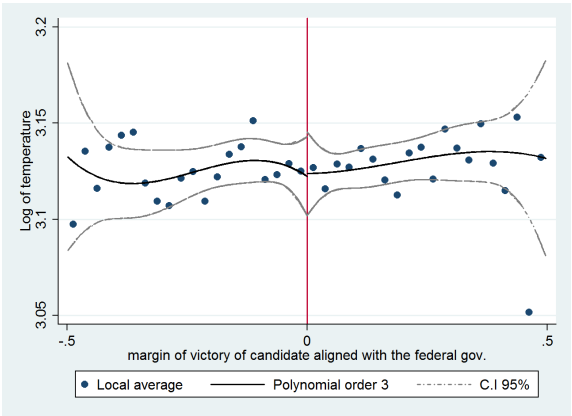


(a) Presidential elections

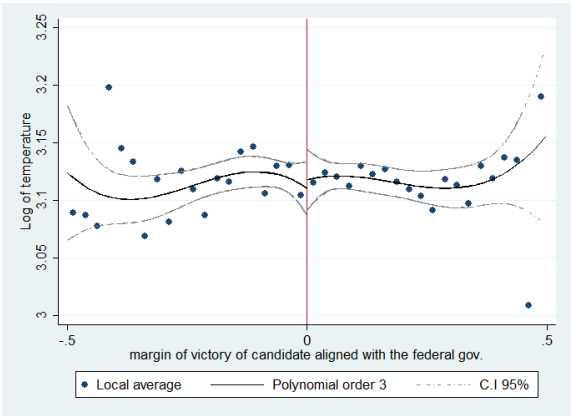


(b) Mayoral elections

Figure 19: temperature



(a) Presidential elections



(b) Mayoral elections

Appendix D Data Sources

Table 9: Data Sources

Variables	Institutions	Sources
Rainfall	INMET	www.inmet.gov.br
Evaporation	INMET	www.inmet.gov.br
Temperature	INMET	www.inmet.gov.br
Share of graduated citizens	Brazilain Census (1991, 2000, 2010) from IBGE	www.ibge.gov.br
Share of workers in agriculture sector	Brazilain Census (1991, 2000, 2010) from IBGE	www.ibge.gov.br
Share of workers in industry sector	Brazilain Census (1991, 2000, 2010) from IBGE	www.ibge.gov.br
Average income	Brazilain Census (1991, 2000, 2010) from IBGE	www.ibge.gov.br
GINI coefficient	Brazilain Census (1991, 2000, 2010) from IBGE	www.ibge.gov.br
Population	FINBRA	www.tesouro.fazenda.gov.br
Share of voters below 18 years old	Tribunal Superior Eleitoral	www.tse.jus.br
Margin of victory before presidential elections	Tribunal Superior Eleitoral	www.tse.jus.br
Margin of victory before mayoral elections	Tribunal Superior Eleitoral	www.tse.jus.br
Vote share of president's party	Tribunal Superior Eleitoral	www.tse.jus.br
Vote share of mayor's party	Tribunal Superior Eleitoral	www.tse.jus.br
Palliative policy	S2ID	s2id.integracao.gov.br
Prevention policy	Portal da Tranparência	www.portaldatransparencia.gov.br