

Does Local Politics Drive Tropical Land-Use Change?

Property-Level Evidence from the Amazon

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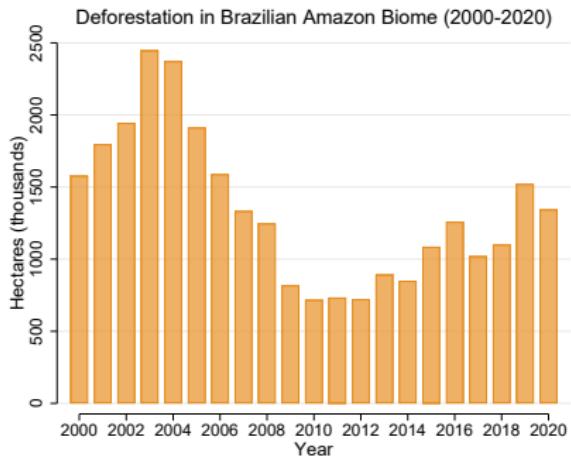
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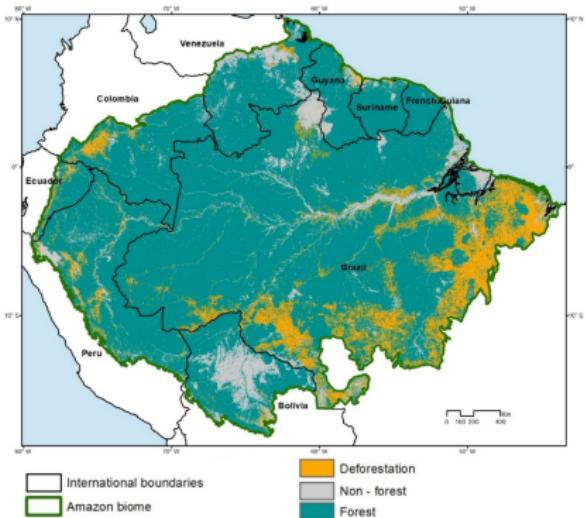
October 12th, 2023

Deforestation in the World's Largest Tropical Forest

| 1



Source: MapBiomas (2023)



Source: Berenguer et al. (2019)

- Deforestation has turned the Amazon from a carbon sink to a net carbon emitter – **1 billion tons of CO₂ in 2020** (Gatti et al.; Nature, 2021)

- Carbon Emissions from Land-Use Change

Amazon Deforestation is an Urgent Environmental Challenge

| 2

- ▶ 75% of Amazon is losing resilience to dry season stress
(Bolton, Lenton, and Boers; *Nature Climate Change*, 2022)
- ▶ Continued deforestation could double wildfires by 2050
(Brando et al.; *Science Advances*, 2020)
- ▶ Deforestation–climate feedback loop ⇒ transformation of Amazon into fire-dominated, low-biomass seasonal forest (Malhi et al.; *PNAS*, 2009)

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Local Impacts:

- ▶ Biodiversity loss (Giam; *PNAS*, 2017)
- ▶ Extreme temperatures (Zeppetello et al.; *Env. Research Letters*, 2020)
- ▶ Agricultural revenues ↓ (Leite-Filho et al.; *Nature Communications*, 2021)

Has the Amazon Reached Its ‘Tipping Point’?

Some Brazilian scientists fear that the Amazon may become a grassy savanna — with profound effects on the climate worldwide.

Source: New York Times (2023)

- ▶ Deforestation is driven by economic incentives to expand **commodity agriculture** – particularly **cattle ranching** and **soy** (Pendrill et al.; Science, 2022)
- ▶ Deforestation rates respond to commodity prices and environmental policies (Assunção et al.; Environment and Development Economics, 2015)

What Drives Deforestation in the Amazon?

| 3

- ▶ Deforestation is driven by economic incentives to expand **commodity agriculture** – particularly **cattle ranching** and **soy** (Pendrill et al.; Science, 2022)
- ▶ Deforestation rates respond to commodity prices and environmental policies (Assunção et al.; Environment and Development Economics, 2015)
- ▶ Land conversion to agriculture progresses in stages:
 - 1 **FOREST** ⇒ low-input, low-productivity **PASTURE**
 - 2 **PASTURE** ⇒ high-input, high-productivity **SOY**

Cattle grazing on deforested land



Source: New York Times (2019)

Mechanized soy production in the Amazon



Source: Soendergaard et al. (2021)

- ▶ Mayors may allow landholders to deforest prior to local elections to win rural votes ([Pailler; JEEM, 2018](#))
- ▶ In Colombia, election of a **donor-funded mayor** (relative to self-funded) ⇒ environmental enforcement ↓ and deforestation ↑ ([Harding et al.; APSR, 2023](#))
- ▶ Election of **self-identified farmer mayors** increased deforestation and promotion of agriculture after 2000 elections; effects disappear in later elections when federal environmental enforcement was stronger ([Bragança and Dahis; Journal of Pub Econ, 2022](#))

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“Those who deforest the Amazon completely dominate local politics... Representatives of the people are, in fact, representatives of those who deforest.”

—Federal Police Chief in Amazonas, quoted in Washington Post (2022)

“The big agricultural producers, the ones with the most capital, are the ones at the front of politics here.”

—Deputy to Environment Minister of Pará, quoted in Globe and Mail (2018)

1 Patronage: Is there an *individualized* exchange of **campaign donations** for favors between **landholders** and **local politicians (mayors)**?

- > **Extensive Margin:** help landholders clear forest for cattle pasture
- > **Intensive Margin:** help landholders intensify from pasture to soy

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3 **Politicians' Self-Enrichment and Identity:** Do mayors deforest or intensify agriculture on their personal properties while in office? Does election of a landholding mayor affect municipal outcomes?

- > **Finding:** Landholding mayors weakly increase personal soy cultivation; no effects at municipal-level

**Novel panel of
land-use change
on properties of
politicians and
donors**

Introduction
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Data
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Property-Level Analysis
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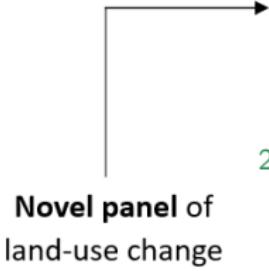
Municipal-Level Analysis
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Discussion
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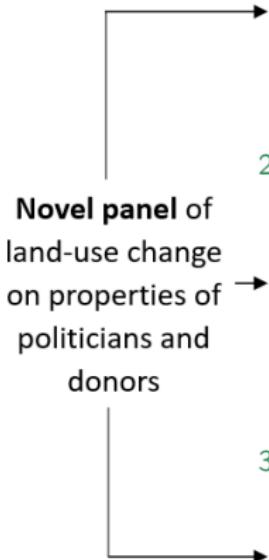
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- > **Feasibility:** Patronage works through channels mayors can influence – not deforestation, which is federally enforced

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 - > We show Amazon landholders are a powerful interest group with **deep ties to local politics**
 - > Landholder-financed mayors don't target favors precisely ⇒ **spillovers** to non-donors (with environmental consequences)

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- 3 **Politician Identity:** Bragança and Dahis (J. Pub Econ, 2022); Brollo and Troiano (JDE, 2016); Bhalotra et al. (JEBO, 2014)
 - > Landholder identity does not affect municipal agricultural or environmental governance

Municipal Governance:

- ▶ Local elections (mayors and legislature) every 4 years; voting is obligatory
- ▶ Municipalities responsible for **significant public goods provision**, but **limited role in environmental regulation**
- ▶ Municipalities can operate or support rural credit co-ops
75% of rural credit went to **large producers** in 2021 (Ministry of Agriculture, 2022)

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Federal Environmental Regulation:

- ▶ 20% of property area can be legally cleared in Amazon; ≈ 90% of existing deforestation is illegal
- ▶ Anti-deforestation enforcement carried out by IBAMA, a federal agency



Source: O Globo (2021)

- ▶ Land registries in the Brazilian Amazon are incomplete and overlapping.
- ▶ We harmonize individually-identified versions of all major registries ([Thank you to the Gibbs Land Use and Environment Lab at UW-Madison](#)):
 - 1 **SIGEF/CCIR/CNIR:** formal land title registries from INCRA (2016-2020)
 - 2 **Terra Legal:** Formal registry begun in 2009 to regularize Brazilian Legal Amazon; focused on public lands (2014-2017)
 - 3 **CAR:** Rural Environmental Property Registry, requires (since 2012) mapping of property boundaries for all holdings, formal or informal (2011-2021)
- ▶ Result: **611,506 unique properties** with personal IDs (names/ID numbers)



CAR Property Boundaries



► **Remote Sensing Land Use Data:**

Connect property shapefiles with annual pixel-level (30m) land use data from MapBiomas V.5 (2000-2020).

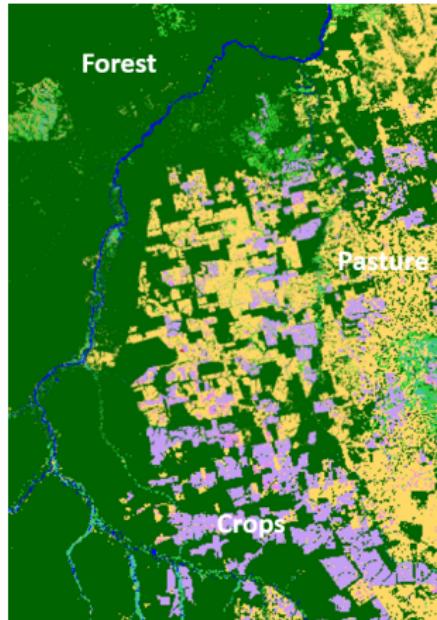
► **Candidate and Donor Registries:**

Connect property owner names, IDs, and municipalities with local politicians and donors in Brazilian Amazon (2000, 2004, 2008, 2012, and 2016 elections), from TSE

► **Other Data:**

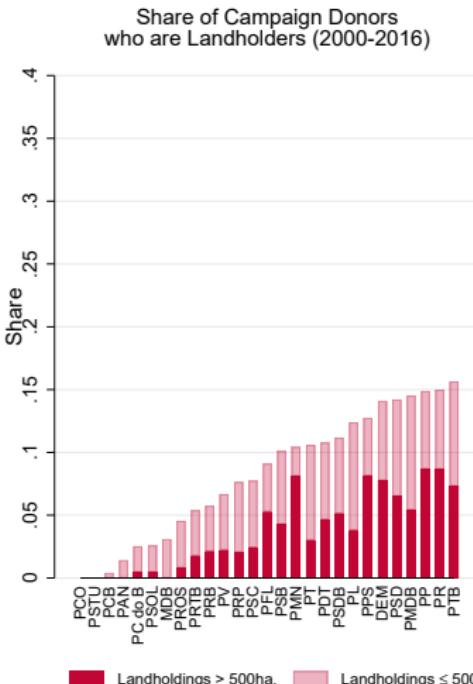
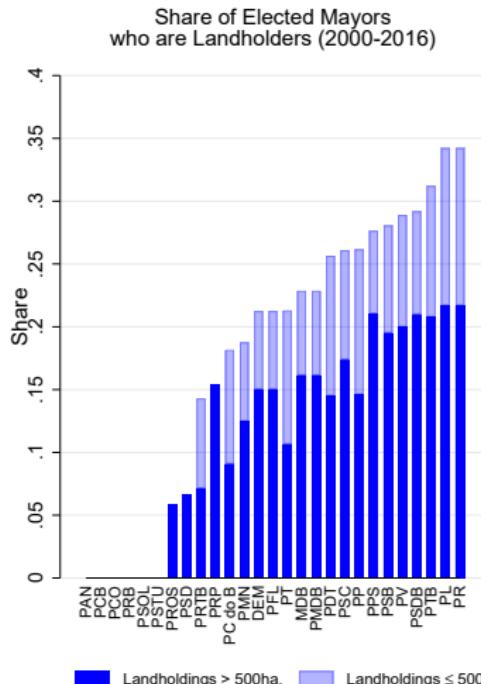
- > Public spending (FINBRA)
- > Matching Grants (PGU)
- > Rural Credit (Central Bank)
- > Municipal Baselines (Ipea, FIRJAN)

► [Data Sources](#)



Source: MapBiomas (2023)

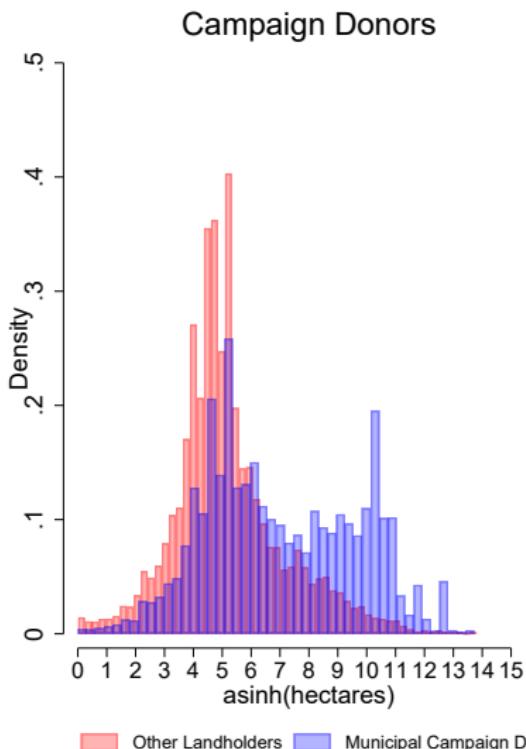
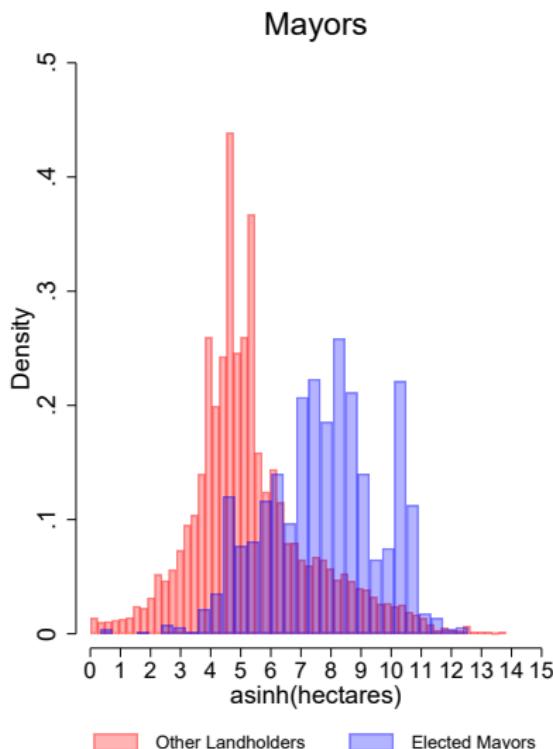
- Landholding is widespread among politicians and donors: we match 25% of winning candidates and 8% of donors to properties ► [Spatial Variation in Match Rates](#)



Candidates and Donors are Disproportionately Largeholders

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Property Size (Hectares)



Introduction
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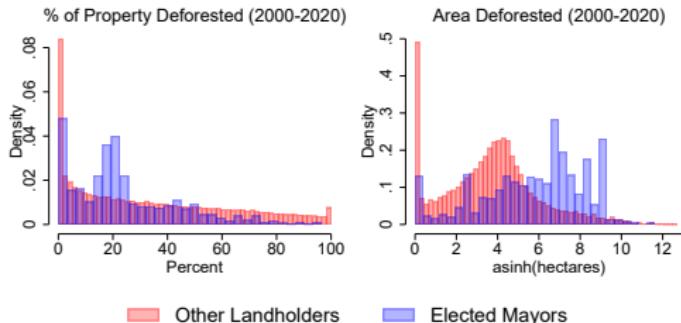
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Property-Level Analysis
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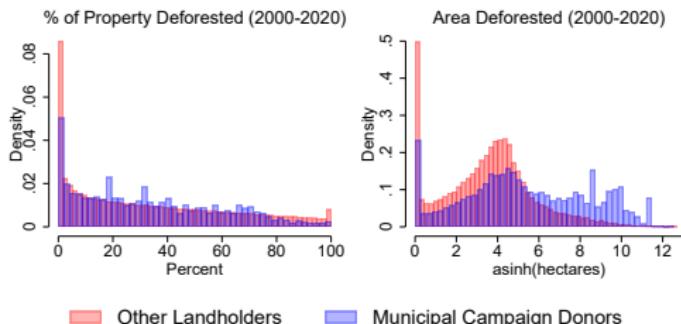
Municipal-Level Analysis
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Discussion
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Candidates



Campaign Donors



► More Comparisons to Other Landholders

Landholding vs. Non-Landholding Mayors & Donors

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

- Mayors with large landholdings are, on average, **more male, slightly less educated, slightly older, born elsewhere, receive more donations, and win more often**

Is there “land-use patronage” in the Amazon?

If so, do mayors help donors at the **extensive margin** (enabling deforestation) or **intensive margin** (enabling agricultural intensification)?

- ▶ **Intuition:** Compare outcomes on properties of *donors to candidate who won a close election* against *donors to candidates who lost a close election*

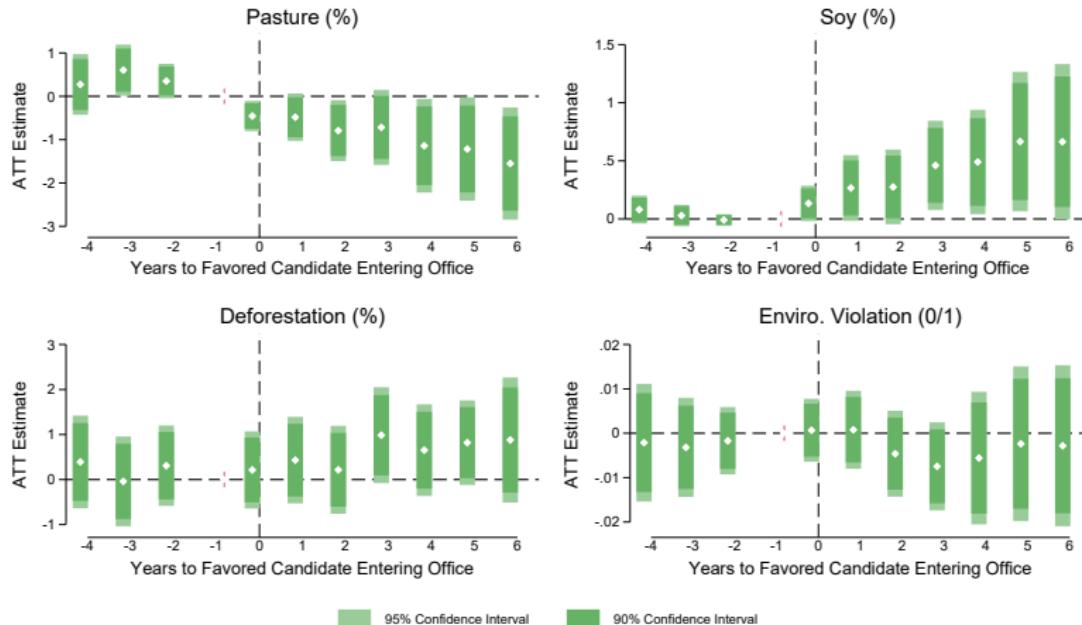
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$$y_{it} = \theta_i + \lambda_t + \sum_{k \neq -1} [\mathbb{1}(K_{it} = k)]\beta_k + \epsilon_{it}$$

- ▶ y_{it} = pasture, soy, deforestation, environmental violations
- ▶ K_{it} = year dummies around entry into office
- ▶ Individual (θ_i) and year (λ_t) fixed effects
- ▶ Cluster standard errors at individual level
- ▶ Callaway and Sant'Anna (2021) estimator to accomodate staggered treatment timing and heterogeneous treatment effects
- ▶ “**Treated individuals**” = donors to candidate who wins a close election
- ▶ “**Control individuals**” = donors to candidate who lose a close election
- ▶ Define close elections using **5% win margin** ▶ Map: # of Close Elections per Municipality

Results: Donors shift pasture to soy while their favored candidate is in office; no evidence of environmental *quid pro quo*

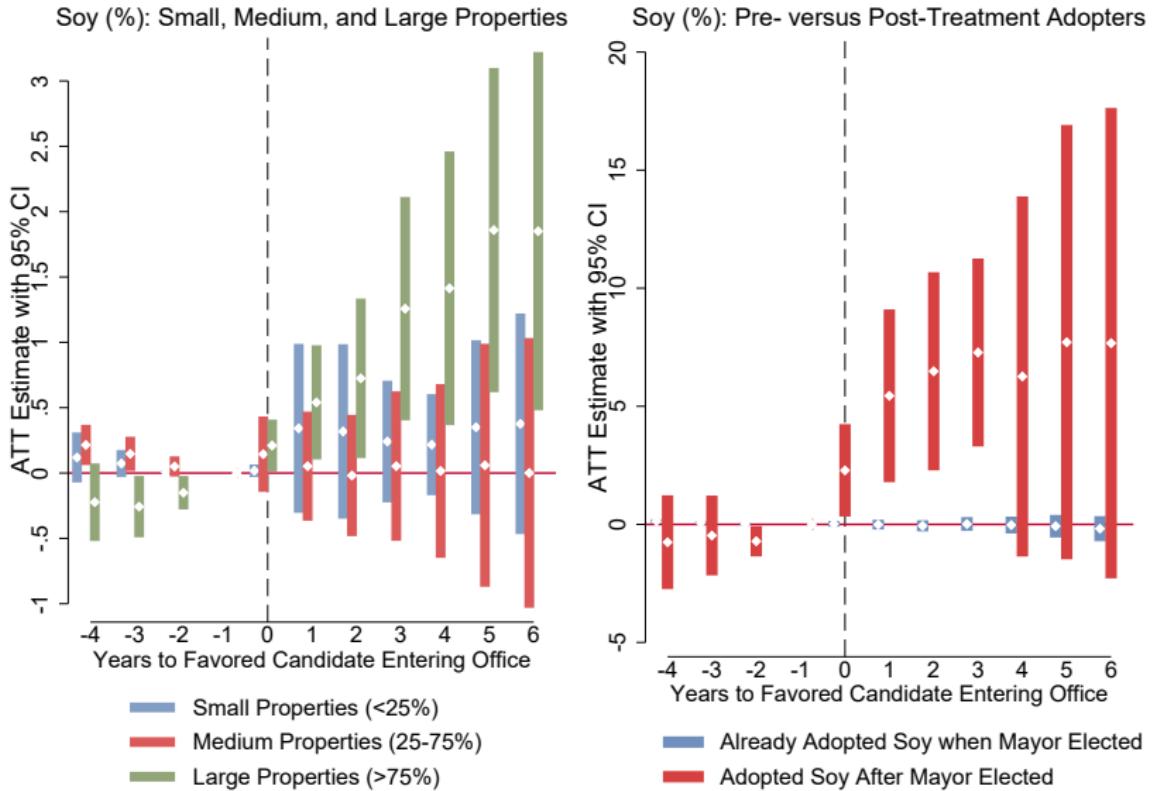
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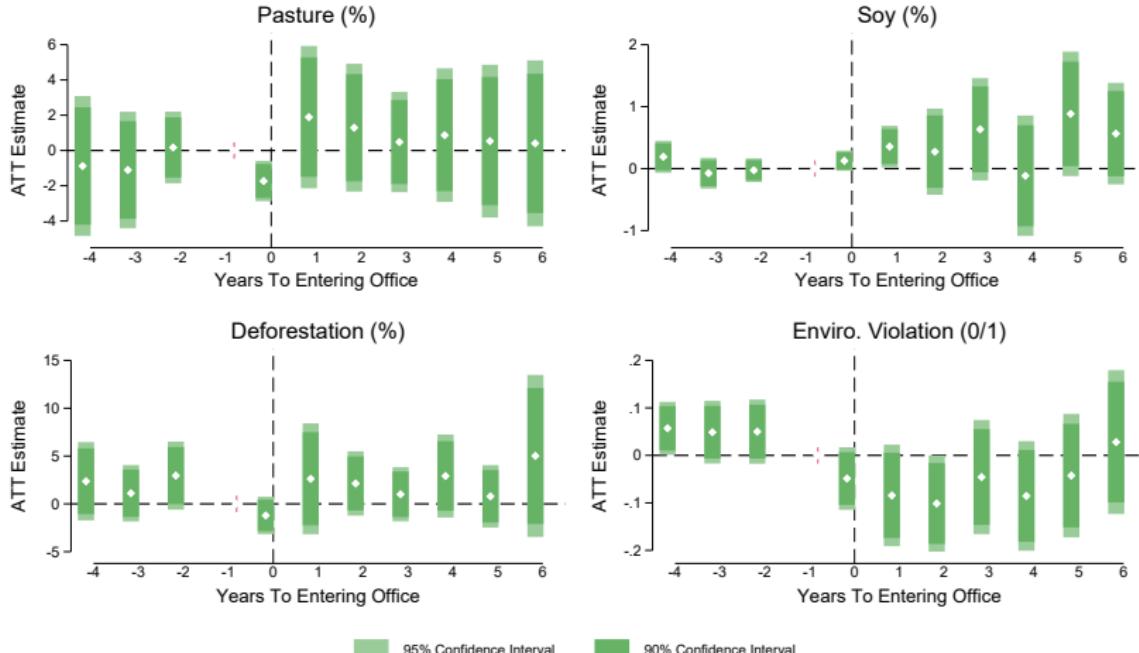


Note: Figure reports ATT estimates and 90 and 95% confidence intervals from Callaway and Sant'Anna (2021) *csdid2* estimator. Sample consists of donors to successful and runner-up mayoral candidates in close mayoral elections ($\leq 5\%$ win-margin) in Amazon biome (2004-2016).

Shift to Soy is Driven by Large Properties and New Adopters

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Are landholders an influential interest group?

Is agricultural patronage precisely targeted, or are there
spillovers to non-donors?

Through which **mechanisms** do mayors favor donors?

- ▶ **Intuition:** Compare outcomes in *municipalities where (i) a landholder or (ii) a landholder-financed mayor wins a close election* against *municipalities with close elections where this type does not win*

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

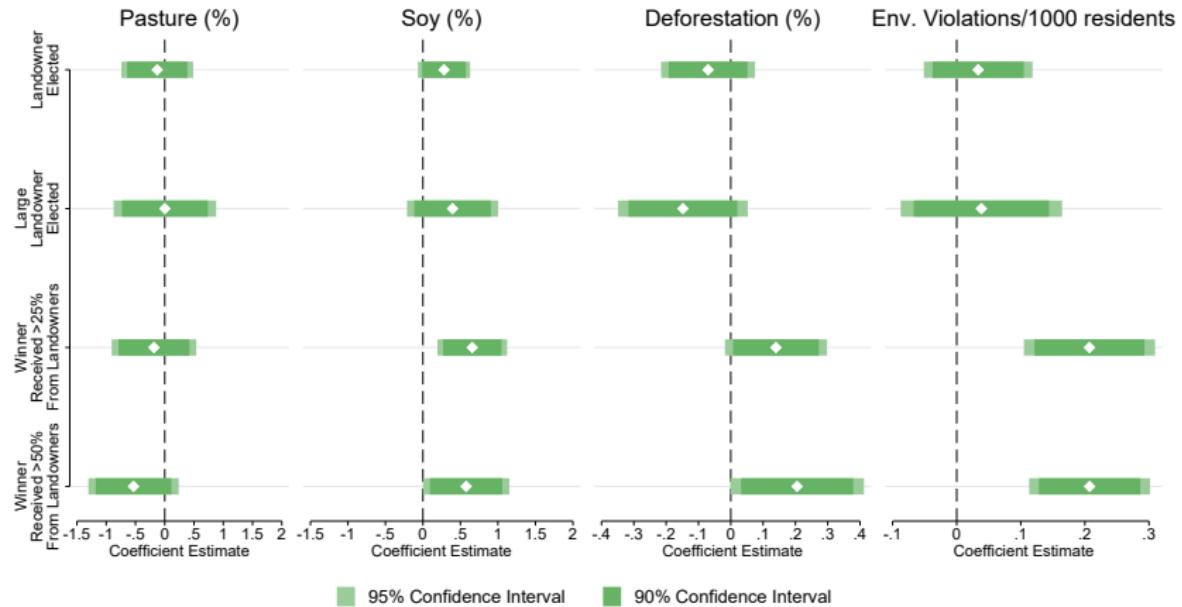
- ▶ y_{me} = outcome in municipality m during election period e with winner i
- ▶ T_{me} = 1 if elected mayor is:
 - > is a landholder
 - > is a large landholder (≥ 500 ha.)
 - > received $\geq 25\%$ donations from landholders
 - > received $\geq 50\%$ donations from landholders
- ▶ \mathbf{X}_{mei} = vector of winner i covariates (sex and education)
- ▶ δ_m and θ_e are municipality and election-period fixed effects; standard errors are clustered at municipality-level

Sample restricted to close elections ($\leq 5\%$ Win Margin)

Election of a Landholder-Financed Mayor Increases Municipal Soy, Deforestation, and Environmental Violations

► Alternative Donor-Funded Treatment

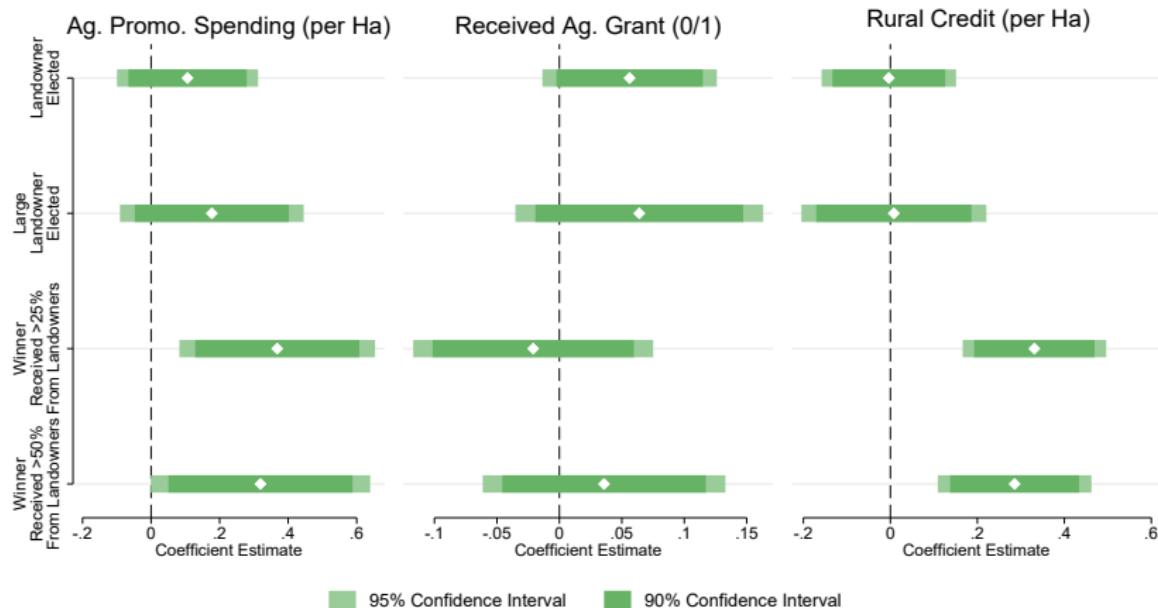
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Note: Figures report coefficient estimates and 90 and 95% CIs from regression of outcome on municipality-election treatment dummies (landholder in office, large landholder (≥ 500 ha.) in office, mayor who received $\geq 25\%$ of donations from landholders in office, and mayor who received $\geq 50\%$ of donations from landholders in office). Sample is Amazon biome municipalities with municipal election win margins $\leq 5\%$ between 2000-2016.

Mechanisms: Landholder-Financed Mayors Increase Agricultural Promotion Spending and Rural Credit

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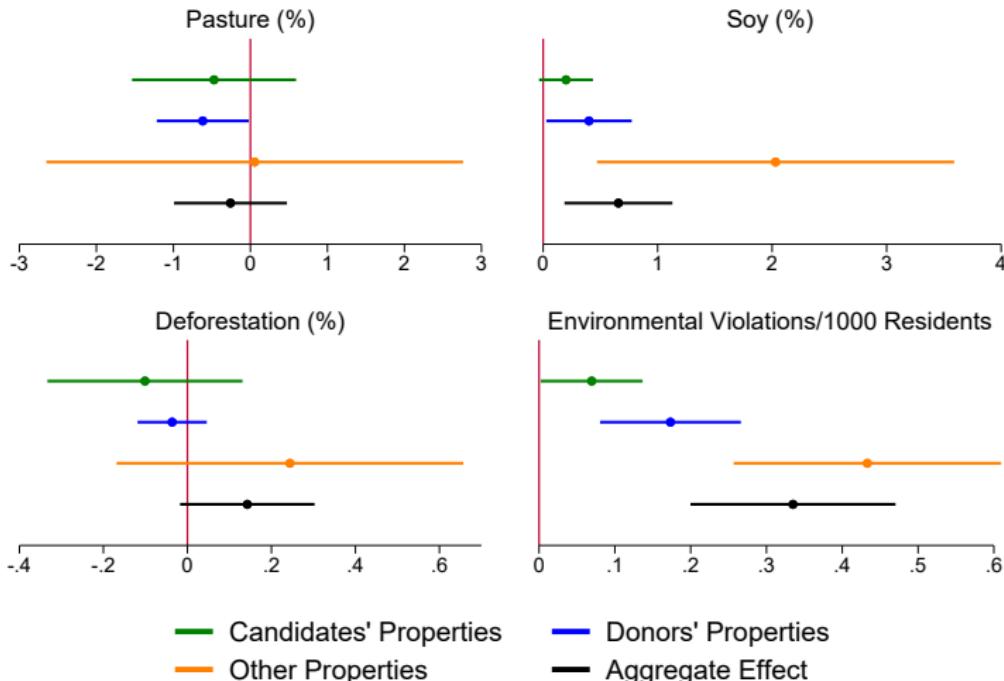


Note: Left figure reports estimated effects on municipal spending on Agricultural Promotion; central figure reports estimated effects on likelihood municipality receives matching grant from Federal Ministry of Agriculture; right figure reports estimated effects on total value of rural credit per ha. of municipal area. Monetary values are deflated to constant 2010 \$BRL and transformed using asinh.

Landholder-Financed Mayors Don't Target Favors Precisely to Donors ⇒ Spillovers to Non-Donors

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Decomposition: Winner Received >25% Donations from Landholders



- ▶ **Land registries are not time variant:** we don't know if candidates/donors held their properties over the full 2000-2020 period

Response: Land transactions in the Amazon are infrequent – involving only 0.51% of properties during 2019-2020 ([Moffette et al., 2023](#))

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Response: Land transactions in the Amazon are infrequent – involving only 0.51% of properties during 2019-2020 ([Moffette et al., 2023](#))

- ▶ **Measurement error:** we miss properties where candidates/donors hold unregistered land or title land in a family member's name

Response: We restrict the sample to states with the most complete land registries as a robustness check

Property-level results are mostly robust to:

- ▶ Restrict sample to states with more complete land registries [► Complete Registries](#)
- ▶ Use alternative 10% close election cutoff or full sample [► Alternative Win Margins](#)
- ▶ Use $\text{asinh}(\text{hectares})$ instead of % of property area for land use changes [► IHS Transformation](#)
- ▶ Include municipality-election fixed effects [► Municipality-Election Fixed Effects](#)

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Municipal-level results are mostly robust to:

- ▶ Restrict sample to states with more complete land registries
- ▶ Use alternative 10% close election cutoff or full sample
- ▶ Use $\text{asinh}(\text{hectares})$ instead of % of property area for land use changes
- ▶ Annual event studies using Callaway and Sant'Anna (2021) estimator to check pre-trends ▶ Municipal-Level Event Studies

*Connections between **land** and **politics** were previously unobservable!*

Introduction



Data
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Property-Level Analysis

Municipal-Level Analysis

Discussion

*Connections between **land** and **politics** were previously unobservable!*

- ▶ **Agricultural Patronage:** Donors adopt soy while their candidate is in office
 - > Large landholders invest in political connections to overcome barriers to ag. intensification (could be access to credit, factor markets, networks)
 - Average “successful” donation is **\$7,364** (current US dollars); only 13.5% of successful donors donate again, with avg. post-treatment donation just US\$1,230

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- ▶ **Interest Group Influence:** Landholder-financed mayors “pay back” donors by promoting agriculture – with negative environmental consequences
 - > Mayors can't target favors precisely → adopt policies favorable to the sector, creating spillovers to non-donors
 - > Corresponding increase in municipal deforestation *and* environmental violations suggests **mayors are not shielding landholders from federal environmental enforcement** – outside of mayors' control

- ▶ **Agricultural intensification** (cattle pasture → soy) would allow Brazil to increase soy production while reducing carbon emissions [Stabile et al. \(Land Use Policy, 2020\)](#); [Marin et al. \(Nature Sustainability, 2022\)](#)
 - > Our findings indicate there is demand for political connections to overcome unobserved barriers to intensification

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 - > Our findings indicate there is demand for political connections to overcome unobserved barriers to intensification
- ▶ **Potential downsides:**
 - > Soy involves heavy **herbicide/pesticide** use ⇒ negative health effects [Panis et al. \(Front. Pub Health, 2022\)](#); [Skidmore et al. \(PNAS, 2023\)](#)
 - > Exacerbation of **inequalities** between large landholders and the broader population [Weinhold et al. \(World Dev., 2013\)](#)
 - > Risk of **indirect land use change** (encroachment of soy displaces pasture to the frontier) [Gollnow et al. \(Land Use Policy, 2018\)](#); [Arima et al. \(Env Res Letters, 2011\)](#)
- ▶ **Inequality in Access & Influence:** self-reinforcing cycle where politicians favor landholders, empowering this group and enabling further influence

Thank you!

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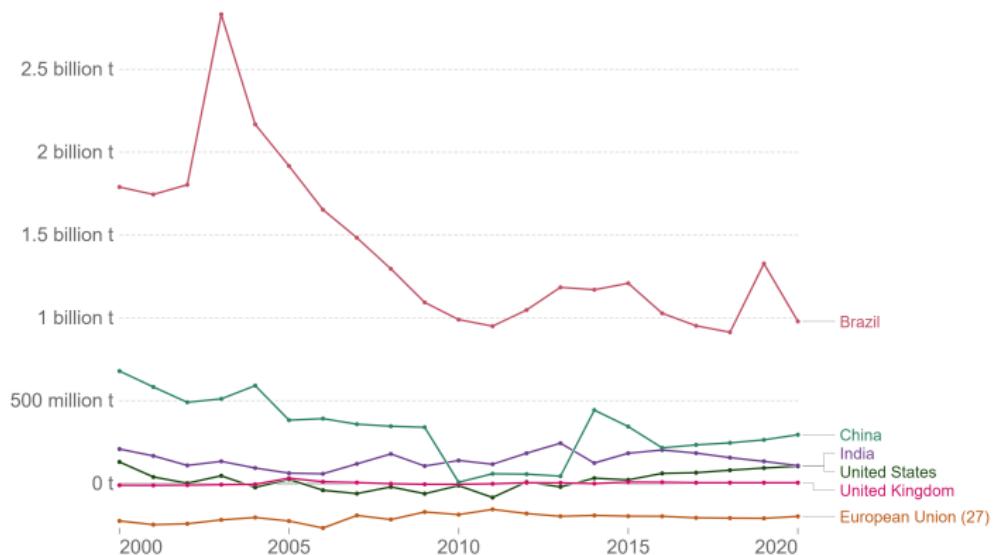
Carbon Emissions from Land-Use Change

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Annual CO₂ emissions from land-use change, 2000 to 2020

Emissions from land-use change can be positive or negative depending on whether these changes emit (positive) or sequester (negative) carbon.

Our World
in Data



Source: Global Carbon Project (2022)

OurWorldInData.org/co2-and-greenhouse-gas-emissions • CC BY

► Return

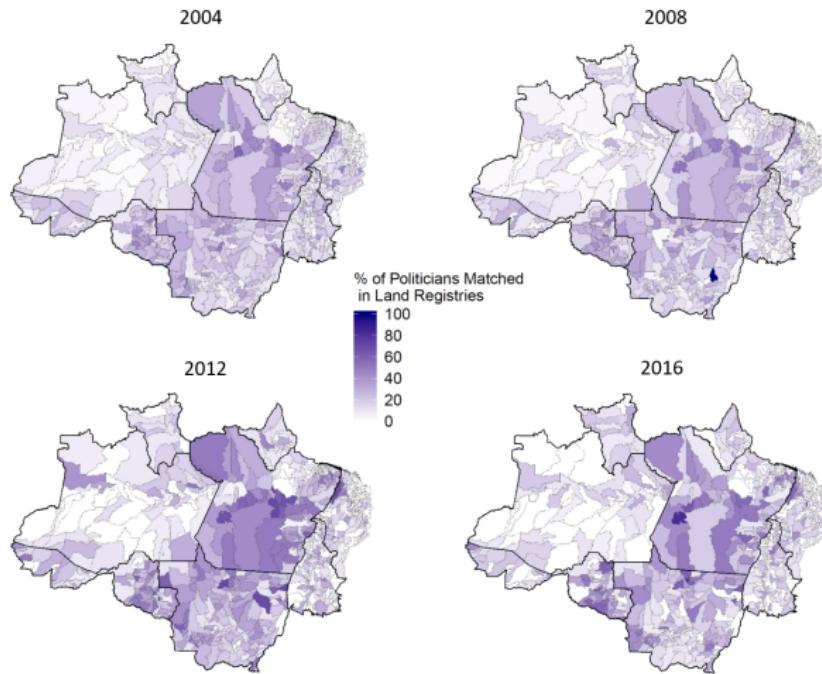


Data	Source	Years	Raw Level	Analysis Level
Deforestation & Land Use	MapBiomas	2000-2019	Pixel	Property/Mun.
Land Registries	CAR	2011-2020	Property	Property
	Terra Legal	2014-2017	Property	Property
	INCRA	2016-2020	Property	Property
Elections (Candidates)	TSE	2000-2016	Individual	Individual
Elections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

► Return

Percent of Politicians Matched in Land Registries

| 31



► Return



Landholding Mayors & Donors vs. Other Landholders

| 32

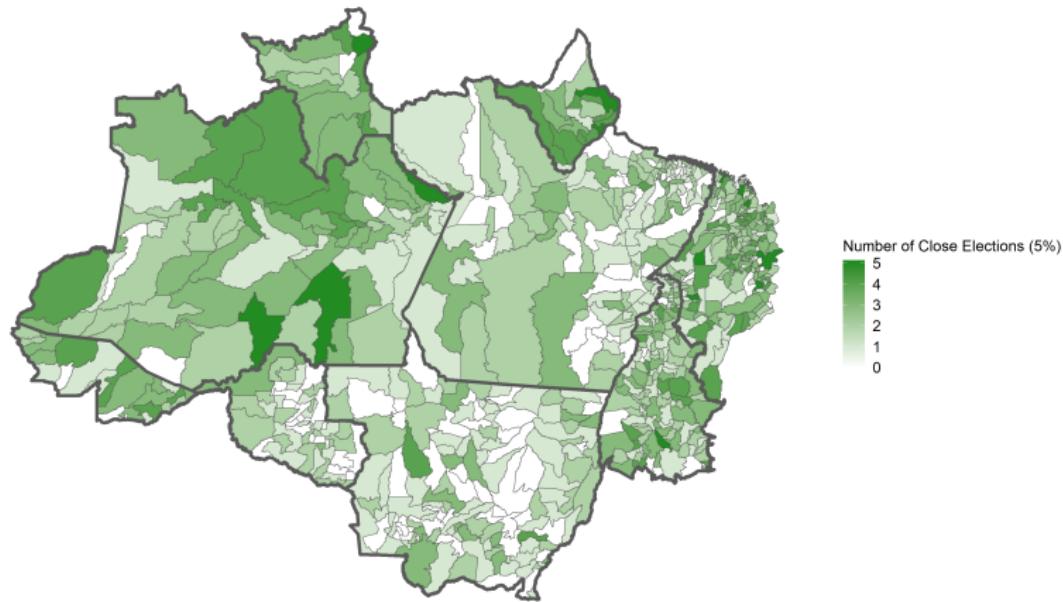
	Landholders in Brazilian Amazon Biome (2000-2020)		
	Elected Mayors	Campaign Donors	Others
<i>% of Property Deforested (2000-2020)</i>	24.2 (20.38)	34.1 (26.97)	35.9 (31.99)
<i>Total Hectares Deforested (2000-2020)</i>	1,103 (2,789)	2,750 (7,652)	342 (2,524)
<i>% of Property Converted to Soy</i>	4.4 (11.95)	1.7 (8.83)	2.0 (10.55)
<i>Total Hectares Converted to Soy</i>	283 (1,314)	156 (1,334)	33 (456)
<i>% Received Environmental Violation</i>	42.8 (49.50)	34.6 (47.59)	10.0 (29.97)
<i>n =</i>	686	17,144	615,643

► Return



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

| 33



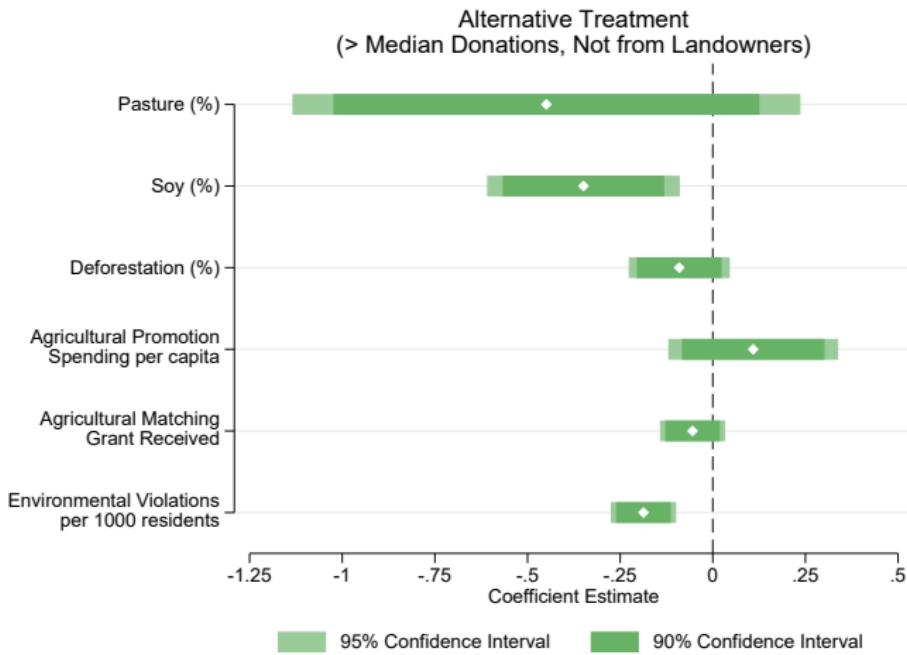
Note: Map reports number of close elections in each municipality over 2000, 2004, 2008, 2012, and 2016 elections for Brazilian Legal Amazon. Close elections are defined as those where the difference between share of votes received by winning and runner-up mayoral candidates was less than or equal to 5%.

▶ Return



Are Results Driven Purely by being Donor-Funded (e.g., Landholder Donations are Spurious)? No.

| 34

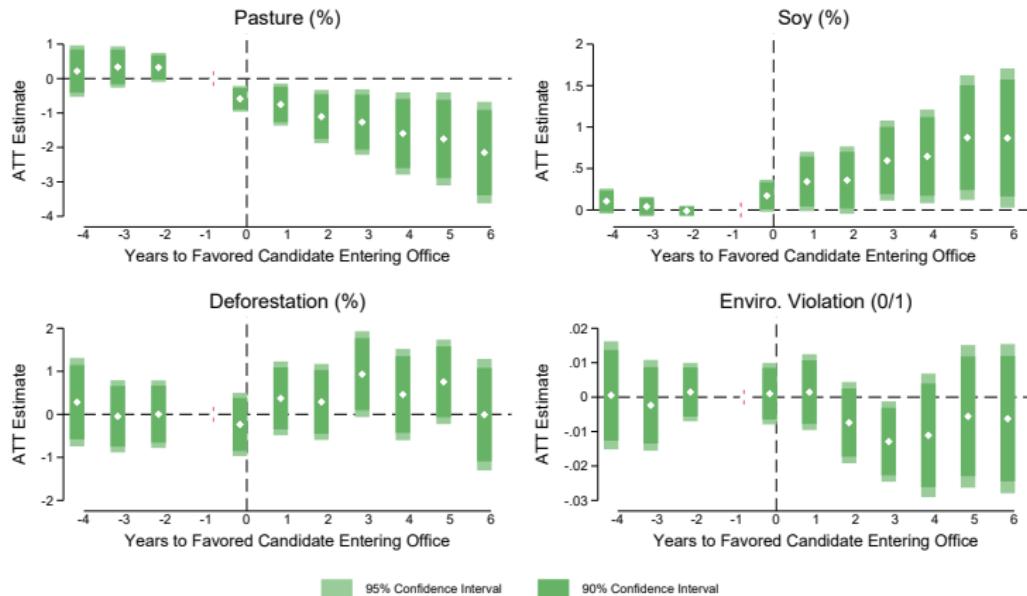


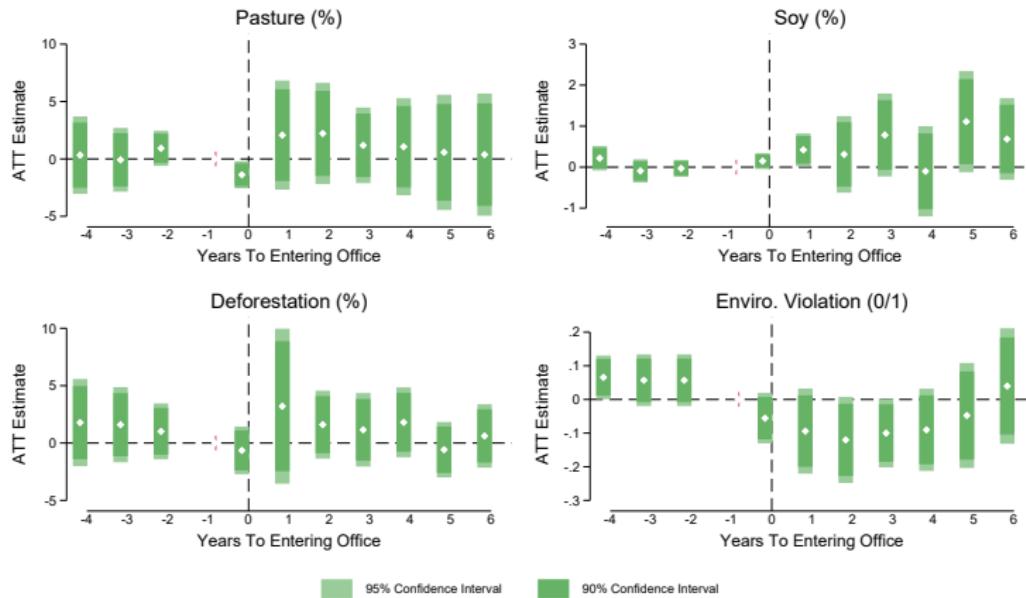
Note: Figure reports coefficient estimates and 90 and 95% CIs from regression of outcome on municipality-election treatment dummy (mayor who received \geq median value of total campaign donations but no donations from landowners). Specifications are otherwise analogous to main results. [Return](#)



Robustness: Donor Properties, 5% Win Margin, MT/PA/RO

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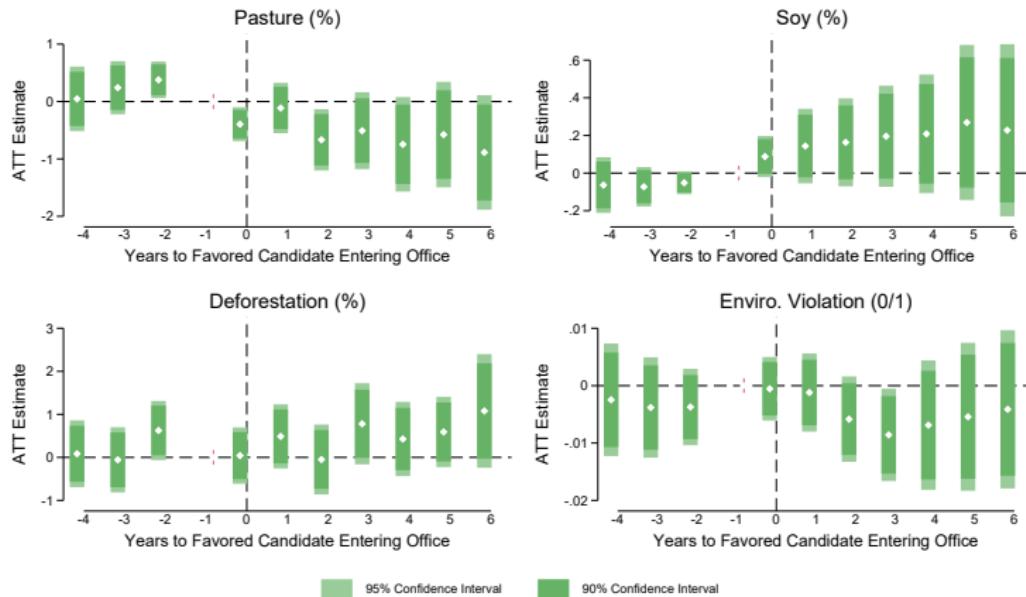


▶ Return



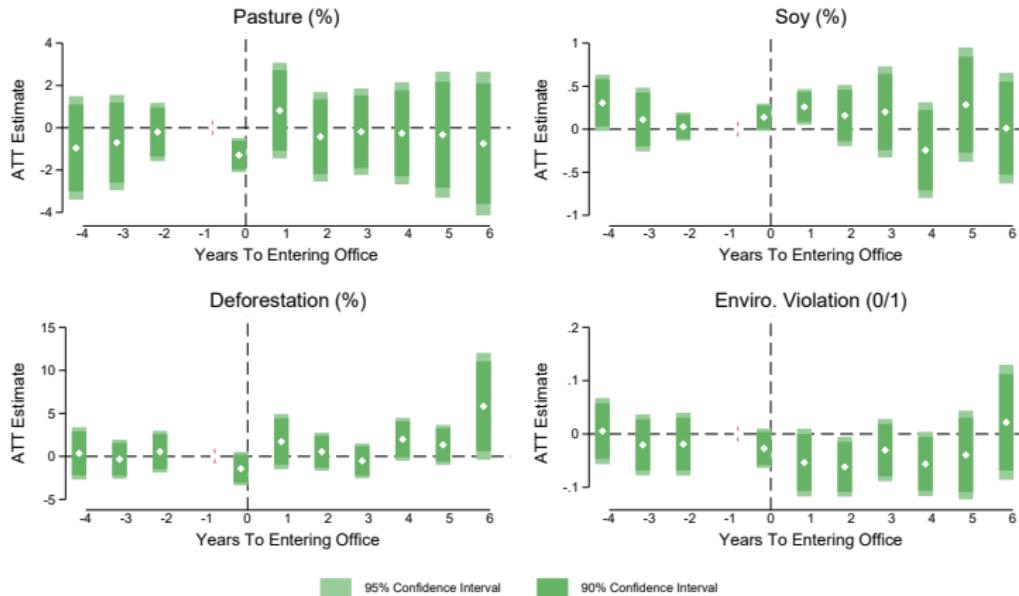
Robustness: Donor Properties, 10% Win Margin, Amazon

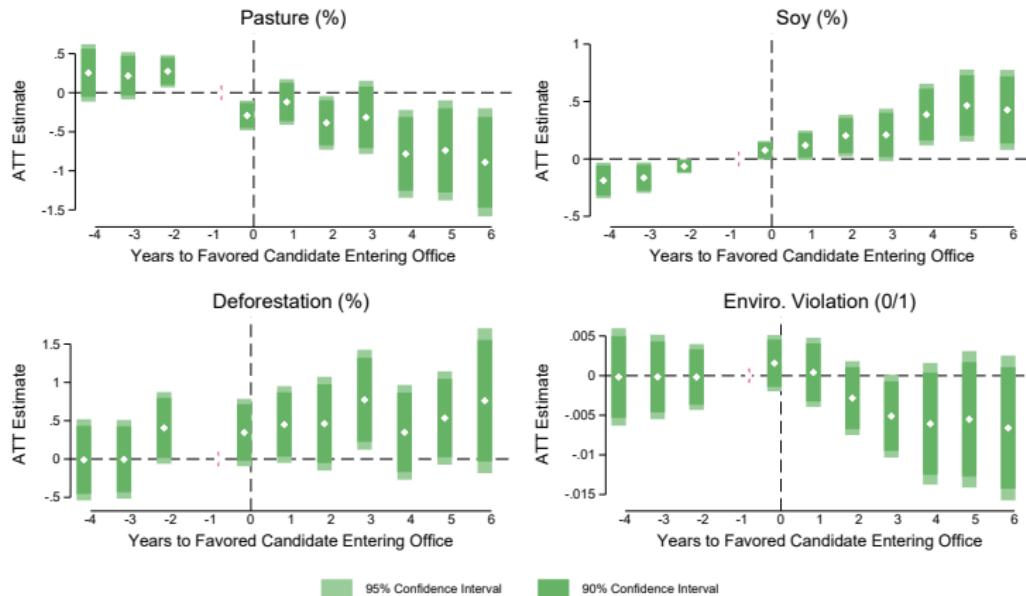
| 37



Robustness: Candidate Properties, 10% Win Margin, Amazon

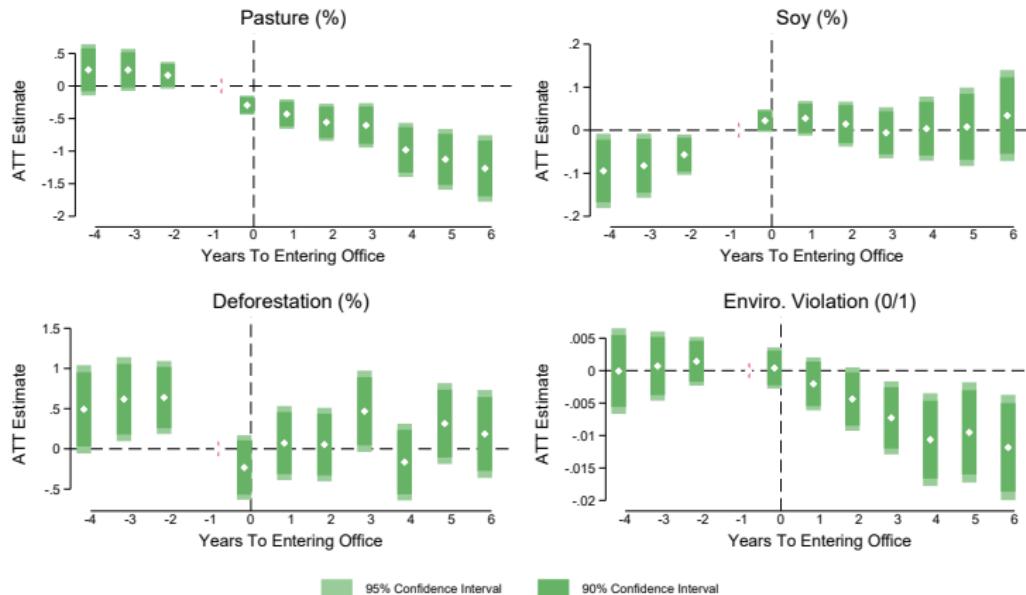
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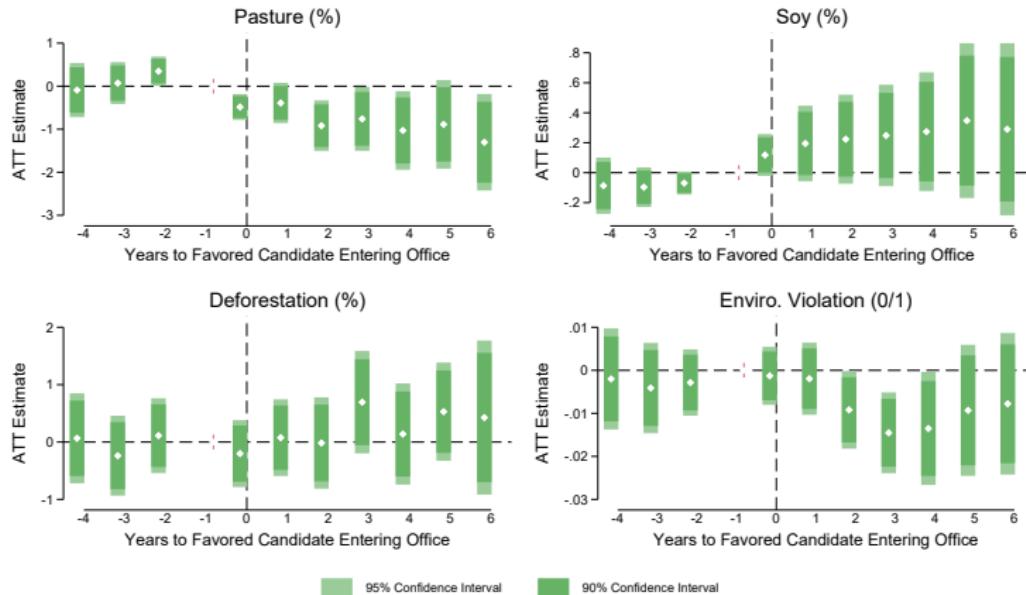




Robustness: Candidate Properties, All Elections, Amazon

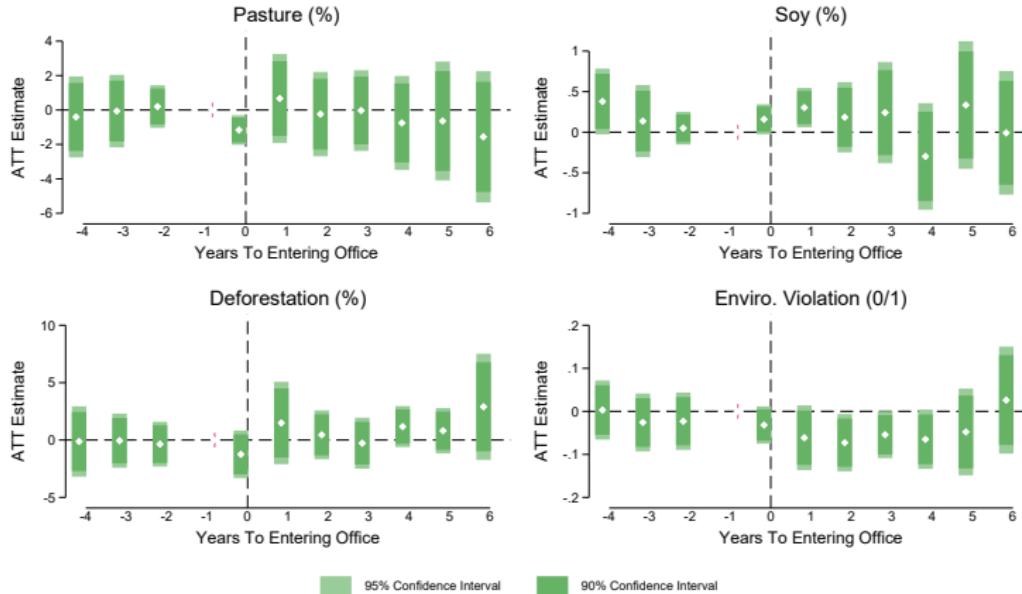
| 40

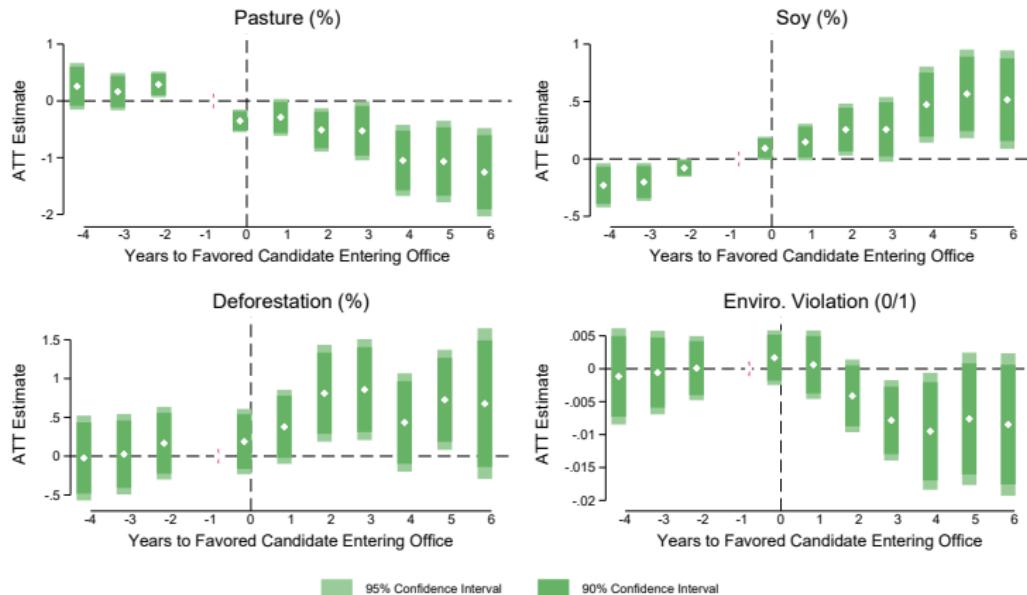




Robustness: Candidate Properties, 10% Win Margin, MT/PA/RO

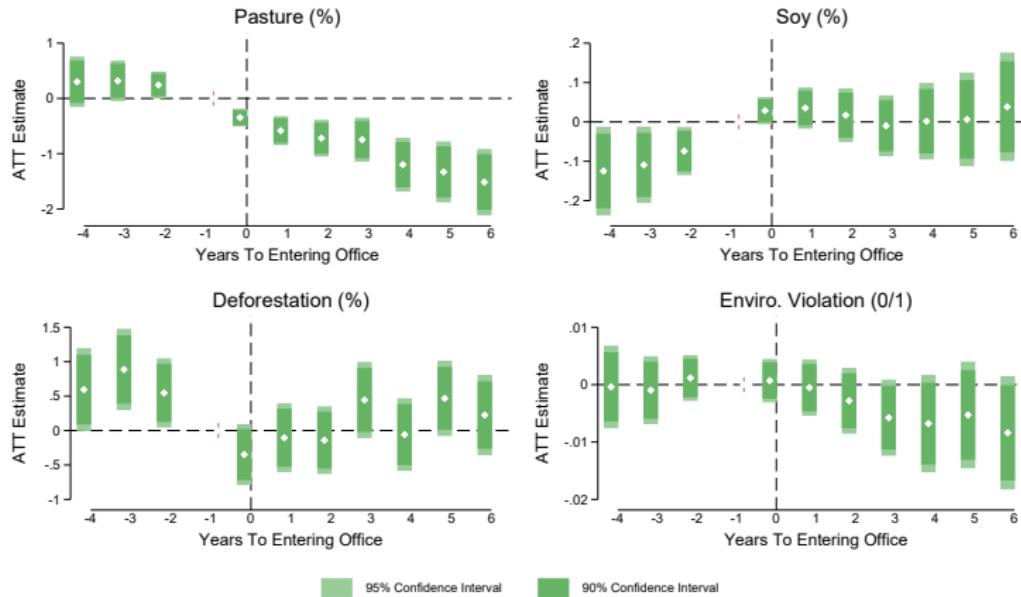
| 42





Robustness: Candidate Properties, All Elections, MT/PA/RO

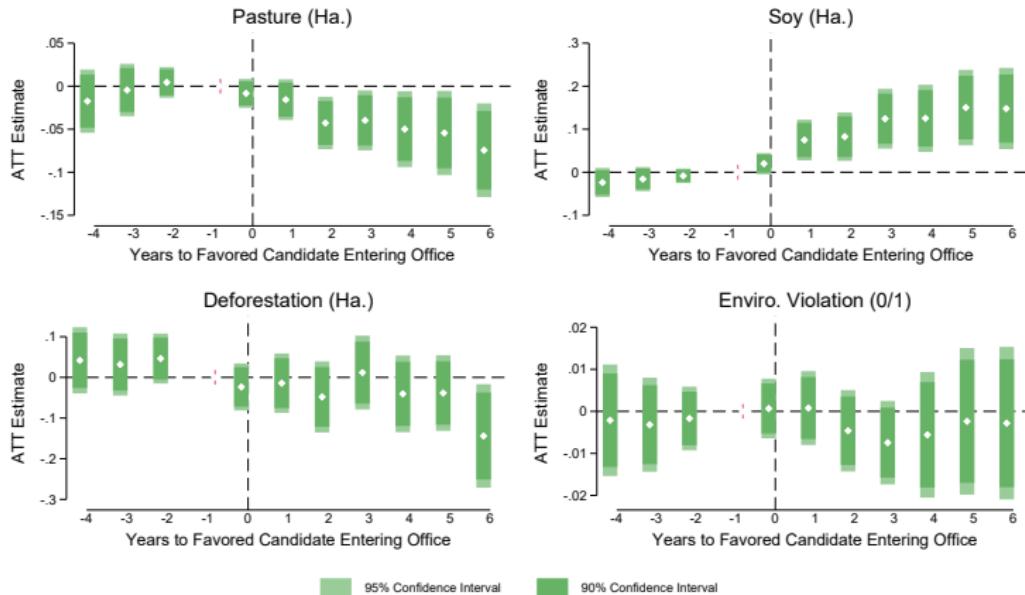
| 44



► Return

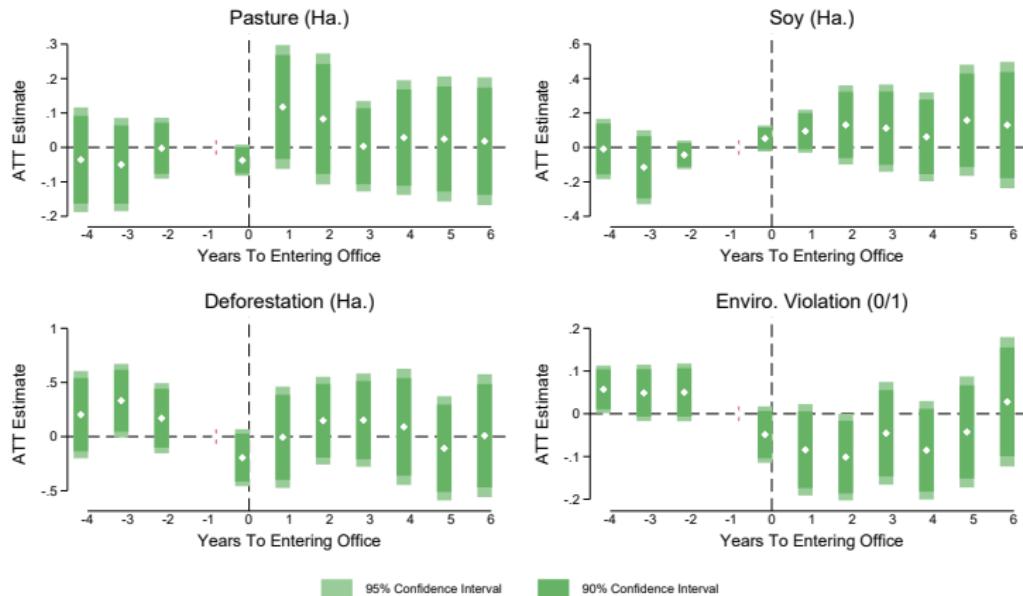
Robustness: Donor Properties, 5% Win Margin, Amazon, asinh

| 45



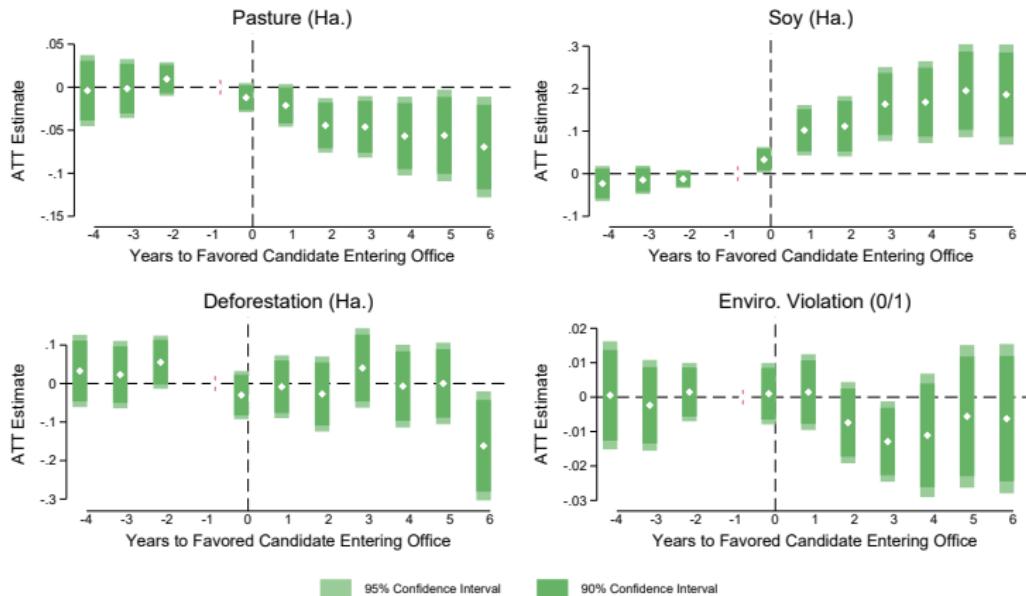
Robustness: Candidate Properties, 5% Win Margin, Amazon, asinh

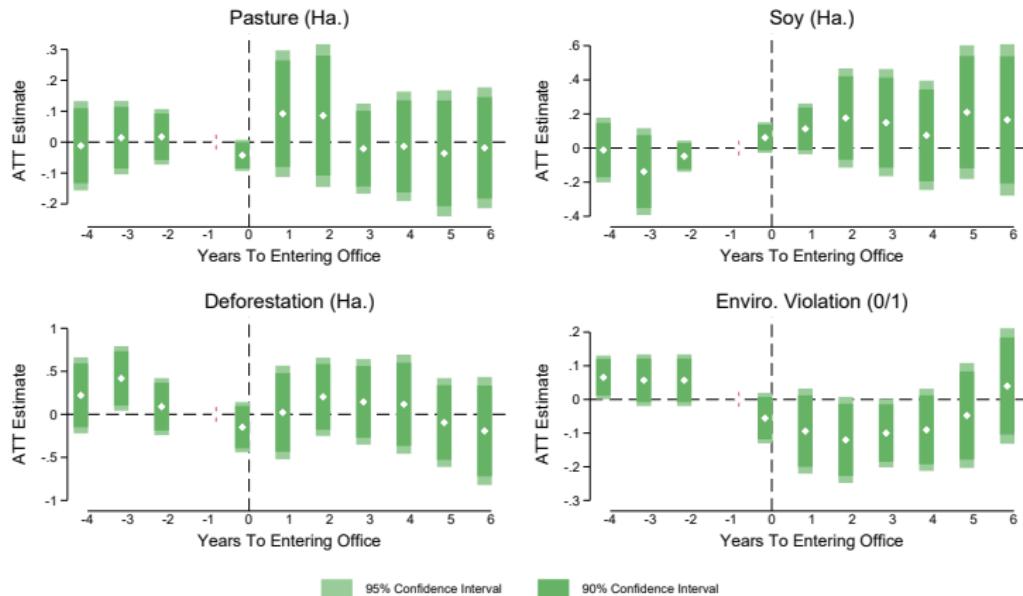
| 46

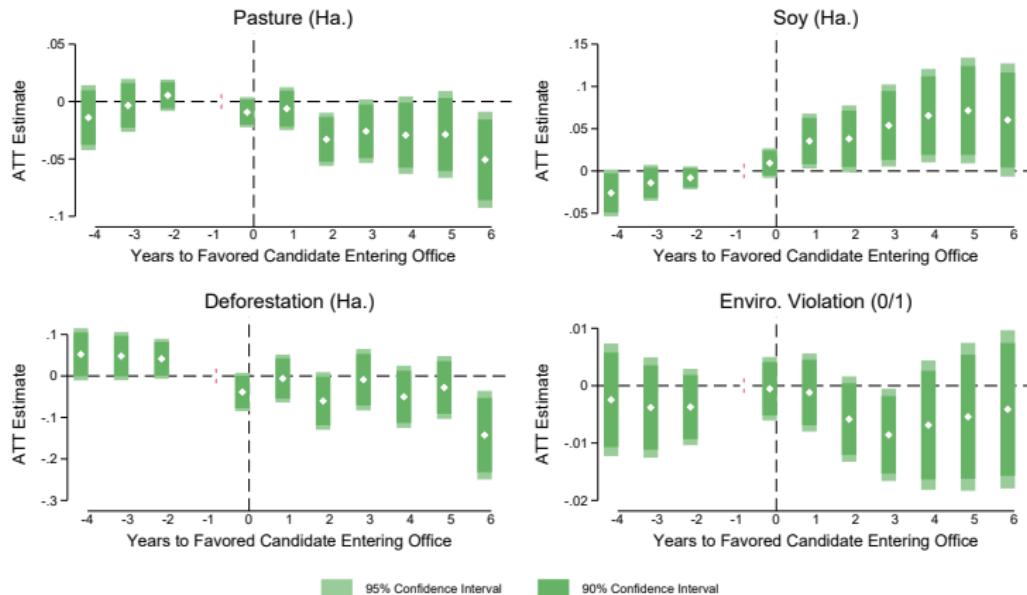


Robustness: Donor Properties, 5% Win Margin, MT/PA/RO, asinh

| 47

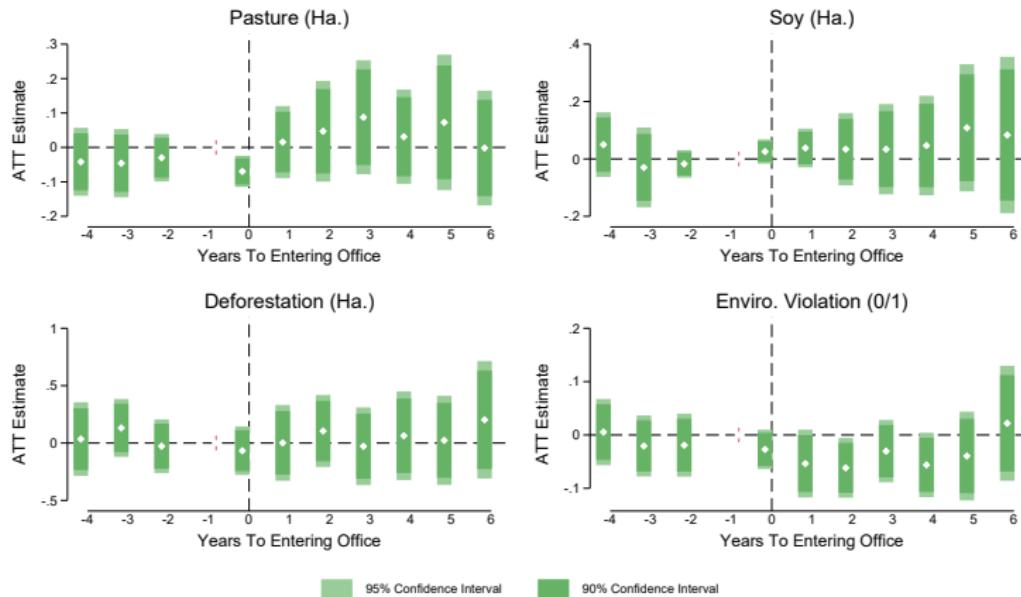


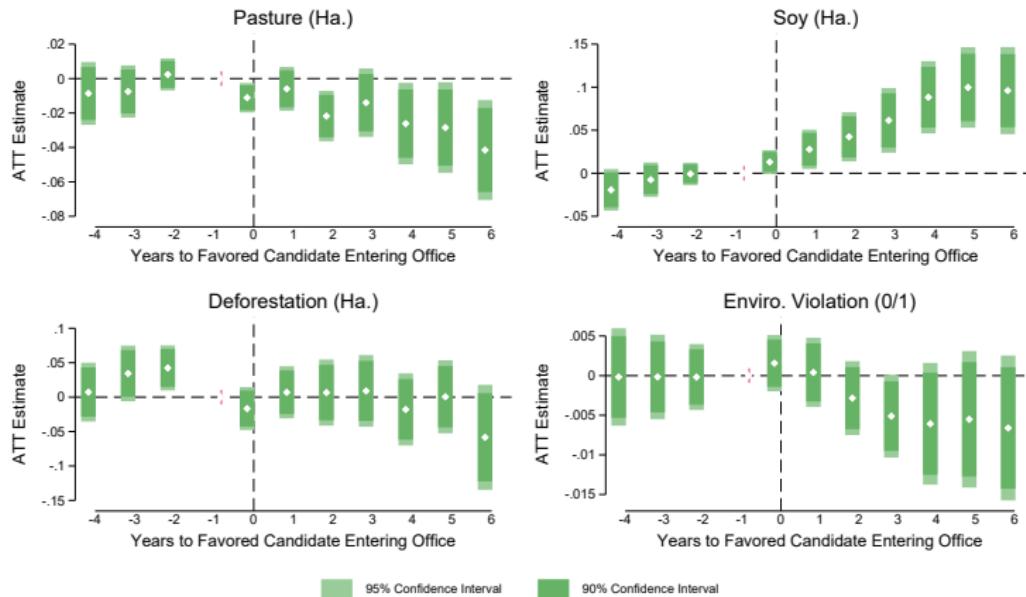


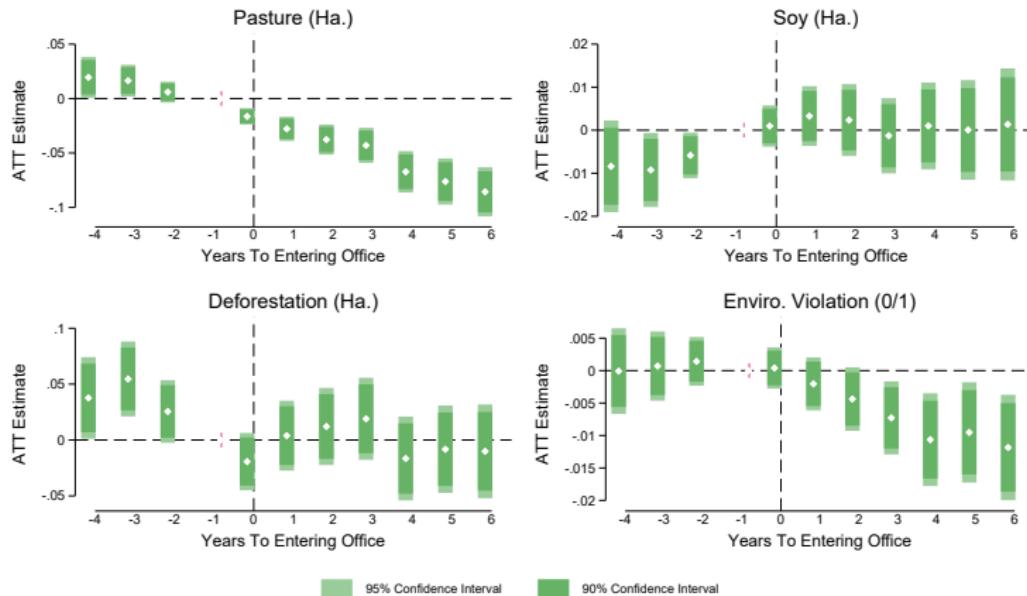


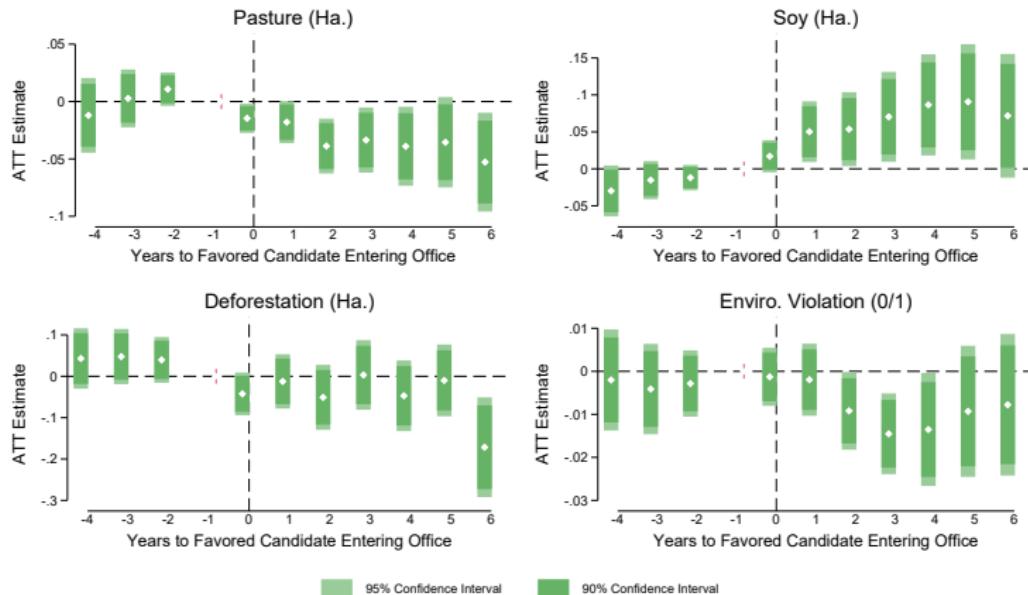
Robustness: Candidate Properties, 10% Win Margin, Amazon, asinh

| 50

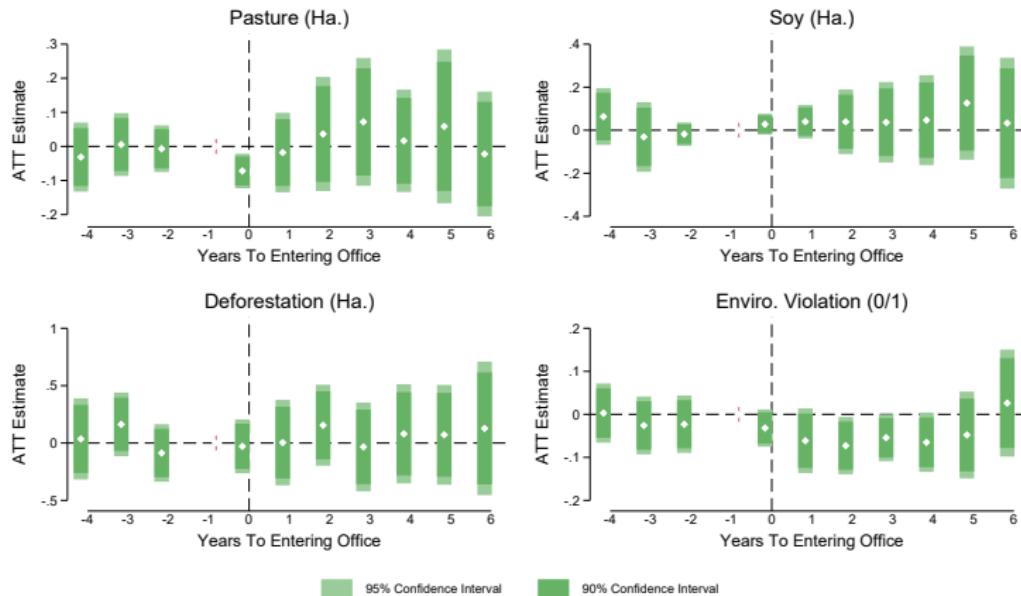


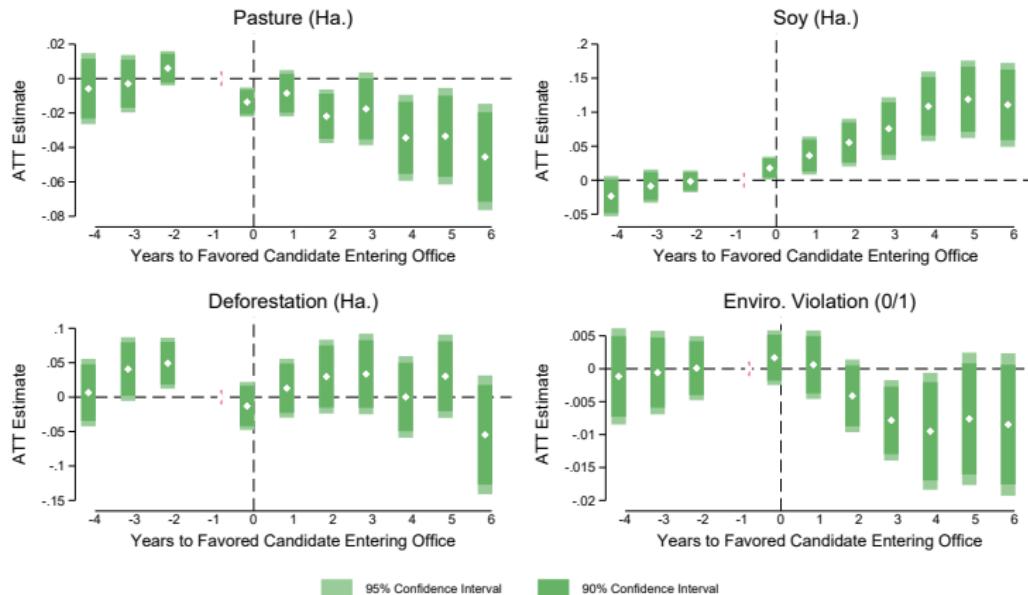


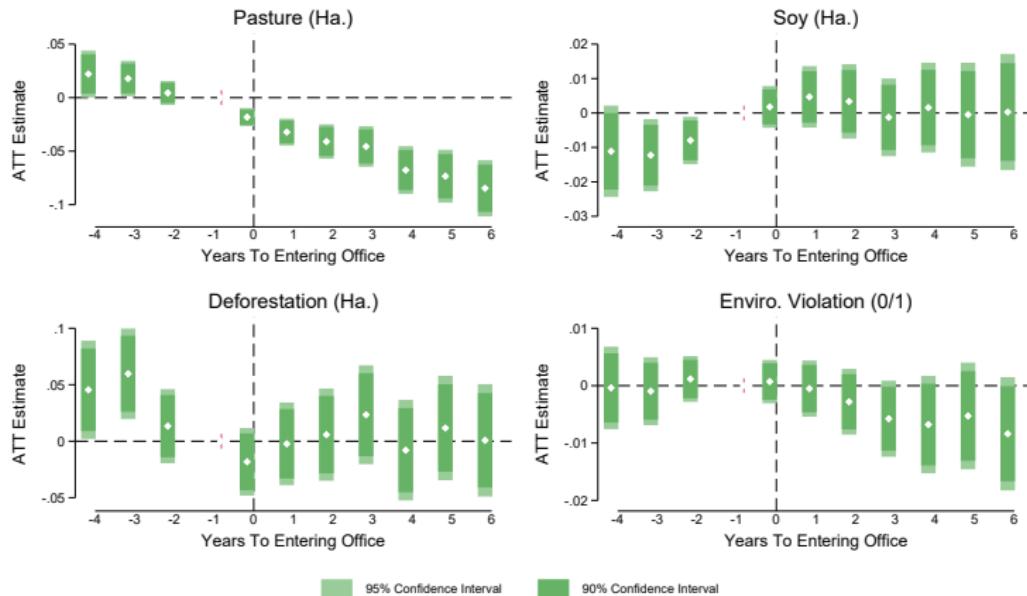




Robustness: Candidate Properties, 10% Win Margin, MT/PA/RO, asinh | 54

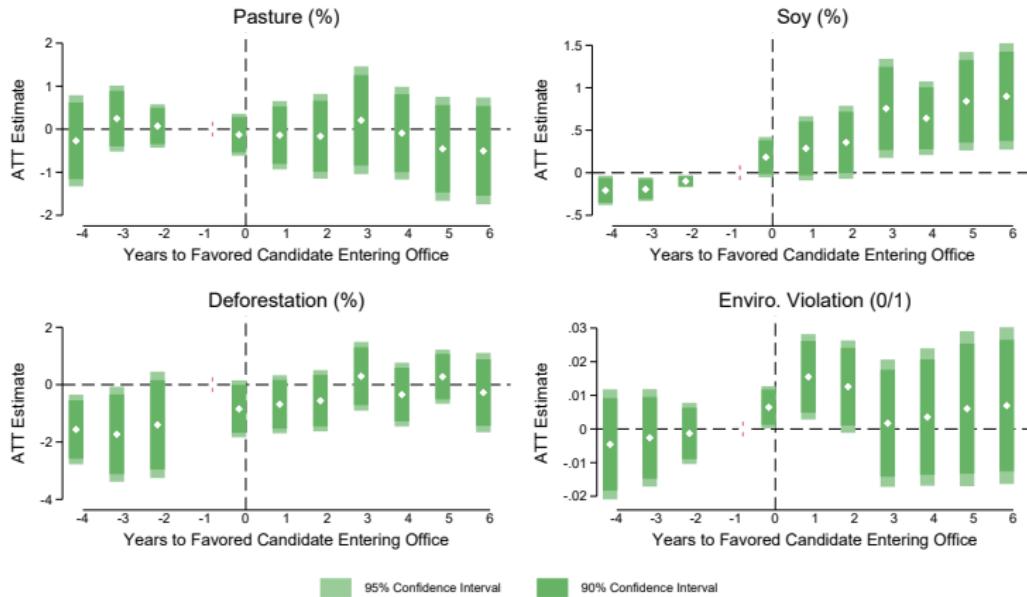


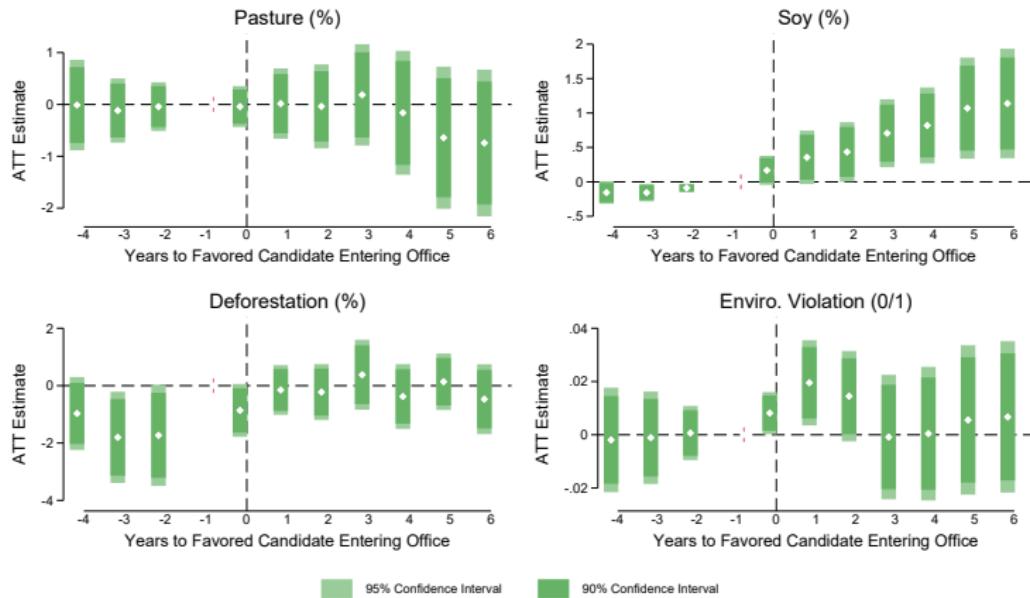




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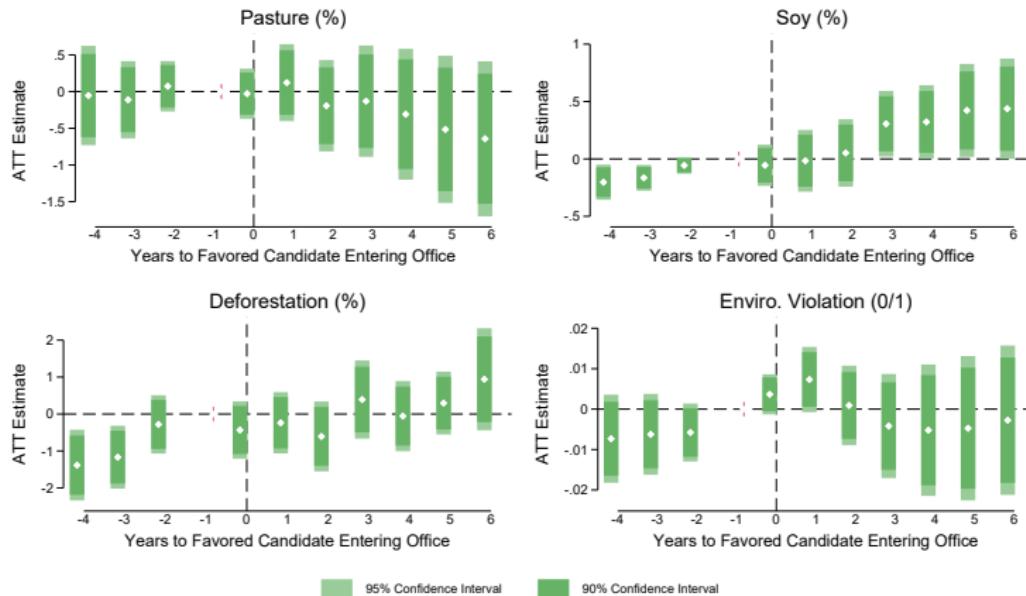




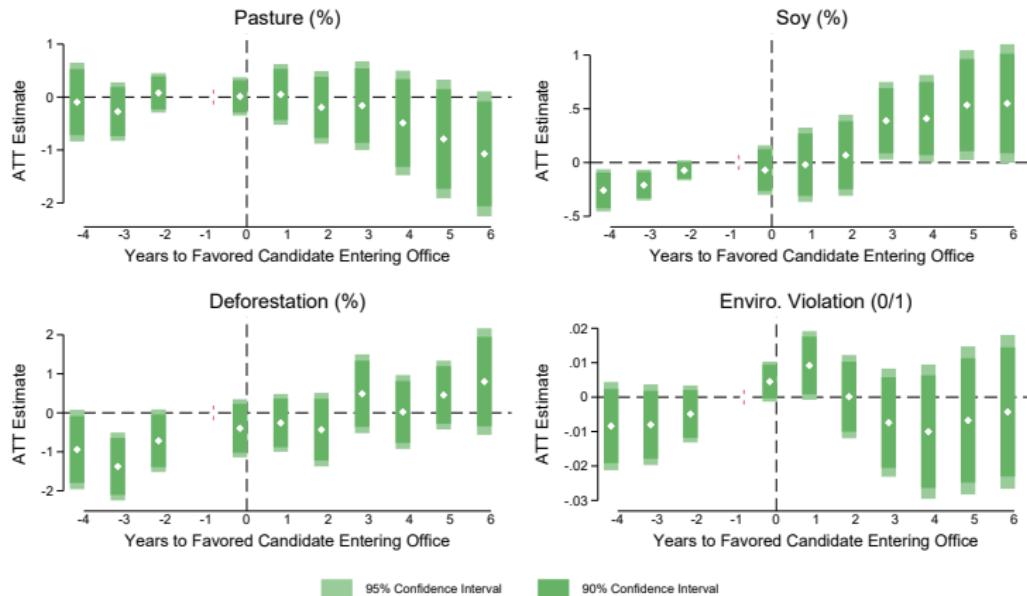


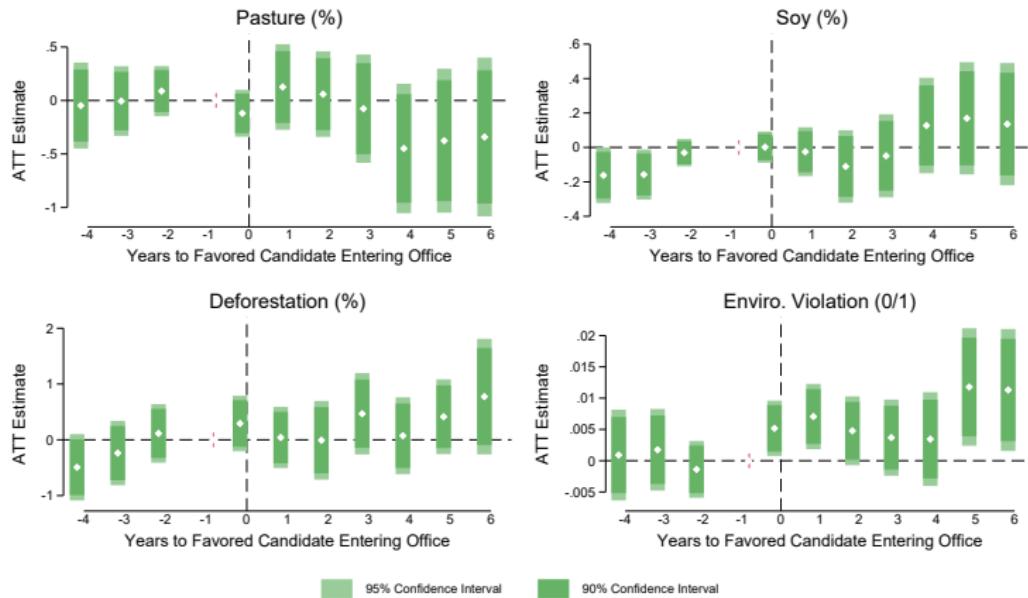
Robustness: Donor Properties, 10% Win Margin, Amazon, M-E FEs

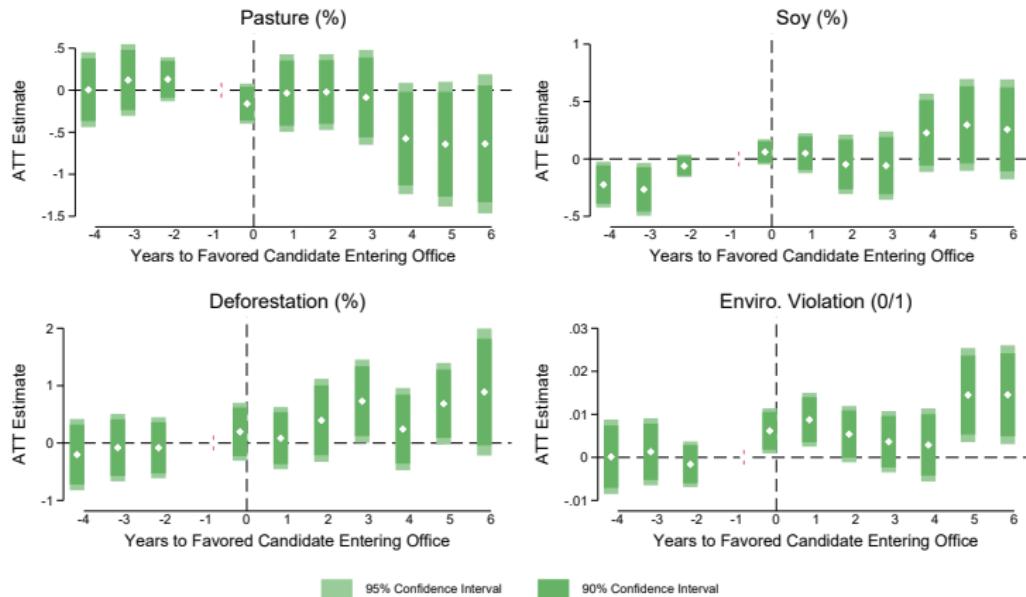
| 59



Robustness: Donor Properties, 10% Win Margin, MT/PA/RO, M-E FEs | 60



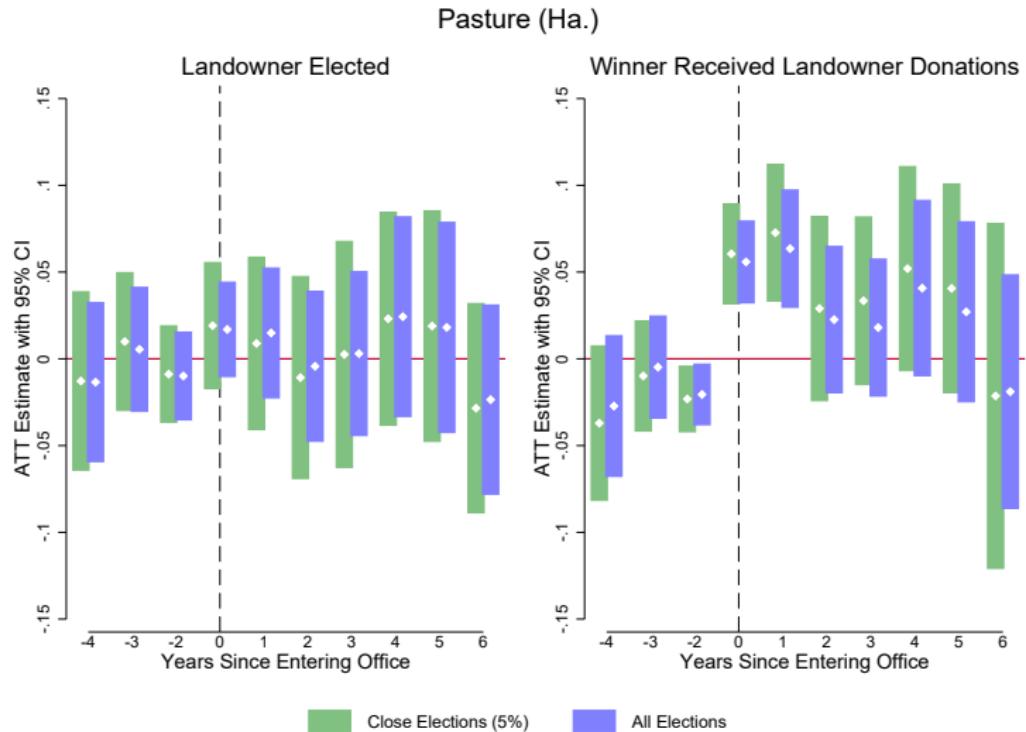




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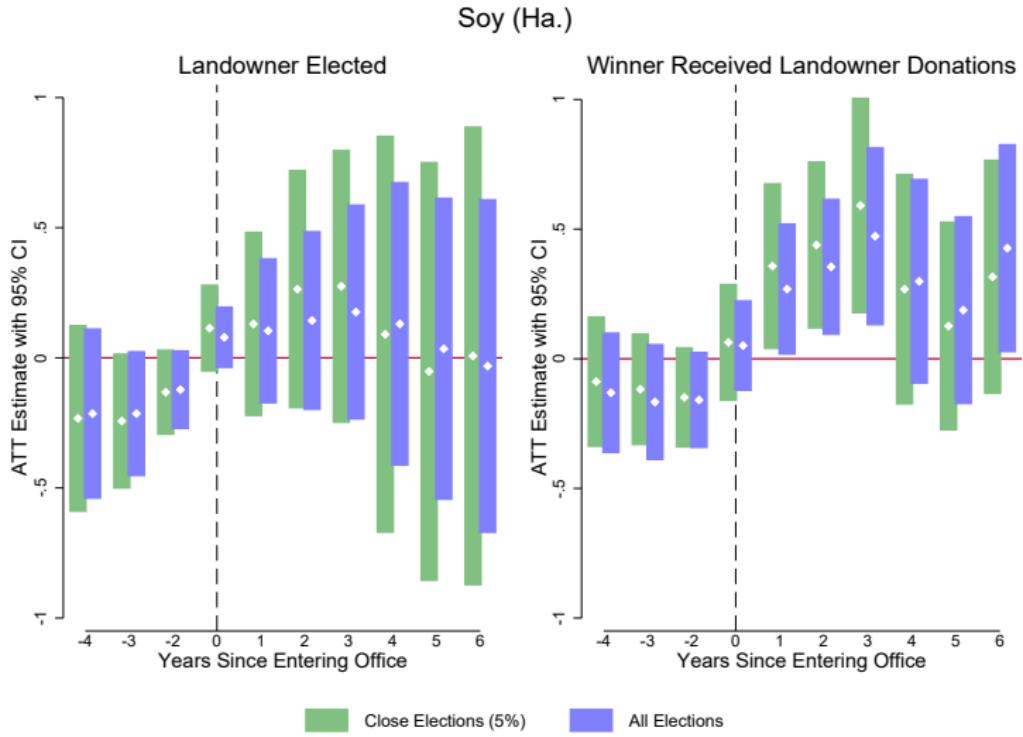
Municipal Event Study: Pasture

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Municipal Event Study: Soy

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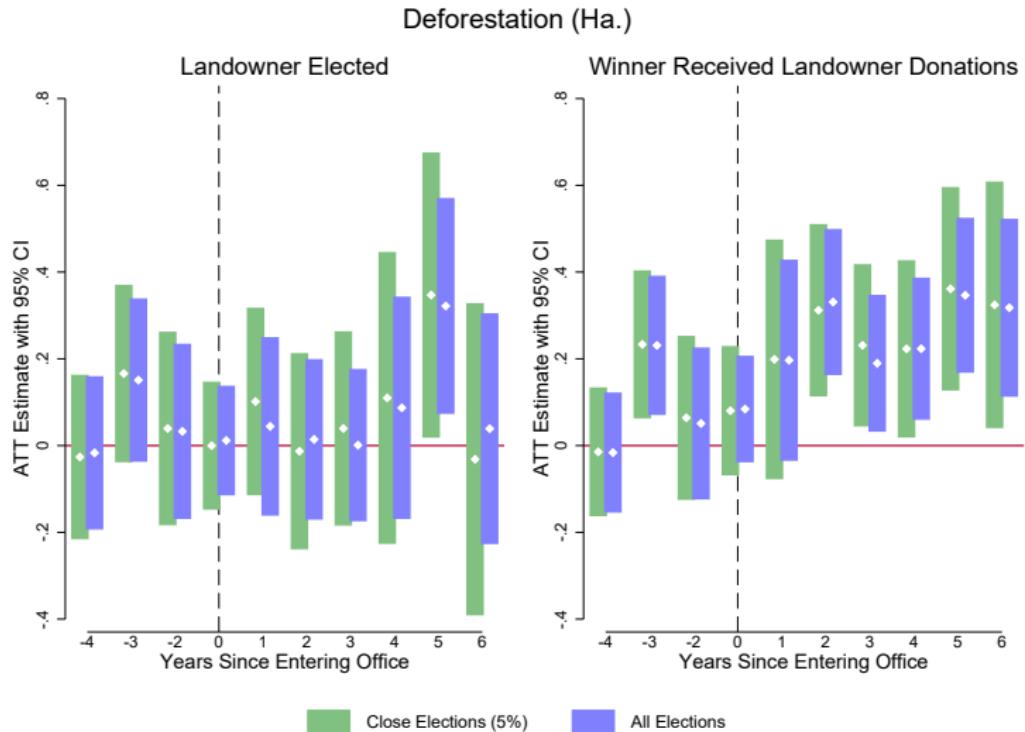


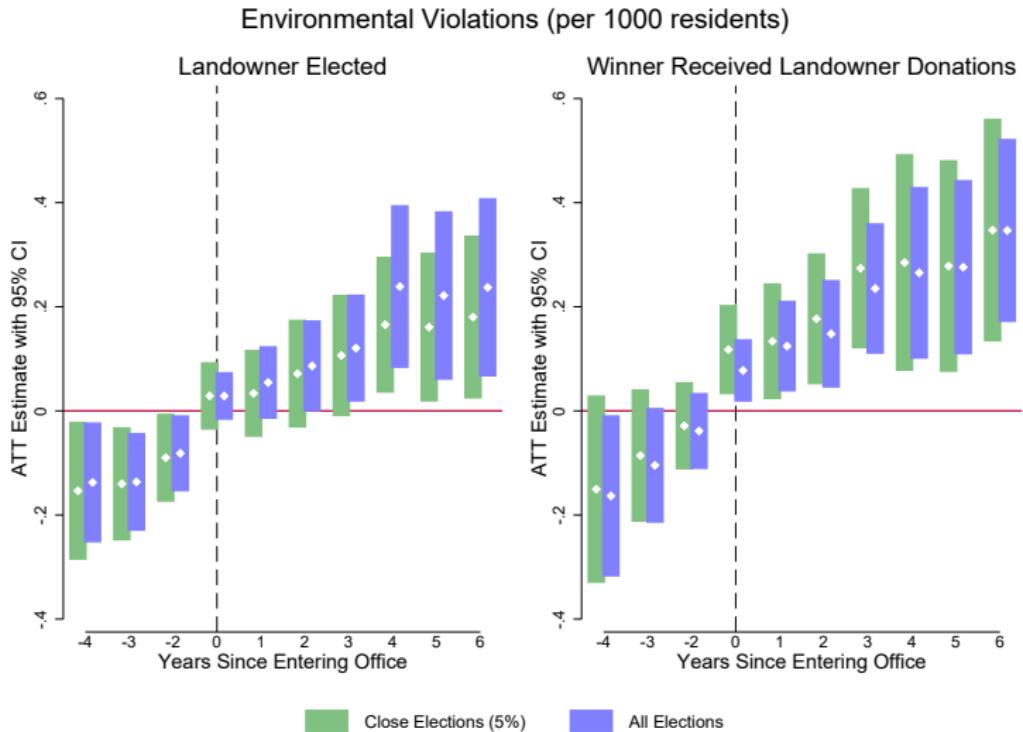
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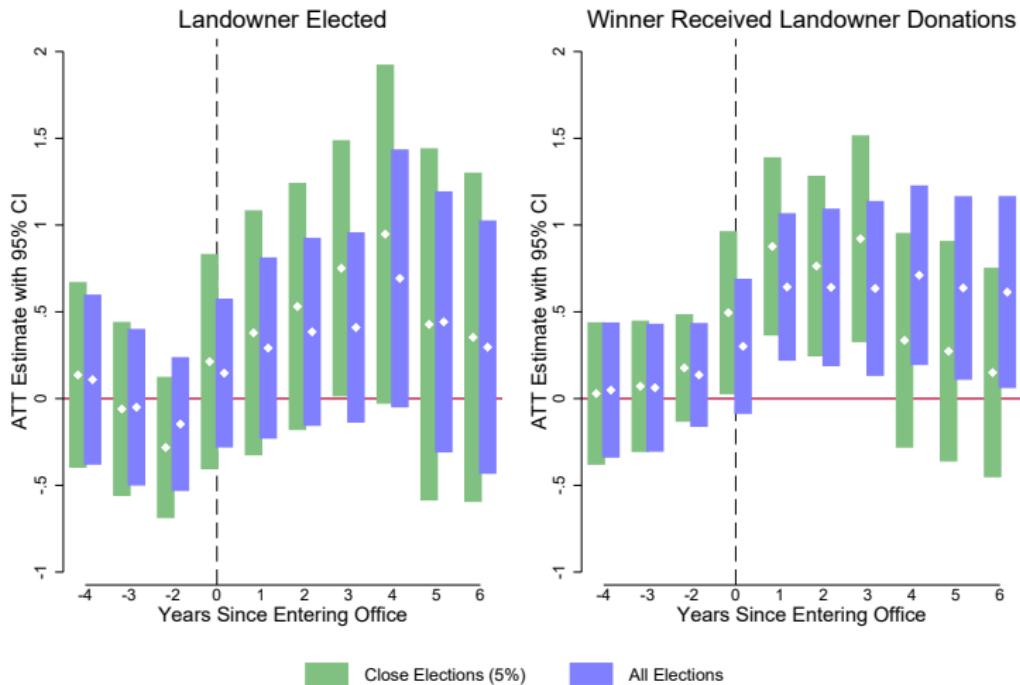
Municipal Event Study: Deforestation

| 65





Agricultural Promotion Spending (per capita)



Municipal Event Study: Ag. Grants

| 68

Obtained Agricultural Matching Grant (0/1)

