Natural disasters support authoritarian populism: Evidence from the Brazilian shrimp vote*

Diogo Baerlocher[†]
University of South Florida

Renata Caldas[‡]
University of South Florida

Francisco Cavalcanti[§]
PUC-Rio

Rodrigo Schneider[¶]
Skidmore College

October, 2022

Abstract

We investigate the effects of extreme weather events on voicing political opposition against authoritarian regimes. We use the Brazilian general elections of 1982 as a case study. At the time, Brazil was under a military dictatorship that promoted local and gubernatorial elections to validate its authoritarian power. This context provides a positive measure of protest coined *shrimp vote*. Moreover, during the elections, the country's northeastern region was facing a long-lasting drought that started in 1979. Using data from meteorological ground stations to compute a measure of drought severity that takes rainfall and evaporation into account, we estimate the effects of the drought on the voting behavior of individuals in this region. Our findings suggest a negative causal effect of adverse weather shocks on the share of protest votes. Specifically, a one-standard deviation from the historical average water deficit reduces the share of shrimp vote by 2.5%. We also test for heterogeneity among factors such as relief transfers, clientelism, social vulnerability, and economic vulnerability. We only find heterogeneous effects for economic vulnerability. Namely, municipalities whose economy depended less on weather-resistant crops featured stronger declines in protest in response to drought severity.

Keywords: Natural Disasters; Drought; Democracy; Authoritarianism; Economic Development
JEL Codes: D72, H76, Q54

*We are grateful to Amrit Amirapu for helpful comments and participants at the 21st Annual Society for the Advancement of Economic Theory Conference. We are also thankful to Rafael Feitosa, Filipe Isidro and Cecília Rattes for their help collecting data from historical documents. Any remaining errors are ours alone.

[†]Department of Economics, University of South Florida, 4202 E. Fowler Ave. CMC342, Tampa, FL, 33620. (email: baerlocher@usf.edu)

[‡]Department of Economics, University of South Florida, 4202 E. Fowler Ave. CMC342, Tampa, FL, 33620. (email: renatad@usf.edu)

[§]Department of Economics, PUC-Rio, Rua Marquês de São Vicente, 225, Sala 210F, Gávea, Rio de Janeiro, RJ 22451-900. (email: francisco.lima.cavalcanti@gmail.com)

[¶]Economics, Skidmore College, 223 Filene Hall, 815 N Broadway, Saratoga Springs, NY, 12866 USA. (email: rschnei2@skidmore.edu)

1 Introduction

In recent years, democratic institutions have been threatened by the rise of authoritarian populist regimes across the globe. At the same time, new studies about climate change predict increases in the severity and frequency of natural disasters (IPCC, 2021). In this paper, we provide evidence that natural disasters can strengthen the control of authoritarian leaders over the population, helping them to perpetuate themselves in office. Specifically, we show that, in the 1982 Brazilian elections, areas more affected by adverse weather conditions featured a smaller share of protest votes against the military dictatorship.

The Brazilian 1982 general elections present a unique context in which we can estimate the impact of natural disasters on the support for democracy. First, the country's semiarid region was facing a long-lasting drought that started in 1979. Second, the political scenario at the time helps us build a positive endorsement measure for the authoritarian ruling party. The "shrimp vote" was a widely spread strategy utilized by voters who locally supported candidates affiliated with the military party but wanted to detach their image from the authoritarian central government. Therefore, municipalities featuring a larger share of shrimp votes are the ones whose voters decided to protest more against the dictatorship. The 1982 general elections are also a rare instance in which the election of local, state, and federal officials take place simultaneously, which allows estimating effects on gubernatorial elections conditional on local preferences.

Our findings suggest that drought severity reduced the impetus of voters to protest against the military regime. In particular, a median increase in the drought severity decreases the share of protest votes against the authoritarian regime by 14.6% of the mean, whereas an increase equivalent to the 90^{th} percentile decreases it by 38.4% of the mean. In absolute terms, about 84 (or 184 in the extreme scenario) more people in a typical municipality with six thousand inhabitants would have held a pro-democracy demonstration had it not been for the drought. Our results are remarkably stable even with the stepwise inclusion of observable characteristics that correlate with political, geographic, and economic factors and robust to several alternative specifications. All our estimates are conditional on state fixed effects, so we compare municipalities that choose from the same pool of candidates.

We interpret our findings as the effect of natural disasters on support for authoritarian populism, given the characteristics of the Brazilian military regime. Although the regime was dictatorial, it promoted local elections to validate its power. Moreover, there were democratic institutions represented by, for example, the Congress and the Supreme Electoral Court; however, they were constrained and weakened by the ruling party. Instead of a totalitarian regime, these characteristics better fit the definition of authoritarian populism used by Eichengreen (2018), in which populist governments take on undemocratic aspects such as weakening the executive's checks and balances and violence.[1]

The paradoxical combination of democratic institutions and state control is well depicted in our case study. In 1982, the military regime promoted a general election, which included the gubernatorial office for the first time since the beginning of the dictatorship in 1964. However, in this election, the regime introduced a crucial electoral rule to prevent a resounding defeat at the polls: voters could only vote for the same party for all the disputed positions. This strategy intended to guarantee that local support for candidates affiliated with the military party would also lead to victories at state-level elections.[2] Importantly to our paper, the strategy backfired since many local politicians promoted the shrimp vote to protest against the central government and keep their local alliances.

The shrimp vote was critical to voters in the Brazilian semiarid region due to its history of local support to conservative parties. Moreover, the area was unevenly hit by one of its most prolonged droughts lasting from 1979 to 1983. These two characteristics make the semiarid region a valuable laboratory to study the effects of adverse natural disasters on support for authoritarianism. Our central underlying assumption is that, conditional on state fixed effects and the history of water deficit, drought severity is uncorrelated to any other local variable that determines authoritarian regimes' political preferences. This assumption is validated by a balance test and our estimates' remarkable stability to the introduction of several geographical, electoral, and socioeconomic covariates into our models.

[1]The Polity IV project defines Brazil as a closed anocracy from 1975 to 1985. As a means of comparison, in 2014, Egypt and Myanmar had a similar Polity IV score to Brazil in 1982. See also Guriev and Papaioannou (2022) for different definitions of populism offered by scholars.

[2]It is important to highlight that the military party controlled many municipal executive branches of small and rural cities. The idea behind it was to translate local support into national backing automatically. We provide more details in Section 3.

We put forth a probabilistic model to help organize our empirical strategy and guide our search for mechanisms connecting natural disasters to support for authoritarianism. The model features prospective voters who vote to maximize their expected utility. Individuals earn a given labor income and expect losses due to adverse weather conditions according to their degree of vulnerability. These variables are independent of the party holding office. Voters also expect to receive disaster relief from authorities, which is proportional to the magnitude of the disaster. The expected transfer depends on the party in office and voters' behavior. Voters also draw idiosyncratic utility from having a given party in office. The model suggests that the marginal effect of natural disasters on the share of voters to party A depends on the expected amount of transfers promoted by party A relative to the opposition. Specifically, if voters expect party A to promote more disaster relief than party B, the natural disaster helps to swing more voters to support party A. We hypothesize that, under authoritarianism, voters have little reason to expect more transfers from the opposition; thus, the natural disaster must swing voters towards the authoritarian ruling party.

The conceptual framework also suggests four factors that can intensify the marginal effect of natural disasters on voters' behavior. They are the magnitude of expected transfers, the degree of vulnerability, the swing propensity, and the weight given to recent weather events to predict future weather conditions. By implementing an interaction model with demeaned variables of municipality characteristics, we find no statistically distinguishable effect among several proxies for each hypothetical mechanism listed above, except for municipalities with a higher economic dependence on crops resistant to drought shocks. These findings provide suggestive evidence that the degree of vulnerability of the electorate plays a significant role in connecting natural disasters and voter behavior.

Our paper contributes to various strands of economic literature. It is closely related to the literature on political outcomes from natural disasters. Several works find that incumbent politicians are likely to be punished for adverse shocks they cannot control in democratic contexts (Achen and Bartels, 2017; Gasper and Reeves, 2011; Cole et al., 2012; Bodet et al., 2016; Smirnov et al., 2018). However, in non-democratic contexts, the results are ambiguous. For instance, Bruckner and Ciccone (2011) argue that economic adversity caused by natural disasters can be an opportunity for democratic transition, whereas Lazarev et al. (2014) show that wildfires in

Russia raised support for the incumbent government at all levels. The provision of aid relief does not fully explain this support. Our results add further evidence indicating that natural disasters can be advantageous for despotic leaders.

We also dialogue with the literature on participation in protests since our response variable refers to a political demonstration against the incumbent government (Edmond, 2013; Enikolopov et al., 2020). Most of the literature focuses on the channel of information, e.g., social media, that leverages political demonstration. We extend this literature to the context of climate change by showing that drought severity is a channel that precludes citizens from engaging in collective actions such as protests. Closely connected, our study also draws near to research about the rise of authoritarian leaders that deteriorate the level of democracy. For instance, several studies show that the spread of social media has caused political polarization among voters and paved the way for populist leaders to win elections (Zhuravskaya et al., 2020; Levy, 2021).

Our work is also part of a broad series of studies connecting climate change and economic development through institutional quality (Nordhaus, 2007; Dell et al., 2014; Burke et al., 2015, 2016; Auffhammer, 2018). We contribute to this literature by showing that droughts dampen people's impetus to engage in defense of democracy. Moreover, as in Bobonis et al. (2019), we identify voters' vulnerability as an essential link between political support and natural disasters.

After this introduction, we present a conceptual framework of our case study. Section 3 discusses the institutional background and Section 4 describes the data. Results and potential mechanisms are presented in Section 5. Section 6 concludes the research paper.

2 Conceptual Framework

In this section, we provide theoretical motivation for our empirical exercise. The model is from the class of probabilistic voting models introduced by Lindbeck and Weibull (1987). It highlights the conditions under which we should observe natural disasters acting in favor of autocratic regimes. In sum, natural disasters yield economic losses to voters that the government can mitigate. Voters will support the political party they believe will provide more relief. If voters expect fewer benefits when they protest against the autocrat, more potent natural disasters will reduce the impetus to support democracy. We discuss below why this assumption is plausible, especially in our study. One fundamental assumption is that individuals form expectations about future weather based on past observations, giving significant weight to recent experiences.

Let voters i choose between parties $p \in \{D, A\}$ to maximize their expected utility, given by $u_i^p = y_i^p + d_i^p$, where y_i^p is the expected income and d_i^p is the idiosyncratic preference to party p.[3] We normalize $d_i^A = 0$ and assume $d_i^D \sim \mathcal{U}(\delta - 1/2\sigma, \delta + 1/2\sigma)$, where $\delta \in \mathbb{R}$ is the social bias toward party D, $\sigma \in \mathbb{R}_+$ is the swing propensity, and $\mathcal{U}$ represents an uniform distribution. Individuals' income depends on their labor income ($c_i \in \mathbb{R}_+$), weather shocks ($w \in \mathbb{R}$), and the relief measures ($m^p : \mathbb{R} \to \mathbb{R}$) promoted by the incumbent government, such that expected income is $y_i^p = c_i - \gamma[w - m^p(w)]$. The parameter $\gamma \in [0, 1]$ measures the vulnerability of the individuals to weather conditions.[4] The net utility from having a democratic party D instead of an authoritarian party A holding office is

$$u_i^D - u_i^A = \gamma[m^D(w) - m^A(w)] + d_i^D. \tag{1}$$

Eq. (1) stresses the factors determining support to one of the parties. The net economic benefit depends on the expected capacity of future governments to mitigate weather shocks, which comes from the assumption that neither labor income nor weather losses depend on which party is in office. The net economic benefit may be irrelevant if individuals are not vulnerable to weather shocks ($\gamma = 0$).

[3] We choose a linear utility function to simplify the exposition. We arrive at the same qualitative results using a quasi-linear utility function $u_i^p = v(y_i^p) + d_i^p$, as long v is strictly increasing and concave.

[4] The assumption that γ is identical for all individuals is not necessary. The same results can be obtained assuming $\gamma_i \sim \mathcal{U}(\bar{\gamma} - 1/2\epsilon, \bar{\gamma} + 1/2\epsilon)$, with $1/2\epsilon \leqslant \bar{\gamma} \leqslant (2\epsilon - 1)/2\epsilon$ and $\sigma \geqslant 1$. In this case, only the average $\bar{\gamma}$ matters. Thus, we can interpret γ as the average vulnerability of individuals.

In what follows, we assume that the disaster relief promoted by the government is a linear function of expected weather shocks, given by $m^p = \tau^p w$. We can interpret $\tau^p \in [0, 1]$ as the share of the expected income loss that individuals expect the government to mitigate. The next step is to connect currently observed weather shocks, denoted by $\bar{w}$, with expected weather shocks (w). The following assumption defines how voters form expectations about future weather.

Assumption 1. *Voters' expectations about weather loss w in the next period are given by*

$$w_{t+1} = w_t + \lambda_t(\bar{w}_t - w_t), \tag{2}$$

where $\bar{w}_t$ is the observed weather loss in the current period. In words, the expected value of w in $t+1$ given the information in t is the expected value of w in t given the information in $t-1$ updated by the error correction term in parentheses. The weight assigned to the error correction term is denoted by λ_t.

Assumption 1 states that voters use previous information about the weather to form their expectations about the future. The weight λ determines how voters account for new information $\bar{w}$. For example, if $\lambda = 1$, voters believe that shock $\bar{w}$ will be repeated in the next period. On the other hand, if $\lambda = 0$, voters ignore new information completely such that expectations are built on their prior beliefs about the weather.[5] We can use Eqs. (1) and (2), and $m^p = \tau^p w$ to compute the share of vote for the democratic party

$$s^D = 0.5 + \sigma\delta + \sigma(\tau^D - \tau^A)\gamma(\lambda\bar{w} + (1-\lambda)\bar{h}), \tag{3}$$

where $\bar{h}$ is a combination of observed weather losses before the current period, which stems from the recursive solution of Eq. (2). The following proposition summarizes the effects of weather shocks on the share of votes for the democratic party.

Proposition 1. *The marginal effect of current weather shocks on the share of votes for the democratic party is*

$$\frac{\partial s^D}{\partial \bar{w}} = (\tau^D - \tau^A)\sigma\gamma\lambda. \tag{4}$$

[5]This assumption is equivalent to, for instance, assuming that voters form beliefs as in a Bayesian learning model. Specifically, if we assume that $w_{t+1} = w_t + \epsilon_{t+1}$, with $\epsilon_{t+1} \sim \mathcal{N}(0, \sigma_w)$, and that individuals receive an imperfect signal about the weather $s_t = w_t + \eta_t$, with $\eta_t \sim \mathcal{N}(0, \sigma_s)$, then Eq. (2) represents voters' belief about w_{t+1}, where λ_t is the Kalman gain.

That is, support for democracy depends on the difference between the expected weather mitigation promoted by the democratic party and the authoritarian party. Moreover, the effect is larger when voters are more vulnerable to weather shocks, assign more weight to recent information to form their beliefs about future weather shocks, and when the swing propensity is higher.

Proof. Follows from Eq. (3). □

Proposition 1 provides a rationale for different findings in empirical studies. It shows that natural disasters can either help or harm incumbents depending on what voters expect from them relative to the opposition. Eq. (3) also reconcile the findings that disaster relief reduces political damage toward the incumbent. Although our model assumes that voters act prospectively, past disaster relief promoted by the incumbent may form positive expectations about future transfers. However, if voters expect the opposition to perform better than the incumbent, the benefits from current relief may not be enough for reelection.

The model also suggests three magnifying effects. First, individuals more vulnerable to weather shocks will react more strongly, which is in line with papers connecting politics and natural disasters through the vulnerability of voters (Bobonis et al., 2019). Second, the marginal effect of weather shocks is more robust when individuals assign more weight to recent information when forming expectations about the weather. Empirical research shows that more recent fluctuations in the climate are more relevant to form individuals' beliefs about future weather conditions (Deryugina, 2013; Gichangi et al., 2015; Kala, 2017). Finally, the effect is stronger where there is a higher swing propensity. This effect is straightforward since it reflects how strongly a group reacts to policy relative to ideology. Higher σ implies smaller diversity in idiosyncratic preferences reducing the share of voters changing their votes as a response to policy.

In general, we need to model how voters form expectations about τ to predict the direction of the effect. In what follows, we argue that we should expect weather shocks favoring the incumbent party under autocracy. First, we need to reinterpret the τ^p since, under autocracy, voters' preferences do not change the ruling party in the future. That is, the party A will remain in office, no matter the election's outcome. Thus, we reinterpret τ^p as the expected share of disaster mitigation if voters express a preference for party $p \in \{A, D\}$. We also reinterpret d_i^D as

the warm-glow utility from expressing support for democracy. The following hypothesis will be tested empirically.

Hypothesis 1. *Under autocracy,* $(\tau^D - \tau^A) < 0$*. Thus, when voters are vulnerable to weather shocks and form expectations about the weather using recent shocks, the marginal effect of weather shocks on political support for democracy is always negative.*

In our empirical exercise, voters express support for an authoritarian regime by voting in gubernatorial elections. In this case, alignment effects between the state government and the central government offer a plausible reason to expect $(\tau^D - \tau^A) < 0$. Another plausible reason is the prospect of pork-barrel behavior where politician favor their supporters when allocating resources. Yet another reason is that voters do not expect anything from the opposition ($\tau^D = 0$) since they would never hold office.[6] We provide empirical support to Hypothesis 1 by showing that municipalities that faced greater drought severity during the Brazilian military regime are associated with a smaller share of protest votes.

[6]The authoritarian party does not need to be in power to benefit from natural disasters. For example, Guiso et al. (2020) provide evidence that economic insecurity increases the distrust of traditional politics, which can be interpreted as a decline in τ^D in our theory.

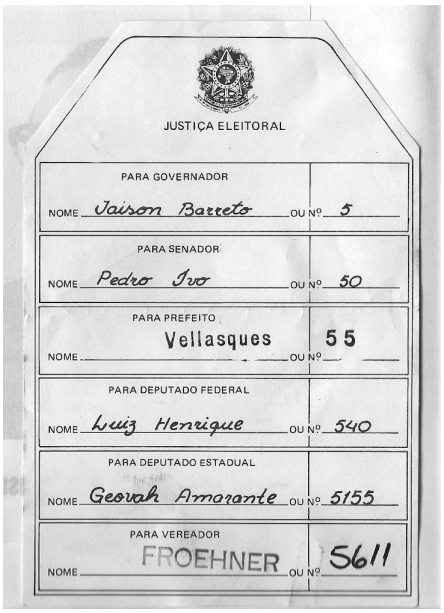
3 Institutional Background

The Shrimp Vote Since the first direct election in 1884, Brazilians have seen periods of political constraints and free elections. The country's notable period of authoritarianism is the military dictatorship that started with a *coup d'état* in 1964 and lasted until 1985. From the beginning, military leaders abolished all political parties and implemented a two-party system representing authoritarian and democratic views. Authoritarians formed the pro-military regime party ARENA (National Renovating Alliance), whereas democrats formed the opposition party MDB (Brazilian Democratic Movement). Although the population was allowed to select mayors – except in state capitals and other important cities – and legislative positions in all tiers of government, it was up to military commanders alone to appoint members of the executive branch, including the president, governors, and mayors of the major cities. The military dictatorship was marked by the harsh persecution of its opponents with torture, executions, and exile.

The military always promised the re-establishment of democracy and direct elections as long it happened in an "ordered" manner. The tightly regulated elections at the time indicated to the central government how fast this transition could happen without creating instability in the country. Thus, significant manifestations against the military party would postpone the return of free elections. For instance, in 1974, the dispute for senate positions drew a lot of attention for being a majoritarian election at the state level. Due to a resounding defeat on the ballot, the military regime postponed the first gubernatorial elections previously scheduled to take place in 1978.

Nonetheless, in 1982 Brazilian voters were again allowed to vote for state governors.[7] This election was overseen by the Brazilian electoral court (TSE) and conducted simultaneously across the country. Voters were called upon to decide on six positions comprising local and central government as well as executive and legislative functions (i.e., governor, senator, mayor, and federal, state, and municipal deputy). Fig. 1 depicts the single paper ballot used to cast votes by either writing down the name or number of each candidate for the six political positions in dispute.

[7] On February 5th, 1966, the military government created the Institutional Act 3, which established indirect elections for governors.



Notes: Figure shows an example of a 1982 ballot ordered by the governor, senator, mayor, federal deputy, state deputy, and councilor.

Figure 1: 1982 election ballot

In 1982, more than two parties were allowed to run for office. Five parties participated in these elections: The central government's party, PDS (ARENA successor), and four opposition parties: PMDB (MDB successor); a leftist party, PT (Worker's Party); and two parties influenced by the former president Getúlio Vargas's ideology, PDT (Worker's Democratic Party) and PTB (Worker's Brazilian Party). However, as the ARENA (military party) and the MDB (opposition party) were the only two political parties allowed to exist for nearly two decades, it was challenging for the newly created parties to launch competitive political candidates across the entire country. In this way, in practice, the 1982 elections were also characterized by the long-standing dispute between the military party (PDS) and the opposition party (PMDB).

A unique feature of the 1982 elections, and essential for our study, was the implementation of the *voto vinculado* (linked vote). This new electoral rule restrained voters from picking candidates from multiple political parties. If a voting ballot had numbers or names for candidates in different parties in any position at stake, the electoral justice should cancel the vote, which would not be counted. According to Andrade (1985), the linked vote was designed to benefit PDS candidates in federal and state disputes. The rule imposed further challenges on newly created parties.

More importantly, it increased the chances that local support for PDS candidates would translate into support at the federal and state levels. As pointed out in Ferraz et al. (2020), the military government managed to accommodate rival local political oligarchies within the same party through electoral legislation mechanisms (*sublegenda* voting system). Thus, the linked voting rule would be particularly important in the Northeast, as the PDS had more municipalities under control.[8]

The military regime did not expect a breach of the linked vote regulation to create a political movement against the central government. The regulation allowed voters to leave a blank space for some positions while filling in others with the number or name of candidates from the same party. In this way, an electorate could demonstrate its support for local positions while not supporting gubernatorial candidates by casting a blank vote. This behavior became known as *voto camarão* or "shrimp vote", where voters with local political ties to the PDS but no political ties to the central government would vote for the mayor belonging to the military party and leave the head of the ballot — governor's choice — blank.

In the 22nd of May 1982, after being consulted by a federal representative belonging to the PDS, the TSE officially permitted voters to leave blank spaces on the voting ballot while casting a vote for other political positions.[9] With this, democratic parties campaigned in favor of the shrimp vote in municipalities tied to PDS politicians. More importantly for this election, the decision also allowed PDS local authorities to show their dissatisfaction with the central command of the military party. For instance, an article in the *Jornal do Brasil* discussed how the shrimp vote would be used by PDS politicians in the states of Rio Grande do Norte, São Paulo, Minas Gerais, Maranhão, and Pernambuco as a protest against the gubernatorial candidates appointed by the military regime.[10]

While democratic parties campaigned in favor of the shrimp votes by playing jingles on the radio and distributing free t-shirts encouraging it, the PDS countered by threatening voters who use the shrimp vote.[11] Politicians tied to the military regime stressed that the shrimp vote could

[8] As Mainwaring et al. (1999) explain, the reason why the military party dominated rural and small towns in Brazil, especially in the Northeast, is because in these areas, the level of information is low and dependence on government resources is high, a combination of factors that foster patronage politics. That is why the press labeled the PDS as 'the party of the Northeast' (Mainwaring et al., 1999). We provide more details in the following subsection.

[9] Jornal do Brasil, "TSE decide que é válida a cédula com voto em branco", May 22nd, 1982.

[10] Jornal do Brasil, "Decisão consagra 'voto camarão'.", May 22nd, 1982.

[11] Jornal do Brasil, "PMDB-AL investe no 'camarão"', October 24th, 1982.

be easily tracked and that they would punish municipalities with a large percentage of protest. To illustrate, almost a month before the election, the military president João Figueiredo traveled to the municipality of Mossoró, in the state of Rio Grande do Norte, to deliver a speech against the shrimp vote, widely disseminated by local authorities affiliated with the PDS.[12][13] However, that was not sufficient to prevent the victory of democratic politicians in several states, such as Minas Gerais and Mato Grosso do Sul, propelled by the shrimp vote.[14]

The narrative above asserts that many voters were constrained to voice their discontentment towards the authoritarian military party due to their local alliances. The shrimp vote served the purpose of a protest vote when not supporting the regime was the second-best option. It is important to note that the protest stemmed from local politicians affiliated with the PDS who wanted to detach their images from the authoritarian regime.[15] In fact, according to an official note issued by the PMDB, the shrimp vote was used as a last-resort strategy by the local PDS candidates to guarantee suffrage for their electorate.[16]

This paper uses the shrimp vote to measure protest against the military regime. This measure is quite conservative since it disregards voters that support the opposition in all tiers of government. Therefore, if anything, our results tend to underestimate the effects of natural disasters on protesting against the military party. It is also noteworthy that the shrimp vote is intrinsically attached to future expected losses, a condition required for hypothesis 1 to hold. Given the threats voiced by the central government, voters should expect punishment when casting the shrimp vote.

Drought in the Brazilian Semiarid Droughts are the most common natural disaster in Brazil. Although these events occur across the entire national territory, in some regions, their consequences are more severe in the population's lives. This is the case in the Brazilian semiarid

[12]Jornal do Brasil, "Figueiredo repúdia 'voto camarão' em Mossoró", October 8th, 1982.

[13]The threats were not empty. Local authorities who disseminated the shrimp vote were penalized afterward. For instance, in the state of Ceará, where the PDS won the gubernatorial race, the governor fired public employees in places where the shrimp vote occurred more intensively (Jornal do Brasil, "Ceará demite para punir o voto camarão", December 7th, 1982). Also, several mayors affiliated with the PDS in municipalities with higher shares of shrimp vote, noticed an unjustifiable drop in tax revenues from the central government (Jornal do Brasil, "Prefeito estranha queda no ICM" August 22nd, 1982).

[14]Jornal do Brasil, "'Camarão' ajudou a derrotar Eliseu", November 18th, 1982.

[15]A Tribuna, "Candidatos do PDS estão omitindo a sigla partidária", September 1st, 1982.

[16]A Tribuna, "Origem do 'voto camarão"' November 3rd, 1982.

region, where the impact of droughts is known to be relevant to cultural, social, and political aspects (Campos, 2015).[17] The region is also the poorest in Brazil, with a predominantly rural population, small cities, and social indicators significantly worse than the rest of the country, such as infant mortality rates and educational indicators. As the semiarid has a drought-prone environment characterized by very precarious conditions, agricultural workers and their families lived permanently on the edge of survival.

During the 1979-1983 drought, the central government implemented a plan to alleviate the negative effect of water scarcity. The plan had three main pillars: (1) the provision of jobs to individuals who lost their crops, (2) subsidized credit, and (3) the provision of water using, for instance, tank trucks. Pessoa (1987) stresses that the first pillar was the most important. The author also explains the nature of jobs provided by the government. Temporary workers benefited from working within properties, mostly big farms in the region, and the work fronts represented the only source of income for many impoverished households. Therefore, the central government provided extensive support to the affected population and, according to Pessoa (1987), the population assisted by the emergency program represented half of the total labor force in the region in 1983.

This high dependence on government resources in the Brazilian semiarid fostered a clientelistic relationship between voters and local landowners, who often were also the local politicians or had, at least, close ties to them (Nelson and Finan, 2009). These landowners who employ many agricultural workers extend their economic control into political control, strongly influencing workers' electoral decisions. By these means, landlords act as local vote brokers (Gingerich, 2013). As depicted by Vilaça and de Albuquerque (1988), politicians can count on thousands of votes cast for them secured by the landlords. These votes come without much effort, as direct contact with the electorate is unnecessary.

The existence of local brokers in the hinterland of the Northeast results from the historical process of land inequality and oligarchical politics. Conservative parties have utilized this

[17] There exist reports describing the terrible effects of droughts in the Brazilian semiarid since the late 16th century, when Brazil was still a colony of Portugal. However, droughts in the semiarid became a national concern only in the late 19th century, when Brazil was already an independent empire. It was only as a young republic, in the early 20th century, that the Brazilian government acted to mitigate the effects of dry seasons in the region. The central policy toward that goal was the creation of a department in charge of improving the infrastructure through the construction of dams and irrigation areas.

political system since the Brazilian independence 1822 (Ames, 2002; Mainwaring et al., 2000; Gans-Morse et al., 2014). Although conservative parties were weakened after the 1930s, the military coup renewed the clientelistic ties between landowners and local politicians, especially in underdeveloped regions (Ferraz et al., 2020). As highlighted by Mainwaring et al. (2000, p. 173), the goal of the military party "was to build political networks and clienteles within the vast, underdeveloped interior of the country".

The type of patronage politics described above explains the solid control of the conservative party in local elections depicted in Fig. 3 in the following section. This dominance is even stronger in mayoral elections, which stresses the rigid political control at the local level. It is hard to believe that adverse weather conditions could affect local elections. This hypothesis is supported by our empirical findings as the share of votes in mayoral elections is the only one not affected by the drought. Nonetheless, the support for governors could be affected by the weather. That is, adverse weather shocks could make voters more vulnerable and, consequently, more afraid of protesting against the dictatorship by doing the shrimp vote and hurting governors belonging to the PDS party. Retaliation for shrimp votes, as promised during the electoral campaigns by the military government, could come as a decrease in aid to alleviate the negative impact of droughts. Thus, voters more negatively affected by the weather would be more vulnerable to retaliation and less prone to do the shrimp vote.

4 Data

Drought Index Many studies about the socioeconomic impacts of droughts use rainfall as the measure of water scarcity (Bobonis et al., 2019; Rocha and Soares, 2015). Nonetheless, droughts in the Brazilian semiarid occur because the soil's capability to retain moisture after precipitation is low. (Pessoa, 1987). Therefore, we follow recent climatology studies stressing the importance of taking soil composition and temperature into account to measure soil moisture, especially in the global warming context (Dai, 2011, 2013; Trenberth et al., 2014; Martins et al., 2018; Short Gianotti et al., 2020; Pascolini-Campbell et al., 2021).[18] Specifically, in the spirit of Vicente-Serrano et al. (2010), we use the inverse estimated Standardized Precipitation Evapotranspiration Index to measure the impact of water scarcity in a given area.[19] The index is the deviation of annual cumulative dryness from its historical mean normalized by the standard deviation, where dryness is the difference between evapotranspiration and precipitation.

Since we study a long-lasting hydrological drought (Dai, 2011), we follow Brito et al. (2018) by defining drought severity as the intensity of dryness during a given period. Therefore, drought severity in each municipality between 1979 and 1982 is the average standardized dryness from November 1978 until October 1982.[20] Specifically,

$$\text{Drought Severity}_{i,t} = \sum_{t=\text{Nov 1978}}^{\text{Oct 1982}} \max\left\{\frac{(E_{i,t} - P_{i,t}) - (\bar{E}_i - \bar{P}_i)}{\sigma_i}, 0\right\}, \tag{5}$$

where $E_{i,t}$ represents the cumulative observed evaporation over 12 months in municipality i in month t, and $P_{i,t}$ represents the same for precipitation. Horizontal lines over the variables represent historical averages and σ_i is the standard deviation of $(E_{i,t} - P_{i,t})$ in municipality i. Positive values imply that the amount of cumulative water retained in the soil is lower than

[18] We are not the first to adopt this approach in economic studies. For example, Cavalcanti (2018) and Olivieri (2020) use the aridity index that takes the ratio of evaporation to rainfall. Smirnov et al. (2018), Albert et al. (2021), and Boffa et al. (2022) use measurements based on the difference between evapotranspiration and precipitation.

[19] The Standardized Precipitation Evapotranspiration Index is computed using precipitation and potential evapotranspiration. Our measure is the estimated index because we use observed evaporation instead. Observed weather data is superior to data gathered from satellites because satellites do not directly measure rainfall and evaporation but instead make inferences (Dell et al., 2014).

[20] We chose this window because this natural disaster is commonly reported to have started in 1979, and elections took place in November 1982 (Pessoa, 1987). We implement alternative measures of drought severity in the robustness check in Table 5.

the historical average. That is, the municipality is going through a period of great aridity. We truncate the measure at zero to capture only dryer periods (Rocha and Soares, 2015).

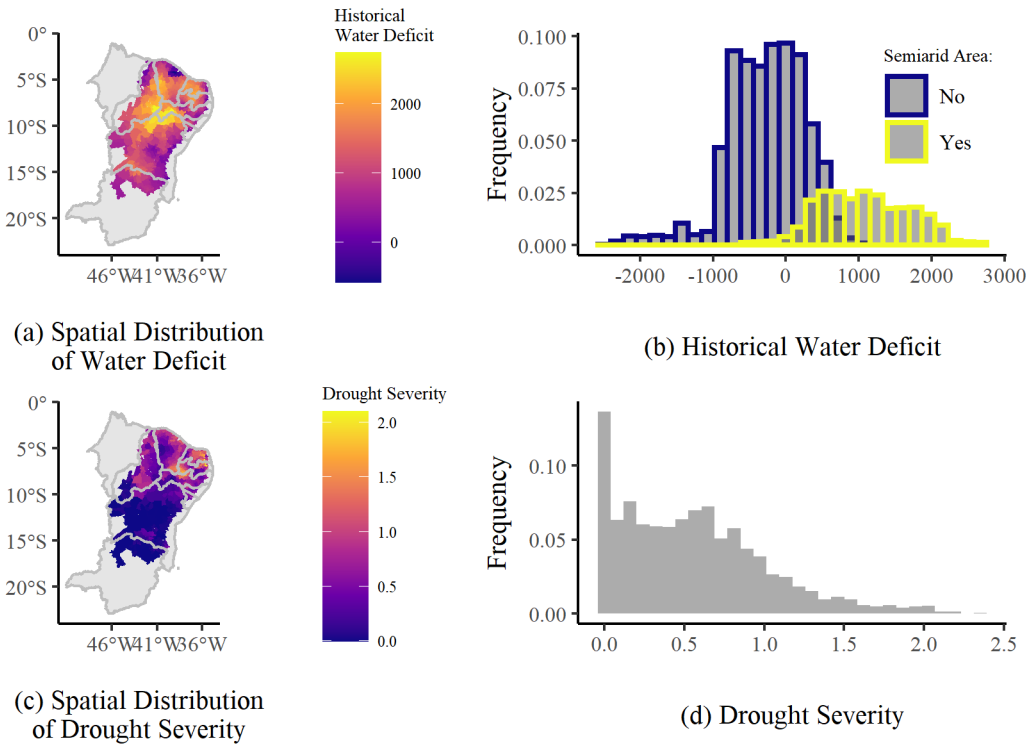
We collect monthly weather data from the Brazilian Institute of Meteorology (INMET) meteorological stations. The raw data is objective weather information recorded with pluviograph and Piche evaporimeter from 180 ground stations from 1963 to 2018. We compute a weighted average of each station's information for each municipality, where weights are the station's squared distance to the municipality's centroid.

Fig. 2 depicts our water scarcity data. In panels (a) and (b), we show the spatial distribution of the data in the semiarid area. The grey background shows the ten Brazilian states that contain municipalities in the semiarid region. Panel (a) highlights that the semiarid municipalities are historically deficient in water. Furthermore, panel (b) shows that these municipalities are comparatively more deficient than the rest of the country. Hence, the impact of droughts in these municipalities represents an extremely high level of aridity. On the other hand, panels (c) and (d) highlight that the drought event we study presents significant heterogeneity in terms of severity calculated as in Eq. (5).

Elections Data from the 1982 general elections is provided electronically by the Superior Electoral Court of Brazil. We have detailed information at the municipality level on voter turnout, the electorate, and votes for each political party in each candidature. We also collected data regarding the 1972 municipal election from the archive reports produced by the Superior Electoral Court in 1988.

Fig. 3 shows the distribution of vote share for PDS politicians in elections for governor, mayor, and legislative positions in municipalities inside and outside the semiarid.[21] The figure reveals the strong influence of the military party in the semiarid region. In the median municipality in the semiarid region, the PDS receives at least 65% of the valid votes in all candidacies in dispute. In contrast, outside the semiarid region, the median is at most 47%. These numbers portray the stylized fact discussed in the previous section about the capture of the semiarid region by conservative parties, which is often represented by agrarian elites exerting substantial political

[21] Boxes represent the interval between the first and third quartiles, whereas the horizontal line within them is the median. The upper and lower whiskers are $\min(x, 1.5 \times \text{IQR})$ and $\max(x, 1.5 \times \text{IQR})$, respectively, where IQR is the distance between the first and third quartiles. Observations beyond the whiskers are considered outliers.



(a) Spatial Distribution of Water Deficit

(b) Historical Water Deficit

(c) Spatial Distribution of Drought Severity

(d) Drought Severity

Notes: a) spatial distribution of average water deficit between 1963 and 2018 in the semiarid region. b) distribution among municipalities inside and outside the semiarid region. c) spatial distribution of drought severity between 1979 and 1982. d) distribution of drought severity between 1979 and 1982.

Figure 2: Descriptive analysis of water deficit

influence over a high share of peasants. Importantly, local elections are particularly skewed towards the military party. The median share of votes for PDS candidates in mayoral elections was 81%. This fact is remarkable, mainly because the votes between candidacies were supposed to be aligned by construction.

We want to measure protest against the military dictatorship. We rely on the electoral behavior known as the shrimp vote discussed in the previous section. This behavior is characterized by validating the vote for a candidate for mayor (likely from PDS in the semiarid region) and casting a blank vote for governor, virtually tearing the ballot at the top. We build our variable of interest as the difference between the total number of valid votes for the PDS mayor candidate and the PDS governor candidate, divided by the number of total votes in each dispute. Specifically, shrimp vote $= v_m - v_g$, where v_m and v_g denotes the share of valid votes for PDS candidates in mayoral and gubernatorial elections, respectively.

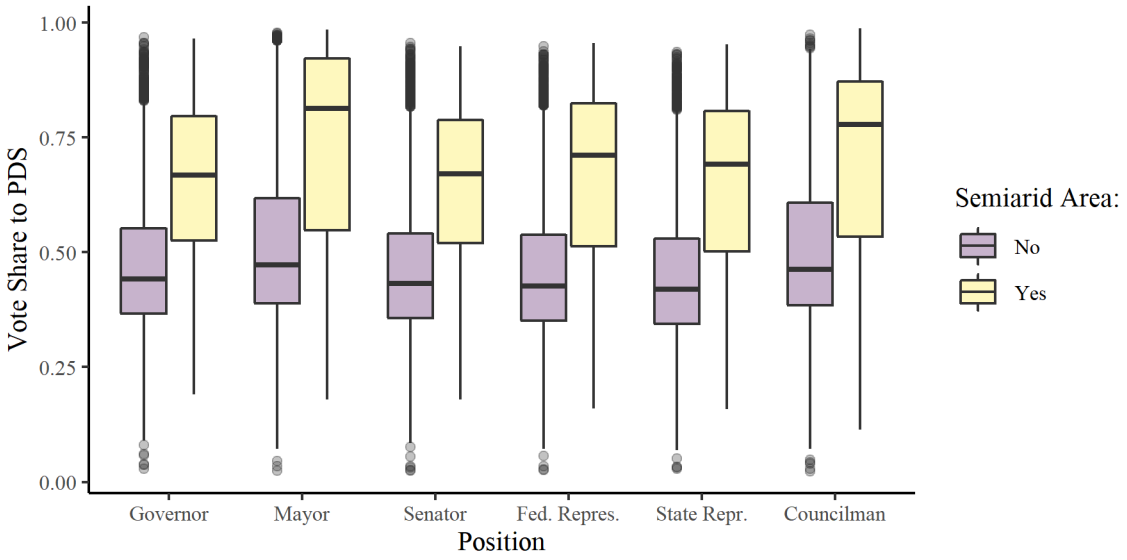


Figure 3: Vote share for PDS politicians in all positions disputed in 1982

The difference between votes for mayor and governor represents precisely the electorate that teared up the ballot. In principle, we adopt a very conservative measure of protest since it does not capture protest from individuals who also protested locally by voting to party differently from PDS. Instead, our main estimates are conditional on the share of votes for PDS candidates in mayoral elections. Thus, in practice, we infer the effect of drought severity on the share of votes for the PDS candidate in gubernatorial elections conditioned on local political preferences.[22]

The distribution of shrimp votes both inside and outside the semiarid region is presented in the left panel of Fig. 4. Note that a large share of the distribution is located in the positive values of both areas. It represents more votes for the PDS locally than in state elections. Notably, the mass in the positive area is larger in the semiarid region, most likely because of the large share of votes for PDS candidates in mayoral elections. Given that election rules precluded voting for politicians from different parties, this mismatch is only possible if voters cast a blank vote for governor. This strategy is depicted in the second panel. Municipalities with a larger share of blank votes for governor have a more significant mismatch in the vote share for PDS candidates.[23]

[22]We opt to use the shrimp votes as the primary measure of protest because it captures local preferences even when ν_m is not included as a covariate and because we can interpret results based on the then-existing definition of protest. Table 1 presents results for several electoral variables as dependent variables.

[23]This relationship suggests that the share of blank votes for governor is also a good measure of protest. Table 4 shows that our results using the share of blank votes as a dependent variable are virtually identical to the result using shrimp vote.

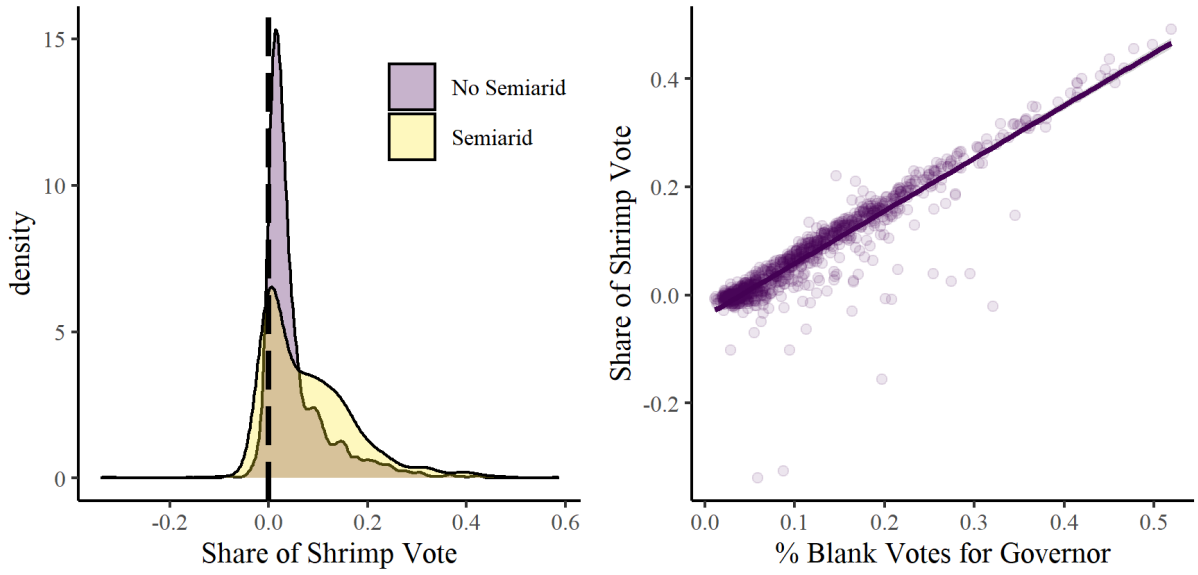


Figure 4: Shrimp vote distribution and its relationship with blank votes

5 Drought severity and protest against dictatorship

Empirical strategy Inspired by Eq. (3), the following linear regression equation guides our empirical strategy:

$$Y_{m,s} = \alpha + \beta_0 D_{m,s} + \beta_1 H_{m,s} + \gamma X_{m,s} + \phi_s + \epsilon_{m,s}, \tag{6}$$

where $Y_{m,s}$ is the share of shrimp vote in municipality m in the state s. $D_{m,s}$ is our measure of drought severity that represents the average deviation cumulative water deficit between November 1978 and October 1982, whereas $H_{m,s}$ represents the history of droughts measured by the averaged historical water deficit. $X_{m,s}$ is a set of municipalities characteristics, ϕ_s is a fixed effect of state, and $\epsilon_{m,s}$ is a random error term.

Our (conditional) independence assumption is that drought severity is uncorrelated with the error term conditional to observable variables and unobservables common across municipalities within the same state. When this assumption holds, an OLS estimation produces an unbiased estimate of β_0. Table 1 presents a balance test with municipalities split below and above the median of drought severity. Municipalities more affected by the drought are, on average, more developed, closer to either rivers or the coast, and inclined to vote less for the military party in 1972. However, when we condition the difference between groups on state fixed effects and historical water deficit in column 4, we cannot reject the null hypothesis that these two groups are similar at a 95% confidence interval for all variables, except distance to a river.[24] This result suggests that the conditional independence assumption is valid.

Further evidence is presented in the results below, in which adding many covariates in $X_{m,s}$ barely changes the estimated marginal effect. Namely, the estimates are conditional on three geography variables: historical water deficit, distance to rivers, and distance to the coast.[25] Three electoral variables are used as controls: the turnout rate, the share of votes for the military regime's candidate in the mayoral election of 1972, and the percentage of votes for the military

[24] Bearing in mind that in our main specification, we include the geographic and development variables as controls.

[25] Historical water deficit is measured between 1960 and 2013, whereas distances are computed using shape-files from the National Institute for Space Research. They are the Euclidean distance from municipal seats to either rivers or the coast.

Table 1: Balance Test

Variables	Low Severity (1)	High Severity (2)	Diff (3)	Cond. Diff (4)
Geography Variables:				
Log(1 + Distance to River)	4.627	4.137	-0.4892	-0.2059
	(0.827)	(0.783)	[0.0553]***	[0.0684]***
Log(Distance to Coast)	5.423	4.807	-0.6159	-0.0202
	(0.616)	(0.922)	[0.0539]***	[0.0443]
Mayoral Elections in 1972:				
Share of Votes to ARENA	0.828	0.779	-0.0486	-4e-04
	(0.186)	(0.202)	[0.0133]***	[0.019]
Share of Blank Votes	0.077	0.071	-0.0058	0.001
	(0.096)	(0.096)	[0.0066]	[0.0087]
Turnout Rate	0.708	0.759	0.0511	0.0151
	(0.106)	(0.093)	[0.0068]***	[0.008]*
Development Variables:				
Share of Pop. in Rural Areas (1970)	0.770	0.746	-0.024	-0.0052
	(0.148)	(0.143)	[0.01]**	[0.0146]
Share of Pop. in Rural Areas (1980)	0.707	0.674	-0.0336	-0.0054
	(0.169)	(0.162)	[0.0113]***	[0.0158]
Log(Population Density) (1970)	2.653	3.324	0.6704	0.0167
	(0.922)	(0.831)	[0.0603]***	[0.0667]
Log(Population Density) (1980)	2.776	3.427	0.6504	0.0317
	(0.903)	(0.82)	[0.0592]***	[0.0676]
Share of Literate (1970)	0.395	0.373	-0.0226	-0.0131
	(0.101)	(0.097)	[0.0068]***	[0.0091]
Share of Literate (1980)	0.459	0.432	-0.0274	-0.0062
	(0.099)	(0.092)	[0.0066]***	[0.0086]

The sample encompasses municipalities in the Semiarid area with information about all variables used in the analysis. High and low severity groups are defined as above and below the median value of drought severity in the sample. Diff is the difference between columns one and two, whereas Cond. Diff. is the difference between groups conditional on state fixed effects and historical water deficit. Standard deviations in parentheses, and standard errors in squared brackets.

regime's candidate in the mayoral election of 1982.[26] Importantly, local support for the military in 1982 makes our estimate conditional on local ideology during the study period. We also add several development variables as covariates. They are population density in 1970 and 1980, literacy rates in 1970 and 1980, and the share of the rural population in 1970 and 1980.

Our sample includes only municipalities in the semiarid region as currently defined. We exclude three states from our sample since they have a small number of municipalities in the semiarid region. Specifically, we exclude *Maranhão* (2), *Alagoas* (34), and *Sergipe* (29).[27] With that, our sample contains 848 municipalities within seven states. Table 2 presents descriptive statistics of variables used in the analysis for our primary sample. Descriptive statistics show that our sample is from municipalities with low education, where on average, 38% of the population cannot read and write, and very rural, where about 69% of households are located in rural areas, in addition to the high dominance of the authoritarian party, where the average vote for ARENA is an impressive 80% in 1972.

Main results We present the main results of our empirical strategy in Table 3. The first column shows a univariate OLS regression between drought severity and shrimp vote. Column 2 adds state fixed effects, column 3 adds geography variables, column 4 adds electoral variables, and development variables enter in column 5. Robust standard errors are presented in parentheses.

The table indicates that drought severity is negatively associated with protests against the military regime. We arrive at this conclusion using the OLS regression in the first column, where the estimated coefficient is negative. Inserting state fixed effects decreases the strength of the impact slightly, which increases again after the introduction of geography covariates. The introduction of electoral and development variables affects the point estimates only slightly and increases their precision. In our preferred specification in column 5, the coefficient is -0.025, which implies that stronger drought severity has reduced the impetus of voters in the semiarid region to tear up the top of the ballot as a form of boycotting against the military regime in

[26] The turnout rate helps us control forced migration as we expect lower turnout rates in municipalities where individuals decide to move out. The share of votes of the military regime's candidate in 1972 helped us to account for historical local political preferences.

[27] Table 5 shows that our results are robust to alternative sample choices

Table 2: Descriptive Statistics

Variables	Count	Mean	Std. Dev.	Min	Max
Shrimp Vote	848	0.08	0.09	-0.34	0.49
Share of Votes to PDS in Gubernatorial Elections	848	0.65	0.16	0.19	0.94
Drought Severity	848	0.59	0.47	0.00	2.10
Geography:					
Historical Water Deficit	848	1108.82	615.22	-573.34	2743.12
Log(1 + Distance to River)	848	4.38	0.84	0.00	6.00
Log(Distance to Coast)	848	5.11	0.84	1.41	6.60
Electoral:					
Share of Votes to PDS in Mayoral Elections	848	0.73	0.20	0.18	0.98
Turnout Rate	848	77.69	8.29	6.47	100.00
Share of Votes to ARENA in Mayoral Elections (1972)	848	0.80	0.20	0.05	1.00
Development:					
Share of Pop. in Rural Areas (1970)	848	0.76	0.15	0.07	0.98
Share of Pop. in Rural Areas (1980)	848	0.69	0.17	0.04	0.98
Log(Population Density) (1970)	848	2.99	0.94	0.18	6.03
Log(Population Density) (1980)	848	3.10	0.92	0.29	6.37
Share of Literate (1970)	848	61.62	9.95	25.20	92.40
Share of Literate (1980)	848	55.46	9.65	19.30	91.40

The sample encompasses municipalities in the Semiarid area with information about all variables used in the analysis. The shrimp vote is the difference between the share of votes for the PDS candidate in the mayoral and gubernatorial elections. Drought Severity is the average deviation from the historical water deficit between November 1978 and October 1982.

Table 3: The Effect of Drought Severity on Shrimp Vote

	(1)	(2)	(3)	(4)	(5)
Drought Severity (Nov 1978 - Oct 1982)	-0.028	-0.015	-0.022	-0.027	-0.025
	(0.006)***	(0.010)	(0.011)**	(0.009)***	(0.008)***
Observations	848	848	848	848	848
State FE	No	Yes	Yes	Yes	Yes
Geography	No	No	Yes	Yes	Yes
Electoral	No	No	No	Yes	Yes
Development	No	No	No	No	Yes

Robust standard errors in parentheses. Drought Severity (Nov 1978 - Oct 1982) is average water deficit between November of 1978 and October of 1982. Geography variables include historical averaged water deficit, distance to rivers, and distance to the coast. Electoral variables include turnout rate, vote share to ARENA (military party) in 1972 and vote share to the PDS candidate in the 1982 mayorial election. Development variables include the share of population living in rural areas in 1970 and 1980, population density in 1970 and 1980, and the share of literate adults in 1970 and 1980. $^{*}p < 0.1,^{**} p < 0.05,^{***} p < 0.01$

gubernatorial elections. In other words, the drought caused less adherence to the protest in favor of democracy.

The marginal effect of drought severity is substantial as the 50th percentile in our sample on relative protest is -0.014 percentage points, which is 17.5% of the relative protest mean. More strikingly, using the 90th percentile strengthens the effect to -0.031 p.p, which is 38.4% of the mean. In absolute terms, a median semiarid municipality with 6,000 voters that experiences a weather shock similar to the municipality in the 90th percentile would observe 184 fewer protest votes.

However, these numbers are not enough to claim that the drought was responsible for the electoral victory of pro-military governors in northeastern states. In most of these states, the PDS candidate won with more than 60% of the valid votes. Our numbers suggest that, in the case of an intense, long-lasting drought (one-standard deviation from historical water deficit), 2.5 percentage points could be attributed to the drought. Therefore, these significant victories are the outcome of other factors. Nonetheless, 2.5 p.p. may be enough in close elections to flip the winner. For example, in the state of *Pernambuco*, the PDS candidate beat the opposition with only 52.5% of valid votes. In this case, severe droughts may have caused the election of the military party candidate.

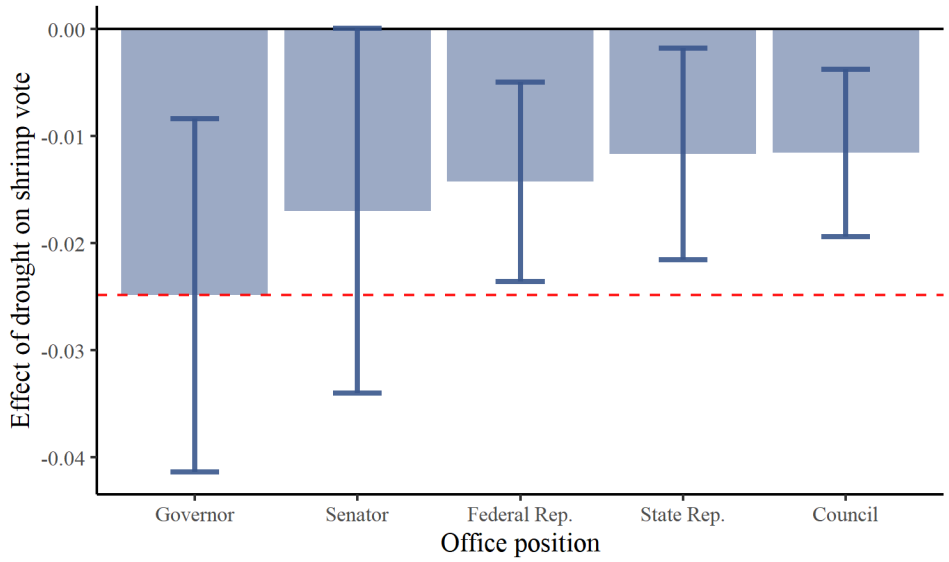


Figure 5: Marginal effect of Drought in the share of vote to PDS in other positions

Is it protest? Fig. 5 helps us to strengthen our argument that drought causes reductions in protest instead of causing fewer shrimp votes for other reasons. For example, one could argue that more severe droughts make it more challenging to collect information about candidates or cause increases in inattention among voters. Columns in Fig. 5 represent point estimates in our most saturated specification using the difference in votes shares to PDS candidates in mayoral and other positions in dispute. Namely, the governor's office, the senate, the federal chamber, the state chamber, and the local councilor. Point estimates are more robust in majoritarian positions, especially for the governor's office. Recall from the discussion in Section 3 that majoritarian elections were the focus of protest against the military dictatorship. Moreover, in 1982, gubernatorial elections were in the spotlight, and were the dispute targeted by the opposition. Importantly, inattention and lack of information are more likely to occur in proportional legislative positions with a larger pool of candidates. Further, for the legislative positions, voters had to either memorize the candidate's names or a four-digit number, in contrast to a one-digit for the candidate for governor's office.[28] Finally, the placeholder vote for governor comes first on the ballot, as shown in Fig. 1. It is well-documented that disputed positions that appear earlier on the ballot are more

[28]See Schneider and Senters (2018) for a discussion on the importance of candidates' numbers for elections in Brazil. Fujiwara (2015) shows that Brazilian paper ballots were characterized by votes riddled with errors and that the introduction of electronic voting in 1998 promoted the enfranchisement of less educated voters.

likely to receive votes (Miller and Krosnick, 1998; Blom-Hansen et al., 2016). Thus, one should expect fewer blank votes in the governor's dispute, which is the opposite of what we find.

Robustness We perform several robustness checks to rule out alternative specifications that may invalidate our interpretation. First, in Table 4, we present results for alternative electoral variables to confirm that the results are driven by the behavior towards gubernatorial elections rather than local. Although our estimates in columns four and five in Table 3 are conditional on the share of votes to the local PDS candidate, it is illustrative — and reassuring — to show that these elections are not affected by drought severity. All columns in the table are conditional on the same variables as in column five of Table 3, except on the share of votes for PDS in local elections and turnout rate since they are in the list of dependent variables. In Table 4, the first column confirms the findings in our primary analysis, although the effect is smaller and less precise with this specification. Column two shows that the share of votes for the PDS candidate in local elections is not affected by drought severity, reinforcing the idea that local politics is well established. Columns three and four show that stronger drought severity increases the support for the military in gubernatorial elections and reduces the share of blank votes in this dispute. The proximity between the estimated marginal effects on the shares of shrimp vote and blank votes is noteworthy, although not surprising, given that differences between local and state support can only be achieved through blank votes. Columns five and six show that the drought severity did not affect blank votes in mayoral elections or the turnout rate.

Table 5 presents the results from a series of alternative specifications and sample choices. For comparison, column 1 is the baseline result presented in column 5 of Table 3. Column 2 adds controls for a third-order polynomial in latitude and longitude to capture nonlinear geographical features. The model in column 3 controls the share of votes for the PDS candidate for councilor instead of controlling for the share of votes for the PDS mayoral candidate to avoid having a dependent variable that is constructed from one of the covariates. Column 4 includes all municipalities in the semiarid region as a sample, whereas column 5 uses all municipalities from the northeastern region and those included in the semiarid region in the state of *Minas Gerais*. Columns 6 and 7 use alternative measures of drought severity. Column 6 uses a dummy indicating whether a municipality is above the median in the distribution of drought severity

Table 4: The Effect of Drought Severity on Additional Electoral Outcomes

	Shrimp	Mayor	Governor	Blank (Gov.)	Blank (Mayor)	Turnout
Drought Severity	-0.021	0.012	0.033	-0.022	-0.002	-0.145
	(0.011)*	(0.020)	(0.016)**	(0.01)**	(0.004)	(0.816)
Observations	848	848	848	848	848	848
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Geography	Yes	Yes	Yes	Yes	Yes	Yes
Electoral	Yes	Yes	Yes	Yes	Yes	Yes
Development	Yes	Yes	Yes	Yes	Yes	Yes

The sample encompasses municipalities in the Semiarid area with information about all variables used in the analysis. Shrimp, Mayor, and Governor are the share of votes for the PDS candidate for that position. Blank (Gov.) is the share of blank votes in the gubernatorial elections, whereas Blank (Mayor) is the share of blank votes in local elections. Turnout is the share of votes over the electorate. Drought Severity (Nov 1978 - Oct 1982) is the average SPEI between November 1978 and October 1982. Geography variables include historically averaged water deficit, distance to rivers, and distance to the coast. The electoral variables include only the vote share to ARENA (military party) in 1972. Development variables include the share of the population living in rural areas in 1970 and 1980, population density in 1970 and 1980, and the share of literate adults in 1970 and 1980. $^{*}p < 0.1,^{**} p < 0.05,^{***} p < 0.01$

and column 7 excludes climate data before November of 1979 from our calculations. Column 8 presents standard errors clustered by micro-regions, whereas columns 9 and 10 present Conley (1999) standard errors with 50km and 100km cutoffs, respectively. It is important to note that results are not only qualitative robust but also quantitatively robust to these alternative specifications.

Table 5: Robustness Checks

		Controls		Sample	
	Baseline	Lat-Long	Council	Semiarid	Sudene
Drought Severity	-0.025	-0.018	-0.028	-0.023	-0.013
	(0.008)***	(0.009)**	(0.009)***	(0.008)***	(0.007)*
Observations	848	848	848	912	1368
	Ind. Var		Standard Errors		
	Dummy	No 1979	Cluster	Conley 50	Conley 100
Drought Severity	-0.022	-0.020	-0.025	-0.025	-0.025
	(0.008)***	(0.007)***	(0.011)**	(0.010)**	(0.011)**
Observations	848	848	848	848	848

The dependent variable is the shrimp vote. Robust standard errors in parentheses, except in the standard errors group. "Cluster" present standard errors clustered at the micro-region level, whereas "Conley 50" and "Conley 100" present Conley standard errors using 50 km and 100 km as cutoff, respectively. Drought Severity (Nov 1978 - Oct 1982) is average SPEI between November of 1978 and October of 1982, except in "Dummy" where it indicates whether the municipality is above the median of the average SPEI between November of 1978 and October of 1982. The column "No 1979" removes Nov 1978 to Oct 1979 from the construction of Drought Severity. All columns control for geography, electoral, and development variables. Geography variables include historical averaged water deficit, distance to rivers, distance to the coast, average terrain ruggedness index, and average elevation. Electoral variables include turnout rate, vote share to ARENA (military party) in 1972, vote share to the PDS candidate in the 1982 mayorial election, and the share of blank votes in the mayoral election. Development variables include average years of schooling in 1980, the log of GDP per capita in 1975 and the log o population in 1980. "Lat-Long" also controls for a third-order polynomial of latitude and longitude and "Council" replace the share of votes for the PDS in mayoral elections for the the this share in election for councilperson as control. "Semiarid" adds the states removed in the main analysis and "Sudene" includes municipalities within the SUDENE region and removes share of votes to ARENA in 1972 as control. $^{*}p < 0.1,^{**} p < 0.05,^{***} p < 0.01$

Mechanisms Having established the negative relationship between drought severity and protest, we seek to understand by which mechanisms this relationship occurs. We consider potential reasons voters in areas more affected by the droughts would protest less against the military regime. To test the mechanisms, we estimate a linear interaction model with demeaned interaction between observable characteristics with drought severity. Specifically, we implement the following specification:

$$Y_{m,s} = \alpha + \beta_0 D_{m,s} + \beta_1 H_{m,s} + \beta_2 M_{m,s} + \beta_3 (D_{m,s} - \overline{D}) \times (M_{m,s} - \overline{M}) + \gamma X_{m,s} + \phi_s + \epsilon_{m,s}, \quad (7)$$

in which β_0 maintains the interpretation of the marginal effect of drought severity at average values of the covariates. We are interested in the linear combination of coefficients β_0 and β_3, representing the heterogeneous effect of drought severity according to the characteristic M. We then calculated the marginal effect of drought severity for five cutoffs of the distribution of M. Specifically, -2, -1, 0, 1, and 2 standard deviations of the variable's mean.

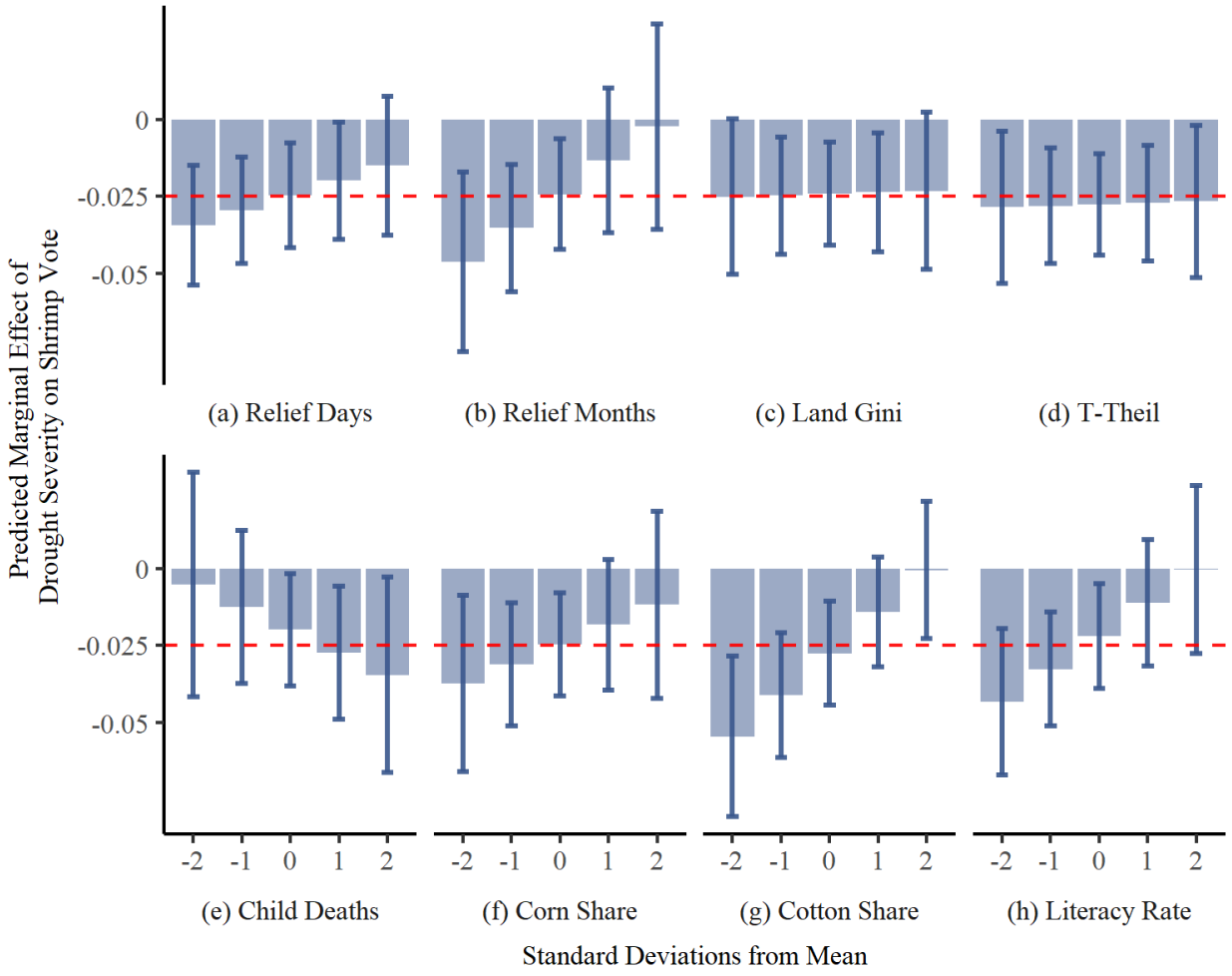
We use the conceptual framework presented in the previous section as a guide to select four groups of mechanisms to be tested. The first feature is the difference in expectations from voters regarding the level of aid relief between the military regime and the democratic opposition parties ($\tau^D - \tau^A$). To test this mechanism, we check for heterogeneity in municipalities regarding the quantity of disaster relief received. Information regarding the value of transfers is not available, so we use the time length between when the municipality was declared in emergency status and the election day as a proxy for the number of resources transferred to that municipality. We collect data on the date when municipalities were declared in emergency status from two distinct sources: archival documents produced by the Sudene in 1982 and the *Sistema Integrado de Informações Sobre Desastres - S2ID*.[29] The second feature that could amplify the marginal effect of drought severity on protest is the vulnerability of people to drought shocks (γ). For that, we use child deaths to measure social vulnerability and two variables of production composition to mea-

[29]Sudene is a central government agency which concerns with the development of the Northeast states, including transfers of funds to alleviate the adverse effects of natural disasters. In principle, the two data sources should provide the same information, but this is not the case. The disparity is conceivable because the Ministry of Integration provides the S2ID while the historical documents are taken from SUDENE, and both are governmental agencies with different apparatuses. In any case, the results using both data sources are very similar.

sure economic vulnerability, namely, the share of corn and cotton production in the agricultural output.[30] The third feature concerns the concentration of political preferences (σ). For this matter, we hypothesize that the degree of control of rural elites over peasants affects the concentration of political preferences. In the context of widespread clientelism, landowners capture peasants' political choices, which could narrow the σ. To measure the degree of capture, we use land and income inequalities. Finally, the last feature we investigate represents the weight citizens assign to previous climate conditions to generate prospective beliefs (λ). We use the level of education of municipalities to study this mechanism.

The results are summarized in Fig. 6 and presented in Table 2. The figure depicts the marginal effects that combine β_0 and β_3 for five levels of the examined municipality characteristic. The horizontal dot line represents the benchmark effect. It is noteworthy that, except for the share of cotton in agricultural production, none of the variables scrutinized exhibits significant heterogeneity. In particular, municipalities with more time in emergency status do not show statistically different effects vis-a-vis municipalities with less time in emergency status in panels (a) and (b). Inequality degrees also do not appear to be an effective mechanism for amplifying the effect in panels (c) and (d), similar to child death rates (e), corn share (f), and literacy rates (h). On the other hand, panel (g) indicates that the effects of drought severity on protests are distinguishable and stronger in municipalities that are less dependent on cotton and, thus, more economically vulnerable to droughts. These findings indicate that economic losses in populations most susceptible to climate shocks are a suggestive mechanism by which citizens decrease their impetus to engage in collective action in favor of more democracy. Despite the low warranty of statistical significance over the other characteristics of drought vulnerability, the results are consistent with other studies connecting the degree of vulnerability of the electorate with the relationship between natural disasters and voter behavior (Bobonis et al., 2019).

[30]The rationale for choosing these cultures is explained by Pessoa (1987) on page 477. The author emphasizes that corn was mainly produced for subsistence consumption, and its crops were very vulnerable to dryness. On the other hand, cotton production was more resistant to droughts, and workers and the landowner would often split the revenue.



Notes: The vertical columns are the predicted marginal effect of drought severity on *shrimp vote* when the variable indicated in the panel is x standard deviations from the mean. The whiskers are the lower and upper bounds of a 95% confidence interval. The dashed line depicts the baseline effect presented in column (5) of Table 3.

Figure 6: Heterogeneous Marginal Effects of Drought Severity on Shrimp Vote

6 Conclusion

In this research paper, we used the 1979-1983 Drought in the Brazilian semiarid region to investigate the relationship between adverse effects of natural disasters on protests against autocratic regimes. We utilized data from meteorological stations to compute deviations from historical means of water deficit and use it as our primary explanatory variable. We also condition our estimates on geographical, developmental, and electoral variables. Our findings suggest a negative causal effect of adverse weather conditions on protests against the military regime. Moreover, we show that disaster relief provided by the government, income inequality, and social vulnerability measures do not seem to drive this effect. On the other hand, the effect is heterogeneous to the degree of economic vulnerability – measured by the importance of cotton for local production – suggesting that this may be the relevant mechanism at play.

We also put forth a probabilistic voting model that reconciles the mixed findings in the literature and guides our empirical exercise. The model predicts that under authoritarian regimes, individuals have no incentive to protest or punish incumbent politicians due to adverse weather conditions. The rationale is that individuals' behavior does not alter the party holding office and may result in punishment toward the voters. It is important to stress that our study focuses on a specific type of protest in which individuals express their disapproval of the central government. Therefore, our findings do not rule out the possibility that protest increases due to natural disasters when individuals believe that they are strong enough to overthrow the authoritarian regime, as found in Bruckner and Ciccone (2011).

A Tables

Table 1: The Effect of Drought Severity on Alternative Measures of Shrimp Vote

	Governor	Senator	Federal Rep.	State Rep.	Council
Drought Severity	-0.025	-0.017	-0.014	-0.012	-0.012
	(0.008)***	(0.009)*	(0.005)***	(0.005)**	(0.004)***
Observations	848	848	848	848	848
State FE	Yes	Yes	Yes	Yes	Yes
Geography	Yes	Yes	Yes	Yes	Yes
Electoral	Yes	Yes	Yes	Yes	Yes
Development	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses. Drought Severity (Nov 1978 - Oct 1982) is average SPEI between November of 1978 and October of 1982. Geography variables include historical averaged water deficit, distance to rivers, and distance to the coast. Electoral variables include turnout rate, vote share to ARENA (military party) in 1972 and vote share to the PDS candidate in the 1982 mayorial election. Development variables include the share of population living in rural areas in 1970 and 1980, population density in 1970 and 1980, and the share of literate adults in 1970 and 1980. $^{*}p < 0.1,^{**} p < 0.05,^{***} p < 0.01$

Table 2: Mechanism Analysis

	Relief Days	Relief Months	Land Gini	Theil	Child Deaths	Corn Share	Cotton Share	Literacy Rate
Drought Severity	-0.025	-0.024	-0.024	-0.028	-0.020	-0.025	-0.027	-0.022
	(0.009)***	(0.009)***	(0.008)***	(0.008)***	(0.009)**	(0.008)***	(0.009)***	(0.009)**
Mechanism	-0.005	-0.005	0.046	0.079	-0.017	-0.017	-0.024	-0.009
	(0.002)***	(0.002)**	(0.031)	(0.023)***	(0.057)	(0.038)	(0.042)	(0.034)
Demeaned Int.	0.003	0.007	0.005	0.004	-0.13	0.082	0.223	0.111
	(0.002)	(0.004)*	(0.056)	(0.037)	(0.131)	(0.08)	(0.073)***	(0.05)**
Marginal Effects								
Below Two STD	-0.034	-0.046	-0.025	-0.029	-0.005	-0.037	-0.054	-0.043
	(0.01)***	(0.015)***	(0.013)*	(0.013)**	(0.019)	(0.015)**	(0.013)***	(0.012)***
Below One STD	-0.029	-0.035	-0.025	-0.028	-0.013	-0.031	-0.041	-0.033
	(0.009)***	(0.011)***	(0.010)**	(0.010)***	(0.013)	(0.010)***	(0.010)***	(0.009)***
Mean	-0.025	-0.024	-0.024	-0.028	-0.020	-0.025	-0.027	-0.022
	(0.009)***	(0.009)***	(0.008)***	(0.008)***	(0.009)**	(0.008)***	(0.009)***	(0.009)**
Above One STD	-0.020	-0.013	-0.024	-0.027	-0.027	-0.018	-0.014	-0.011
	(0.010)**	(0.012)	(0.010)**	(0.010)***	(0.011)**	(0.011)*	(0.009)	(0.011)
Above Two STD	-0.015	-0.002	-0.023	-0.027	-0.034	-0.012	-0.001	0.000
	(0.011)	(0.017)	(0.013)*	(0.013)**	(0.016)**	(0.015)	(0.011)	(0.014)
Observations	848	848	846	848	719	848	848	848

The dependent variable is the shrimp Vote. Robust standard errors in parentheses. Drought Severity (Nov 1978 - Oct 1982) is average SPEI between November of 1978 and October of 1982. Mechanism is the variable indicated in the title of each column and interaction is the interaction of the mechanism with drought severity. All columns control for geography, electoral, and development variables. Geography variables include historical averaged water deficit, distance to rivers, distance to the coast, average terrain ruggedness index, and average elevation. Electoral variables include turnout rate, vote share to ARENA (military party) in 1972, vote share to the PDS candidate in the 1982 mayorial election, and the share of blank votes in the mayoral election. Development variables include average years of schooling in 1980, the log of GDP per capita in 1975 and the log o population in 1980. Relief days is the number of days a municipality was under state of emergency before the 1982 elections. Land gini is a measure of land inequality and Theil is a measure of income inequality. Child deaths is the number of deaths of childs under 5 over the population under 5. Corn and Cotton share is the share of agricultural production assign to each product. $^{*}p < 0.1,^{**} p < 0.05,^{***} p < 0.01$

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