Does Local Politics Drive Tropical Land-Use Change? Property-Level Evidence from the Amazon*

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Abstract

Land conversion to agriculture is a defining environmental challenge for tropical regions. We construct a novel panel dataset of land-use changes on the properties of municipal politicians and campaign donors in the Brazilian Amazon to assess channels through which local politics may drive land conversion. Estimating event studies around close mayoral elections, we find that large landholders significantly increase soy adoption and cultivation while the candidate they donated to is in office. This suggests landholders invest in political influence to overcome barriers to agricultural intensification. In turn, mayors who receive landholder donations govern in favor of agriculture – increasing spending on agricultural promotion and distribution of rural credit. While agricultural promotion "returns the favor" for mayors' donors, it is not precisely targeted. We document large spillovers onto non-donor properties, resulting in increased deforestation and environmental violations. Results reveal how patronage and special interests drive land-use change and deforestation in the Amazon.

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1 Introduction

"*The big agricultural producers, the ones with the most capital, are the ones at the front of politics here.*" —Deputy Environment Minister of Pará, quoted in Nolen and Elkaim (2018).

Deforestation in the Brazilian Amazon – the world's largest tropical rainforest – is driven primarily by the expansion of commodity agriculture, particularly cattle ranching and soy (Pendrill et al., 2022). These activities contribute to economic growth but also empower large landholders, exacerbating local inequalities (Weinhold et al., 2013). Landholding elites are key arbiters of economic development and governance, and may capture or influence local political processes to promote their interests (Viana et al., 2016; Anderson et al., 2015; Amsden et al., 2012; Acemoglu et al., 2007; Bardhan and Mookherjee, 2000).[1]

Conversion of forests to pasture and cropland is the second largest source of human-caused carbon emissions after fossil fuel combustion (van der Werf et al., 2016), and represents one of the primary obstacles to achieving global emission reduction targets (Harris et al., 2021). Deforestation also has serious *local* consequences, including biodiversity loss (Giam, 2017), higher temperatures and associated health complications (Zeppetello et al., 2020; Lawrence and Vandecar, 2015), and reductions in agricultural productivity (Leite-Filho et al., 2021).

In this paper, we quantify channels through which landholders intervene in local politics to overcome barriers to land conversion in the Brazilian Amazon. Landholders may buy political influence through campaign donations, or participate in local politics as a candidate. In turn, politicians may pay back their campaign donors directly through targeted favors or special treatment (i.e., patronage), or indirectly by governing in favor of donors' special interests. We assess both property-level and policy-level channels of landholder political influence using a novel panel dataset.

[1]Recent reporting by The Washington Post identified tens of millions of dollars in campaign donations made by landholders accused of environmental violations in the Amazon, as well as 1,900 cases in which landholders accused of environmental violations were elected to public office (McCoy and do Lago, 2022). In a review of models of tropical deforestation, McCarthy and Tacconi (2011) conclude that: "Policies that demand reform in developing countries with high rates of deforestation will be ineffective unless they address the power, incentives and culture of local political elites."

We combine individually-identified, geo-referenced land cadasters, registries of political candidates and campaign donors across five municipal elections (2000-2016), and remote sensing data to build a panel dataset measuring land use transitions on properties belonging to municipal political candidates and campaign donors in Brazil's Amazon biome between 2000-2019. This is the most complete accounting of its kind ever assembled, encompassing over 135,000 candidates, 277,000 donors, and 611,000 properties.

Methodologically, we estimate effects of a mayor's entry into office on land-use and deforestation on the mayor's personal properties and those of their campaign donors by comparing outcomes on the properties of successful candidates and donors versus runner-up candidates and donors in close mayoral elections (where outcomes are as-if-random). Our goal is to detect whether mayors precisely target benefits or favors to their landholding donors to facilitate land-use changes on their properties – a dynamic we refer to as "agricultural patronage." This is analogous to the public employment patronage identified in Colonnelli et al. (2020), but may be more relevant in communities dominated by agriculture. To explore dynamic effects before, during, and after mayors' time in office, we estimate event study specifications and implement the Callaway and Sant'Anna (2020) estimator to accommodate staggered treatment timing and heterogeneous treatment effects. To measure whether landholders' participation in local politics (either as donors or candidates) affects municipal policy-making and land-use, we estimate difference-in-differences specifications comparing outcomes in municipalities where a candidate who is a landholder or who received substantial landholder donations wins or loses a close election.

We find strong evidence of agricultural patronage at the property-level. Specifically, landholding campaign donors significantly increase soy cultivation on their properties (+0.46 percentage points – or 13.2ha – from a baseline mean of 0.27% of property area) while the candidate they donated to is in office. Land conversion to soy comes from already-cleared pasture – which declines by a proportionate amount – while deforestation and environmental violations remain mostly unaffected. Heterogeneity analysis reveals that donors' significant increase in soy is driven by the largest quartile of properties and by first-time soy adopters. Overall, these findings suggest that large landholders in the Amazon invest in local political influence to overcome barriers to *agricultural intensification* – specifically, adoption of high-value soy.[2] Landholders evidently value political influence highly, and use donations sparingly to facilitate adoption: the average donation to a winning candidate was worth US$7,363 (current), and only 13.5% of successful donors donate again – with subsequent donations averaging just US$1,230. Absence of effects at the extensive margin (forest clearing) may be due to mayors' relative lack of power over this dimension, since deforestation is federally regulated and enforced.[3]

Furthermore, we find that landholder donations affect municipal governance and land-use. The close election of a mayor who received substantial campaign donations from landholders (>25% of their total donations) leads to significant increases in municipal spending on agricultural promotion and distribution of rural credit. Election of a landholder-financed mayor is also associated with agricultural intensification and adverse environmental consequences: municipal soy cultivation increases by 0.66p.p., or 126ha (from a baseline mean of 0.07% of municipal area), deforestation increases by 0.14p.p. (from a baseline mean of 1.71%), and environmental violations increase by 23% during that mayor's time in office.

Decomposing these municipal-level effects into changes occurring on the properties of donors, candidates, and other landholders, we find large spillovers in soy cultivation, deforestation, and environmental violations onto non-donor properties. Evidently, promotion of agriculture by landholder-financed mayors does pay back their donors, but not in a precisely targeted way.[4] Increased deforestation *and* registry of (federal) environmental violations suggests mayors promote land conversion to agriculture, but do not protect local landholders from federal anti-deforestation enforcement. In contrast to the large effects we document for landholder-*financed* mayors, we find no effects of the election of mayors with *personal landholdings* on municipal governance or land-use.

[2]Soy cultivation offers much higher profitability than pasture-fed livestock, but shifting to soy is capital- and knowledge-intensive and landholders may struggle to overcome barriers to adoption, including credit, technology, training, and labor constraints and access to buyer and supplier networks (Moffette and Gibbs, 2021; Szerman et al., 2022). Political connections with the mayor may assist donors in overcoming these barriers by, for instance, giving them preferential treatment by service providers or improved access to rural credit or factor markets.

[3]While soy cultivation trends upwards on mayors' personal properties after their entry into office, effects are not significant at the 5% level. Overall, we do not find evidence of significant land-use changes on candidates' properties, suggesting landholders do not pursue political office to enable personal land conversions.

[4]Donors' properties are, on average, significantly larger than non-donors properties, and have larger amounts of cleared land at baseline. Thus, agricultural promotion likely affects donors more at the intensive margin (intensification from pasture to soy), and non-donors at the extensive margin (forest clearing).

This paper contributes to three main strands of the political economy literature: (i) patronage in local government, (ii) special interest groups and money in politics, and (iii) the effects of politician type.[5]

By linking candidates and donors to property-level land-use changes, we are the first to identify and quantify a channel of agricultural patronage – through which largeholders engage in *quid pro quos* with mayors to facilitate high-value crop adoption. Individualized transactions of this kind were never previously observable. This finding complements prior studies of public employment patronage (Toral, 2022; Colonnelli et al., 2020) and increased receipt of public contracts for firms that donate to winning candidates (Boas et al., 2014) in Brazil. Our findings suggest that mayors target patronage through *feasible* channels. Mayors wield a degree of influence over discretionary public employment, municipal contracts, agricultural promotion, and rural credit, making these mechansims through which they can pay back donors. They have less control over deforestation enforcement, limiting their capacity to reward donors along this dimension. In rural communities, agricultural favors may be more attractive than public employment or contracts, suggesting patronage dynamics may exhibit subnational and regional variations. Further, channels of patronage have varying levels of precision: while public jobs or contracts can be assigned directly, we show that mayors resort to less-targeted agricultural promotion to pay back landholders – generating negative environmental externalities.

Our study connects to the literature on special interests and money in politics (Avis et al., 2022; Bertrand et al., 2020; Voss and Schopf, 2018; Chamon and Kaplan, 2013; Grossman and Helpman, 2002) by documenting the extent and influence of landholders as a special interest group. We find that large landholders (>500ha) are over-represented among winning mayors by a factor of 28 relative to the general population; largeholders are over-represented among donors by a factor of 2.6. Harding et al. (2023) show donor-funded mayors in Colombia pay back donors by reducing environmental enforcement. By identifying landholding donors,

[5]Cutting across these topics, our study contributes to literature on the political economy of deforestation (Kuusela and Amacher, 2016; Burgess and Olken, 2012). In Brazil, Pailler (2018) shows that mayors may allow landholders to deforest prior to local elections to win support from rural voters. Abman (2021) finds that deforestation fell significantly further in municipalities where mayors were eligible for reelection after the introduction of a deforestation disincentive policy (i.e., blacklisting). Burgess et al. (2019) exploit border discontinuities to show that deforestation rose and fell in Brazil in line with the intensity of federal anti-deforestation efforts, highlighting the key role of institutions in tropical forest governance.

we refine Harding et al. (2023)'s analysis of aggregate donations and arrive at a similar conclusion: landholders buy influence with mayors to support agriculture. In contrast to their findings, we show *total* donation receipts have no association with environmental governance or land-use in Brazil – that is, *landholder* donations are different.

We contribute to the literature on politician type or identity by studying land-use changes on candidates' properties and whether landholding mayors govern differently. Studies of politicians' gender (Brollo and Troiano, 2016; Broockman, 2014; Balafoutas and Sutter, 2012), ethnicity (Gulzar and Pasquale, 2019; Chin and Prakash, 2011), religion (Bhalotra et al., 2014), and education (de Paola and Scoppa, 2011), have documented significant differences in governing behavior along these dimensions. Particularly relevant for our study, Bragança and Dahis (2022) use candidates' self-declared occupations to identify "farmer politicians," and show that election of farmers as mayors led to increased promotion of agriculture and deforestation after Brazil's 2000 municipal elections. Similar effects disappear in later years after federal anti-deforestation enforcement increased. Our results corroborate these findings: using an alternative measure of "farmer politicians" (we match 24.8% of elected mayors to landholdings, versus 12.7% who self-declare as farmers), we find no effects of candidates' landholding status during a period when federal regulation largely took environmental enforcement out of mayors' hands. Extending these authors' findings, we analyze landholding mayors' own land-use and find no measurable evidence of self-enrichment, suggesting mayors may derive alternative benefits from holding office that outweigh the potential benefits of land conversion on their properties.[6]

[6] Bragança and Dahis (2022) develop a theoretical model in which mayors maximize expected utility across personal and political rents by choosing whether to implement pro-deforestation policies based on their identity (farmer or non-farmer), voters (pro-deforestation and ordinary), and strength of federal environmental enforcement. The model predicts that (i) farmer mayors are more likely to win re-election and enact pro-deforestation policies, and (ii) increased environmental enforcement curtails pro-deforestation incentives. Our data allow us to add two dimensions of nuance to this framework. First, we are able to identify landholding donors, and thus separately analyze effects of mayors' own landholdings vs. effects of landholder donations. We find that landholder donations have significant effects on governance, while personal landholdings do not. Second, rather than focusing exclusively on deforestation, we study two margins of influence: the *extensive* (deforestation) margin and the *intensive* (pasture-to-soy) margin. We find that environmental enforcement curtails mayors' political influence at the extensive margin, but not at the intensive margin, where largeholders seek political favors to overcome barriers to soy adoption.

2 Context

2.1 Deforestation and Land Use in the Brazilian Amazon

Brazil is home to the majority of the world's largest tropical forest – the Amazon – which supports flourishing biodiversity and acts as an enormous carbon sink. Concerns about how Brazil can balance agricultural development with forest conservation are high (Marin et al., 2022), and efforts to reduce deforestation must account for the ways in which soybean expansion can indirectly drive forest cover loss. Across South America, soybean expansion has occurred most quickly in the Brazilian Amazon, increasing from 0.4 million hectares in 2000 to 4.6 million hectares in 2019 (Song et al., 2021). While soy contributes to income growth, poverty reduction, and industrial growth, it is also associated with increased inequality, as large landholders benefit disproportionately from soy's large-scale, mechanized, labor-saving production processes (Sauer, 2018; Bustos et al., 2016; Weinhold et al., 2013). At the same time, Brazil is amongst the largest pesticide consumers in the world (Panis et al., 2022), and use of pesticides for soy production is high (Garrett and Rausch, 2016). High levels of pesticide use are associated with negative health effects (Panis et al., 2022), and Skidmore et al. (2023) show soy expansion in Brazil is linked to increased childhood cancer mortality.

Severe deforestation in the 1990s and early 2000s led Brazil's federal government to implement a series of policies to reduce tree-cover loss in the Amazon, which proved highly effective: deforestation fell from 27,000 km^2 in 2004 to 7,000 km^2 in 2009 (INPE, 2017).[7] This trend reversed in 2014, when deforestation rates rose again due to a weakening federal commitment to enforcement of environmental regulations (Burgess et al., 2019). The main drivers of deforestation in the Brazilian Amazon are cattle ranching and agriculture.

[7]Multiple policies and initiatives combined to bring about this decline in deforestation (Nepstad et al., 2014). The multi-pronged Action Plan for the Prevention and Control of Deforestation in the Legal Amazon (PPCDAm) was the principal legal instrument to curb deforestation in the Brazilian Legal Amazon. The Priority List (also called Blacklisted Municipalities) was a vital part of the PPCDAm and contributed significantly to dissuading deforestation (Assunção et al., 2019). Studies have shown that protected and indigenous areas are effective in preserving natural vegetation and sustainable land uses (BenYishay et al., 2017; Amin et al., 2019). Most of these policies would not have been possible without the creation of cutting-edge monitoring systems, including federal annual deforestation data and a near-real-time deforestation alert system called DETER (Assunção et al., 2017). Supply-chain commitments and policies have also been put in place to reduce deforestation in specific commodity markets, including the Soy Moratorium in 2006 and the Zero-Deforestation Cattle Agreements in 2009 (Gibbs et al., 2015; Alix-Garcia and Gibbs, 2017).

Pasture, which covered 13.9% of the Legal Amazon in 2020, is generally characterized by low-productivity livestock production (Moffette et al., 2021; Ermgassen et al., 2018). Agriculture, which covered 2.8% of the Legal Amazon in 2020, exhibits much higher productivity and more sophisticated production techniques (e.g., double cropping and mechanization). In the Legal Amazon, most agricultural production is soy (88.9%), although other commodities such as sugar cane, rice, maize, cotton, and other perennial crops are also produced. Brazil is the world's leading exporter of soybean (Panis et al., 2022).[8]

Cattle ranching and agriculture differ fundamentally in their production characteristics, with agriculture generally requiring high inputs and capital, and cattle ranching requiring low inputs and capital. Agriculture has much higher potential profitability, but farmers may struggle to convert land to agriculture due to barriers to entry including credit constraints, transportation costs, or lack of skills or training. Deforested land is often used initially as pasture for grazing before being converted to soy production (Moffette and Gibbs, 2021). Deforestation is itself costly, requiring substantial labor and equipment inputs that may be compensated for, in part or in whole, by selling timber. The Brazilian Forest Code is the central piece of legislation governing land use and management on private properties, and defines the legality of deforestation across Brazil's biomes. According to this federal law, properties in the Amazon biome should retain 80% natural vegetation. As much as 90% of Brazilian deforestation has likely been illegal under these rules (Lawson et al., 2014).

Finally, the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA) is an arm of the Brazilian Ministry of the Environment, and has the specific mandate to enforce the Forest Code. Under Decree No. 6686, IBAMA can issue fines for illegal deforestation, destroy equipment used in illegal deforestation, and seize harvested timber. Although individuals and companies that receive environmental violations (embargoes) can appeal these decisions, violations remain costly and cumbersome, potentially limiting business opportunities in the agricultural sector.

[8]Following Marin et al. (2022) and Skidmore et al. (2023), we refer throughout this paper to "agricultural intensification" in reference to land-use transitions from livestock pasture to soy. This presents a useful contrast with "extensification," referring to forest clearing for pasture. However, it is also a simplification, given that agricultural intensification can take other forms (e.g., cattle feedlots).

2.2 Local Politics and Environmental Governance

Formal environmental governance in Brazil is set and enforced mostly at federal and state levels, but municipal governments often host environmental secretariats, councils, or other entities that are responsible for preservation, conservation, and recuperation of municipal natural resources. Municipalities also play an important role in agricultural promotion, including agricultural extension services, phytosanitary defense, irrigation, land-use policy, and rural credit (Ávila and Malheiros, 2012; Leme, 2016). Municipalities may also apply for matching grants from federal ministries, including the Ministry of Agriculture.

Brazilian municipalities are governed by a mayor and municipal council. Municipal elections occur every four years and are offset by two years from state and federal elections. Both mayors and councilors serve four-year terms, with mayors eligible to serve up to two consecutive terms, and voting is obligatory (Lavareda and Telles, 2016).[9] Brazil has over thirty political parties, which typically lack consistent programmatic identities at the municipal level, and candidates frequently switch between parties (Hott and Sakurai, 2021).

3 Data

In this section, we describe land registries covering the Brazilian Amazon, remote sensing land-use data, political candidate and campaign donor registries, and supplementary datasets. Appendix Table B1 summarizes data sources.

3.1 Land Registries

Data from private land registries were provided by the Gibbs Land Use and Environment Lab, and come from three sources: Terra Legal, INCRA (National Institute for Settlement and Agrarian Reform), and CAR (Rural Environmental Registry).[10] Property owners have

[9] In municipalities with populations less than 200,000 (including 758 out of 772 in the Legal Amazon), mayors are elected in a first-past-the-post system. For municipalities with more than 200,000 people, mayoral elections go to a second round if no candidate wins a majority in the first. Councilors are elected using an open list proportional representation system.

[10] Terra Legal is a federal program that began registering formal property rights in the Brazilian Legal Amazon in 2009, with a special focus on regularizing holdings on public lands. INCRA is a federal agency that oversees agrarian reform and land ownership issues. Its formal property registries include the Land Management System–SIGEF (*Sistema de Gestão Fundiária*), the Rural Property Registry Certificate–CCIR

strong incentives to register their properties under one or more of these systems in order to avoid land theft and facilitate access to environmental licensing and rural credit.

We combine and harmonize individually-identified property records from the Terra Legal, INCRA, and CAR datasets spanning 2014-2017, 2016-2020, and 2011-2021, respectively. Properties may be retrospectively registered after their date of acquisition, allowing our data to include properties acquired or registered prior to 2011. In the states of Mato Grosso, Pará, and Rôndonia, our data represent complete coverage of property boundaries due to full availability of identified CAR registrations. Property registries are somewhat less complete in other Amazon states due to partial availability of CAR. To the best of our knowledge, these combined cadasters constitute the most complete set of individually-identified property maps available for the Brazilian Amazon.

3.2 Remote Sensing Land Use Data

We use satellite-collected remote sensing data from Collection 5 of MapBiomas to measure land-use change. Data cover the 2000-2019 period for the entire Legal Amazon with a spatial resolution of 30m. Based on MapBiomas' data, we calculate land-use outcomes (deforestation, soy cultivation, non-soy agriculture, and pasture) at both property and municipal levels. At the property level, we measure deforestation as hectares of land that transition from natural vegetation (Forest Formation and Savannah Formation classes) to non-natural (Anthropic) classes during a given year, as a percentage of property area.[11] To measure agricultural and livestock (primarily cattle) land uses, we compute hectares under crops (soy and other crops) and pasture as percentages of property area. We compute analogous measures of deforestation and land-use at the municipal level.[12]

(*Certificado de Cadastro de Imóvel Rural*), and the Rural Property National Registry–CNIR (*Cadastro Nacional de Imóveis Rurais*). CAR is a program that requires (since 2012) the mapping of property boundaries for each rural property in Brazil, whether property rights are formally held or not.

[11]The minimum mappable unit in MapBiomas is one hectare (Tobler, 1987). To ensure the detected transition from natural to anthropic land use is not the result of satellite error, we verify that each pixel where deforestation was detected remains under anthropic land use the following year

[12]Advantages of the MapBiomas dataset are multiple. First, the dataset has complete coverage of the region. Second, MapBiomas' methodology is customized by biome, with a collaborative network of biome specialists ensuring precise land-use classifications. Third, MapBiomas includes deforestation occurring in non-primary forests, allowing us to account for re-growth and secondary deforestation of previously deforested lands. In contrast, PRODES, the deforestation dataset created by the National Institute for Space Research of Brazil, does not capture secondary deforestation.

3.3 Candidate and Donor Registries

Brazil's Supreme Electoral Tribunal (TSE) publishes complete registries of political candidates for the 2000, 2004, 2008, 2012, and 2016 municipal elections, as well as complete registries of campaign donations made in the 2004, 2008, 2012, and 2016 elections. For mayoral candidates, we compute election win margins by identifying winning and runner-up vote shares and taking the difference between these shares. We set win margins to 100 when a mayoral candidate runs uncontested. Based on win margins, we identify municipality-election pairs with close elections ($\leq$5% win margin). Appendix Figure A1 maps the number of close elections between 2000-2016 for each municipality in the Legal Amazon. Competitive mayoral elections are relatively evenly spread across the region and represent 25% of elections over the study period. We do not compute close election cutoffs for council elections, as these use an open list proportional representation system. Elected candidates enter office on January 1st of the year after their election (which occurs in October). Thus, their term in office spans the four years after their election year (e.g., 2013-2016 for the 2012 election).

3.4 Supplementary Datasets

To measure environmental compliance, we use data on property and owner-level "embargoes" for environmental violations spanning 2005 to 2020, from IBAMA, which was shared by the Gibbs Land Use and Environment Lab. At the property level, we create an indicator registering when an embargo is associated with a property or property owner in a given year. At the municipal level, we sum individual embargoes to create an aggregate measure of environmental violations.

To analyze municipal governance, we draw disaggregated municipal spending from FINBRA/SICONFI (the System of Fiscal and Accounting Information for the Brazilian Public Sector), from which we compute spending on Agricultural Promotion (Agriculture, Colonization, Agro-livestock Defense and Sanitation, Rural Extension, Irrigation, Agrarian Organization, Agro-Livestock Promotion, Land Reform, and Other Ag. Subfunctions) and Environmental Management (Environmental Control, Management, Preservation and Conservation, Recuperation of Degraded Areas, and Other Environmental Subfunctions). We draw data on federal matching grants from the *Procuradoria Geral da União*. Finally, we draw data on rural credit received by producers and cooperatives from the National System of Rural Credit (SNCR) of the Central Bank of Brazil. Monetary variables are deflated to constant 2010 $BRL using the INPC deflator from Ipea, and continuous variables are transformed using the inverse hyperbolic sine function.

3.5 Data Merging and Limitations

We perform exact matches between (i) political candidates' and donors' name/ID number and municipality and (ii) the name/ID number and municipality associated with properties in the union of land registries. Since multiple properties may be associated with an individual, we aggregate property-level data to the candidate/donor level. In our preferred specification, we restrict the sample to municipalities within the Amazon biome (a subset of the Legal Amazon administrative region) in order to avoid inconsistencies in legal restrictions and land use dynamics between Amazon and Cerrado biomes.

Although the quality and coverage of our harmonized land registries are exceptionally high compared to data available in most developing countries, we note two limitations of this dataset. First, our matching between candidates/donors and land registries is not perfect. Identified CAR registries are not fully available outside of Mato Grosso, Pará, and Rondônia, and as a result, we may not correctly identify some politicians as landholders in other Amazon states. Appendix Figure A2 shows the percentage of municipal political candidates matched with properties in combined land registries by election period. Matches are not expected to reach 100%, as not all candidates are landholders. Further, land could be held by candidates' or donors' family members or associates. To address the threat from measurement error introduced by incomplete land registries outside of Mato Grosso, Pará, and Rôndonia, we implement robustness checks wherein we limit our analysis to the subsample of properties and municipalities in these three states.

A second limitation of our data is that we only observe property ownership at the moment of land titling or registration, and it is not possible to determine whether the identified holder truly held that property for the duration of the 2000-2019 period. We thus make a simplifying assumption that land ownership is time-invariant over this period.[13] In our property-level empirical strategy, we minimize potential bias or measurement error from these limitations by estimating effects *between* treated (winner of a close election) and control (runner-up in a close election) landholding candidates and donors. Thus, candidates or donors who we mis-identify as non-landholders due to gaps in land registries are excluded from the sample.

3.6 Descriptive Statistics

In Table 1, we present descriptive statistics for mayoral candidates and campaign donors to mayoral candidates, as well as sub-samples of these groups corresponding to our treatment and control groups (i.e., winners and runners-up), for the 2000, 2004, 2008, 2012, and 2016 municipal elections in the Brazilian Amazon.

Our first takeaway from these data is that *landholding is widespread among politicians and donors.* We match 25% of winning candidates and 17% of runners-up with land registries, as well as 8% of donors to winners and 7% of donors to runners-up. Just 13% of elected mayors self-identify as farmers or ranchers, suggesting there is substantial under-reporting of politicians' true landholding status.[14] In Appendix Figure A3, we plot the share of elected mayors and campaign donors who are landholders or large landholders (>500ha), disaggregated by political party. Landholding is highest among parties associated with agribusiness, with some parties reaching rates of 34% landholder mayors and 22% largeholder mayors. For comparison, landholders account for 3.5% of the total population within Brazil's Amazon biome, and largeholders account for 0.64%.

Our second takeaway is that *mayoral candidates and campaign donors are disproportionately large landholders.* Among the subset of candidates and donors who match with

[13] We justify this assumption with recent evidence that land transactions are infrequent in the Amazon region – involving only 0.51% of properties during 2019-2020 (Moffette et al., 2023). This value is calculated by dividing the number of properties in Amazon states posted for sale between August 2019 and April 2020 on the sales platform OLX (similar to Craigslist, OLX is commonly used for property transactions) by the total number of registered properties in CAR in December 2021 (MAPA, 2021).

[14] The share of self-declared farmers and ranchers may be lower than values derived from land registries because (i) some politicians may hold small properties, thus appearing in our classification as landholders despite holding another occupation (though candidates' large average landholding suggests this is not a primary factor); (ii) many politicians list their occupation as "politician," or do not declare an occupation, introducing measurement error and highlighting the contribution of our real matching procedure relative to the self-declared data used in Bragança and Dahis (2022).

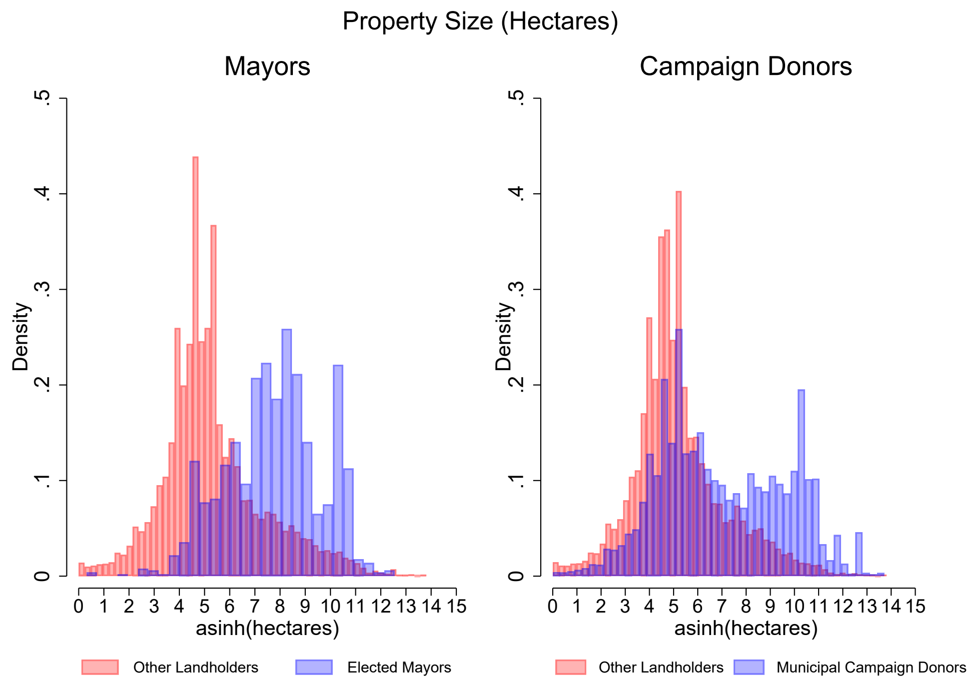
Table 1: Descriptive Statistics: Candidates and Donors in Amazon Biome

	Municipalities in Amazon Biome (Elections: 2000, 2004, 2008, 2012, 2016)					
	Mayoral Candidates			Donors to Mayoral Candidates		
	All	Runner-Up	Winner	To All	To Runner-Up	To Winner
No. Total Candidates/Donors	7,062	2,061	2,148	277,735	40,819	90,009
No. Landholder Candidates/Donors	1,387	342	533	19,283	3,124	7,170
% Landholders	19.6	16.6	24.8	6.9	7.7	8.0
Full Sample:						
% Declared Land-Linked Occup.	10.8	11.8	12.7	-	-	-
	(31.0)	(32.3)	(33.3)			
Age	47.3	47.4	46.7	-	-	-
	(14.5)	(9.7)	(9.7)			
% Female	13.4	13.5	11.9	-	-	-
	(34.1)	(34.2)	(32.4)			
Education Level	6.1	6.0	6.0	-	-	-
	(1.9)	(1.9)	(1.8)			
No. Donations Received/Given	15.7	16.6	21.8	1.9	1.4	1.5
	(39.1)	(35.3)	(39.1)	(3.7)	(1.3)	(1.4)
Val. Donations Received/Given	62,338	69,526	75,250	3,127	4,443	2,298
	(310,473)	(348,459)	(208,075)	(54,259)	(29,555)	(10,852)
Among Landholders:						
Total Landholding (ha.)	2,074	1,742	2,898	1,538	1,592	1,410
	(7,752)	(4,239)	(9,771)	(19,221)	(17,295)	(16,591)
No. Properties	2.6	2.7	2.9	1.5	1.8	1.6
	(3.7)	(4.3)	(4.4)	(1.5)	(2.1)	(1.6)
% Baseline Forest Cover (2000)	54.8	55.8	53.4	52.7	50.7	51.7
	(31.0)	(29.8)	(31.1)	(34.0)	(33.8)	(33.6)
Avg. Yrly Deforest. (% Landholding)	2.0	2.0	2.0	2.3	2.3	2.3
	(1.8)	(1.7)	(1.8)	(2.0)	(2.0)	(1.9)
No. of Years with Deforest. Registered	3.8	4.0	4.0	2.6	2.8	2.7
	(4.2)	(4.2)	(4.6)	(3.7)	(3.7)	(3.7)
% of Landholding Deforested (2000-2020)	40.8	40.6	40.7	46.8	45.2	45.7
	(36.6)	(34.8)	(36.2)	(39.8)	(39.8)	(39.5)
% with Environmental Violation	16.4	14.9	19.9	6.3	9.2	7.7
	(37.0)	(35.7)	(40.0)	(24.3)	(28.9)	(26.7)
Avg. Yrly Pasture (% Landholding)	49.6	49.3	50.9	55.5	55.3	56.0
	(30.5)	(29.2)	(30.4)	(32.1)	(32.5)	(31.8)
% Converted to Pasture (2000-2020)	11.4	11.4	10.8	15.8	12.8	15.1
	(24.3)	(26.0)	(23.1)	(27.2)	(25.5)	(27.2)
Avg. Yrly Soy (% Landholding)	0.7	0.8	0.9	0.6	0.7	0.8
	(4.4)	(5.1)	(4.9)	(4.4)	(4.3)	(5.0)
% Converted to Soy (2000-2020)	1.8	1.8	2.1	1.7	2.1	2.0
	(8.2)	(8.0)	(8.8)	(9.8)	10.3	(10.4)
Avg. Yrly Other Ag. (% Landholding)	0.4	0.6	0.5	0.4	0.5	0.4
	(2.2)	(3.5)	(1.8)	(2.4)	(2.5)	(2.3)
% Converted to Oth Ag. (2000-2020)	0.5	0.8	0.5	0.4	0.4	0.4
	(3.8)	(6.2)	(3.2)	(3.7)	(3.3)	(3.8)
% Land-Linked Declared Occup.	22.6	22.2	22.5	-	-	-
	(41.9)	(41.6)	(41.8)			
Age	48.6	48.2	47.7	-	-	-
	(12.7)	(9.3)	(9.7)			
% Female	9.6	9.1	9.0	-	-	-
	(29.5)	(28.8)	(28.7)			
Education Level	5.9	5.8	5.9	-	-	-
	(1.9)	(1.9)	(1.9)			
No. Donations Received/Given	22.6	20.4	29.5	2.5	1.9	2.7
	(43.2)	(43.6)	(47.2)	(4.8)	(2.5)	(6.8)
Val. Donations Received/Given	94,953	102,389	110,653	6,299	10,585	7,100
	(265,478)	(399,380)	(223,227)	(38,464)	(47,323)	(37,133)

Note: Table presents sample means with standard deviations in parentheses. Data on candidates are averaged across the 2000-2016 elections, while data on donors are averaged across the 2004-2016 elections since donation data are unavailable in 2000. Data on forest cover and land use are from MapBiomas (Collection 5). Data on landholdings are drawn from Terra Legal, INCRA, and CAR. Data on mayoral candidates and campaign donors are from TSE. Environmental violations refer to IBAMA embargoes registered to either the individual or a property held by that individual. Education levels include 1 (illiterate), 2 (basic literacy), 3 (incomplete primary), 4 (complete primary), 5 (incomplete secondary), 6 (complete secondary), 7 (incomplete higher ed.), 8 (complete higher ed.). Monetary donation values are deflated to constant 2010 $BRL.

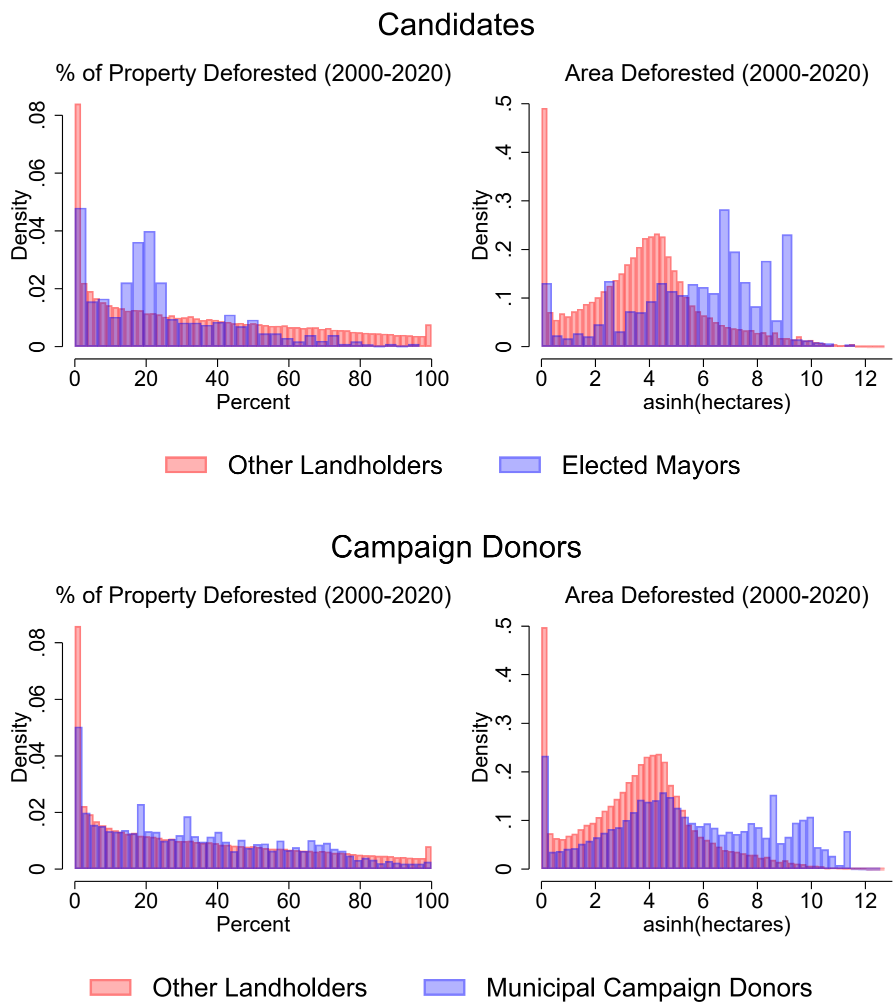
land registries, the average mayoral candidate held 2,074ha across 2.6 properties (2,898ha across 2.9 properties for elected mayors), while the average donor to a mayoral candidate held 1,538ha across 1.5 properties. In Figure 1, we plot histograms of property size held by elected mayors and campaign donors relative to all other Amazon landholders, for whom the average landholding is 564ha across 1.3 properties.

Figure 1: Distributions of Property Size among Mayors, Donors, and Other Landholders



Third, we note that *landholding candidates' and donors' properties experienced significant deforestation between 2000-2019.* Among landholding mayoral candidates, deforestation averaged 41% of baseline forest cover, and 16% received at least one environmental violation (20% for elected mayors). Figure 2 illustrates the distribution of deforestation as a percentage of property area and in total hectares on mayoral candidates' and campaign donors' properties, relative to all other Amazon properties. Both mayoral candidates and donors deforested more in absolute terms than the average landholder, but less as a share of property area due to their larger than average holdings. The average mayoral candidate had 50% of their land under pasture and 0.7% under soy during the study period, and converted 1.8% (2.1% for elected mayors) of their land to soy by 2019. On average, donors had 56% of land under pasture, 0.6% under soy, and converted 1.7% to soy by 2019.

Figure 2: Deforestation (2000-2020) on Properties of Candidates, Donors, and Others



Finally, we compare landholding and non-landholding candidates and donors and note that *largeholding mayors and donors differ substantially from other mayors and donors.* As reported in Appendix Table B2, mayors who are large landholders (>500ha) are less often female (8.5% versus 12.6% for non-landholders), slightly older and less educated, and much less likely to be born locally (10% versus 31% for non-landholders). Large landholding mayors receive 54% higher donation values and are 55% more likely to win their election than non-landholders. Among donors, large landholders give an average of 3.1 donations (versus 1.8 for non-landholders) and give 570% higher values (R$16,844 vs. R$2,959).

Appendix Table B3 reports means and standard deviations of municipal characteristics for municipalities in the Brazilian Amazon biome. Of 432 municipalities in the Amazon biome, 326 had at least one close election at the 5% win-margin level. Across municipal characteristics, there are no noteworthy differences between places that had close elections and places that did not.

4 Empirical Strategies and Identification

In Section 4.1, we present our property-level strategy to identify causal effects of the close election of a mayoral candidate on land use and environmental outcomes on the properties of the mayor and their campaign donors. In Section 4.2, we present a municipal-level strategy to identify causal effects of election of a mayor with (i) personal landholdings, or (ii) who received landholder donations, on municipal governance and land-use. Section 4.3 discusses assumptions and identification arguments.

4.1 Property-Level Event Studies

We leverage candidate and donor-level annual panel datasets spanning 2000-2019 to estimate dynamic event study specifications (e.g., Schmidheiny and Siegloch, 2019). Specifically, we compare land-use outcomes on properties held by donors to winning versus runner-up mayoral candidates (separately, we compare outcomes for candidates themselves) in years before and after the candidate's entry into office. To account for endogeneity of election outcomes, we restrict our sample to close elections ($\leq$ 5% win margin), where the outcome was plausibly random.[15] To avoid bias introduced by staggered treatment timing and heterogeneous treatment effects (Goodman-Bacon, 2021), we implement Callaway and Sant'Anna (2020)'s group-time average treatment effect estimator with never-treated and not-yet treated runners-up as controls.[16]

For donor i in year t, let E_i be the year in which the candidate i supported enters office

[15]Close election identification strategies have been employed previously in the context of Brazilian municipal elections, e.g., Bragança and Dahis (2022), Colonnelli et al. (2020) and Brollo and Troiano (2016).

[16]A new literature is currently emerging on nonclassical measurement error in satellite data (e.g., Alix-Garcia and Millimet, 2023). However, this literature is thus far limited to binary outcomes and cannot be combined with estimators such as Callaway and Sant'Anna (2020).

for the first time. Let $K_{it} = t - E_i$ be the relative number of years before or after this event. We regress outcome y_{it} on $\mathbb{1}(K_{it} = k)$ relative year indicators. We control for individual and year fixed effects as well as a vector of time-varying covariates for the winning mayor (sex and education level), and cluster standard errors at the donor-level. (Abadie et al., 2022):

$$y_{it} = \theta_i + \lambda_t + \sum_{k \neq -1} [\mathbb{1}(K_{it} = k)]\beta_k + \epsilon_{it}.$$

This specification flexibly identifies dynamic effects of entry into office and enables evaluation of the identifying parallel pre-trends assumption. Controlling for individual fixed effects identifies treatment effects off within-individual variation over time. Year fixed effects absorb changes that affect all units in specific years, such as commodity price changes or policy changes at the national level.

4.2 Municipality-Level Difference-in-Differences

We use a difference-in-differences strategy to measure effects of landholders' participation in local politics on municipal governance and land-use.[17] We define treatment T_{me} as an indicator that assumes a value of 1 when the elected mayor in municipality m in election period e either: (i) is a landholder, (ii) is a large landholder ($\geq$500 ha.), (iii) received more than 25% of their total value of donations from landholders, and (iv) received more than 50% of their total value of donations from landholders. We regress outcomes y_{me} separately on these treatment indicators, including municipality and election-period fixed effects and a vector of time-varying controls for the winning mayor (sex and education level) as follows:

$$y_{me} = \beta T_{me} + \mathbf{X}'_{ime}\mu + \delta_m + \ \theta_e + \epsilon_{me}.$$

We cluster standard errors at the municipality-level and limit the sample to municipality-election pairs with close elections ($\leq$5% win-margin), thus reducing concerns over the en-

[17] We do not implement Callaway and Sant'Anna (2020) at the municipality-level in our preferred specification since election of a landholding or landholder-financed mayor is a treatment that turns on and off again frequently, while Callaway and Sant'Anna (2020) assume treated units remain treated. To check pre-trends, we estimate municipality-level event studies for key outcomes using Callaway and Sant'Anna (2020) in Appendix Figures C41-C47.

dogeneity of election outcomes. Municipal outcomes of interest include land-use (pasture, soy, and deforestation) as a percentage of municipal area, environmental violations, and governance mechanisms, including municipal spending on agricultural promotion, municipal receipt of federal matching grants, and the value of rural credit.

4.3 Identification

The identifying assumption in our property-level analysis is that, absent an as-if-random election result, outcomes on properties of successful versus unsuccessful donors would have evolved in parallel.[18] One threat to identification could come from spatial spillovers between treated and control units. Spatial spillovers are unlikely at the property-level, given that municipalities in the Brazilian Amazon are large (averaging 6,682 km^2) and properties of winners and runners-up are unlikely to abut. Spillovers are also unlikely at the municipal-level, given that municipalities with both close elections and treated mayors are unlikely to be adjacent in space and coincident in time. Furthermore, governance mechanisms (e.g., public spending) are use-restricted to within a municipality's boundaries. At the municipal-level, we evaluate the identifying parallel pre-trends assumption prior to the first instance of treatment using event studies in Appendix Figures C41-C47.

5 Results

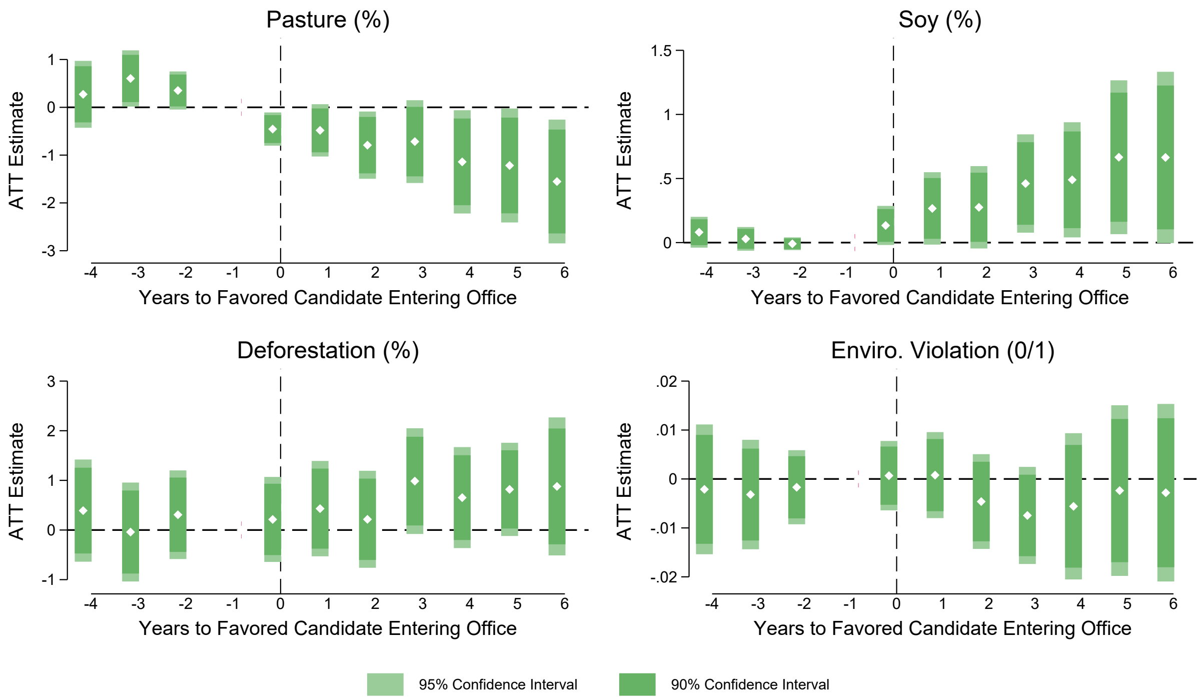
5.1 Property-Level

We first compare outcomes on properties of donors to candidates who win a close election ($\leq$5% win-margin) relative to donors to candidates who lose a close election, around the

[18] We opt for event-studies over a regression discontinuity (RD) approach for four reasons. First, event studies fully leverage our property-level panel, while RD is cross-sectional and requires a significantly larger sample size to achieve the same level of statistical power (McKenzie, 2012; Schochet, 2009). Second, event studies allow inclusion of individual fixed effects, which absorb unobservable property characteristics that could strongly shape land-use, including slope, soil type, and accessibility, as well as owner characteristics insofar as these are time-invariant. Third, RD identifies a local average treatment effect immediately around the close election cutoff, while event studies identify more general average treatment effects on the treated within the sample of close elections. Fourth, Marshall (2022) shows that cross-sectional close election RDs may fail to identify effects of candidate characteristics if other characteristics correlate with the characteristic of interest. As a robustness check, we estimate an alternative specification that includes a flexibly-defined win-margin running variable, following the RD-difference-in-differences approach in Colonnelli et al. (2020).

year of the candidate's entry into office. Figure 3 reports the main results. Appendix Table B5 reports corresponding point estimates, standard errors, and sample statistics.

Figure 3: Donors: Effects of Supported Candidate's Entry Into Office

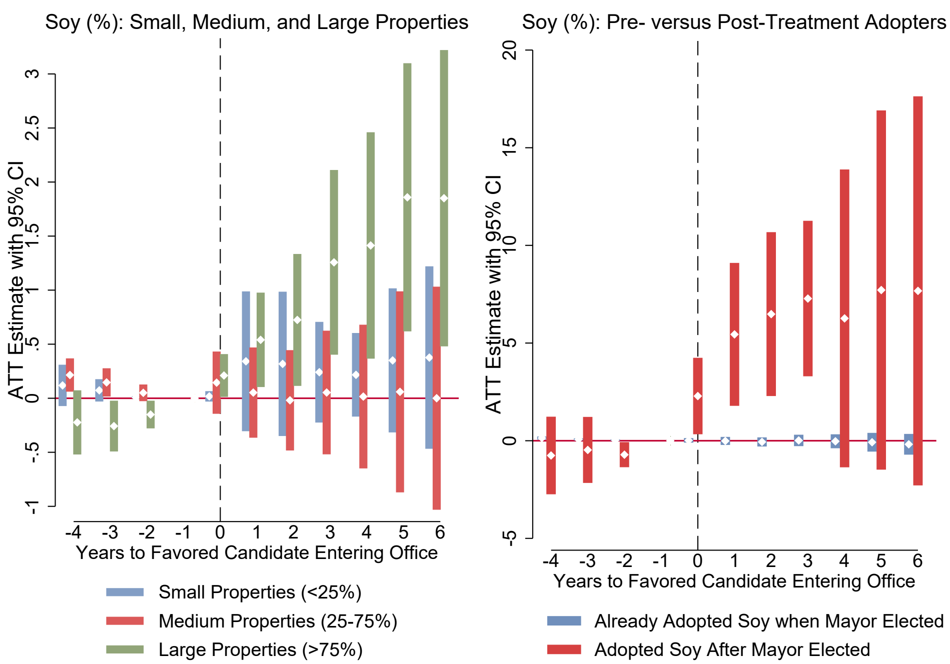


Note: Figure reports dynamic ATT estimates and 90 and 95% confidence intervals from Callaway and Sant'Anna (2020) estimator. Sample is restricted to close mayoral elections ($\leq$ 5% win-margin). Donor and year fixed effects are included and standard errors are clustered at the donor-level. Outcomes measure hectares of pasture, soy, and deforestation as a percentage of property area and a binary indicator of whether a property or owner received an environmental violation in a given year.

As shown in Figure 3, donors' soy cultivation increases significantly upon their favored candidate's entry into office (+0.46 percentage points three years after entry and +0.66p.p. five years after, from a baseline mean of 0.27% of property area). This constitutes a 270% increase over baseline during the mayoral mandate, and in hectares represents an increase of 16.2ha six years on. Donors' shift to soy appears to come mostly from existing pasture, which declines by 0.72-1.6p.p. from a baseline mean of 53% of property area. Deforestation weakly increases in several years following candidates' entry into office (+0.99p.p. in $t + 3$), though effects are not significant at the 5% level. Environmental violations remain unchanged.

In Figure 4, we re-estimate effects on donors' soy cultivation separately for (i) small, medium, and large landholders, and (ii) landholders who previously cultivated soy versus those who adopt for the first time after their candidate enters office. Results suggest that donors' shift to soy is driven by the largest quartile of properties and first-time adopters. Soy is much more profitable than raising livestock on pasture, but also involves substantial up-front inputs and connections to buyer and supplier networks that may present barriers to adoption for landholders (Moffette and Gibbs, 2021). Political influence with the mayor may enable landholders to overcome these barriers and place them on a trajectory of sustained soy-intensification.[19] Soy cultivation enjoys economies of scale (e.g., combine harvesters) and is more viable on large properties.

Figure 4: Soy (%): Heterogeneity by Property Area and Adoption Status



Note: Results are analogous to those reported in Figure 3 for soy, but with effects estimated separately for each treated sub-sample (small, medium, and large properties; pre- and post-adopters) relative to not-yet treated controls.

We also examine effects of mayoral candidates' entry into office on land-use and environmental violations on their own properties. Results are reported in Appendix Figure A4, with corresponding point estimates, standard errors, and sample statistics reported in Appendix Table B6. In general, sample sizes for candidates are much smaller than for donors, leading

[19]Our ability to analyze additional mechanisms (e.g., rural credit or agricultural inputs) at the property-level is limited by data requirements, since these analyses require identified property-level panel data.

to less precise estimates. Soy cultivation weakly increases on candidates properties after their entry into office, though estimates are not significant at the 5% level. Point estimates suggest soy increases by 0.63p.p. (11.9ha) – from a low baseline mean of 0.06% of property area – by the last year of the mayoral mandate. Environmental violations weakly decrease during the same period, suggesting mayors may enjoy some level of political cover from environmental enforcement on their personal properties.

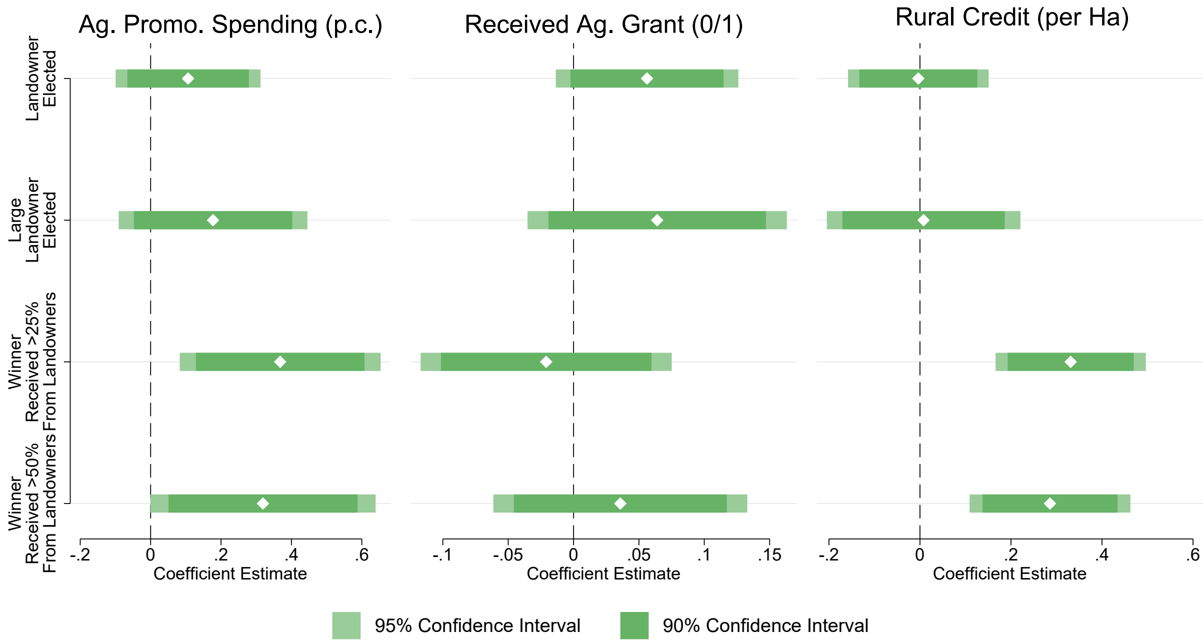
5.2 Municipal-Level

In this section, we report municipal-level effects of the close election of a landholding or landholder-financed mayor on governance, land-use, and environmental outcomes. Figure 5 reports results for municipal governance indicators related to agricultural promotion. Corresponding tables are reported in Appendix B8. Each column in Figure 5 reports coefficient estimates and 90 and 90% confidence intervals for separate estimation of the specific treatment variable on an outcome of interest. Close election of a mayor with personal landholdings or large landholdings has no significant effect on municipal spending on agricultural promotion, receipt of federal matching grants from the Ministry of Agriculture, or distribution of rural credit. In contrast, close election of a mayor who received 25% or more of their total campaign donations from landholders leads to significant increases in agricultural promotion spending (+45%) and distribution of rural credit (+40%).[20] Rural credit is allocated to producers primarily through public and commercial banks as well as credit cooperatives, all of which can have close ties with municipal governments.[21]

[20]As reported in Appendix Figure A5, election of landholder-financed mayors leads to increased spending on environmental management and has no effects on environmental grants or total municipal spending.

[21]Some municipal governments operate their own rural credit cooperatives, while others provide facilities and staff for cooperatives' operations. Thus, there are a variety of formal and informal channels through which mayors could influence local provision of rural credit. In 2021, 13.7% of rural credit was allocated to small producers, 11.5% to medium producers, and 74.8% to large producers, suggesting that large landholders are major beneficiaries of increases in rural credit (Ministério da Agricultura e Pecuária, 2022).

Figure 5: Effects of Election of a Landholding or Landholder-Financed Mayor on Governance

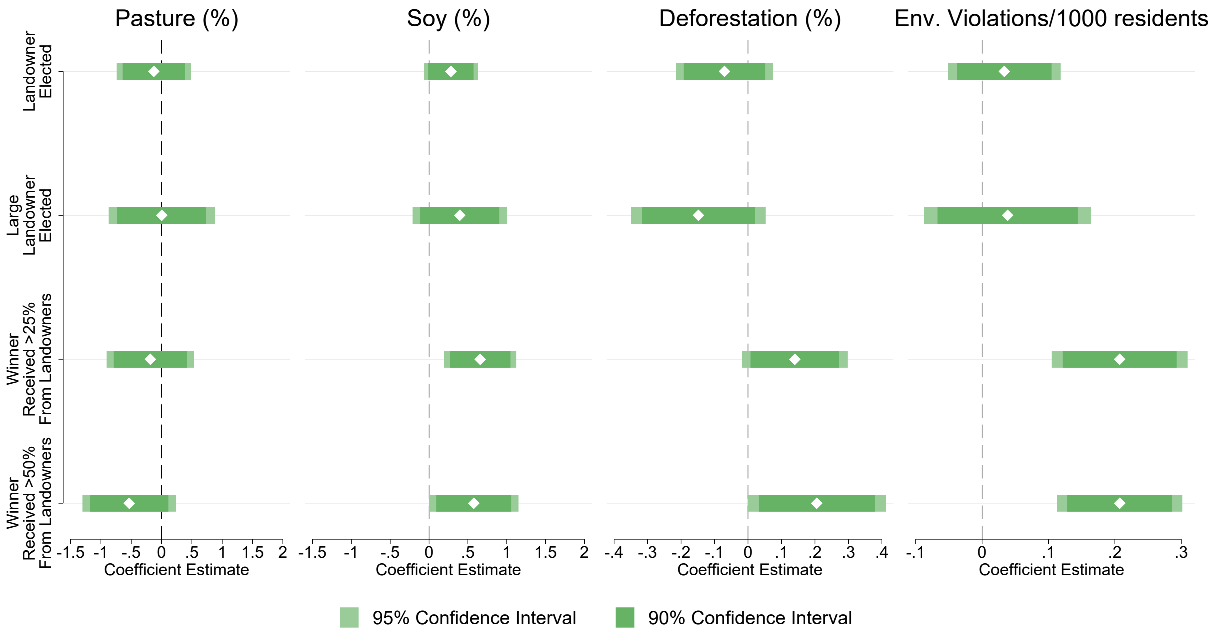


Note: Figures report coefficient estimates and 90 and 95% confidence intervals from regression of outcome on municipality-election level treatment dummies: (i) landholder in office, (ii) large landholder ($\geq$ 500 ha.) in office, (iii) mayor who received $\geq$ 25% of their donations from landholders in office, and (iv) mayor who received $\geq$ 50% of their donations from landholders in office. Specifications include municipality and election FEs, candidate-level controls (mayor's sex and education level), and cluster standard errors at the municipality level. Sample is panel of municipality-election periods (2001-2005 through 2016-2019) where win-margin between winner and runner-up mayor was $\leq$ 5%. Left figure reports estimated effects on municipal spending on Agricultural Promotion per capita; central figure reports estimated effects on the likelihood the municipality receives a matching grant from the Federal Ministry of Agriculture; right figure reports estimated effects on the total value of rural credit for agriculture and livestock per hectare of municipal area. Monetary values are deflated to constant 2010 $BRL and transformed using inverse hyperbolic sine function.

Does landholder-financed mayors' promotion of agriculture affect municipal land-use and environmental outcomes? Figure 6 reports municipal results for pasture, soy, deforestation, and environmental violations. Close election of a mayor with personal landholdings or large-holdings has no significant effect on land-use, deforestation, or violations at the municipal level. Election of a landholder-financed mayor is associated with a downward trend in pasture and a significant increase in soy (+0.66p.p. or +126ha, from a baseline mean of 0.07% of municipal area). Landholder-financed mayors are also associated with increased deforestation (+0.14p.p., from a baseline mean of 1.71%) and environmental violations (+23%).[22]

[22] We expect that – all else equal – increased deforestation in an Amazon municipality (where almost all forest clearing is illegal) should result in more registration of environmental violations if enforcement is applied objectively. A significant increase in deforestation that is not accompanied by increased violations would thus provide suggestive evidence that mayors exert influence over federal inspectors to protect local landholders from environmental enforcement. Our finding that increased deforestation is accompanied by more-than-proportional increases in environmental violations thus lends evidence *against* an illicit influence channel underlying increases in soy cultivation and deforestation.

Figure 6: Effects of Election of a Landholding or Landholder-Financed Mayor on Land-Use

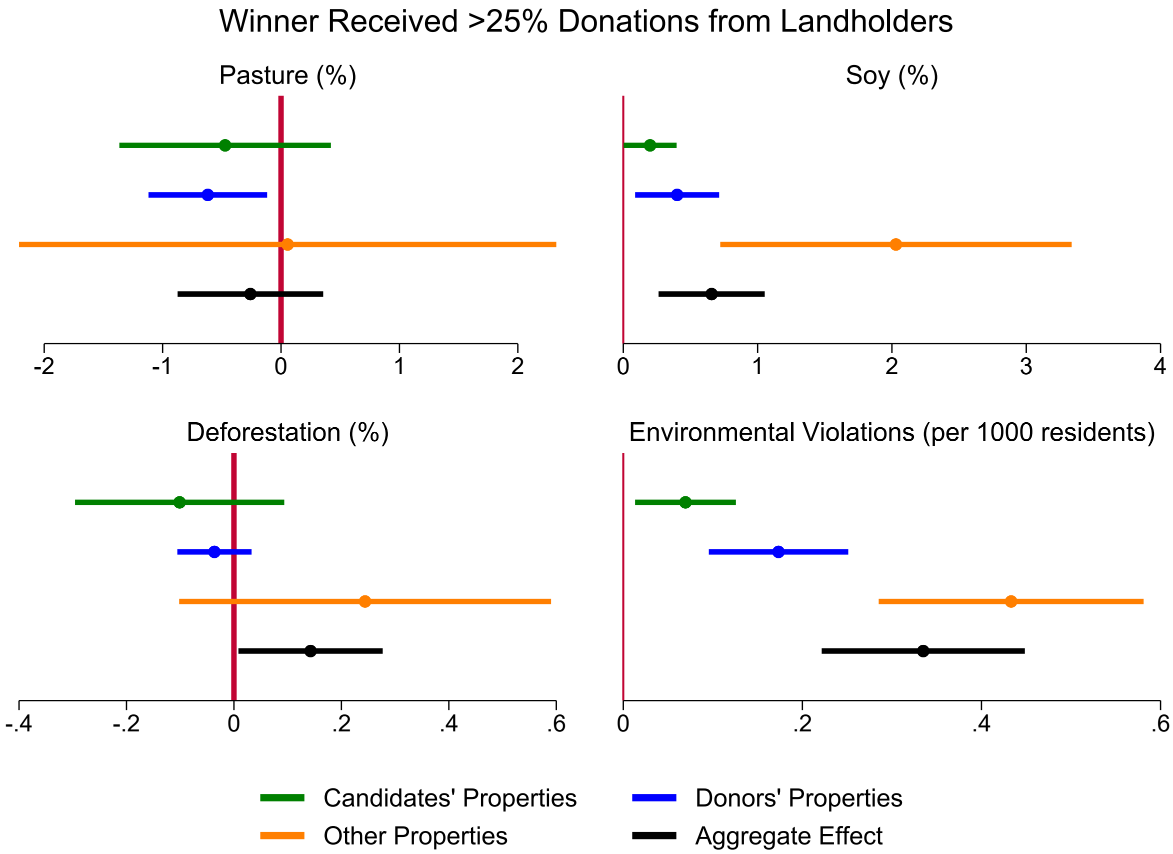


Note: Figures report coefficient estimates and 90 and 95% confidence intervals from regression of outcome on municipality-election level treatment dummies (landholder in office, large landholder ($\geq$ 500 ha.) in office, mayor who received landholder donations in office, mayor who received $\geq$ 25% of their donations from landholders in office, and mayor who received $\geq$ 50% of their donations from landholders in office). Specifications include municipality and election FEs, candidate-level controls (mayor's sex and education level), and cluster standard errors at municipality level. Sample is panel of municipality-election periods (2001-2005 through 2016-2019) where win-margin between winner and runner-up mayor was $\leq$ 5%. Figures report, from left to right, estimated effects on pasture, soy, and other crops as percentages of municipal area.

In Figure 7, we decompose aggregate municipal treatment effect estimates for the *landholder-financed mayors* treatment (>25% of total donations) into changes that occurred on the properties of three landholder groups (mayoral candidates, campaign donors, and all other properties). Our aim is to assess whether aggregate effects are driven by precise targeting of agricultural promotion to donors, or whether there are spillovers onto non-donor properties.[23] Results suggest the presence of substantial spillovers onto the properties of non-donors. In particular, negative environmental consequences of agricultural promotion (e.g., deforestation and environmental violations) are concentrated on the properties of non-donors. Likewise, landholder-financed mayors are associated with large increases in soy cultivation on non-donor properties. Collectively, these results indicate that agricultural promotion was not precisely targeted to donors, either because targeting is not feasible or because landholder donations represent landholders as a collective special interest group.

[23] There are far fewer candidates and donors than other landholders. This decomposition shows *absolute* changes on each group's landholdings as a percentage of *total municipal property area*, and does not reflect relative intensity of effects by group.

Figure 7: Decomposition of Municipal-Level Effects by Landholder Group



Note: Results are analogous to those reported in Figures 6, with effects estimated separately on outcomes decomposed by group (mayoral candidates, campaign donors, and other properties). Point estimates with 90% confidence intervals are reported. Decomposed effect estimates may be compared to the aggregate effect in black.

If receipt of landholder donations is correlated with total donation receipts, could it be that we are finding a spurious effect of landholder donations, while the real effect is driven by large donations receipts (of any origin)? To exclude this possibility, we re-estimate an analogous specification with an alternative treatment: municipalities are classified as treated if a mayor who received more than the median total donation value – but no donations from landholders – wins a close election. The intention of this exercise is to isolate the effect of receiving large donation values. Results, presented in Appendix Figure A6, show that simply receiving large donation values does not reproduce the previous findings. In fact, close election of mayors who receive above median donation values from sources other than agriculture leads to significantly *reduced* soy cultivation and environmental violations and downward trends in deforestation and agricultural promotion spending. Evidently, politicians who receive substantial donations from non-landholding donors may govern on behalf of non-landholding special interest groups (e.g., urban or commercial), which may desire less deforestation and reduced promotion of agriculture relative to alternative investments.

6 Robustness

We implement a battery of robustness checks to test the sensitivity of property- and municipal-level findings to alternative specifications and sample definitions. We summarize these exercises below, focusing on donor results for brevity.

6.1 Property-Level Robustness Checks

Alternative Win-Margin Cutoffs: We assess the sensitivity of property-level results to alternative win-margin cutoffs by re-estimating specifications using (i) a 10% cutoff and (ii) no cutoff, retaining all municipality elections in sample. While the stricter 5% cutoff makes the as-if-random election result more plausible, it also drops non-competitive elections, where patronage dynamics may be more prevalent. Results with alternative close election cutoffs are reported in Appendix Figures C1-C4. Results at the 10% level follow the same patterns as our preferred specification, though estimates for soy lose significance at conventional levels. With no close election cutoff, effects on soy are significant and positive, while effects on deforestation are significant and positive at the 10% level. Overall, alternative win-margin cutoffs do not substantively change our main findings.

Restrict to States with Complete CAR Registries: We re-estimate our preferred specification in the sub-sample of municipalities located in Mato Grosso, Pará, and Rondônia, where CAR land registries are most complete – minimizing measurement error. Results are reported in Appendix Figures C5-C6. Results are strongly robust to this restriction.

Alternative Outcome Normalization: We re-estimate our preferred specification with land-use outcomes defined as the inverse hyperbolic sine of hectares under each land use. While normalizing land-uses to percentage of property area better accommodates large differences in property sizes and reflects changes in land-use intensity, this alternative definition gives a better measure of absolute land-use impacts. Results, reported in Appendix Figures

C7-C8, are strongly robust to this change.

Include Municipality-Election Fixed Effects: Inclusion of municipality-election fixed effects restricts comparisons to donors to winner versus runner-up mayors *within* the same municipality-election period.[24] Results are reported in Appendix Figure C9. Our main finding that soy cultivation increases significantly on treated donors' properties is robust to this more restrictive specification. While there are minor pre-trend violations, these are substantially smaller than post-treatment effects.

Flexibly Control for Win-Margin Running Variable: Following Colonnelli et al. (2020), we re-estimate property-level event studies controlling for the win-margin interacted with year fixed effects to allow effects of the running variable to vary across candidates' time in office. This specification represents an "RD-difference-in-differences" approach. Results,. reported in Appendix Figures C10-C11, are strongly robust to this specification.[25]

6.2 Municipal-Level Robustness Checks

Alternative Win-Margin Cutoffs: We re-estimate municipal-level results using (i) an alternative 10% win-margin cutoff to define close elections, and (ii) no win-margin cutoff. Results, reported in Appendix Figures C32-C35, are strongly robust to these alternative cutoffs with the exception of deforestation, which loses significance but retains similar sign and magnitude in the no-cutoff specification.

Restrict to States with Complete CAR Registries: We restrict the sample to municipalities with more complete land registries to minimize measurement error. Results are reported in Appendix Figures C36-C37. Land-use results are slightly less statistically significant, but point estimates exhibit similar signs and magnitudes.

Alternative Outcome Normalization: We use the inverse hyperbolic sine of hectares of

[24] While this restriction makes comparisons between treated and control donors more credible, it is also quite demanding on our relatively small sample. We thus apply this restriction to donor-level results but not to candidates, since there are many municipality-election pairs with only a winner or runner-up landholder candidate, but not both.

[25] We also check robustness to iterations of these modifications, including the 10% and full samples for Mato Grosso, Pará, and Rondonia, with and without the asinh transformation and municipality-election fixed effects. Results for these robustness iterations are reported in Appendix Figures C12-C31. While levels of significance and non-soy outcomes vary to some degree across specifications, our main finding of a positive treatment effect on donors' soy cultivation is robust.

soy, pasture, and deforestation instead of percentage of property area. Results, reported in Appendix Figure C38, strongly robust to this alternative normalization with the exception of deforestation, which loses statistical significance.

Control for Win-Margin Running Variable: We re-estimate our preferred specification including the win-margin running variable as a control. Results, reported in Appendix Figures C39-C40, are strongly robust to inclusion of this variable.

Event Studies: Finally, to assess the identifying parallel pre-trends assumption, explore dynamic treatment effects, and avoid biases created by staggered treatment timing, we estimate municipal-level event studies using annual panel data and the Callaway and Sant'Anna (2020) estimator. Results are reported in Appendix Figures C41-C47. This approach faces the limitation of only registering the first time a municipality is treated, while in practice treatment turns on and off frequently within municipalities. Event study results confirm that pre-trends are parallel and effects are robust to the Callaway and Sant'Anna (2020) estimator for soy, deforestation, environmental violations, and agricultural promotion spending.[26]

7 Discussion

We construct a novel panel dataset measuring land-use changes on the properties of municipal politicians and campaign donors across five elections in the Brazilian Amazon. These data reveal previously unobservable connections between landholders and politics in the world's largest tropical forest. We document extensive involvement of landholders in local politics – both as candidates and donors – and show that these landholders are disproportionately largeholders engaged in significant deforestation on their properties.

We are the first to document "agricultural patronage," whereby mayors pay back large landholding donors by facilitating high-value crop adoption on their properties. We also show that mayors cannot or do not target their support to donors precisely. Instead, they promote agriculture broadly, leading to spillovers of deforestation and environmental violations onto

[26]Exceptions to parallel pre-trends for the landholder-financed mayors treatment ($\geq$25% of total donation value) include pasture, which are negative in treated municipalities in period $t-2$, and deforestation, which is positive in treated municipalities in $t-3$. Event study results for rural credit suggest a negative treatment effect, suggesting this result is not fully robust across specifications. The $t-1$ period is omitted from event study figures for brevity, but is set as the base period in all specifications.

non-donor properties. Findings suggest that rural producers face barriers to agricultural intensification in the Amazon. Conversion of pasture to soy requires significant up-front investments and buyer and supplier connections – and landholders turn to buying political influence through campaign donations to overcome these barriers.

Cattle ranching on pasture in the Amazon is notoriously unproductive (Bragança et al., 2022), and conversion of pasture to soy can increase land productivity substantially – with concomitant contributions to local economic development (Marin et al., 2022). On the other hand, soy production in the Amazon leads to increased agro-chemical use, which has been linked to elevated rates of childhood cancer (Skidmore et al., 2023). Previous studies have also highlighted the risk of indirect land-use change, whereby conversion of pasture to soy in one location provokes deforestation for new pasture elsewhere (Gollnow et al., 2018). Our results reveal a political mechanism underlying indirect land-use change: political pressure to help large landholders convert pasture to soy leads politicians to promote agriculture broadly, which allows smaller landholders to deforest more.

Finally, land inequality in the Amazon is extreme, and our results show that it is the largest landholders who benefit from agricultural patronage. This dynamic could exacerbate local inequalities and contribute to a self-reinforcing cycle wherein politicians favor large landholders, empowering this group and enabling further political influence. Quantifying these local incentives and channels of influence is an important step toward achieving more inclusive and sustainable land-use practices in the region.

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Online Appendix

Does Local Politics Drive Tropical Land-Use Change?
Property-Level Evidence from the Amazon

Erik Katovich and Fanny Moffette

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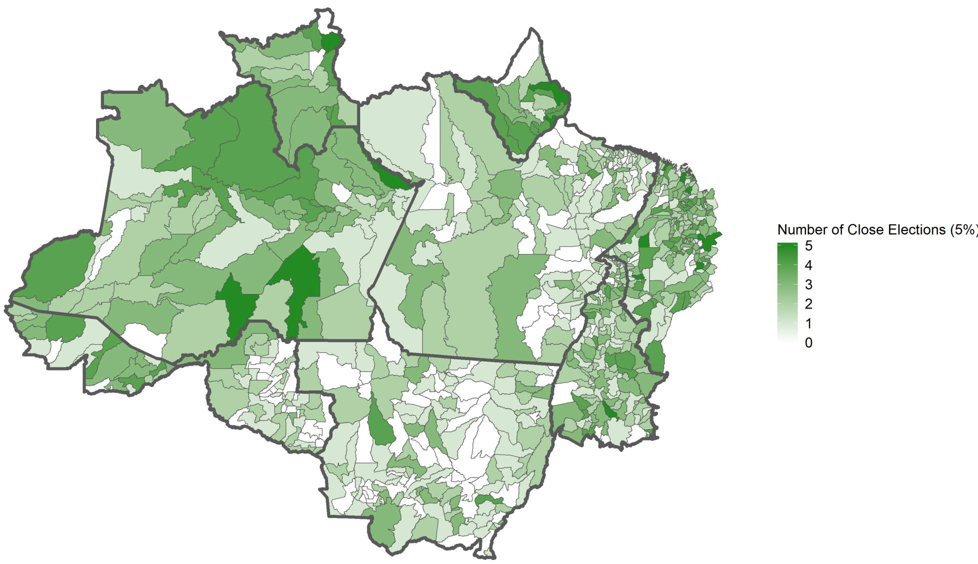
A Supplementary Figures

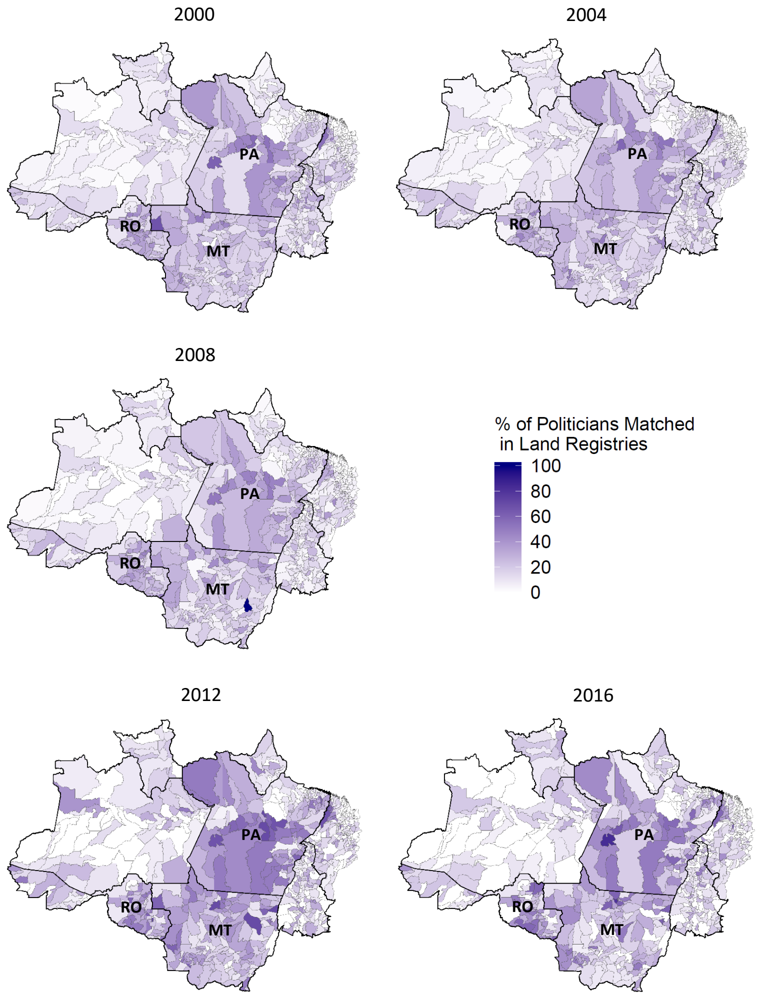
A.1 Descriptive Figures

Figure A1: Number of Close Elections ($\leq$ 5% Win Margin) per Municipality (2000-2016)



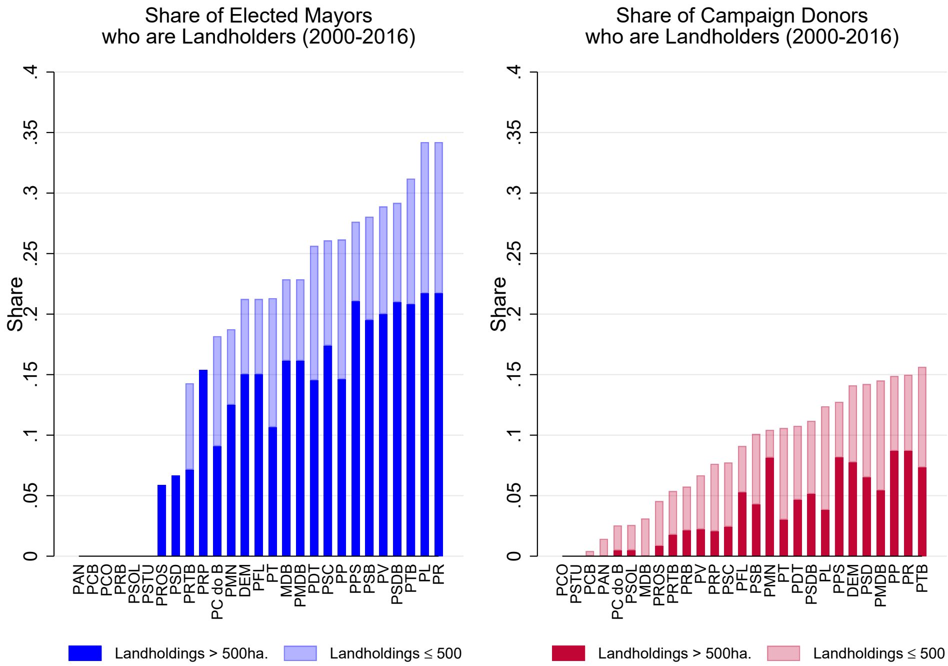
Note: Map reports numbers of close elections in each municipality over 2000, 2004, 2008, 2012, and 2016 elections for the Brazilian Legal Amazon.

Figure A2: Percent of Mayoral Candidates Matched with Land Registries (2000-2016)



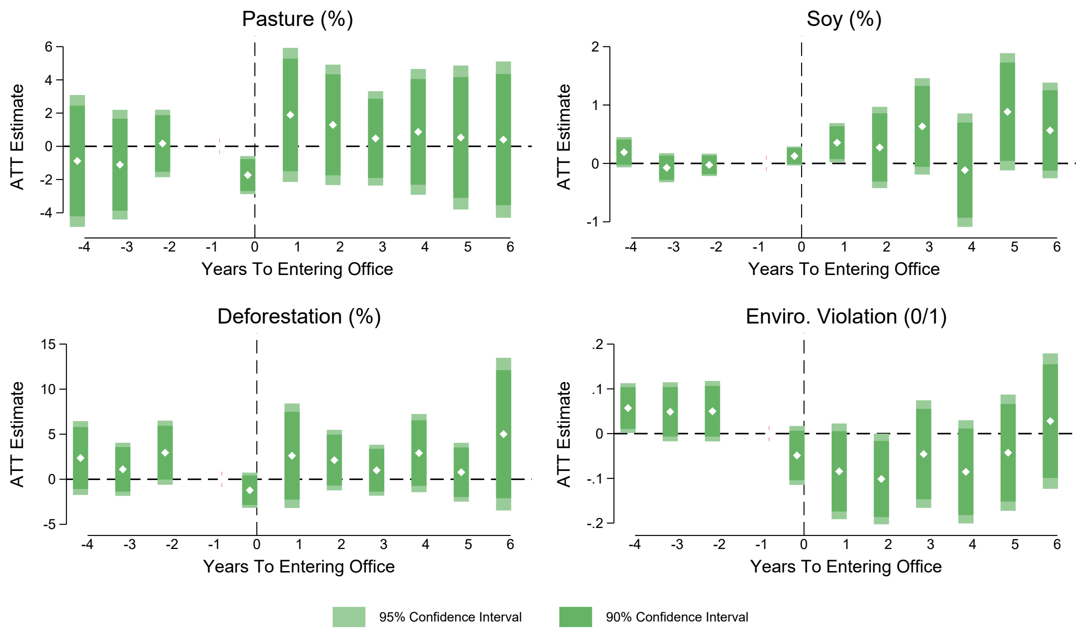
Note: Map reports percentage of municipal mayoral candidates that matched in each election with property boundaries from CAR, Terra Legal, or INCRA. Match percentages should not be expected to be near 100, as many politicians are not landowners.

Figure A3: Share of Elected Mayors and Campaign Donors Matching with Landholder Registries, by Party



A.2 Additional Results: Property-Level

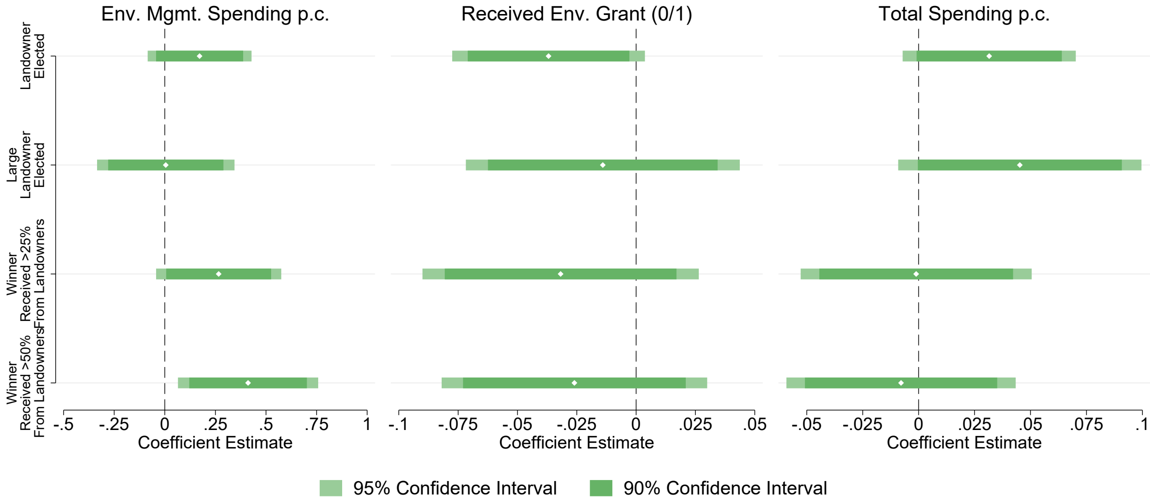
Figure A4: Candidates: Effects of Entry into Office on Own-Property Outcomes



Note: Figure reports dynamic ATT estimates and 90 and 95% confidence intervals from Callaway and Sant'Anna (2021) *csdid* estimator. Sample is restricted to successful and runner-up mayoral candidates in close mayoral elections ($\leq$ 5% win-margin) in the Brazilian Amazon biome. Candidate and year fixed effects are included and standard errors are clustered at the candidate level. Outcomes measure hectares of pasture, soy, and deforestation as a percentage of property area, and an indicator of whether an environmental violation is reported for the property/owner in a given year.

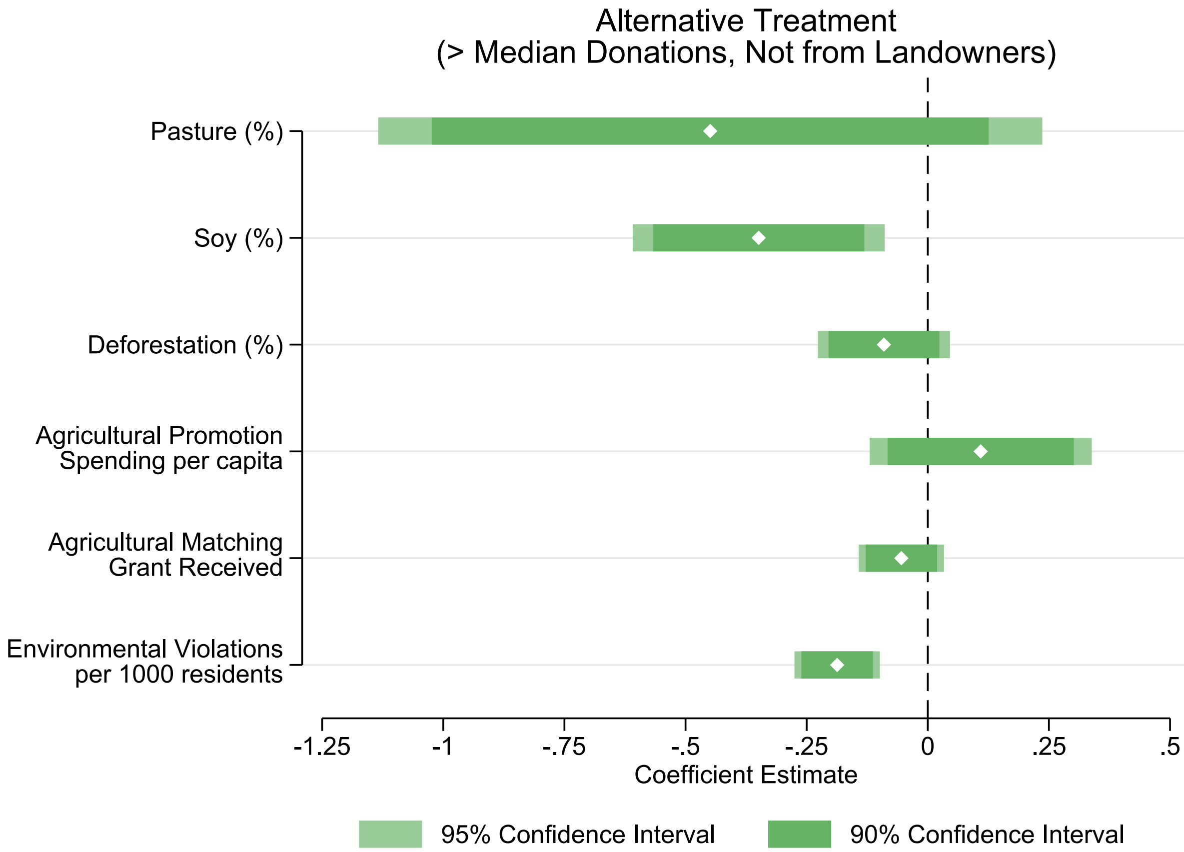
A.3 Additional Results: Municipal-Level

Figure A5: Effects of Election of Mayor with Personal or Donor Ties to Land on Other Outcomes



Note: Figure is organized analogously to Figure 5. Left sub-figure presents estimated effects on municipal environmental spending per capita; central sub-figure presents estimated effects on an indicator of whether the municipality received a matching grant from the Ministry of the Environment. Right sub-figure presents estimated effects on total municipal spending per capita. Monetary values are deflated to constant 2010 $BRL and transformed using inverse hyperbolic sine function.

Figure A6: Effects of Election of Mayor with Above Median Donations but No Donations from Landowners on Selected Outcomes (Sample = Elections with $\leq$ 5% Win Margin)



Note: Figure reports coefficient estimates and 90 and 95% confidence intervals from regression of outcome on municipality-election level treatment dummy (mayor who received $\geq$ median value of total campaign donations but no donations from landowners in office). Specifications include municipality and election FEs, candidate-level controls (mayor's sex and education level), and cluster standard errors at municipality level. Sample is panel of municipality-election periods (2001-2005 through 2016-2019) where win-margin between winner and runner-up mayor was $\leq$ 5%. Outcomes are pasture, soy, and deforestation as percentages of municipal area, agricultural promotion spending per capita (transformed by inverse hyperbolic sine and deflated to constant 2010 BRL), an indicator of whether the municipality received a federal matching grant from the Ministry of Agriculture, and the number of environmental violations per 1000 residents, transformed by inverse hyperbolic sine)

B Supplementary Tables

B.1 Descriptive Tables

Table B1: Data Sources

Data	Source	Years	Raw Level	Analysis Level
Deforestation & Land Use	MapBiomas	2000-2019	Pixel	Property/Municipality
Land Registries	CAR	2011-2020	Property	Property
	Terral Legal	2014-2017	Property	Property
	INCRA	2016-2020	Property	Property
Elections (Candidates)	TSE	2000-2016	Individual	Individual
Elections (Donors)	TSE	2004-2016	Individual	Individual
Environmental Violations	IBAMA	2005-2020	Property/ID	Property/Municipality
Public Finances	FINBRA	2000-2020	Municipality	Municipality
Greenhouse Gas Emissions	SEEG	2000-2018	Municipality	Municipality
Federal Matching Grants	PGU	2000-2020	Municipality	Municipality
Rural Credit	Banco Central	2004-2017	Municipality	Municipality
Municipality Characteristics	Census/Ipea	2000	Municipality	Municipality
Municipal Development Index	FIRJAN	2000	Municipality	Municipality

Table B2: Descriptive Statistics: Landholding vs. Non-Landholding Mayors and Donors

	Elected Mayors		
	>500ha Land	≤500ha Land	No Land
% Female	8.6	12.3	12.6
	(28.0)	(32.9)	(33.2)
Schooling (Years)	11.9	12.1	12.3
	(3.6)	(3.6)	(3.5)
Age	47.1	46.4	46.6
	(10.0)	(9.1)	(9.8)
% Born Locally	10.2	21.9	31.0
	(30.3)	(41.5)	(46.3)
Value of Donations Received	106,835	65,943	69,188
	(223,664)	(124,914)	(211,610)
Num. of Donations Received	25.4	25.0	20.6
	(45.3)	(46.4)	(36.5)
Winning % of Candidates	44.0	31.4	28.3
	(49.7)	(46.5)	(45.1)
	Campaign Donors		
	>500ha Land	≤500ha Land	No Land
Value of Donations Given	16,844	3,674	2,959
	(71,308)	(25,344)	(55,220)
Num. of Donations Given	3.1	2.2	1.8
	(7.3)	(3.8)	(3.6)

Table B3: Descriptive Statistics: Municipalities in Amazon Biome

	Close Election ($\leq$ 5% Win Margin)	Close Election ($\leq$ 10% Win Margin)	All Municipalities
No. Municipalities	326	409	432
Descriptives:			
Size (sq. km.)	10,728	10,225	9,218
	(20,508)	(20,071)	(17,605)
Dist. from State Capital (km.)	310.0	308.6	323.0
	(280.1)	(269.7)	(266.8)
% Forest Cover Loss (to 2020)	39.81	40.61	43.08
	(32.48)	(32.66)	(32.77)
Population	35.0	36.7	33.2
	(103.2)	(119.5)	(100.8)
GDP (Millions of 2010 BRL)	163.7	198.2	177.9
	(697.9)	(1,117.6)	(1,007.2)
Mun. Development Index	0.44	0.45	0.45
	(0.09)	(0.08)	(0.08)
% of Population Urban	50.83	51.43	51.33
	(23.25)	(23.57)	(23.22)
Income Gini Coefficient	0.60	0.59	0.59
	(0.06)	(0.07)	(0.07)
% of Population in Poverty	63.30	63.19	61.63
	(16.82)	(16.76)	(17.50)
% Workers Empl. in Agricult.	49.44	49.95	49.88
	(18.97)	(18.71)	(18.48)
No. of Donations/1000 ppl.	18.61	19.24	19.84
	(19.02)	(19.87)	(19.19)
Value Donations/1000 ppl.	21,645	22,009	21,437
	(16,527)	(17,915)	(17,787)

B.2 Results Tables: Property-Level

[Tables Under Revision]

Table B4: Donors: Dynamic Effects of Favored Candidate's Entry into Office on Land Use (Sample = Elections with ≤ 5% Win Margin)

Relative Year	**Pasture (%)**		**Soy (%)**		**Other Ag. (%)**	
	Coef.	*(St. Err.)*	*Coef.*	*(St. Err.)*	*Coef.*	*(St. Err.)*
-4	-0.152	(0.197)	-0.026	(0.036)	0.011	(0.030)
-3	0.332	(0.207)	-0.052	(0.032)	0.031	(0.046)
-2	-0.251	(0.183)	-0.038	(0.032)	-0.007	(0.036)
-1	-0.352	(0.203)	0.009	(0.025)	0.206	(0.093)
0	-0.455	(0.177)	0.134	(0.078)	-0.043	(0.070)
1	-0.482	(0.279)	0.267	(0.144)	-0.096	(0.105)
2	-0.792	(0.359)	0.275	(0.164)	0.006	(0.130)
3	-0.717	(0.442)	0.461	(0.196)	-0.143	(0.130)
4	-1.141	(0.551)	0.490	(0.229)	0.061	(0.167)
5	-1.217	(0.608)	0.666	(0.306)	-0.102	(0.163)
6	-1.552	(0.660)	0.664	(0.341)	-0.073	(0.175)
n =	29,480		29,480		29,480	
Baseline DV Mean	52.57		.27		0.18	
Donor FE	YES		YES		YES	
Year FE	YES		YES		YES	

Note: Table reports dynamic ATT coefficient estimates and standard errors using Callaway and Sant'Anna (2021) estimator. Sample is restricted to donors to successful and runner-up mayoral candidates in close mayoral elections (≤ 5% win-margin) in the Brazilian Amazon biome. Treatment is defined as a donor's favored candidate's first entry into mayoral office; controls are restricted to not-yet-treated and never-treated donors. Donor and year fixed effects are included and standard errors are clustered at the donor-level. Outcomes measure hectares of pasture, soy, and other crops as a percentage of property area. Baseline dependent variable corresponds to the average between the value at t-1 for treated units and at t=2001 for controls.

Table B5: Donors: Dynamic Effects of Favored Candidate's Entry into Office on Environmental Outcomes (Sample = Elections with ≤ 5% Win Margin)

Relative Year	**Deforestation (%)**		**Deforestation (0/1)**		**Embargo (0/1)**	
	Coef.	*(St. Err.)*	*Coef.*	*(St. Err.)*	*Coef.*	*(St. Err.)*
-4	-0.061	(0.192)	0.021	(0.015)	0.005	(0.006)
-3	0.071	(0.178)	-0.002	(0.014)	-0.001	(0.004)
-2	-0.027	(0.162)	-0.002	(0.014)	0.001	(0.004)
-1	-0.067	(0.141)	-0.028	(0.014)	0.002	(0.004)
0	-0.182	(0.137)	0.006	(0.014)	0.001	(0.004)
1	0.052	(0.170)	0.006	(0.015)	0.001	(0.004)
2	0.096	(0.173)	0.002	(0.017)	-0.004	(0.004)
3	0.241	(0.173)	0.018	(0.018)	-0.004	(0.005)
4	0.026	(0.164)	0.005	(0.019)	-0.004	(0.007)
5	0.069	(0.151)	-0.008	(0.019)	0.001	(0.008)
6	0.162	(0.234)	-0.017	(0.026)	-0.002	(0.009)
n =	26,532		28,006		23,584	
Baseline DV Mean	2.20		0.40		0.05	
Donor FE	YES		YES		YES	
Year FE	YES		YES		YES	

Note: Table reports dynamic ATT coefficient estimates and standard errors from Callaway and Sant'Anna (2021) estimator. Sample is restricted to successful and runner-up mayoral candidates in close mayoral elections (≤ 5% win-margin). Treatment is defined as a donor's favored candidate's first entry into mayoral office; controls are restricted to not-yet-treated and never-treated donors. Donor and year fixed effects are included and standard errors are clustered at the donor level. Outcomes are (i) hectares that transitioned from natural vegetation (Forest and Savannah Formations) to anthropic use as a percentage of property area, (ii) deforestation as a binary outcome, and (iii) an indicator of whether an IBAMA environmental embargo was registered to an individual's ID or properties in a given year. Baseline dependent variable corresponds to the average between the value at t-1 for treated units and at t=2001 for controls.

Table B6: Candidates: Dynamic Effects of Entry into Office on Land Use (Sample = Elections with ≤ 5% Win Margin)

Relative Year	**Pasture (%)**		**Soy (%)**		**Other Ag. (%)**	
	Coef.	*(St. Err.)*	*Coef.*	*(St. Err.)*	*Coef.*	*(St. Err.)*
-4	-0.257	(0.858)	-0.176	(0.172)	0.091	(0.084)
-3	0.214	(0.842)	-0.003	(0.003)	0.162	(0.140)
-2	1.183	(0.920)	0.059	(0.057)	-0.040	(0.126)
-1	-0.172	(1.036)	0.025	(0.098)	0.050	(0.163)
0	-1.732	(0.584)	0.127	(0.083)	0.051	(0.097)
1	1.890	(2.059)	0.355	(0.171)	-0.039	(0.214)
2	1.292	(1.849)	0.273	(0.355)	-0.263	(0.261)
3	0.479	(1.450)	0.634	(0.421)	-0.423	(0.358)
4	0.870	(1.933)	-0.115	(0.496)	-0.402	(0.443)
5	0.531	(2.210)	0.884	(0.512)	-0.016	(0.510)
6	0.405	(2.401)	0.565	(0.418)	0.168	(0.687)
n =	1,717		1,717		1,717	
Baseline DV Mean	41.74		0.06		0.27	
Candidate FE	YES		YES		YES	
Year FE	YES		YES		YES	

Note: Table reports dynamic ATT coefficient estimates and standard errors from Callaway and Sant'Anna (2020) estimator. Sample is restricted to successful and runner-up mayoral candidates in close mayoral elections (≤ 5% win-margin) in the Brazilian Amazon biome. Treatment is defined as a candidate's first entry into mayoral office; Never-treated and not-yet-treated candidates compose the control group. Candidate and year fixed effects are included and standard errors are clustered at the candidate level. Outcomes measure hectares of pasture, soy, and other crops as a percentage of property area. Baseline dependent variable mean corresponds to the average between the value at t-1 for treated units and at t=2001 for controls.

Table B7: Candidates: Dynamic Effects of Entry into Office on Environmental Outcomes (Sample = Elections with $\leq$ 5% Win Margin)

Relative Year	**Deforestation (%)**		**Deforestation (0/1)**		**Embargo (0/1)**	
	Coef.	*(St. Err.)*	*Coef.*	*(St. Err.)*	*Coef.*	*(St. Err.)*
-4	0.820	(0.511)	0.072	(0.091)	0.058	(0.093)
-3	-1.643	(1.123)	0.078	(0.075)	-0.057	(0.034)
-2	0.416	(0.900)	-0.049	(0.062)	0.083	(0.080)
-1	-1.262	(0.667)	-0.065	(0.087)	-0.050	(0.034)
0	-0.368	(0.433)	-0.028	(0.068)	-0.049	(0.034)
1	2.216	(1.505)	0.053	(0.076)	-0.017	(0.048)
2	1.320	(0.585)	0.130	(0.071)	-0.029	(0.042)
3	0.998	(0.503)	0.077	(0.087)	-0.070	(0.027)
4	1.307	(0.556)	0.012	(0.091)	-0.089	(0.046)
5	-0.017	(0.518)	-0.047	(0.077)	-0.056	(0.058)
6	0.831	(0.691)	0.040	(0.106)	-0.039	(0.062)
n =	1,573		1,573		1,331	
Baseline DV Mean	2.53		0.59		0.05	
Candidate FE	YES		YES		YES	
Year FE	YES		YES		YES	

Note: Table reports dynamic ATT coefficient estimates and standard errors from Callaway and Sant'Anna (2020) estimator. Sample is restricted to successful and runner-up mayoral candidates in close mayoral elections ($\leq$ 5% win-margin) in the Brazilian Amazon biome. Treatment is defined as a candidate's first entry into mayoral office; candidates never treated and not yet treated compose the control group. Candidate and year fixed effects are included and standard errors are clustered at the candidate level. Outcomes are (i) hectares that transitioned from natural vegetation (Forest and Savannah Formations) to anthropic use as a percentage of property area, (ii) deforestation as a binary outcome, and (iii) an indicator of whether an IBAMA environmental embargo was registered to an individual's ID or properties in a given year. Baseline dependent variable corresponds to the average between the value at t-1 for treated units and at t=2001 for controls.

B.3 Results Tables: Municipal-Level

[Tables Under Revision]

Table B8: Effects of Election of Landholder or Landholder-Financed Mayor on Municipal Governance

	Ag. Spend	**Ag Grant**	**Rural Credit**	**Env. Spend**	**Env. Grant**
Land	0.026	0.042	0.068	0.182	0.005
	(0.104)	(0.037)	(0.069)	(0.130)	(0.020)
Large Land	0.064	0.013	-0.079	-0.109	0.020
	(0.149)	(0.047)	(0.095)	(0.180)	(0.028)
>25% Land Donations	0.211	-0.006	0.408	0.165	-0.042
	(0.140)	(0.048)	(0.084)	(0.171)	(0.026)
>50% Land Donations	0.180	0.045	0.317	0.291	-0.025
	(0.158)	(0.051)	(0.094)	(0.183)	(0.028)
n =	1,236	1,264	1,195	1,236	1,264
Baseline DV Mean	2.39	0.70	1.78	0.34	0.19
Municipality FE	YES	YES	YES	YES	YES
Election FE	YES	YES	YES	YES	YES
Candidate Controls	YES	YES	YES	YES	YES

Table B9: Effects of Election of Landholder or Landholder-Financed Mayor on Municipal Land Use and Environmental Outcomes

	Pasture (%)	**Soy (%)**	**Other Ag. (%)**	**Deforest. (%)**	**Embargos**
Land	-0.344	0.221	-0.003	-0.131	0.035
	(0.377)	(0.196)	(0.045)	(0.074)	(0.043)
Large Land	-0.367	0.224	-0.069	-0.212	-0.009
	(0.439)	(0.362)	(0.080)	(0.105)	(0.067)
>25% Land Donations	0.259	0.705	0.093	0.137	0.266
	(0.416)	(0.195)	(0.065)	(0.068)	(0.052)
>50% Land Donations	0.049	0.766	0.064	0.088	0.223
	(0.513)	(0.259)	(0.084)	(0.071)	(0.053)
n =	1,264	1,264	1,264	1,264	983
Baseline DV Mean	27.05	0.07	0.13	1.71	0.32
Municipality FE	YES	YES	YES	YES	YES
Election FE	YES	YES	YES	YES	YES
Candidate Controls	YES	YES	YES	YES	YES

C Robustness Checks

C.1 Robustness Checks: Property-Level

Figure C1: Donors: Alternative 10% Close Election Cutoff

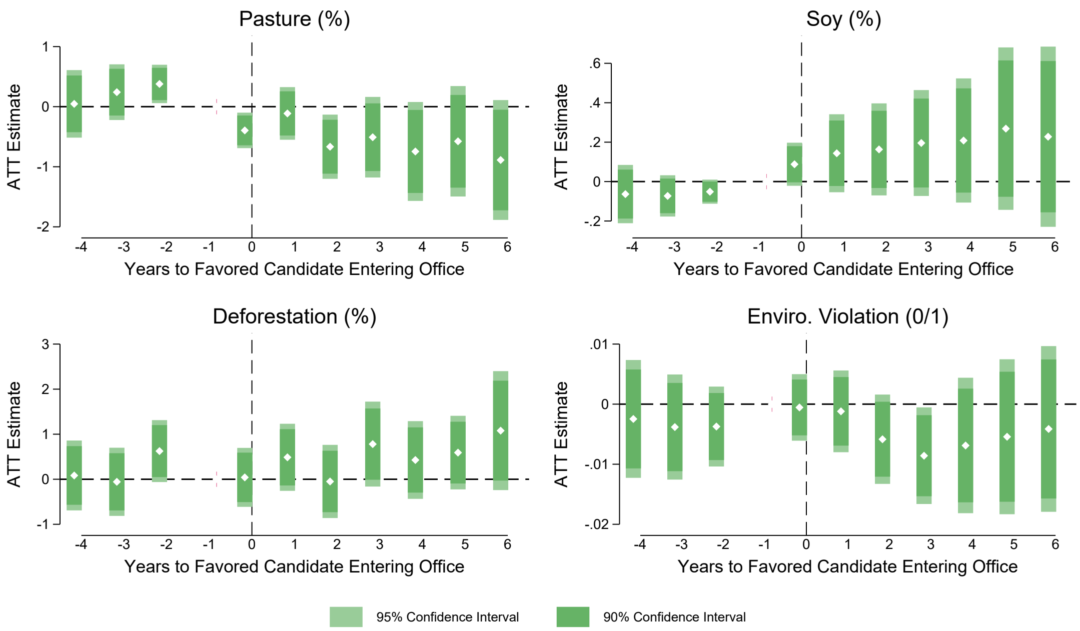


Figure C2: Candidates: Alternative 10% Close Election Cutoff

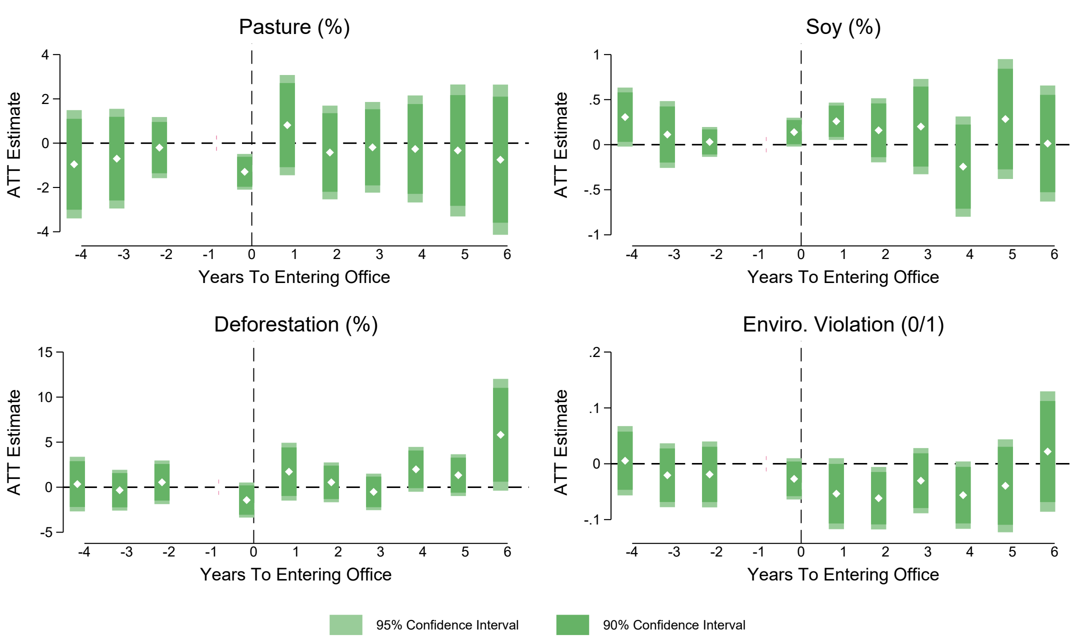


Figure C3: Donors: No Election Cutoff

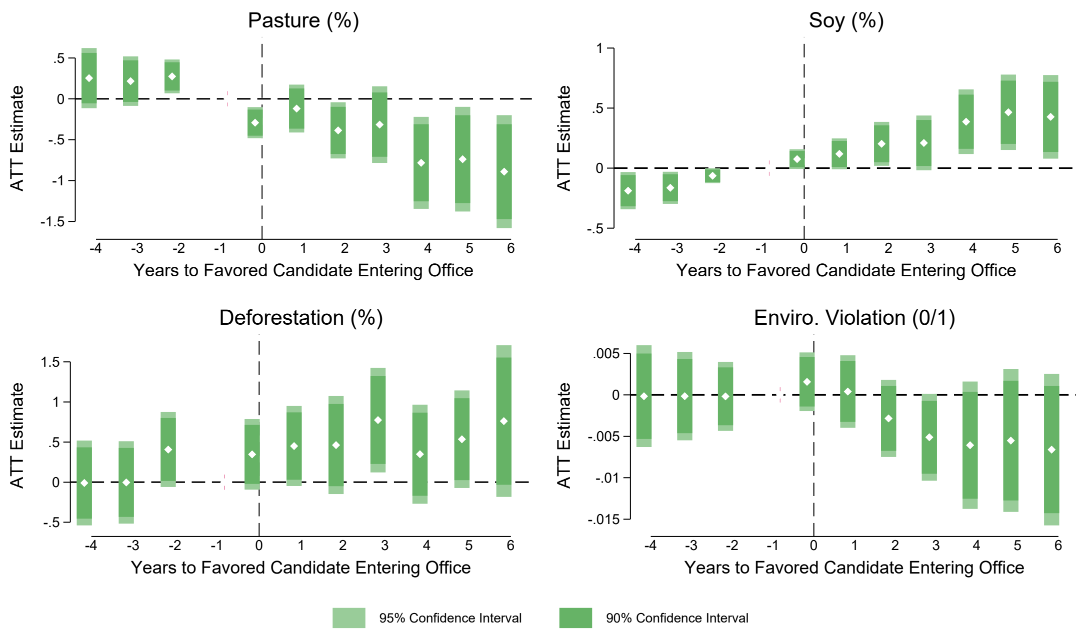


Figure C4: Candidates: No Election Cutoff

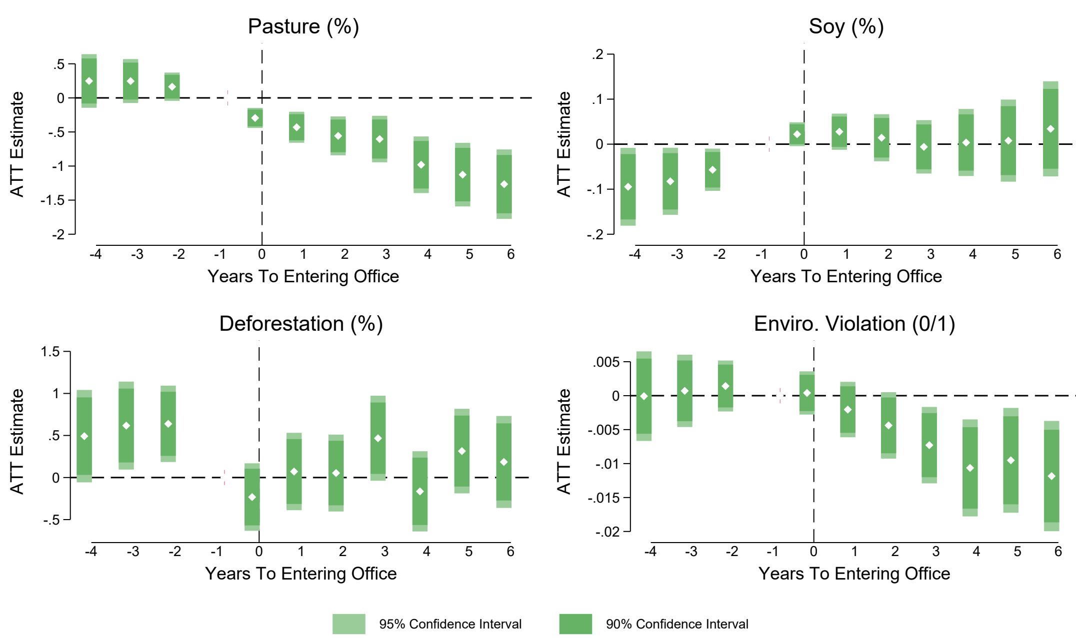


Figure C5: Donors: Sample Restricted to Mato Grosso, Pará, and Rondonia

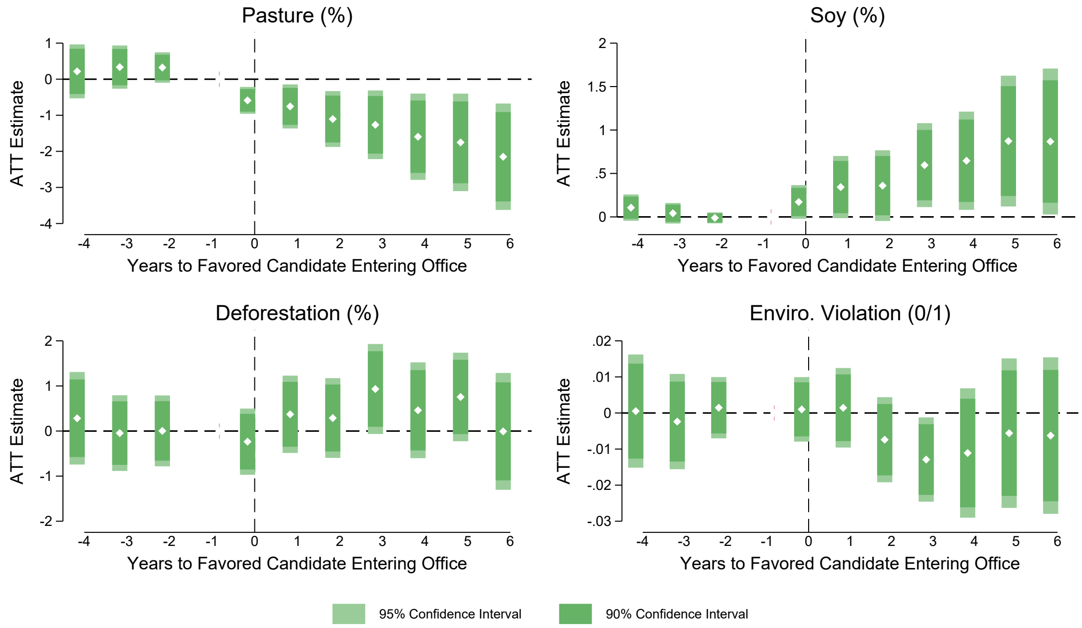


Figure C6: Candidates: Sample Restricted to Mato Grosso, Pará, and Rondonia

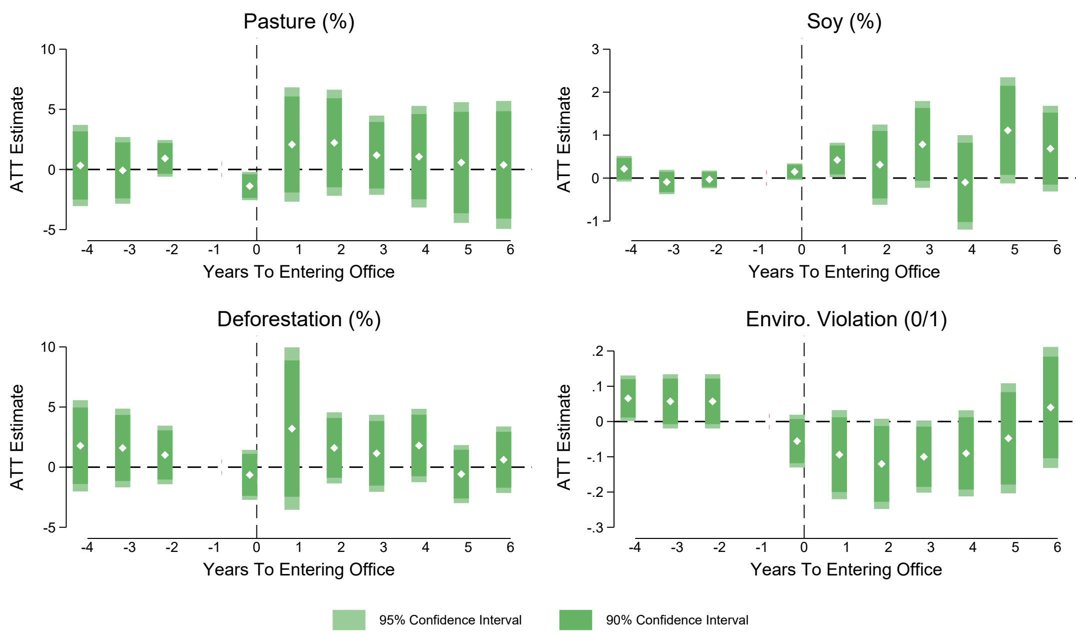


Figure C7: Donors: Main Results with asinh Transformation

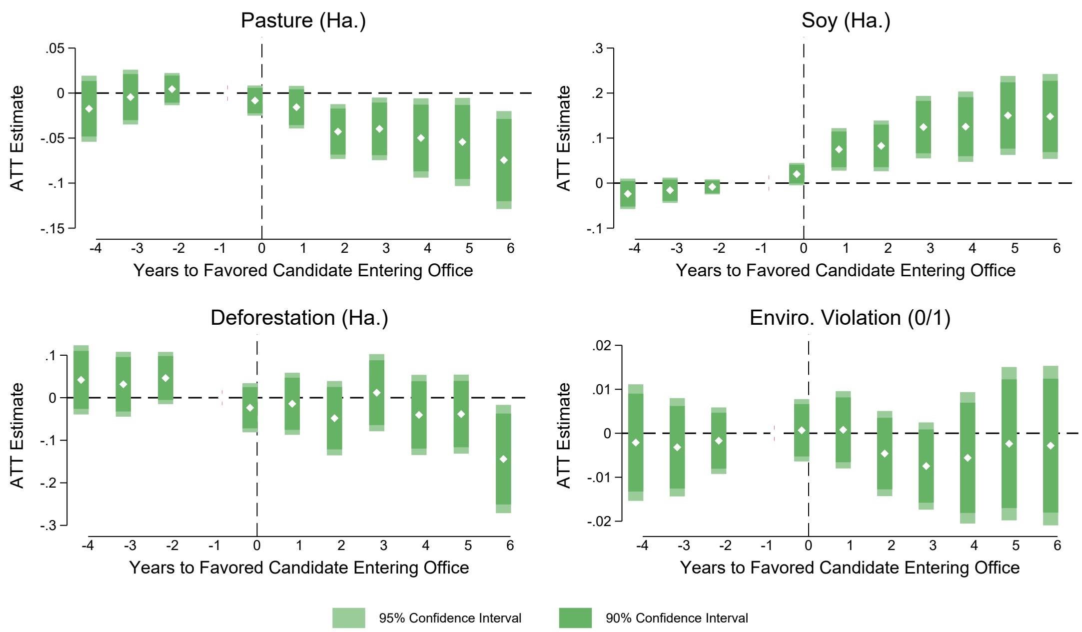


Figure C8: Candidates: Main Results with asinh Transformation

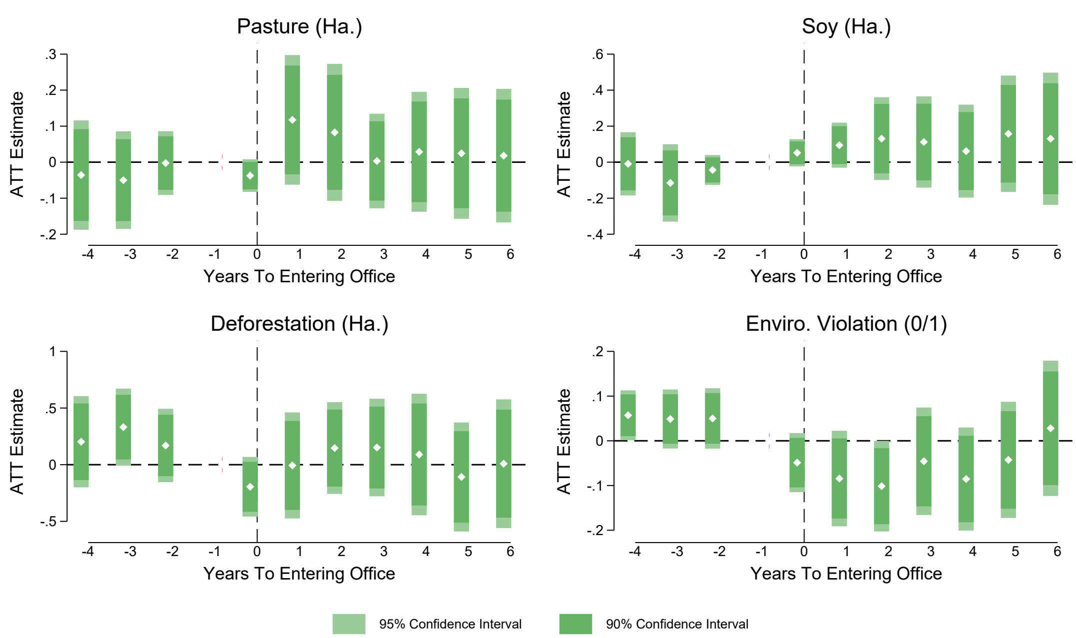


Figure C9: Donors: Main Results with Municipality-Election Fixed Effects

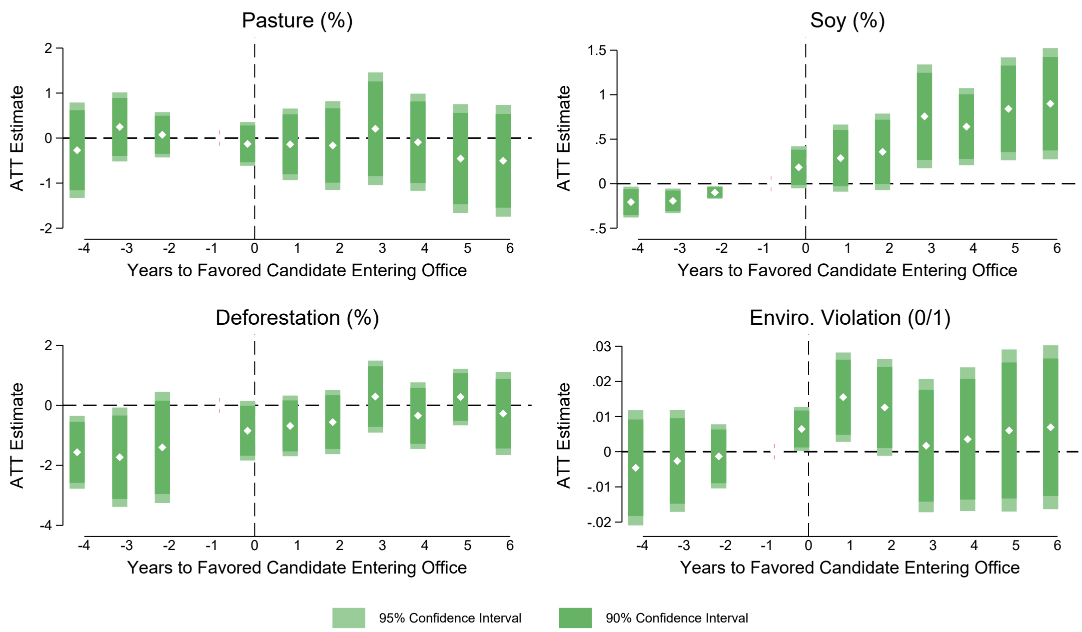


Figure C10: Donors: Inclusion of Win-Margin Running Variable

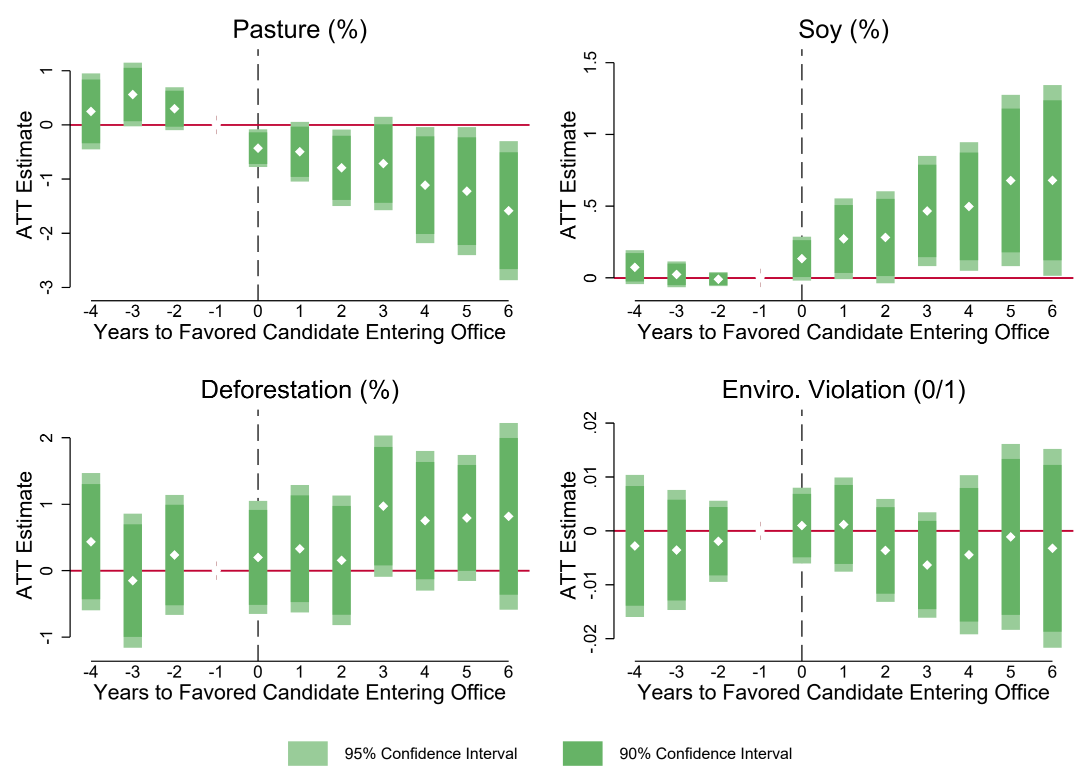


Figure C11: Candidates: Inclusion of Win-Margin Running Variable

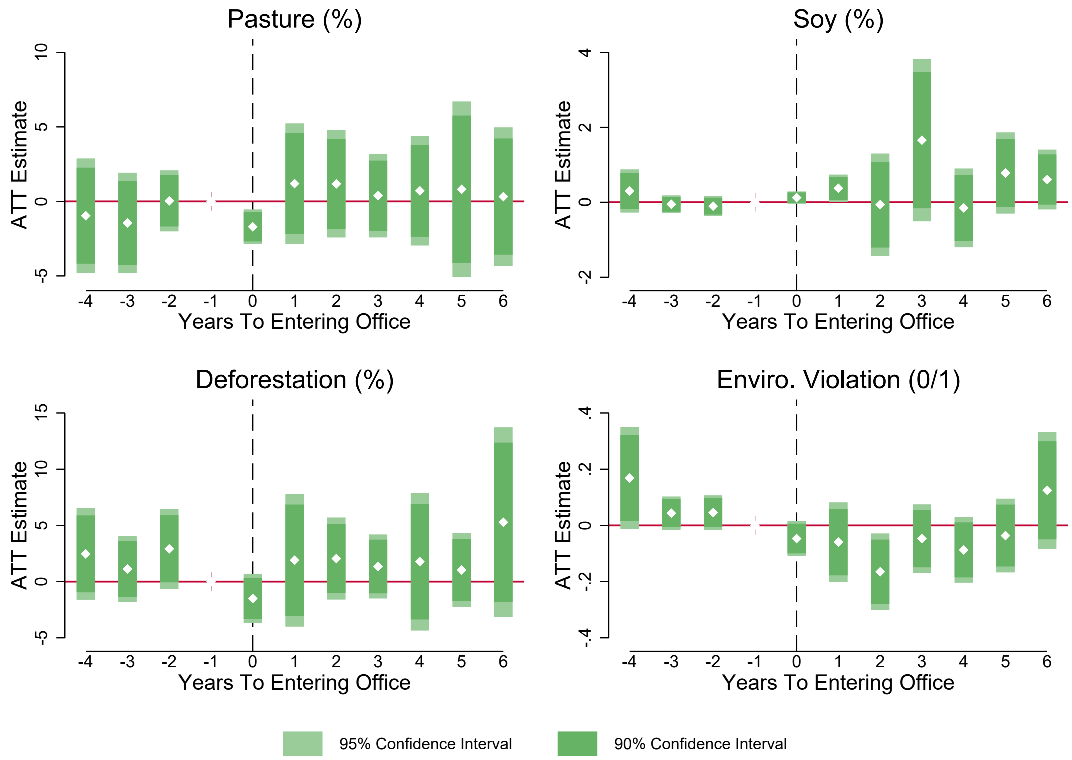


Figure C12: Donors: 10% Election Cutoff in Mato Gross, Pará, and Rondonia

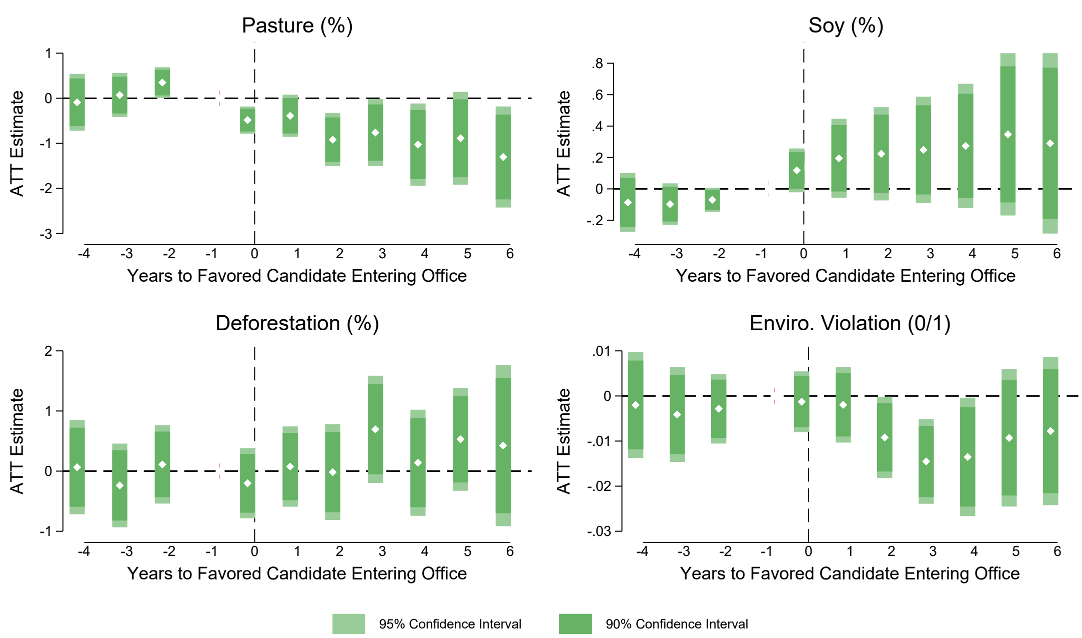


Figure C13: Candidates: 10% Election Cutoff in Mato Gross, Pará, and Rondonia

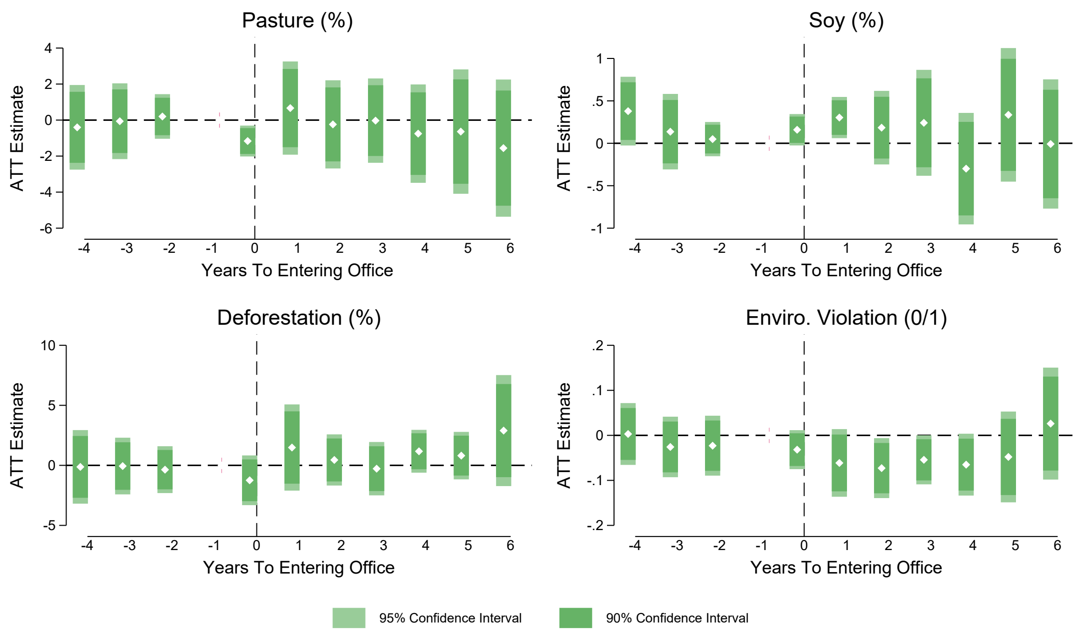


Figure C14: Donors: No Election Cutoff in Mato Gross, Pará, and Rondonia

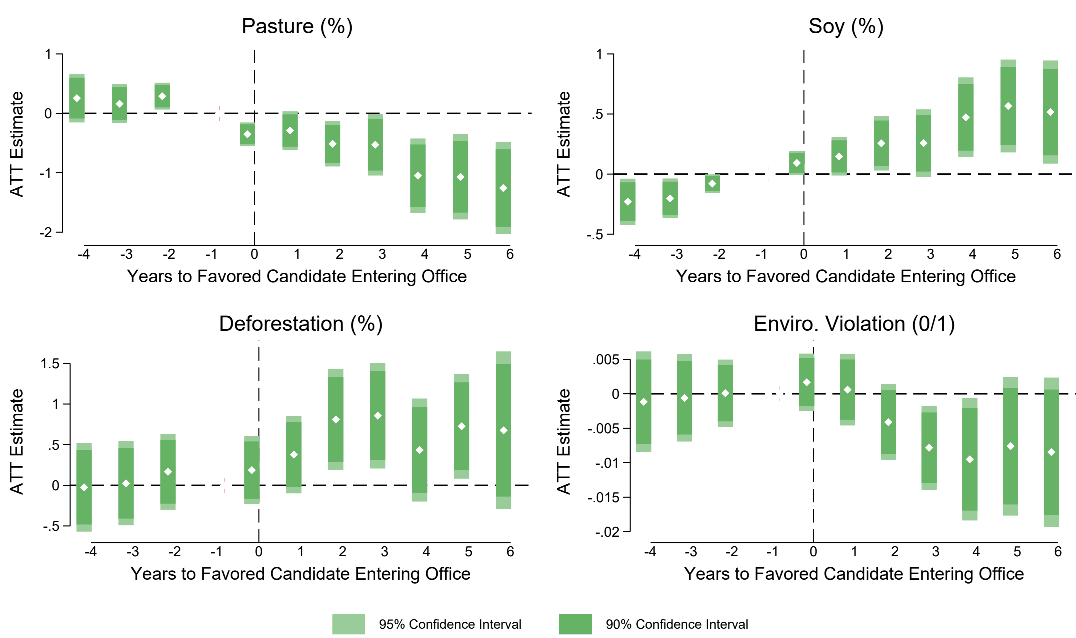


Figure C15: Candidates: No Election Cutoff in Mato Gross, Pará, and Rondonia

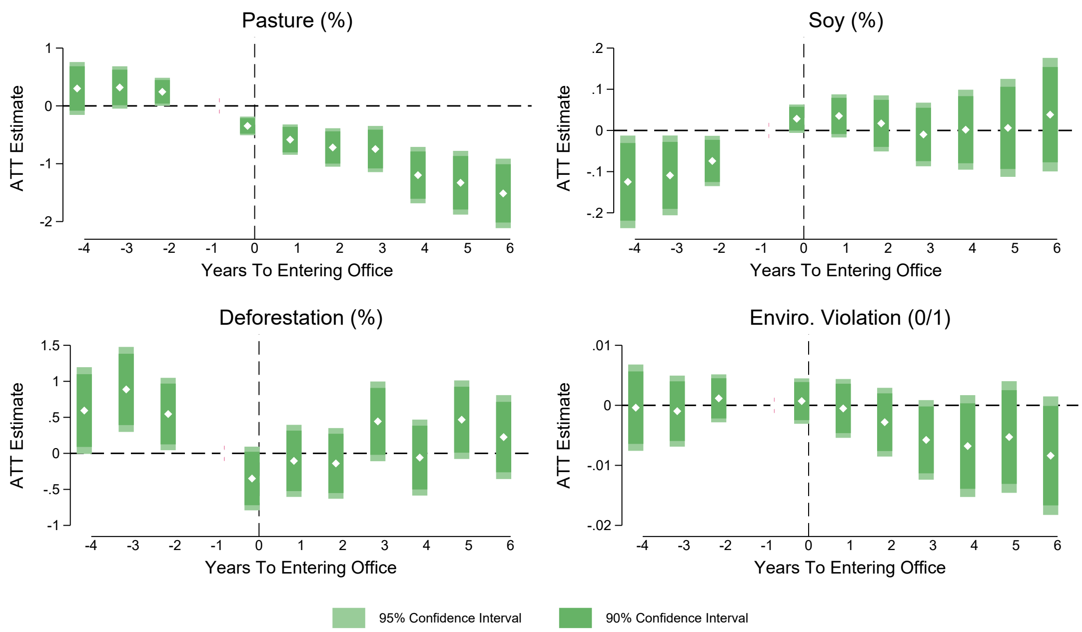


Figure C16: Donors: Mato Gross, Pará and Rondonia with asinh Transformation

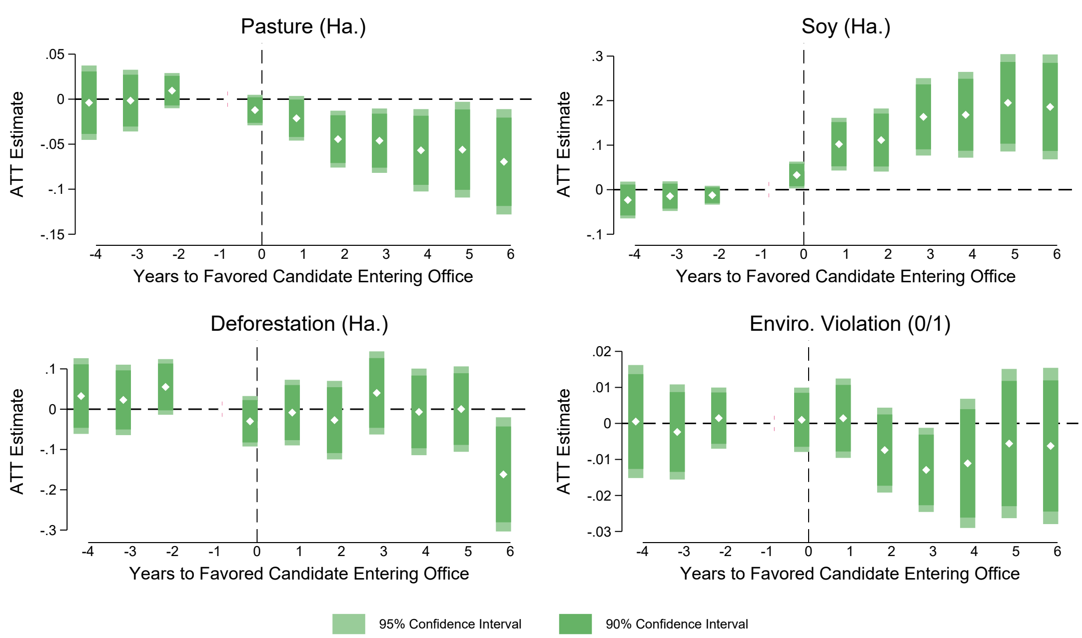


Figure C17: Candidates: Mato Gross, Pará and Rondonia with asinh Transformation

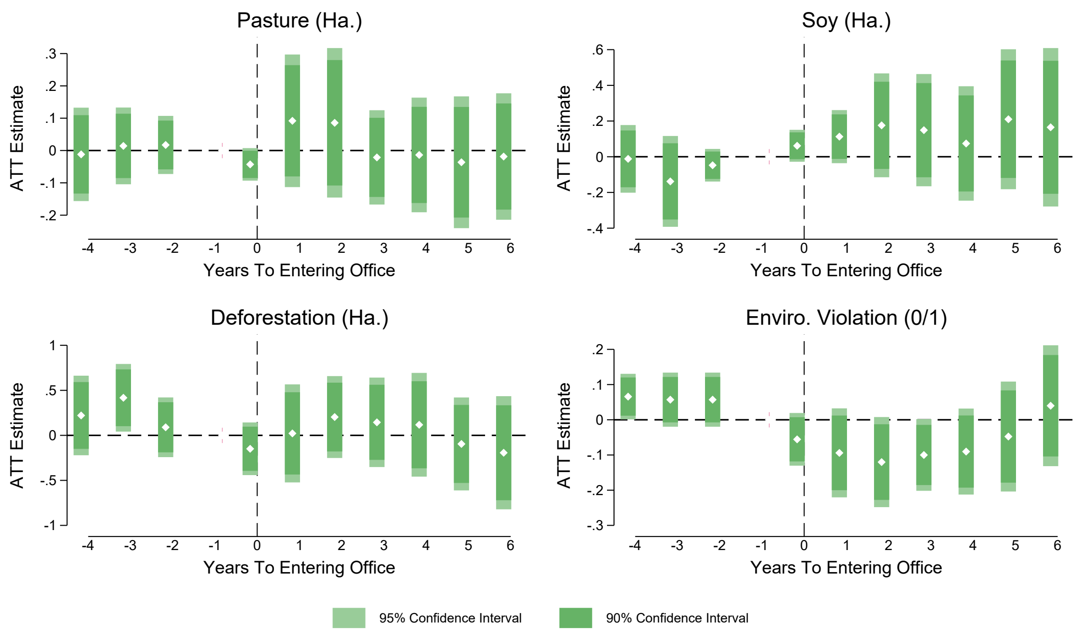


Figure C18: Donors: Alternative 10% Close Election Cutoff with asinh Transformation

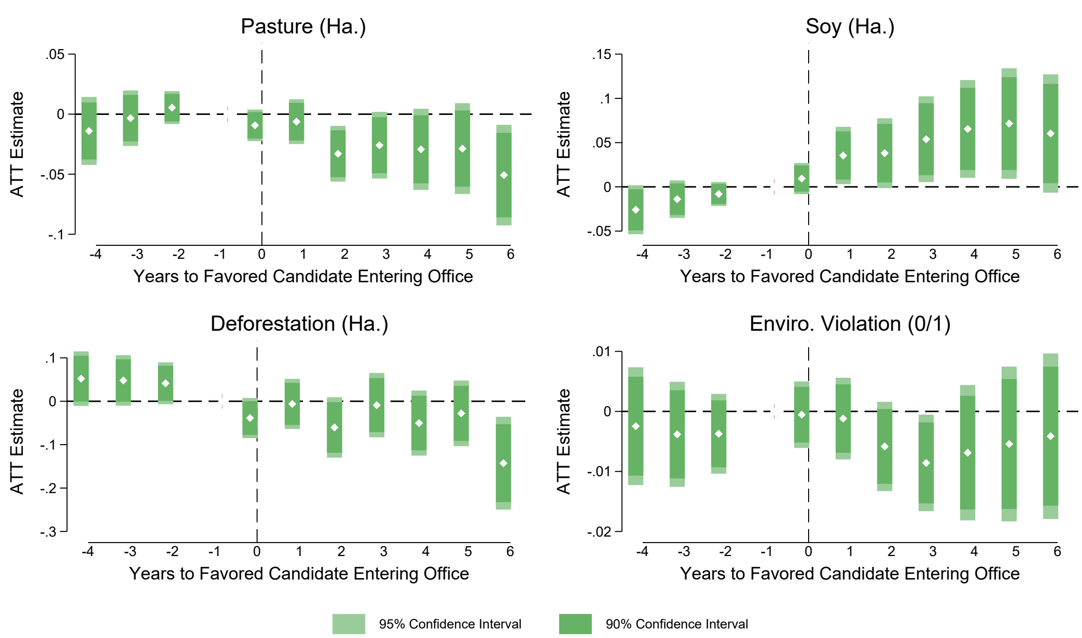


Figure C19: Candidates: Alternative 10% Close Election Cutoff with asinh Transformation

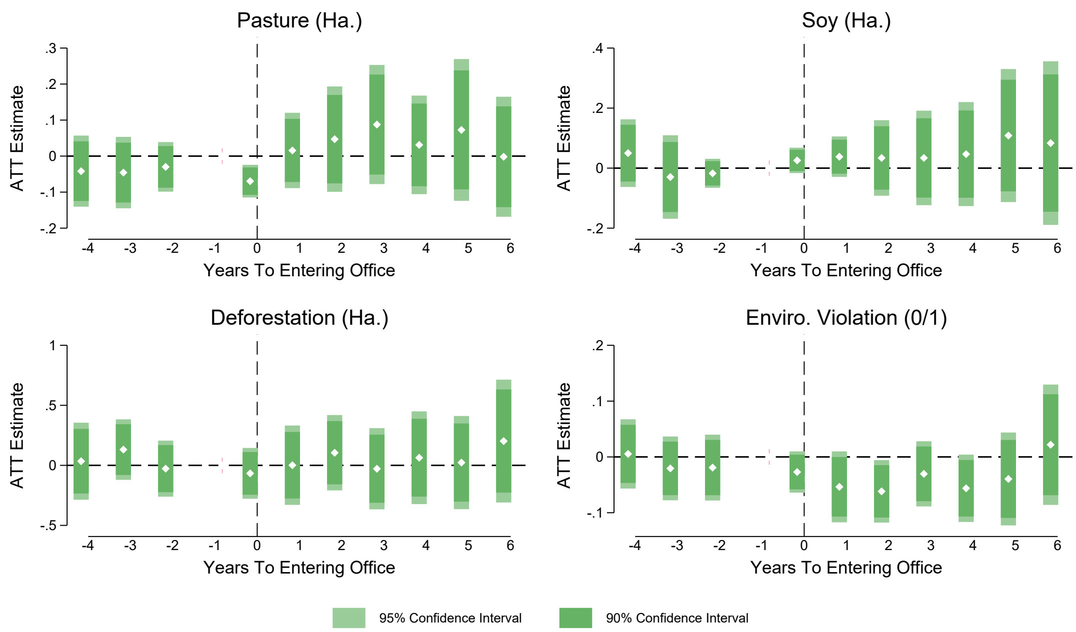


Figure C20: Donors: No Close Election Cutoff with asinh Transformation

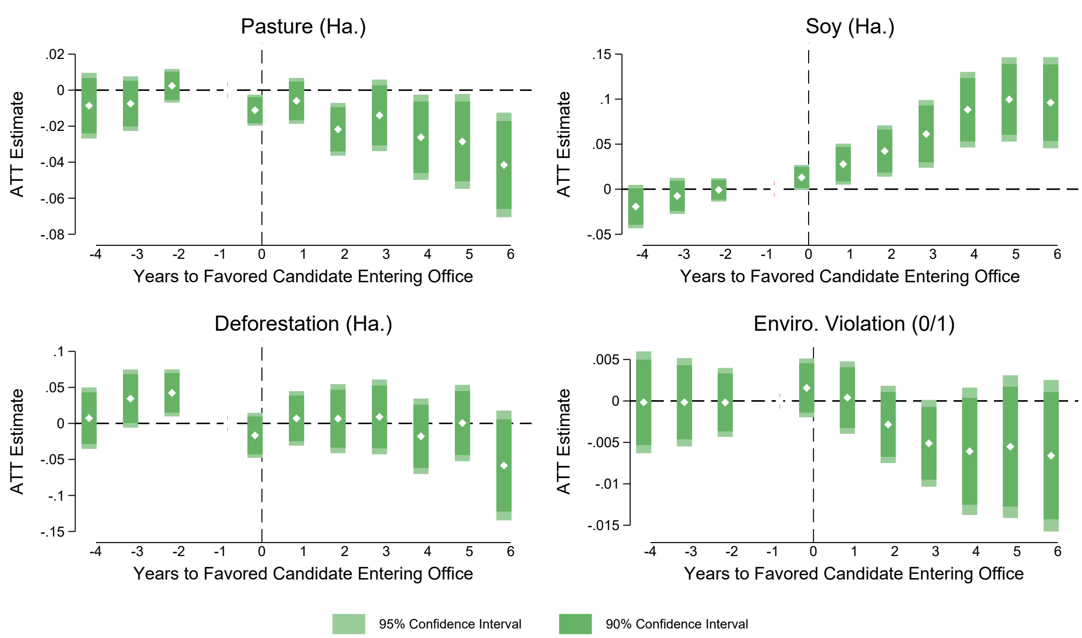


Figure C21: Candidates: No Close Election Cutoff with asinh Transformation

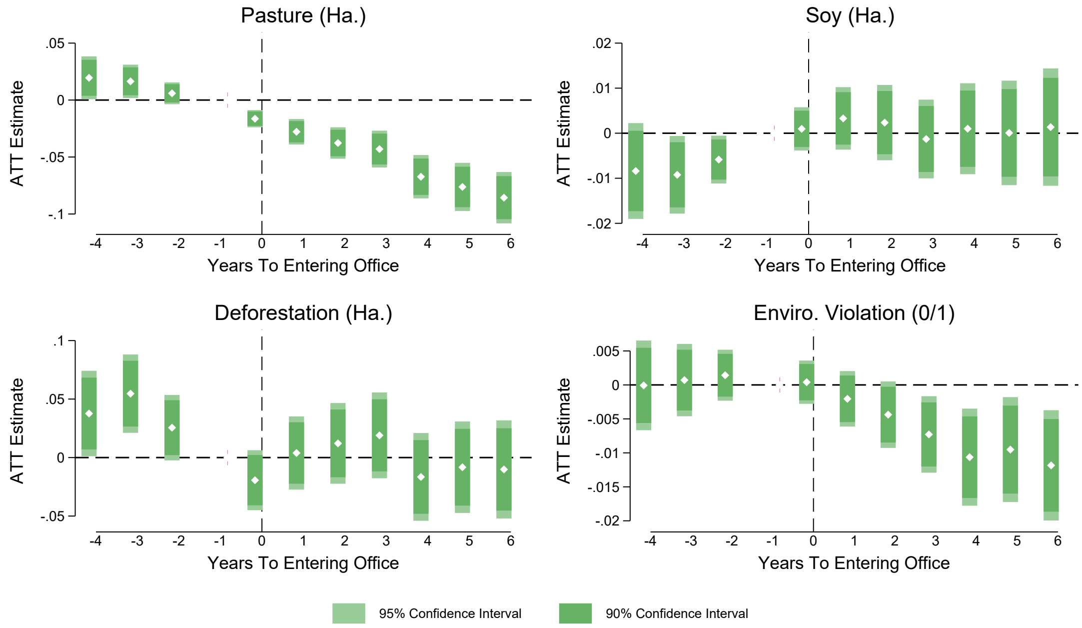


Figure C22: Donors: Mato Grosso, Pará and Rondonia with 10% Close Election Cutoff and asinh Transformation

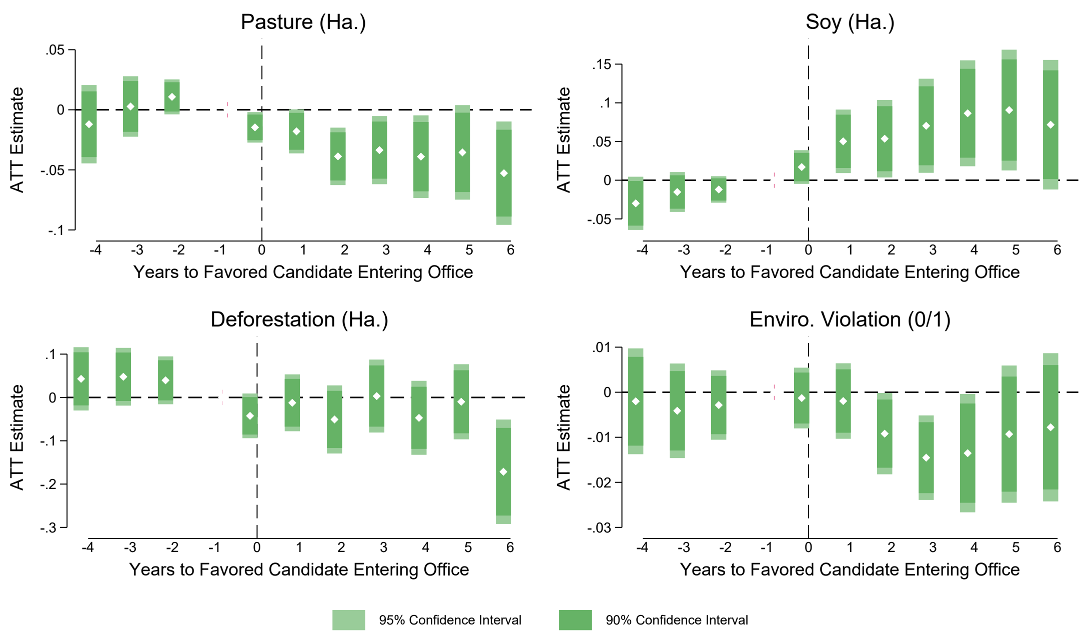


Figure C23: Candidates: Mato Grosso, Pará and Rondonia with 10% Close Election Cutoff and asinh Transformation

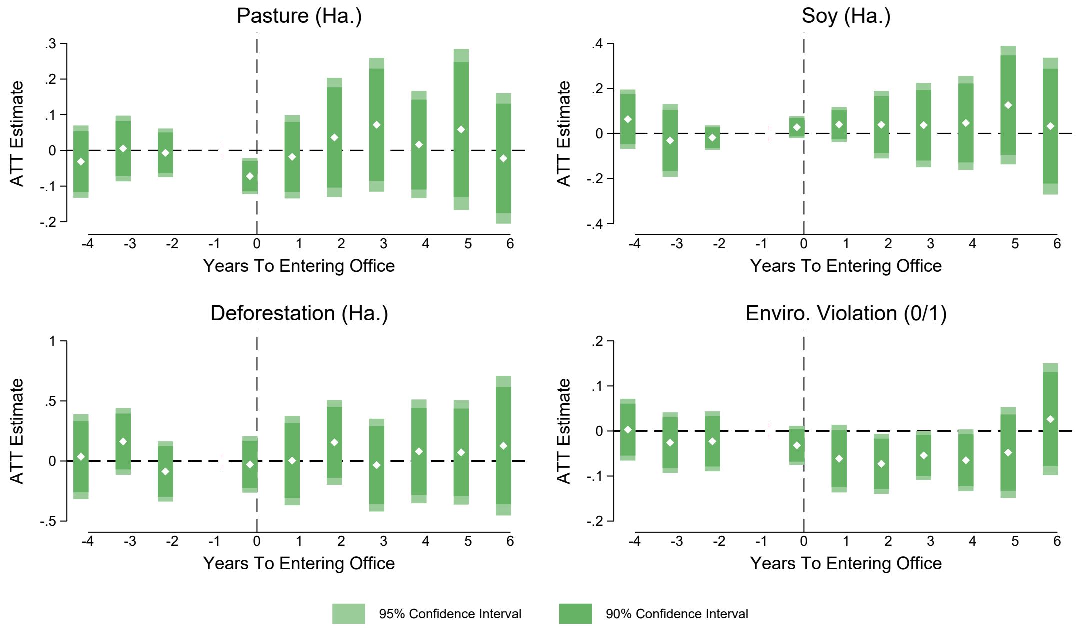


Figure C24: Donors: Mato Grosso, Pará and Rondonia with No Election Cutoff and asinh Transformation

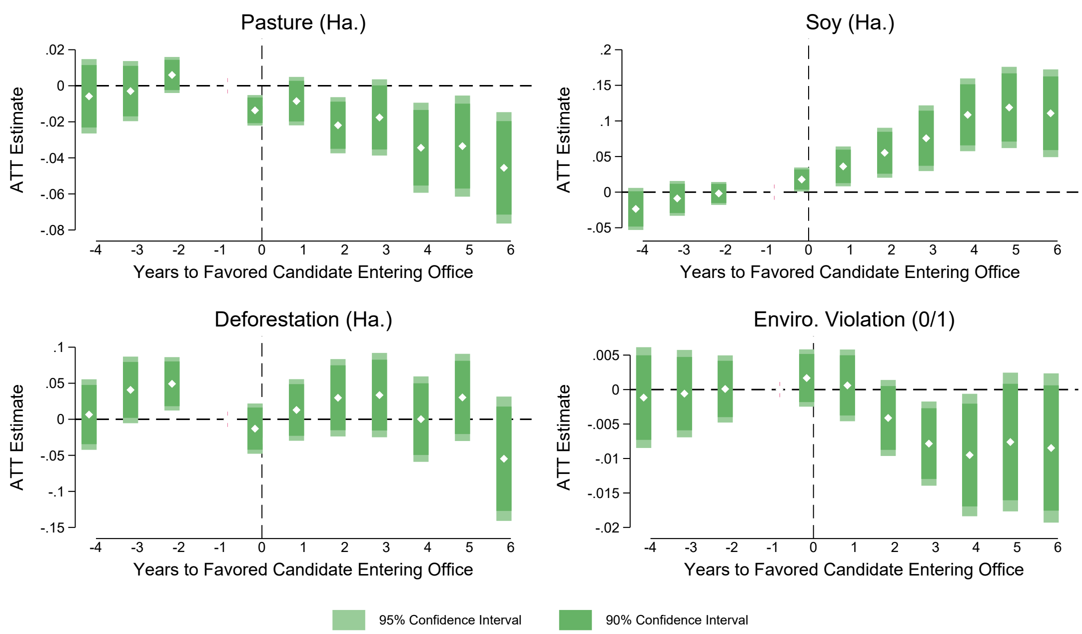


Figure C25: Candidates: Mato Grosso, Pará and Rondonia with No Election Cutoff and asinh Transformation

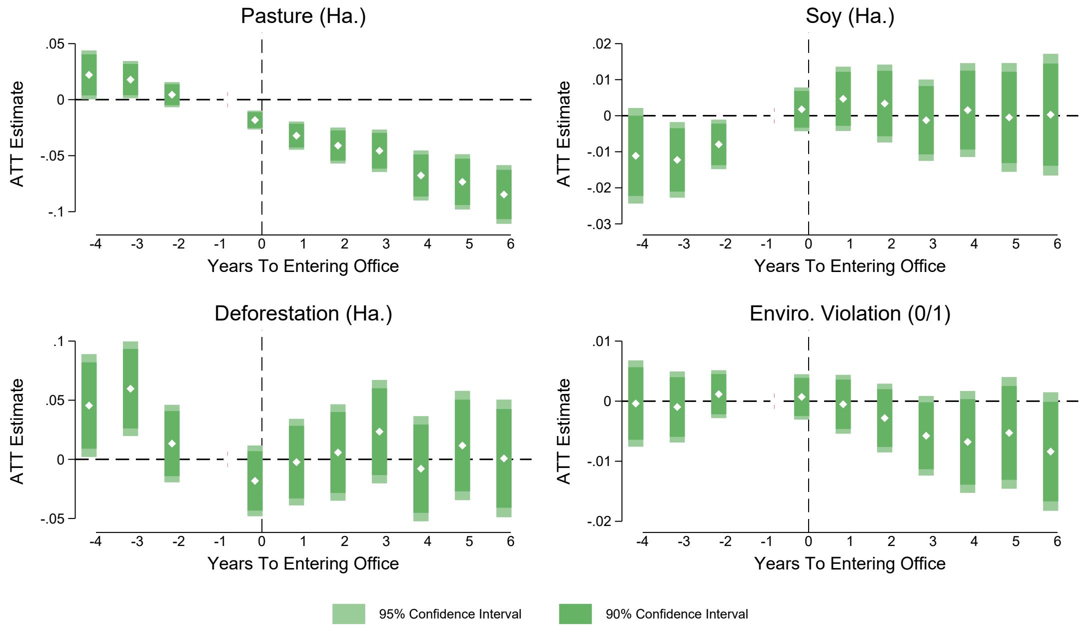


Figure C26: Donors: Inclusion of Win-Margin Running Variable (asinh)

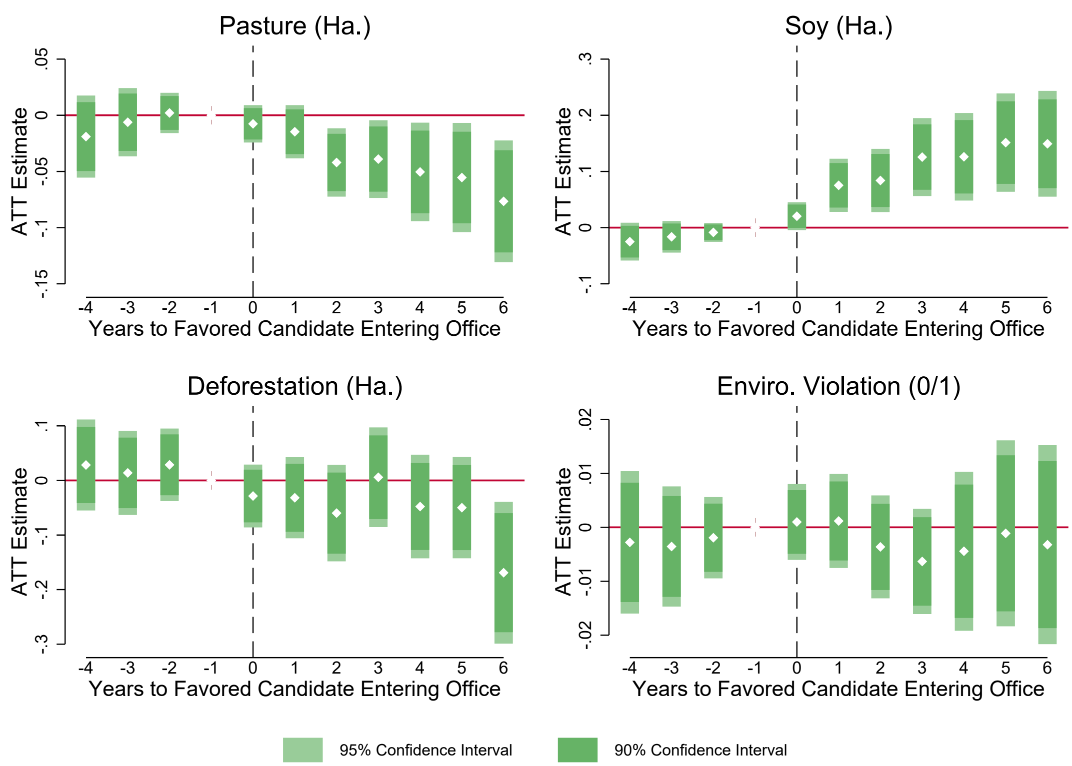


Figure C27: Donors: Mato Grosso, Pará, and Rondonia with Municipality-Election Fixed Effects

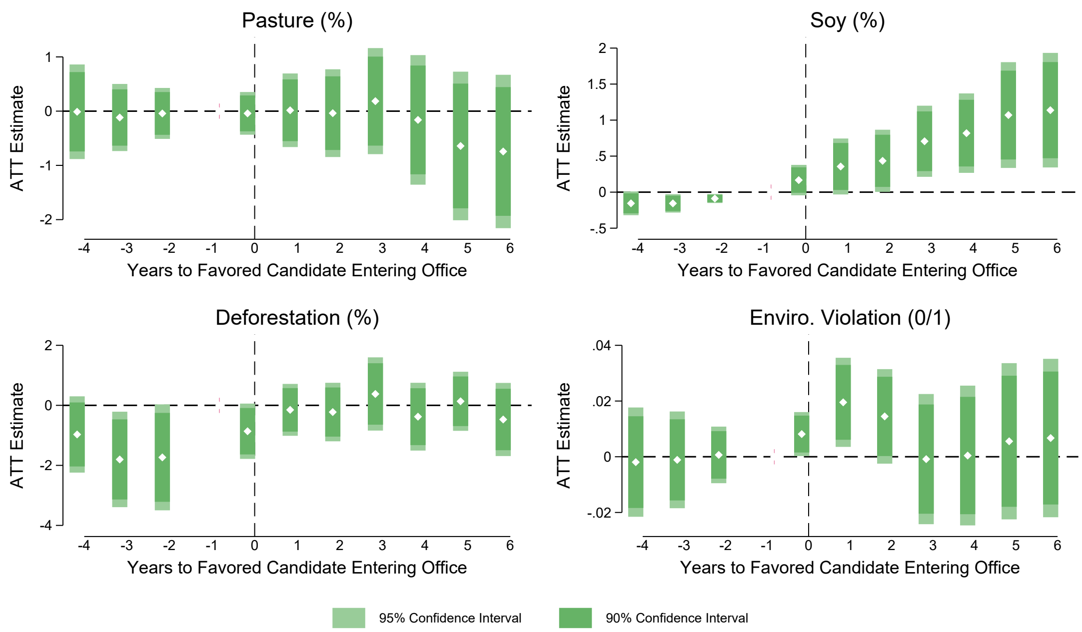


Figure C28: Donors: Alternative 10% Close Election Cutoff and Municipality-Election Fixed Effects

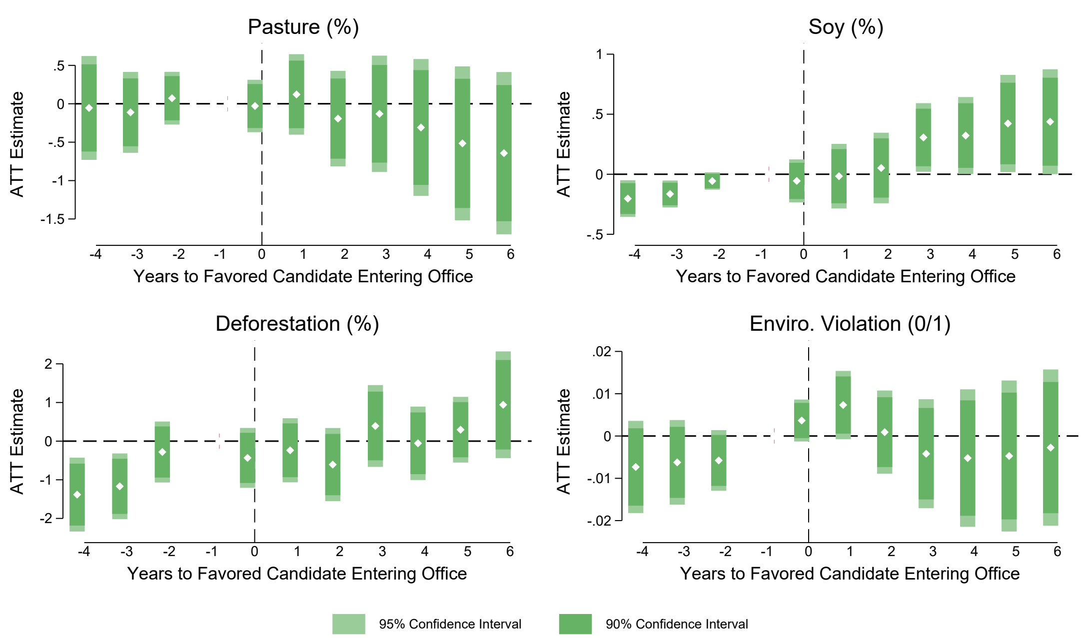


Figure C29: Donors: Mato Grosso, Pará, and Rondonia with 10% Close Election Cutoff and Municipality-Election Fixed Effects

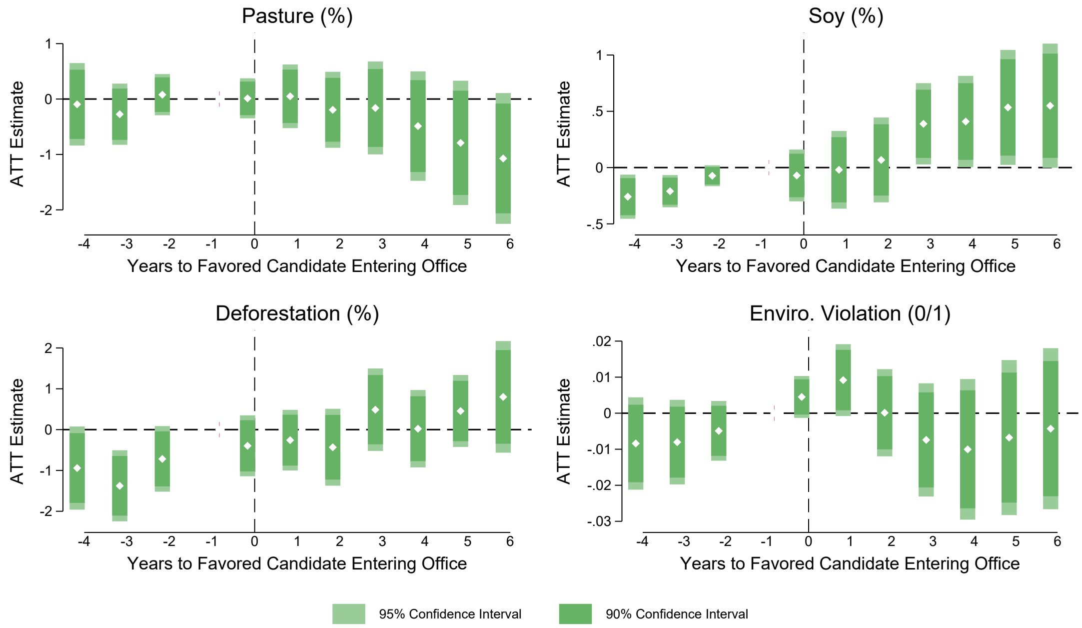


Figure C30: Donors: No Close Election Cutoff and Municipality-Election Fixed Effects

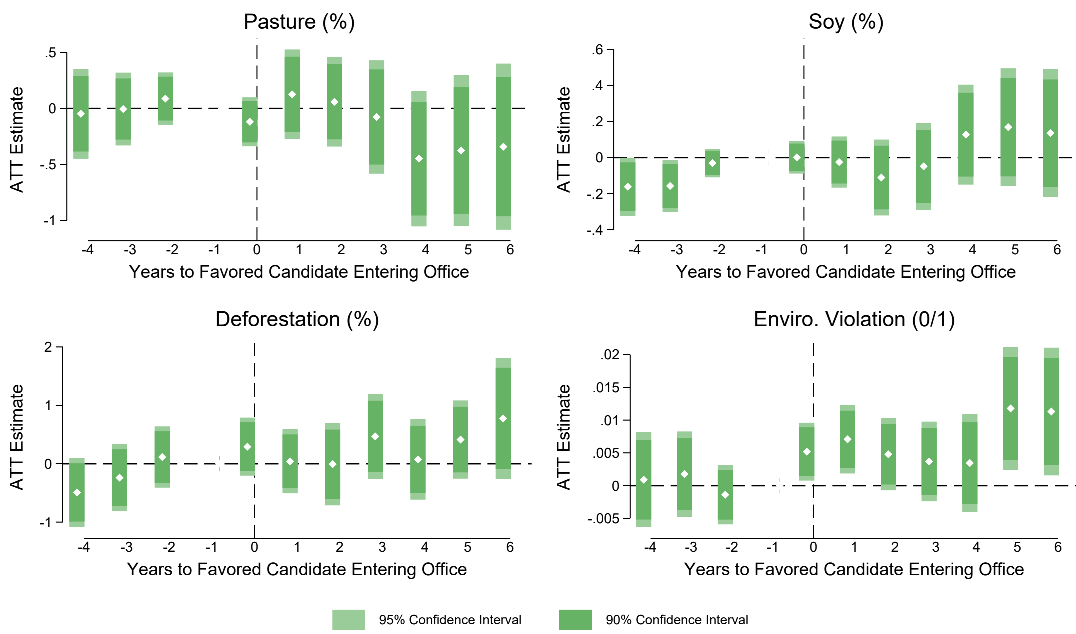
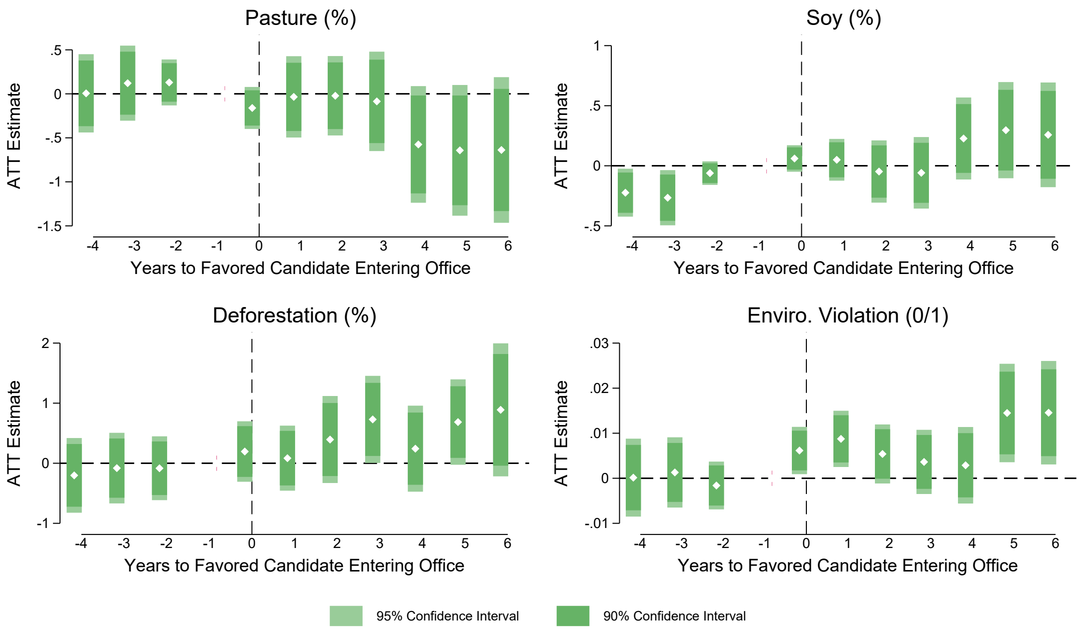


Figure C31: Donors: Mato Grosso, Pará, and Rondonia with No Close Election Cutoff and Municipality-Election Fixed Effects



C.2 Robustness Checks: Municipal-Level

Figure C32: Municipalities: 10% Close Election Cutoff (Governance)

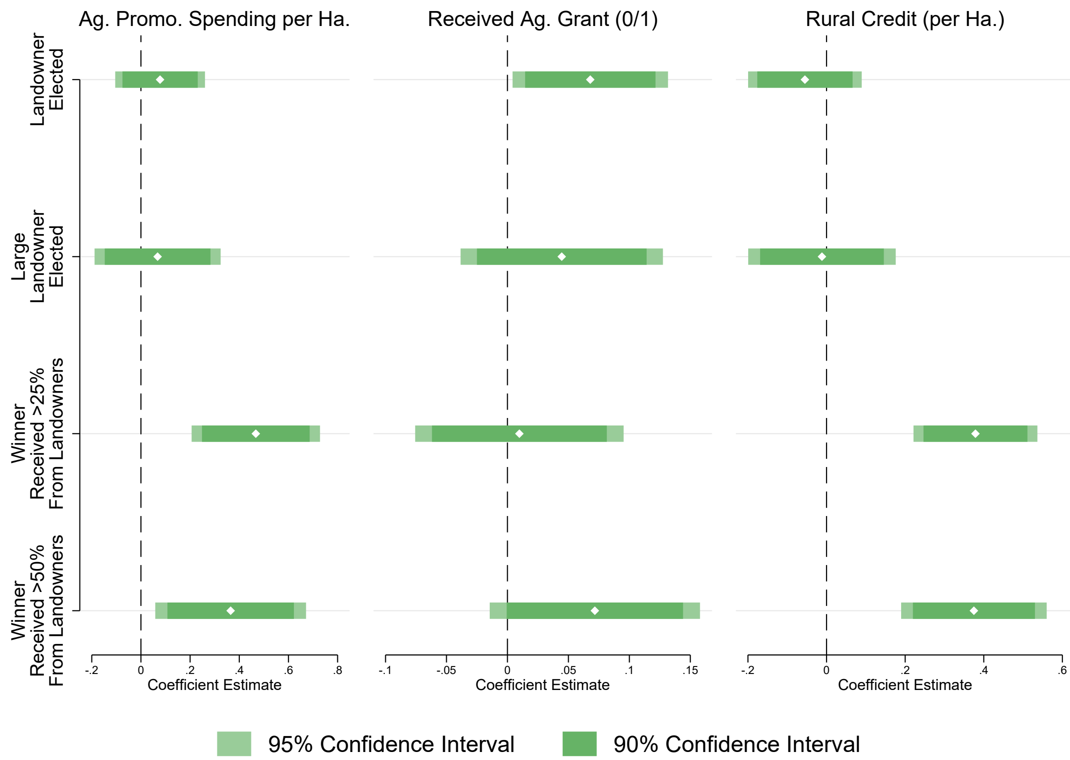


Figure C33: Municipalities: 10% Close Election Cutoff (Land-Use)

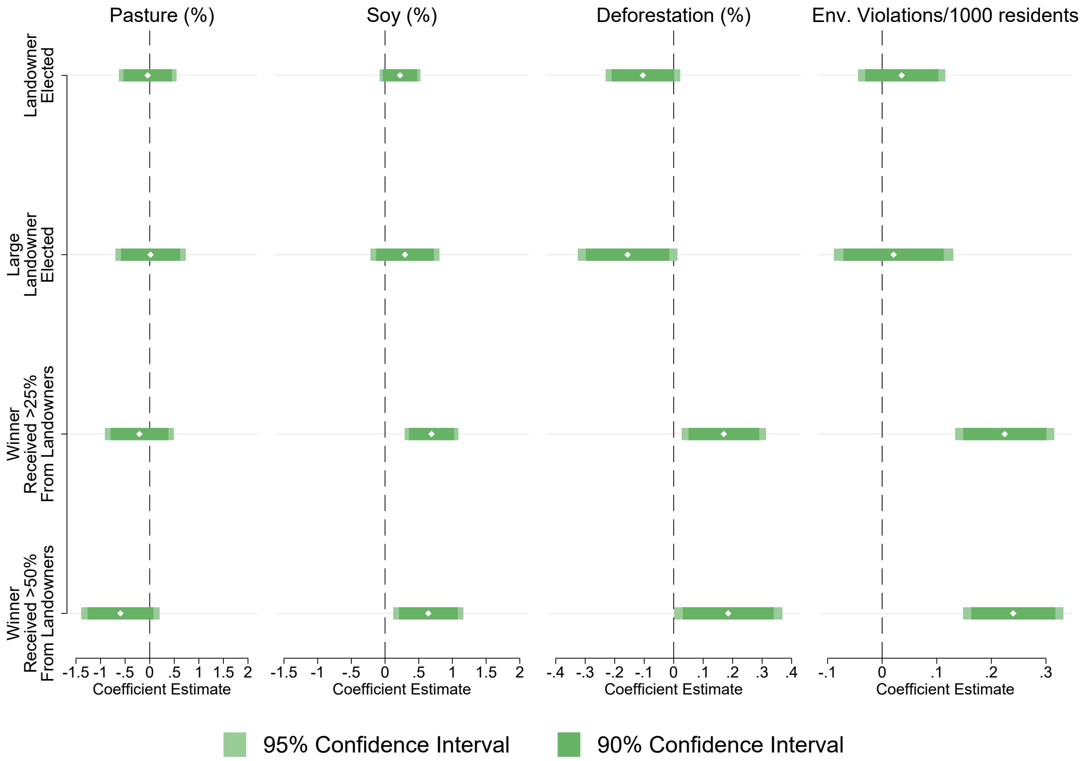


Figure C34: Municipalities: No Close Election Cutoff (Governance)

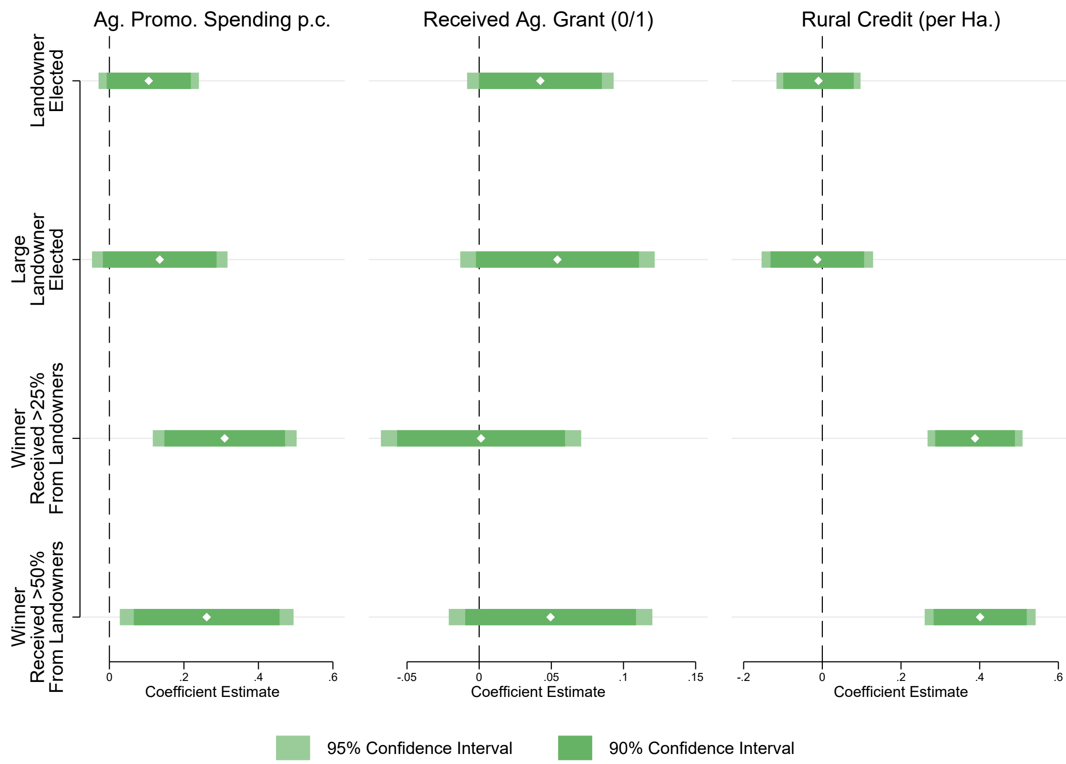


Figure C35: Municipalities: No Close Election Cutoff (Land-Use)

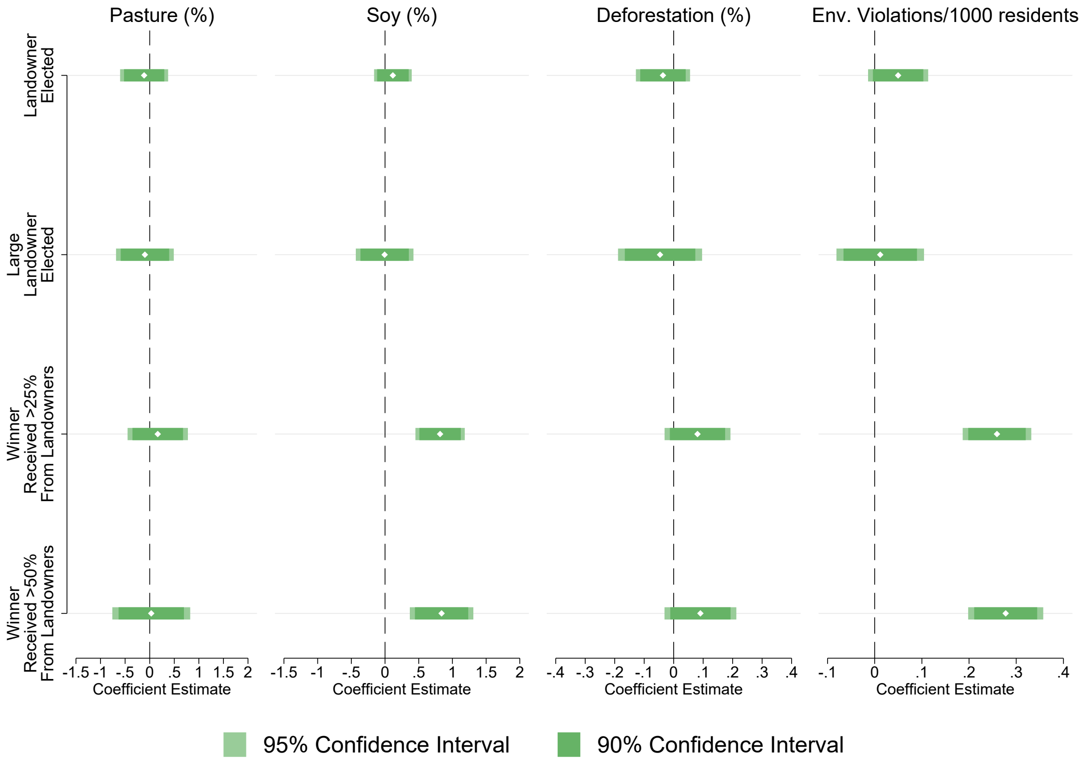


Figure C36: Municipalities: Mato Grosso, Pará, and Rondonia (Governance)

Figure C37: Municipalities: Mato Grosso, Pará, and Rondonia (Land-Use)

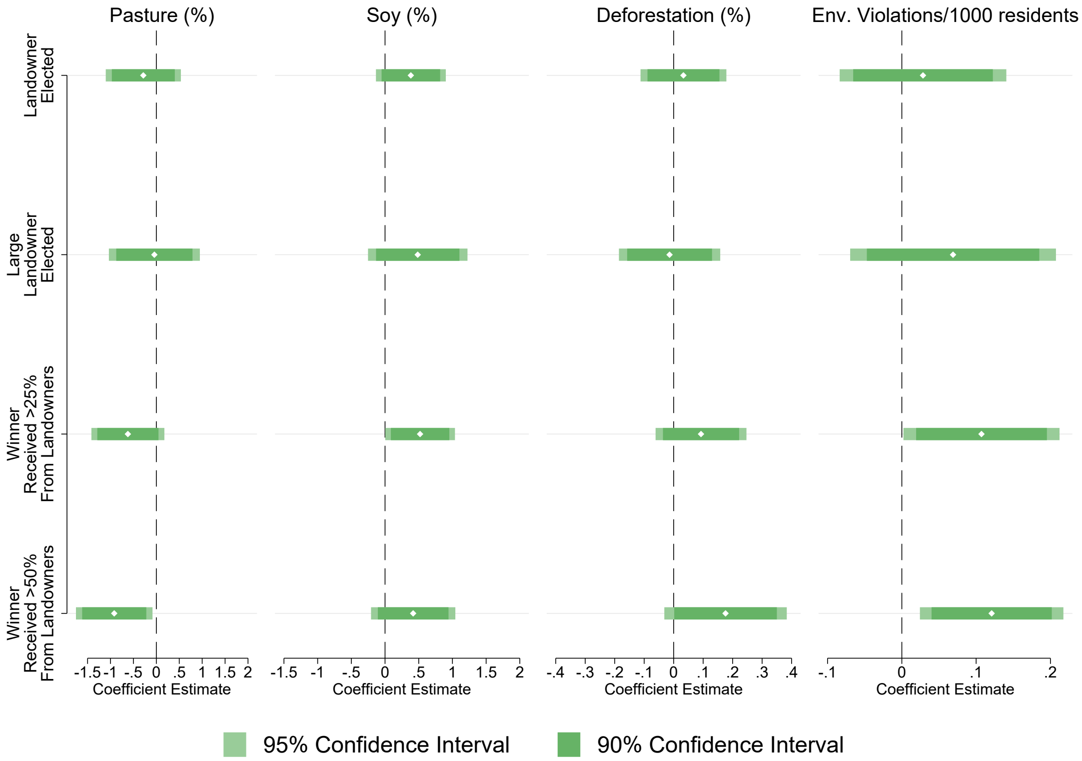


Figure C38: Municipalities: Land-Use with asinh Transformation

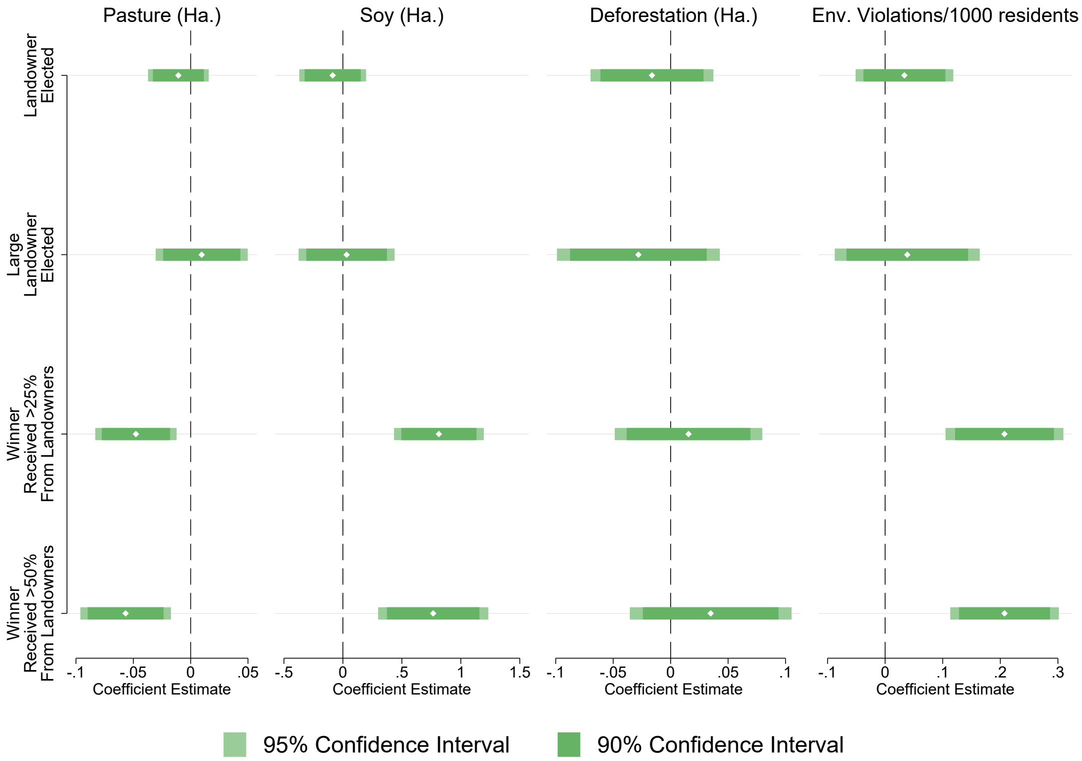


Figure C39: Municipalities: Governance with Win-Margin Running Variable

Figure C40: Municipalities: Land-Use with Win-Margin Running Variable

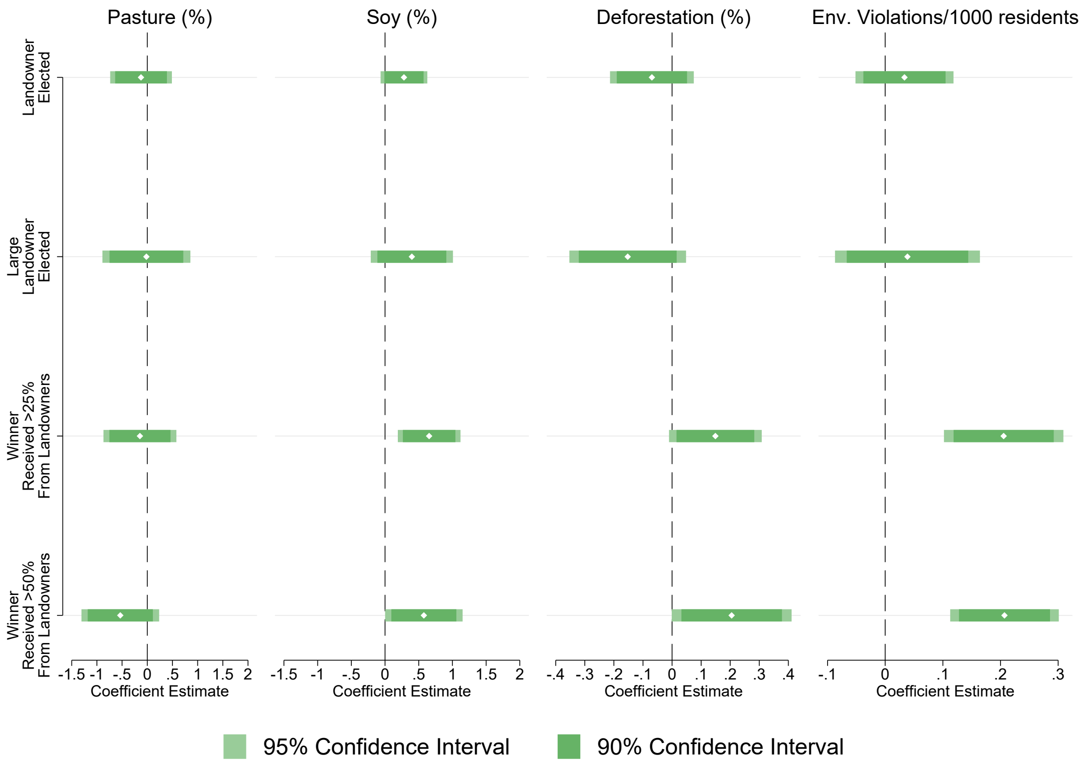


Figure C41: Municipalities: Dynamic Effects of Landholder or Landholder-Financed ($geq25\%$) Mayor on Pasture

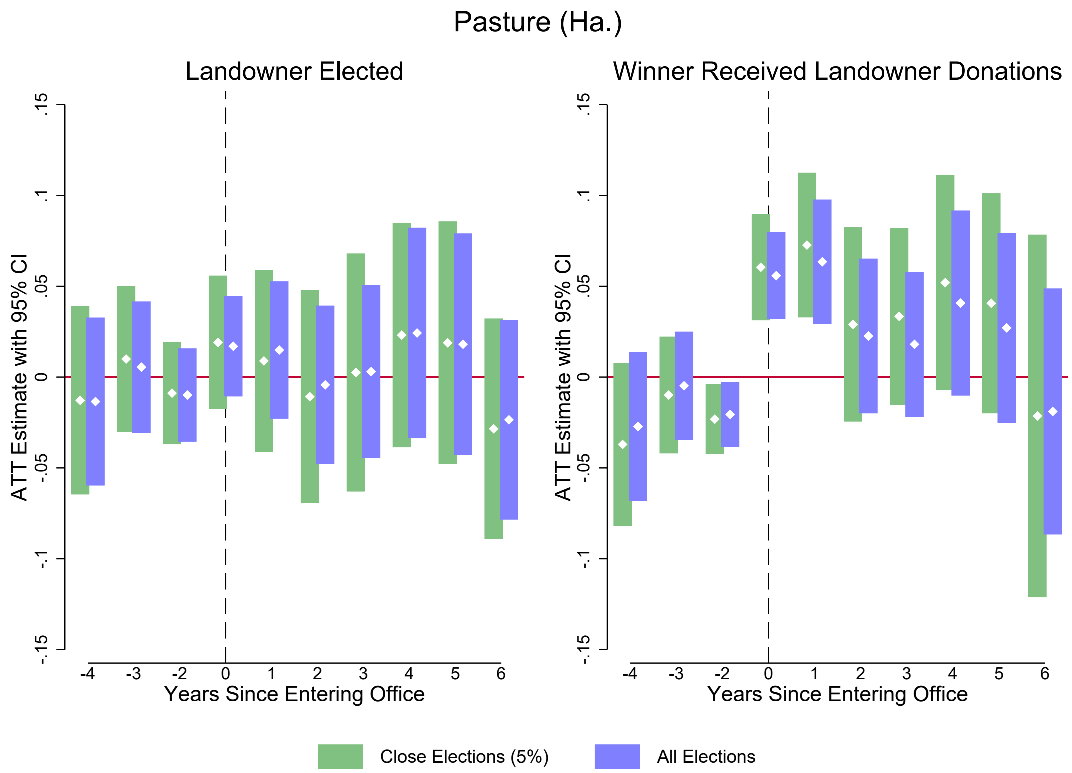


Figure C42: Municipalities: Dynamic Effects of Landholder or Landholder-Financed ($geq25\%$) Mayor on Soy

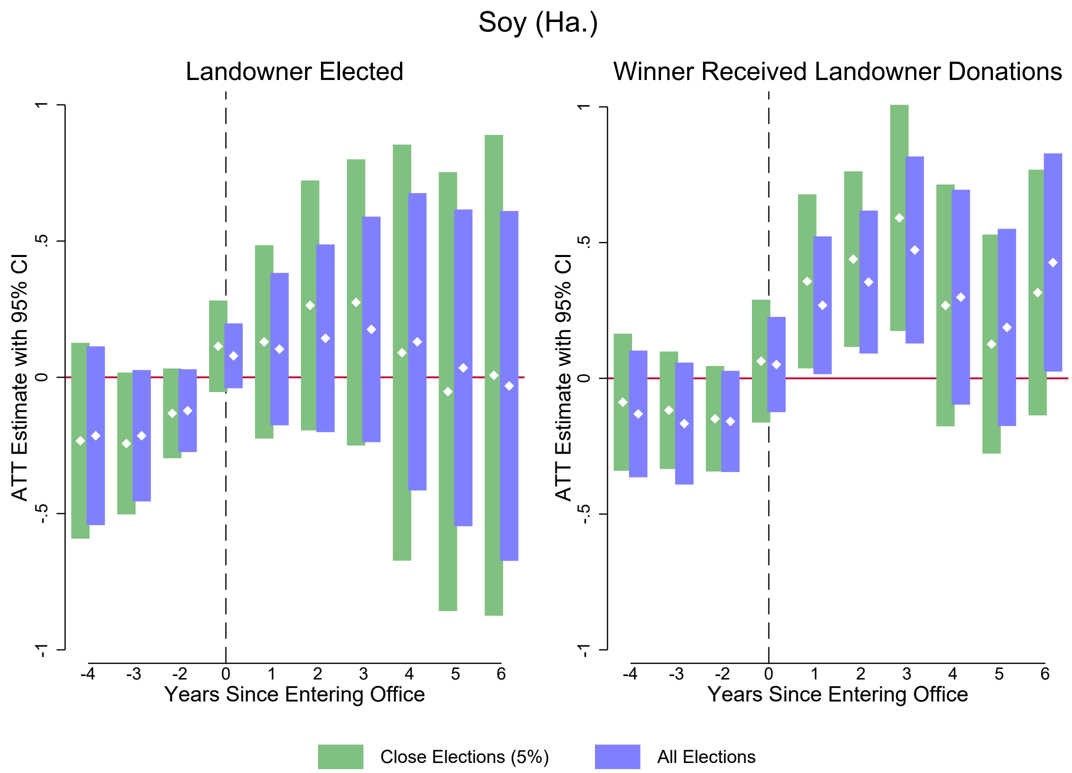


Figure C43: Municipalities: Dynamic Effects of Landholder or Landholder-Financed (geq25%) Mayor on Deforestation

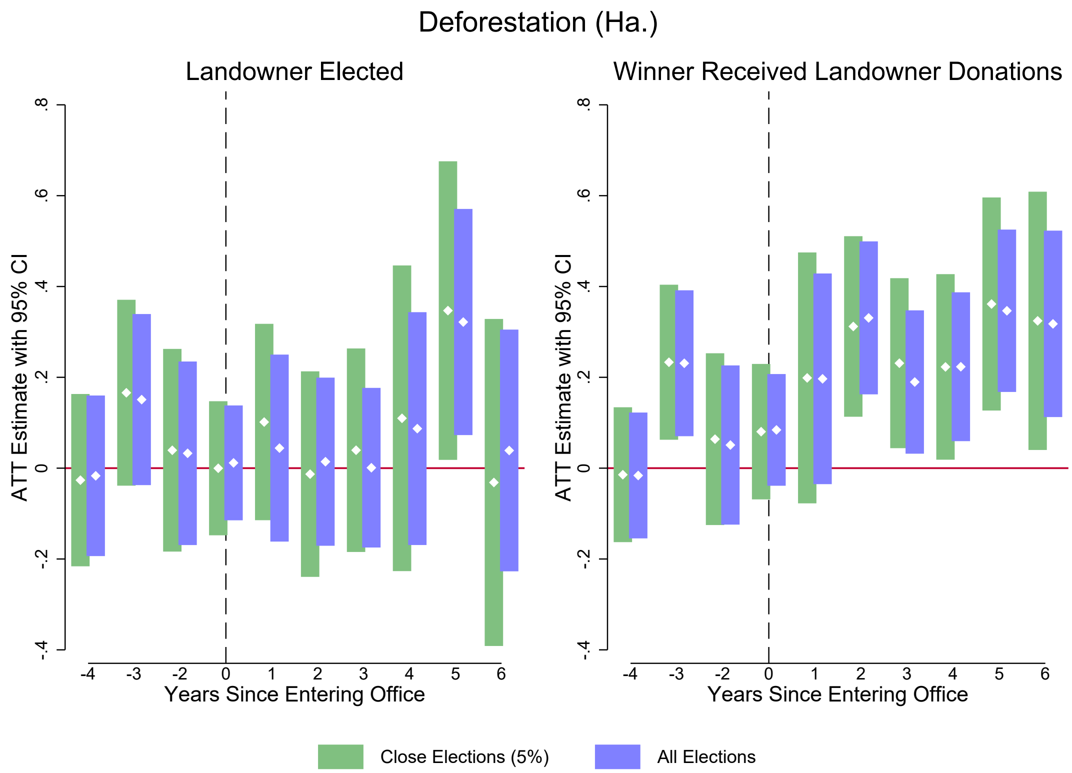


Figure C44: Municipalities: Dynamic Effects of Landholder or Landholder-Financed (geq25%) Mayor on Environmental Violations

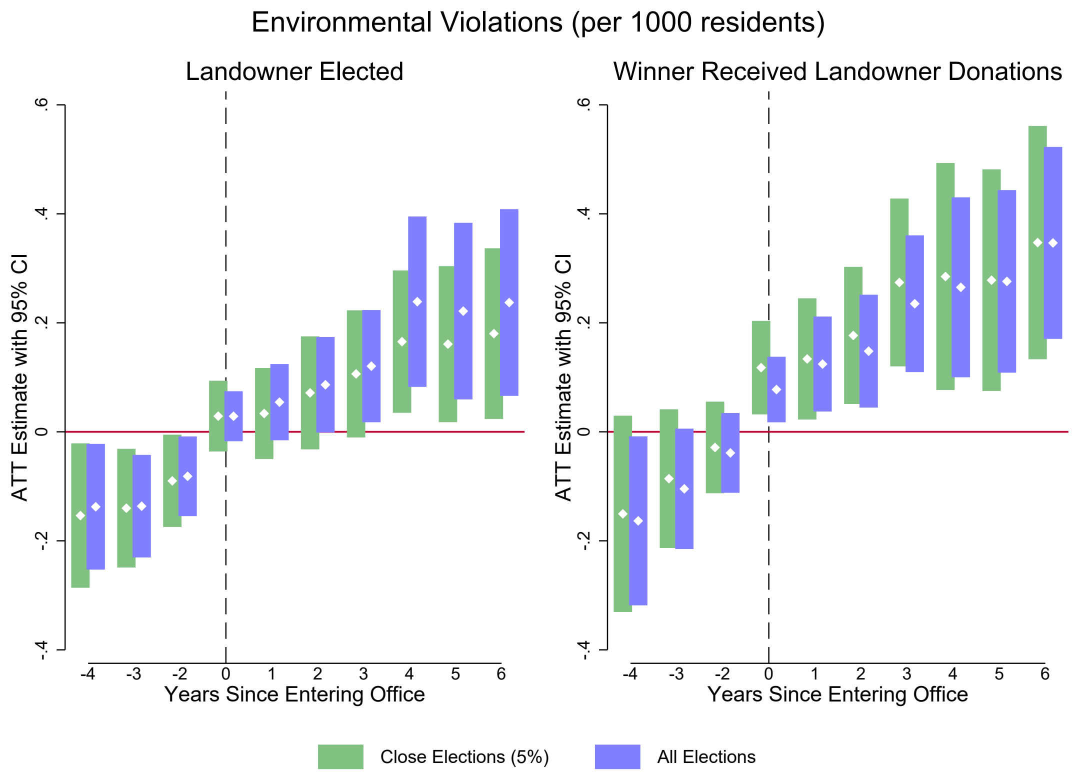


Figure C45: Municipalities: Dynamic Effects of Landholder or Landholder-Financed ($geq25\%$) Mayor on Agricultural Promotion Spending

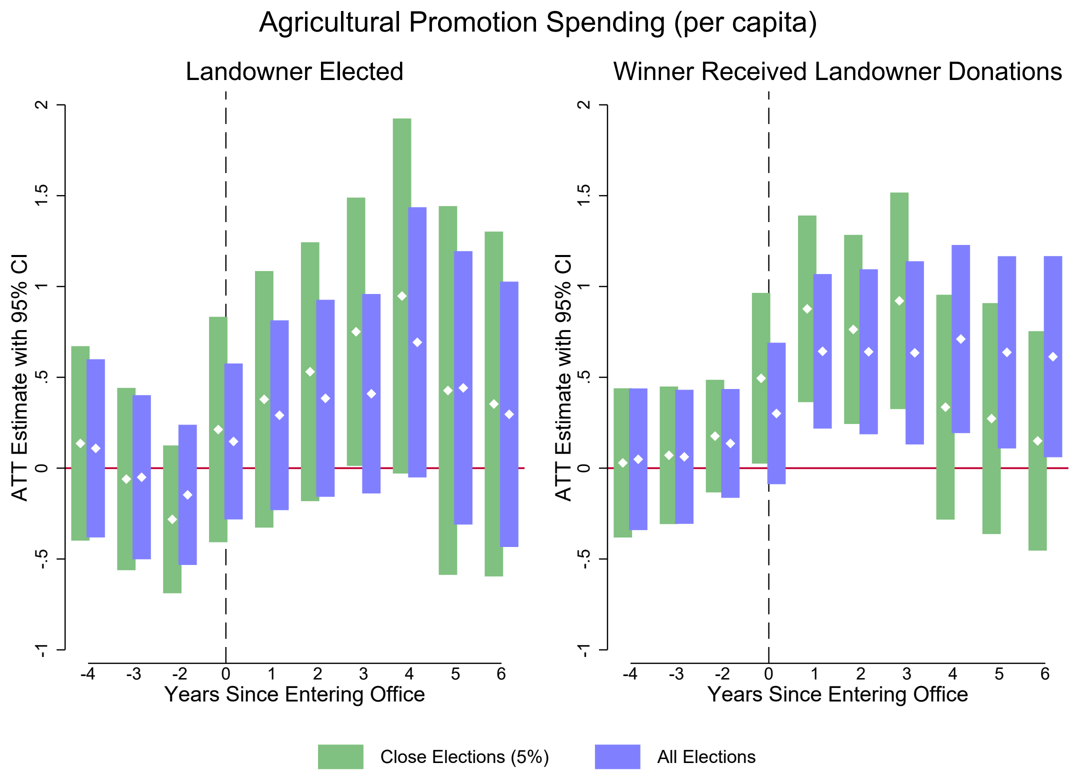


Figure C46: Municipalities: Dynamic Effects of Landholder or Landholder-Financed (geq25%) Mayor on Agricultural Grants

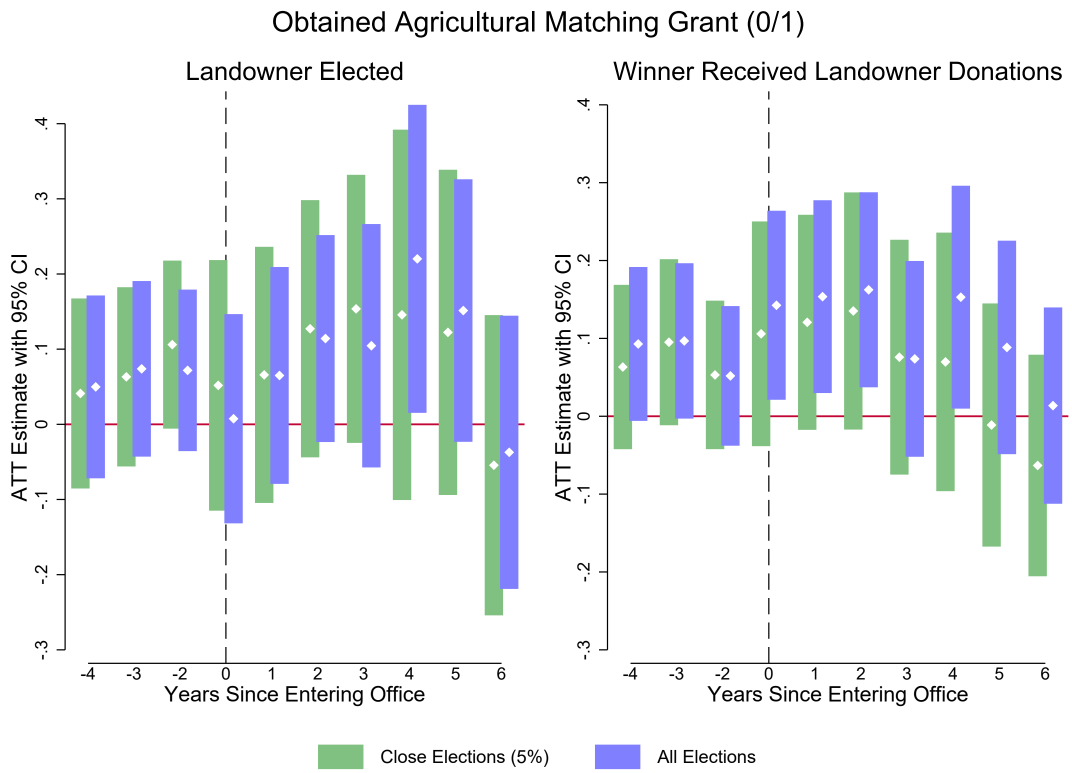


Figure C47: Municipalities: Dynamic Effects of Landholder or Landholder-Financed (geq25%) Mayor on Rural Credit