

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

Erik Katovich
University of Geneva

Fanny Moffette
Université du Québec à Montréal

World Bank Land Conference

May 16th, 2024

- ▶ Economic incentives to expand **commodity agriculture** – particularly **cattle ranching** and **soy** (Pendrill et al., 2022)

- ▶ Economic incentives to expand **commodity agriculture** – particularly **cattle ranching** and **soy** (Pendrill et al., 2022)
- ▶ 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 deforestation prior to local elections to win rural votes (Pailler, 2018)
- ▶ In Colombia, election of a **donor-funded mayor** (relative to self-funded) \Rightarrow environmental enforcement \downarrow and deforestation \uparrow (Harding et al., 2023)
- ▶ **Farmer mayors** increased deforestation and promotion of agriculture after 2000 elections; effects disappear when federal environmental enforcement \uparrow (Bragança and Dahis, 2022)

- ▶ Mayors may allow deforestation prior to local elections to win rural votes (Pailler, 2018)
- ▶ In Colombia, election of a **donor-funded mayor** (relative to self-funded) ⇒ environmental enforcement ↓ and deforestation ↑ (Harding et al., 2023)
- ▶ **Farmer mayors** increased deforestation and promotion of agriculture after 2000 elections; effects disappear when federal environmental enforcement ↑ (Bragança and Dahis, 2022)

“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)

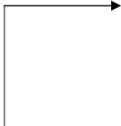
“The big agricultural producers, the ones with the most capital, are the ones at the front of politics here.”

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

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

1 Patronage: Colonelli et al. (2020); Boas et al. (2014)

- > We identify a novel channel of **agricultural patronage**
- > Donors significantly increase soy cultivation while the candidate they supported is in office



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

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

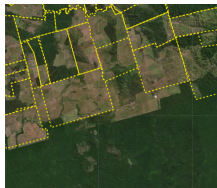
- 1 **Patronage:** Colonelli et al. (2020); Boas et al. (2014)
 - > We identify a novel channel of **agricultural patronage**
 - > Donors significantly increase soy cultivation while the candidate they supported is in office
- 2 **Special Interests:** Harding et al. (2023); Avis et al. (2022)
 - > We show Amazon landholders are a powerful interest group with **deep ties to local politics**
 - > Landholder-financed mayors govern in favor of agriculture (with negative environmental consequences)

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

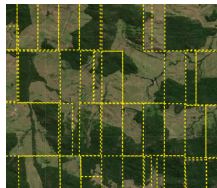
- 1 **Patronage:** Colonelli et al. (2020); Boas et al. (2014)
 - > We identify a novel channel of **agricultural patronage**
 - > Donors significantly increase soy cultivation while the candidate they supported is in office
- 2 **Special Interests:** Harding et al. (2023); Avis et al. (2022)
 - > We show Amazon landholders are a powerful interest group with **deep ties to local politics**
 - > Landholder-financed mayors govern in favor of agriculture (with negative environmental consequences)
- 3 **Politician Identity:** Bragança and Dahis (2022); Brollo and Troiano (2016); Bhalotra et al. (2014)
 - > Landholder identity does not affect municipal agricultural or environmental governance

- ▶ Land registries in the Brazilian Amazon are incomplete and overlapping.
- ▶ We harmonize individually-identified versions of all major registries
 - 1 **SIGEF/CCIR/CNIR:** formal land title registries from INCRA
 - 2 **Terra Legal:** Formal registry begun in 2009 to regularize Amazon holdings
 - 3 **CAR:** Rural Environmental Property Registry, covers all holdings, self-declared

- ▶ Land registries in the Brazilian Amazon are incomplete and overlapping.
- ▶ We harmonize individually-identified versions of all major registries
 - 1 **SIGEF/CCIR/CNIR**: formal land title registries from INCRA
 - 2 **Terra Legal**: Formal registry begun in 2009 to regularize Amazon holdings
 - 3 **CAR**: Rural Environmental Property Registry, covers all holdings, self-declared
- ▶ Result: **611,506 unique properties** with personal IDs (names/ID numbers)



CAR Property Boundaries



► Remote Sensing Data:

Annual pixel-level (30×30m) land use data from MapBiomass Version 5 (2000-2020).

► Candidate and Donor Registries:

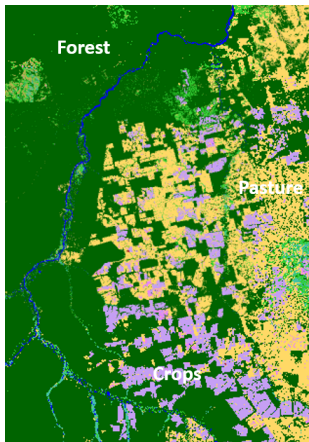
Campaign and election data on politicians and donors in Brazilian Amazon (2000-2016 elections), from TSE

► Other Data:

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

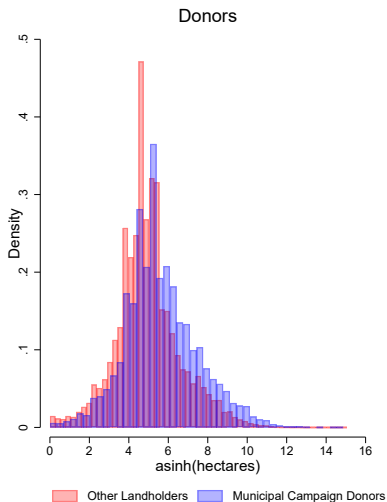
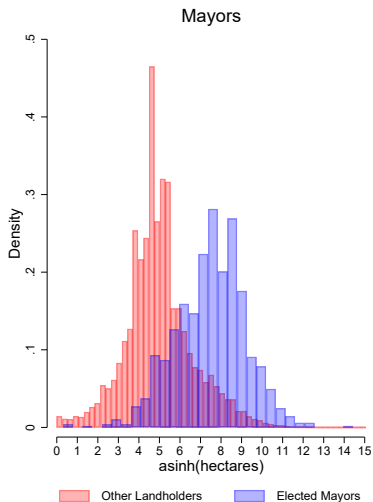
► Data Sources

► Data Limitations



Source: MapBiomass (2023)

Property Size (Hectares)



► Additional Descriptive Evidence

Introduction
○○○

Data
○○●

Property-Level Analysis
○○○○

Municipal-Level Analysis
○○○○○

Discussion
○○○

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

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

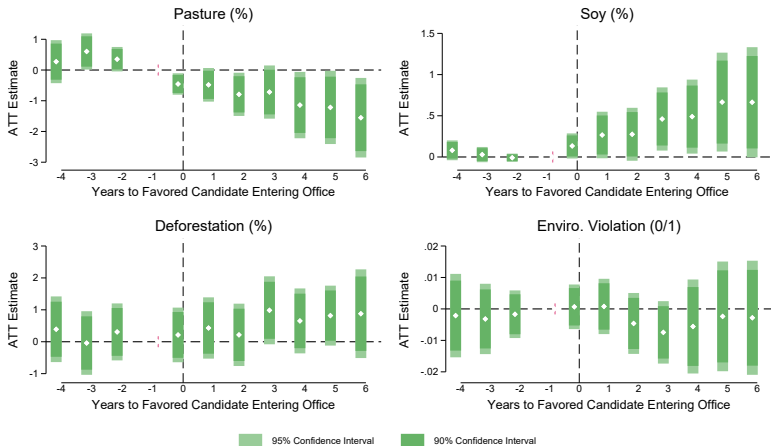
$$y_{it} = \theta_i + \lambda_t + \sum_{k \neq -1} [\mathbb{1}(K_{it} = k)]\beta_k + \epsilon_{it}$$

- ▶ 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

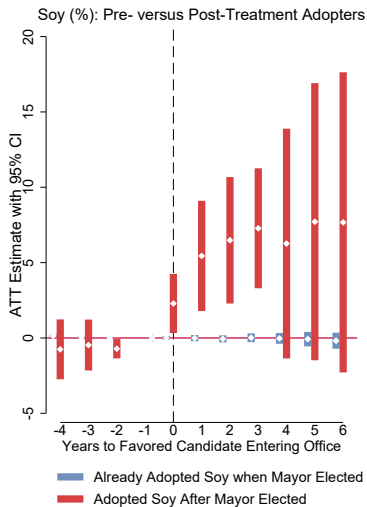
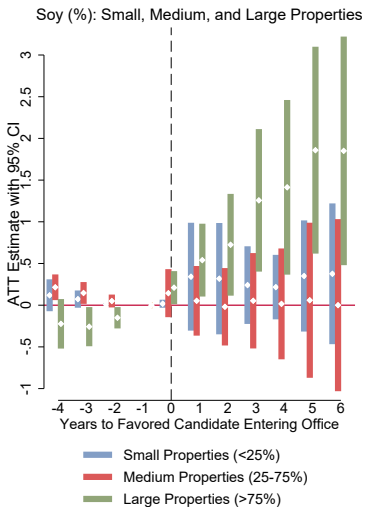
- ▶ Callaway and Sant'Anna (2021) estimator to accommodate staggered treatment timing and heterogeneous treatment effects

- ▶ Define close elections using **5% win margin** ▶ Map: # of Close Elections per Municipality

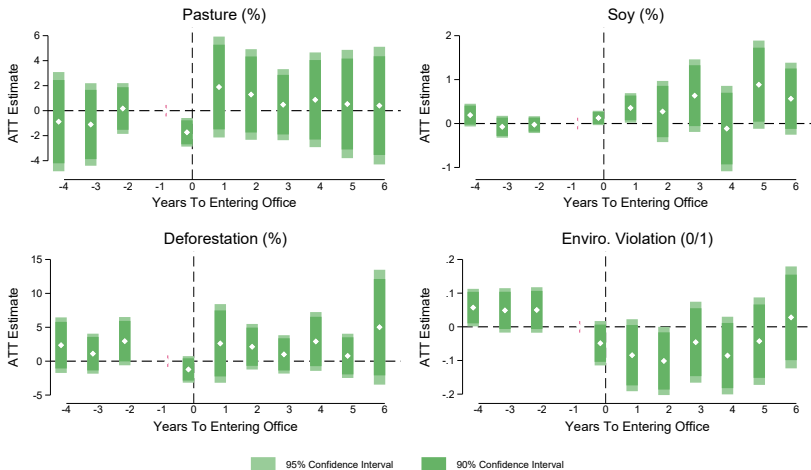
Results: Donors shift pasture to soy while their favored candidate is in office; no evidence of effects at the extensive margin



Note: Figure reports ATT estimates and 90 and 95% confidence intervals from Callaway and Sant'Anna (2021) 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).



► Heterogeneity by Mayor Type and Level of Electoral Competition



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

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

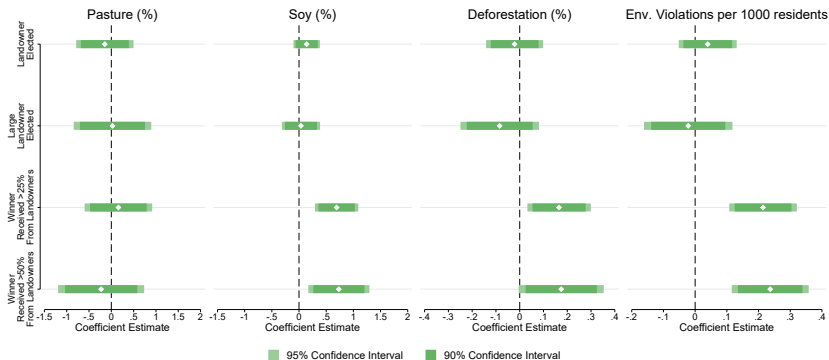
- ▶ **Intuition:** Compare outcomes in *municipalities where (i) a landholder or (ii) a landholder-financed mayor wins a close election* against *municipalities where this type does not win*

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

- ▶ 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}_{me} = vector of mayor characteristics
- ▶ δ_m and θ_e are municipality and election-period fixed effects; standard errors are clustered at municipality-level

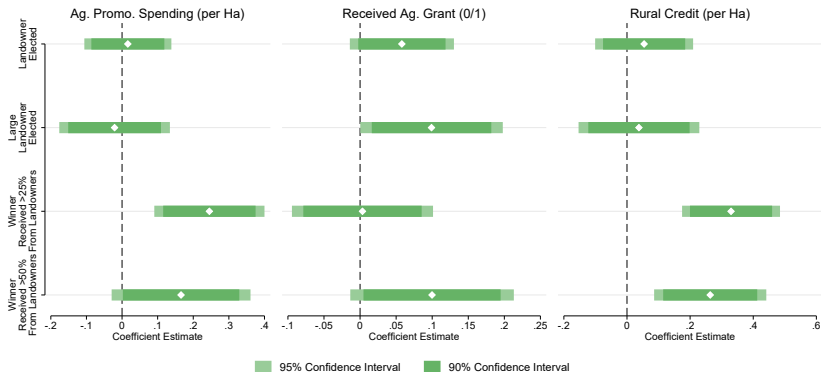
Sample restricted to close elections ($\leq 5\%$ Win Margin)

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

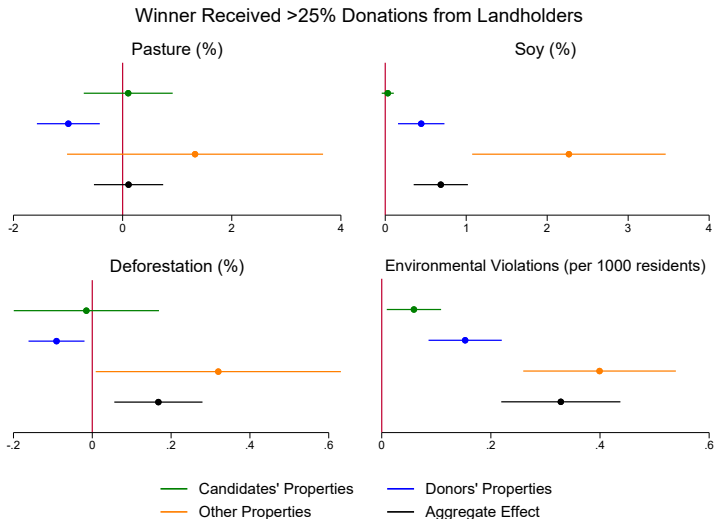


Note: Figures report coefficient estimates and 90 and 95% CIs from regression of outcome on municipality-election treatment dummies (landholder in office, large landholder (≥ 500 ha.) in office, mayor who received $\geq 25\%$ of donations from landholders in office, and mayor who received $\geq 50\%$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

- ▶ Test for Spurious Landholder Effect
- ▶ Effects on Specific Land-Use Transitions



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.



Property-level results are mostly robust to:

- ▶ Restrict sample to states with more complete land registries ▶ Complete Registries
- ▶ Expand sample to full Legal Amazon ▶ Legal Amazon
- ▶ Use alternative 10% close election cutoff or full sample ▶ Alternative Win Margins
- ▶ Use $\text{asinh}(\text{hectares})$ instead of % of property area ▶ IHS Transformation
- ▶ Include municipality-election fixed effects ▶ Municipality-Election Fixed Effects
- ▶ Flexibly control for win-margin (RD-DID approach) ▶ RD-DID

Municipal-level results are mostly robust to:

- ▶ Restrict sample to states with more complete land registries ▶ Complete Registries
- ▶ Expand sample to full Legal Amazon ▶ Legal Amazon
- ▶ Use alternative 10% close election cutoff or full sample ▶ Alternative Win Margins
- ▶ Use $\text{asinh}(\text{hectares})$ instead of % of property area ▶ IHS Transformation
- ▶ Annual event studies using `csdid` ▶ Municipal-Level Event Studies

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

*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 agricultural intensification
 - 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

*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 agricultural intensification
 - 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
- ▶ **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

- ▶ **Agricultural intensification** (cattle pasture → soy) would allow increased soy production without new deforestation [Stabile et al. \(2020\)](#); [Marin et al. \(2022\)](#)
 - > Our findings indicate there is demand for political influence to overcome barriers to intensification

- ▶ **Agricultural intensification** (cattle pasture → soy) would allow increased soy production without new deforestation [Stabile et al. \(2020\)](#); [Marin et al. \(2022\)](#)
 - > Our findings indicate there is demand for political influence to overcome barriers to intensification

- ▶ **Potential downsides:**
 - > Soy involves heavy **herbicide/pesticide** use ⇒ negative health effects [Panis et al. \(2022\)](#); [Skidmore et al. \(2023\)](#)
 - > Exacerbation of **inequalities** between large landholders and the broader population [Weinhold et al. \(2013\)](#)
 - > Risk of **indirect land use change** (encroachment of soy displaces pasture to the frontier) [Gollnow et al. \(2018\)](#); [Arima et al. \(2011\)](#)

- ▶ **Agricultural intensification** (cattle pasture → soy) would allow increased soy production without new deforestation [Stabile et al. \(2020\)](#); [Marin et al. \(2022\)](#)
 - > Our findings indicate there is demand for political influence to overcome barriers to intensification

- ▶ **Potential downsides:**
 - > Soy involves heavy **herbicide/pesticide** use ⇒ negative health effects [Panis et al. \(2022\)](#); [Skidmore et al. \(2023\)](#)
 - > Exacerbation of **inequalities** between large landholders and the broader population [Weinhold et al. \(2013\)](#)
 - > Risk of **indirect land use change** (encroachment of soy displaces pasture to the frontier) [Gollnow et al. \(2018\)](#); [Arima et al. \(2011\)](#)

- ▶ **Inequality in Access & Influence:** self-reinforcing cycle where politicians favor landholders, empowering this group and enabling further influence

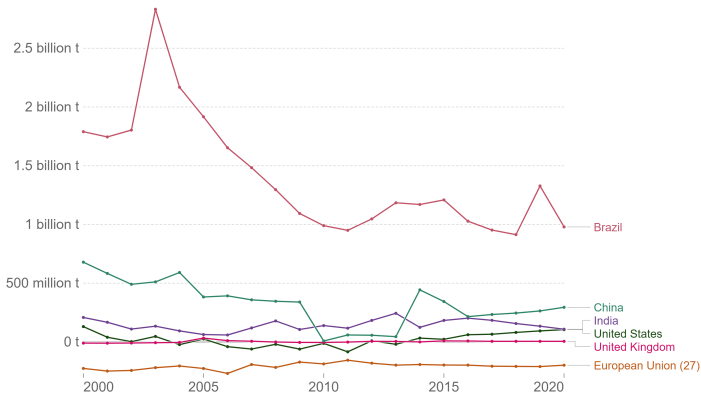
Thank you!

E-mail: erik.katovich@unige.ch

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.



Source: Global Carbon Project (2022)

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

► Return



- ▶ **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)

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

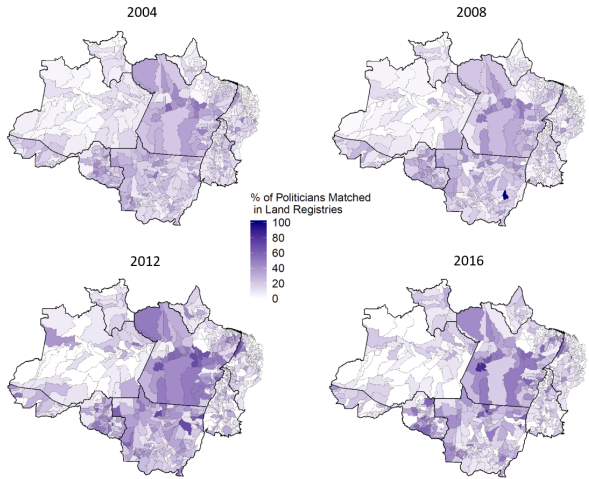
Response: Land transactions in the Amazon are infrequent – involving only 0.51% of properties during 2019-2020 (Moffette et al., 2023)

- ▶ **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

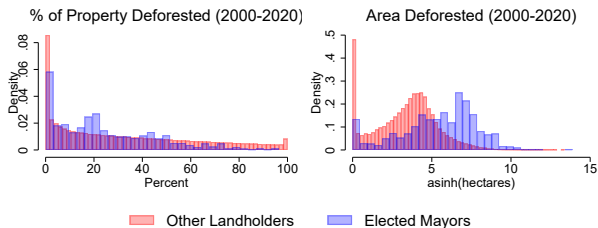
▶ Return

Percent of Politicians Matched in Land Registries

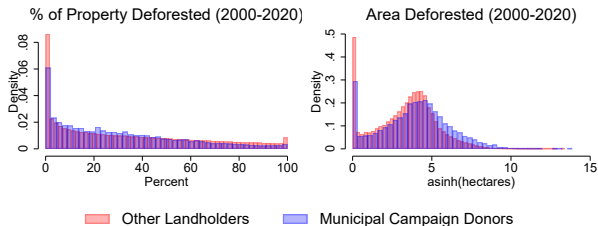


[▶ Return](#)

Candidates



Campaign Donors



▶ Return

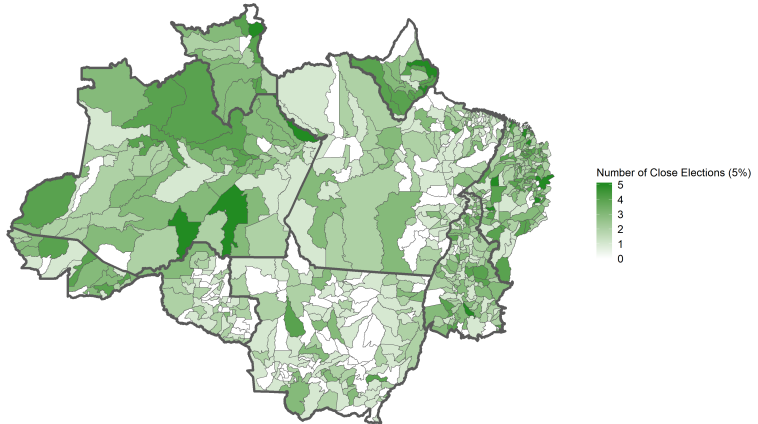
Table: Descriptive Statistics: Landholding Mayors and Donors vs. Other Landholders

	Elected Mayors	Campaign Donors	Other Landholders
Mean Property Size (ha.)	2,898 (9,771)	1,538 (19,221)	459.9 (5,946)
Median Property Size (ha.)	1,236	335	60.9
No. Properties	2.9 (4.4)	1.5 (1.5)	1.2 (2.2)
% Baseline Forest Cover	53.4 (31.1)	52.7 (34.0)	57.7 (35.9)
# of Years with Deforestation Registered	4.0 (4.6)	2.6 (3.7)	3.9 (4.7)
% of Property Deforested (2000-2020)	24.0 (26.6)	26.4 (29.0)	36.0 (32.3)
% with Environmental Violation	19.9 (40.0)	6.3 (24.3)	8.2 (27.5)
% Converted to Pasture (2000-2020)	10.8 (23.1)	15.8 (27.2)	20.4 (32.1)
% Converted to Soy (2000-2020)	2.1 (8.8)	1.7 (9.8)	2.0 (10.7)
Number (Total)	2,148	277,735	556,645

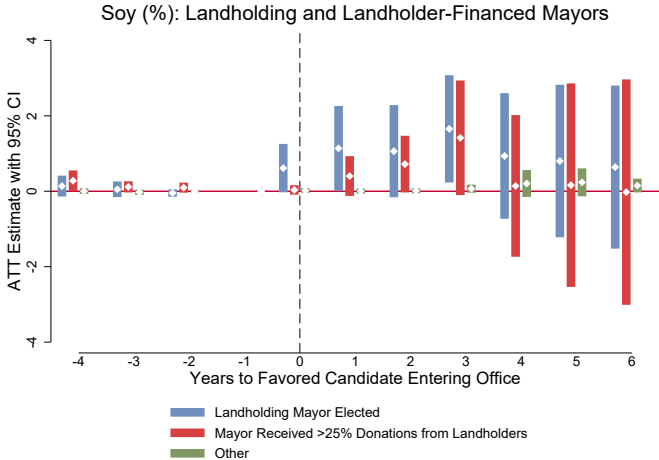
[Return](#)

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

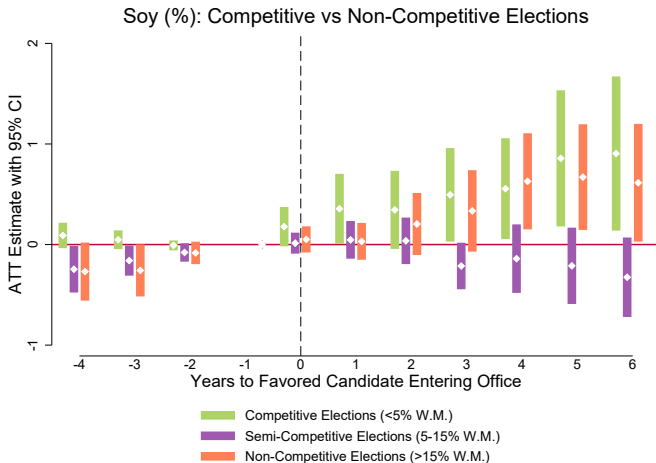
| 27



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](#)

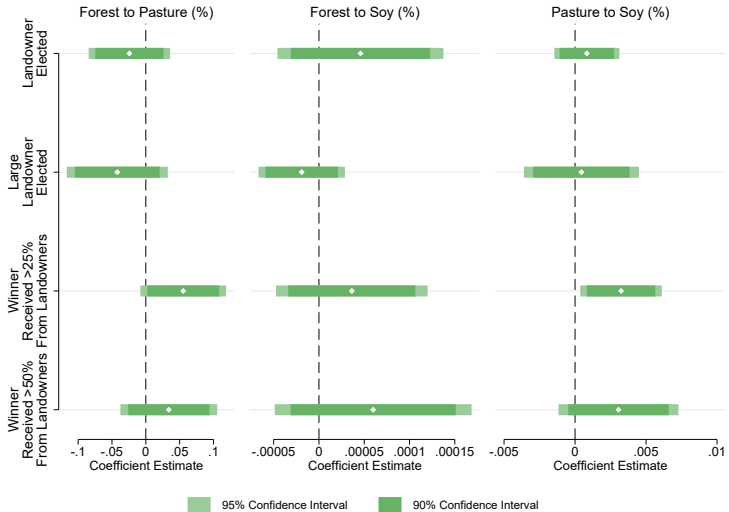


[Return](#)



Effects of Landholder/Landholder-Financed Mayors on Land-Use Transitions

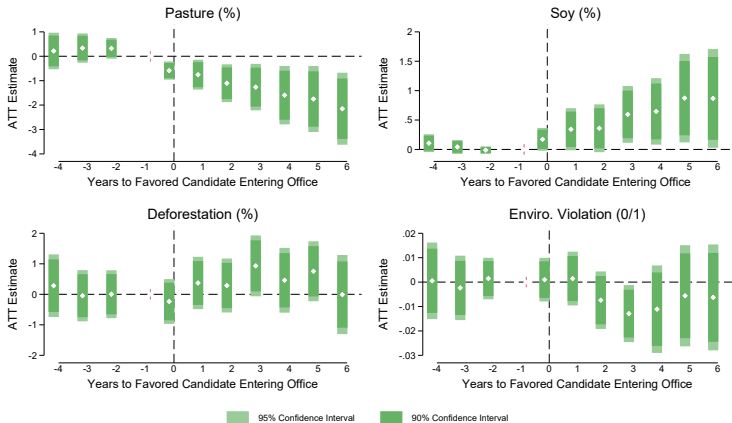
| 31

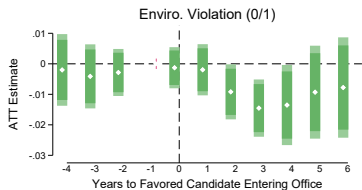
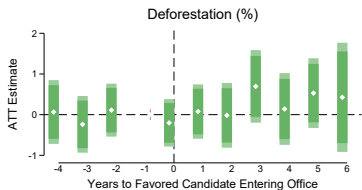
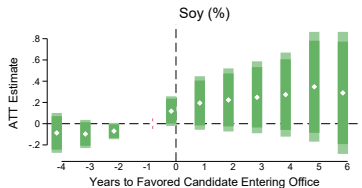
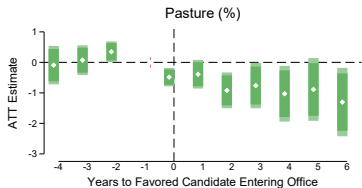


[Return](#)



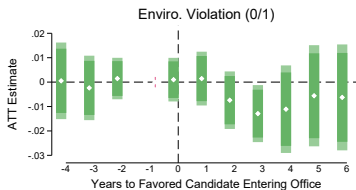
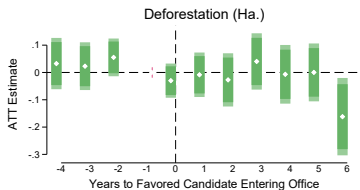
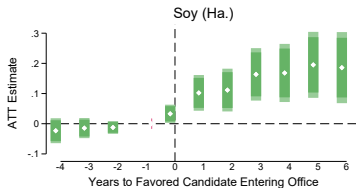
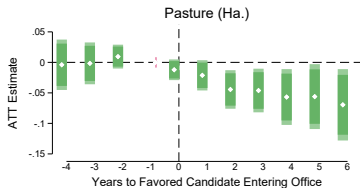
Robustness: Donor Properties, 5% Win Margin, MT/PA/RO





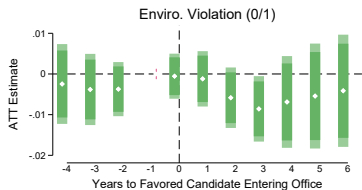
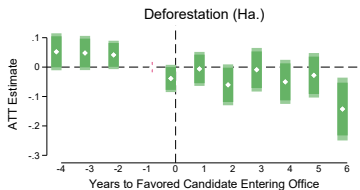
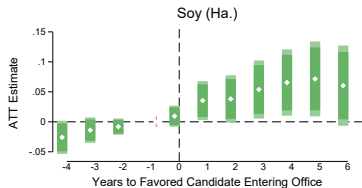
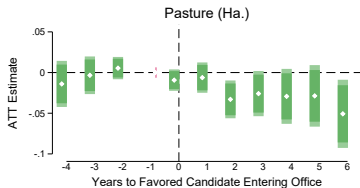
95% Confidence Interval 90% Confidence Interval





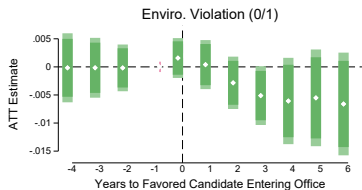
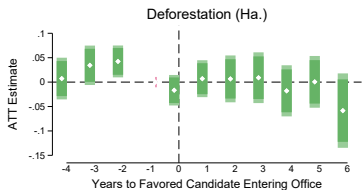
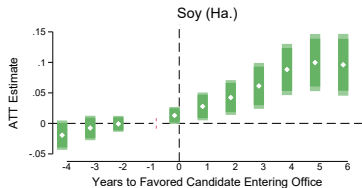
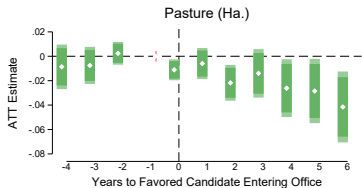
95% Confidence Interval 90% Confidence Interval





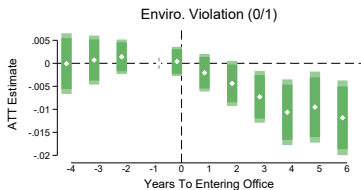
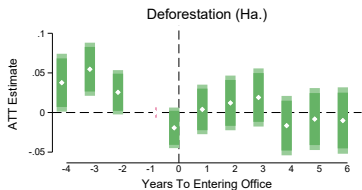
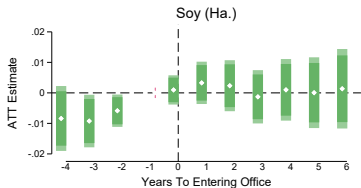
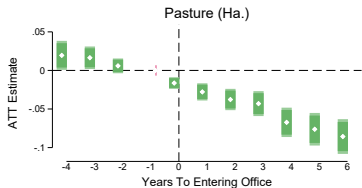
95% Confidence Interval 90% Confidence Interval



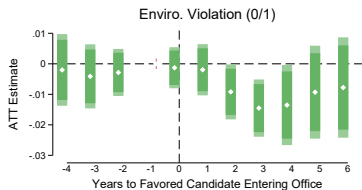
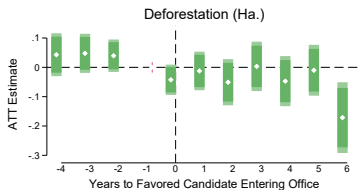
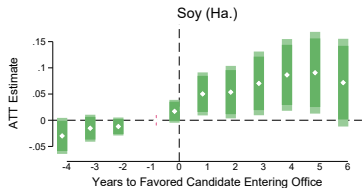
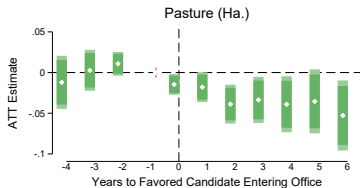


95% Confidence Interval 90% Confidence Interval

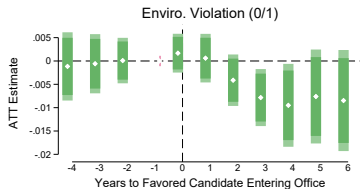
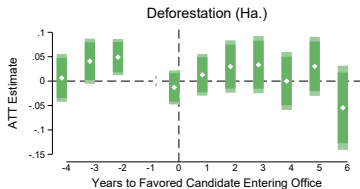
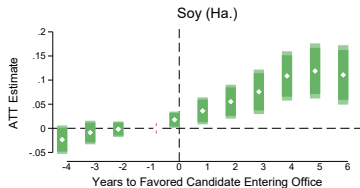
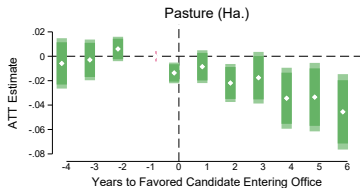




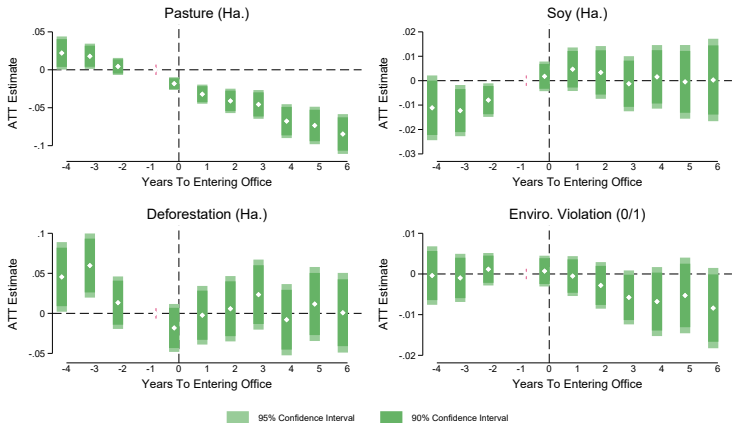
95% Confidence Interval 90% Confidence Interval



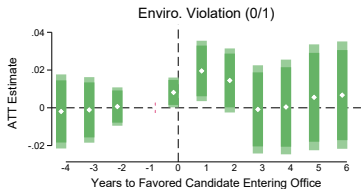
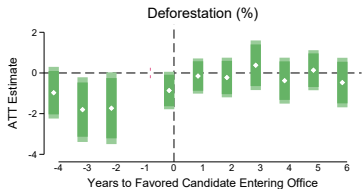
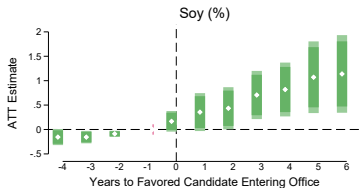
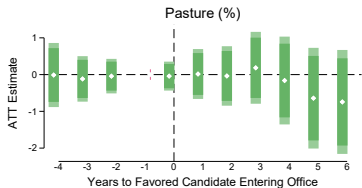
95% Confidence Interval 90% Confidence Interval



95% Confidence Interval 90% Confidence Interval

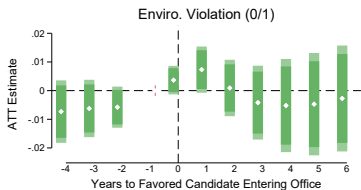
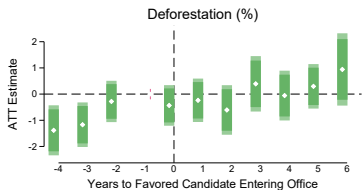
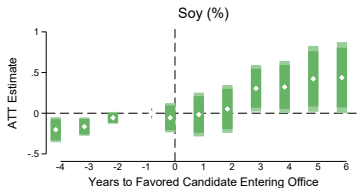
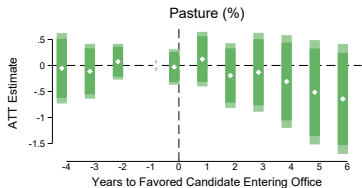


[Return](#)



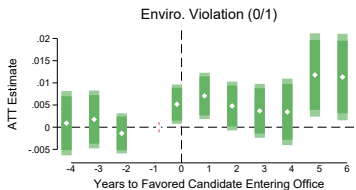
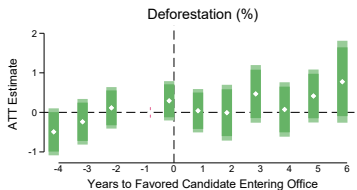
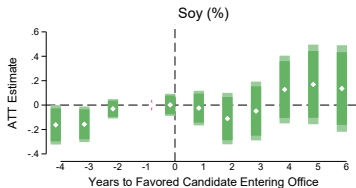
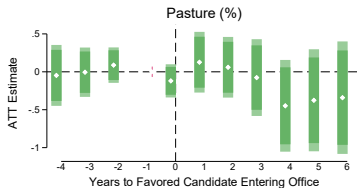
95% Confidence Interval 90% Confidence Interval





95% Confidence Interval 90% Confidence Interval





95% Confidence Interval 90% Confidence Interval



Figure: Donors: Inclusion of Win-Margin Running Variable

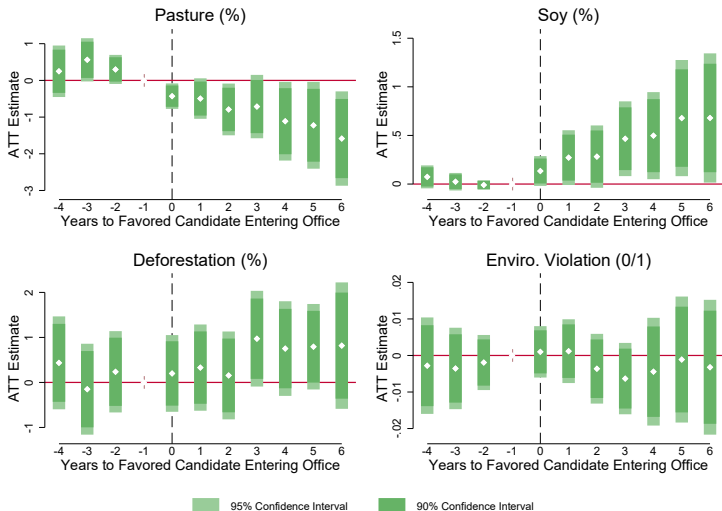


Figure: Municipalities: Mato Grosso, Pará, and Rondonia (Governance)

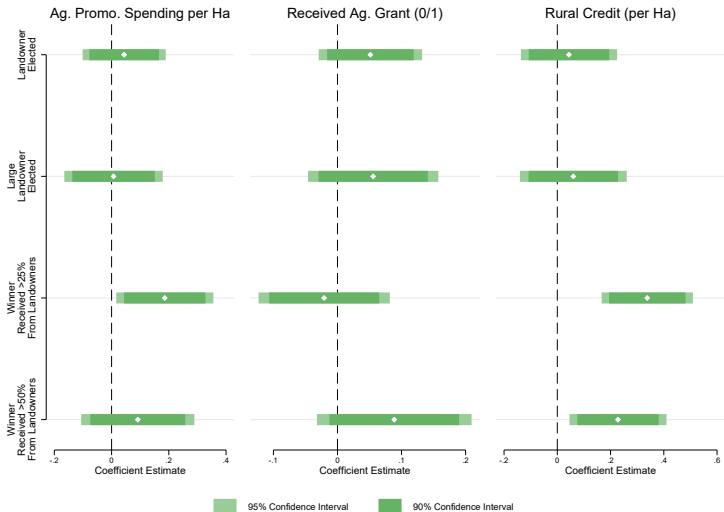


Figure: Municipalities: Mato Grosso, Pará, and Rondonia (Land-Use)

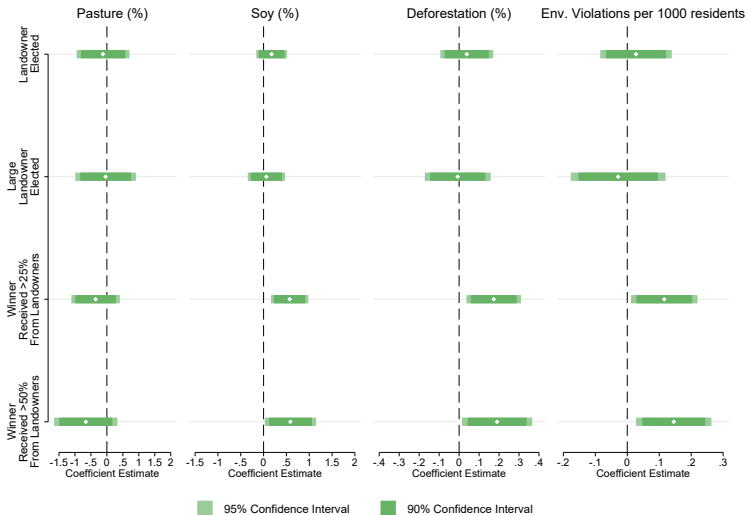


Figure: Municipalities: Legal Amazon (Governance)

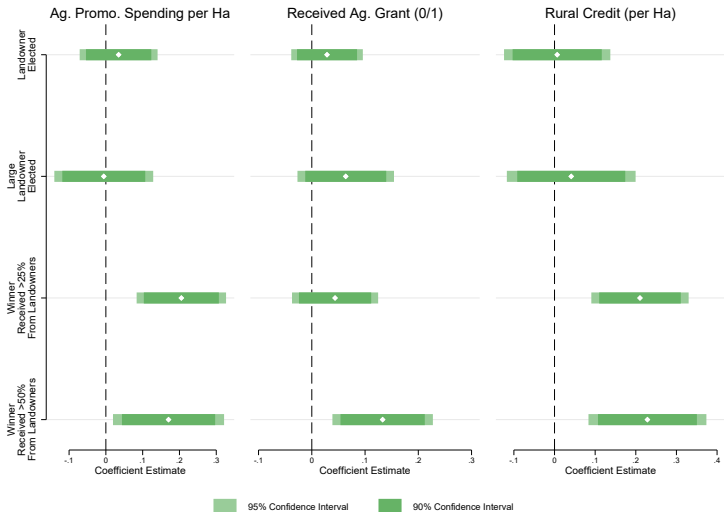


Figure: Municipalities: Legal Amazon (Land-Use)

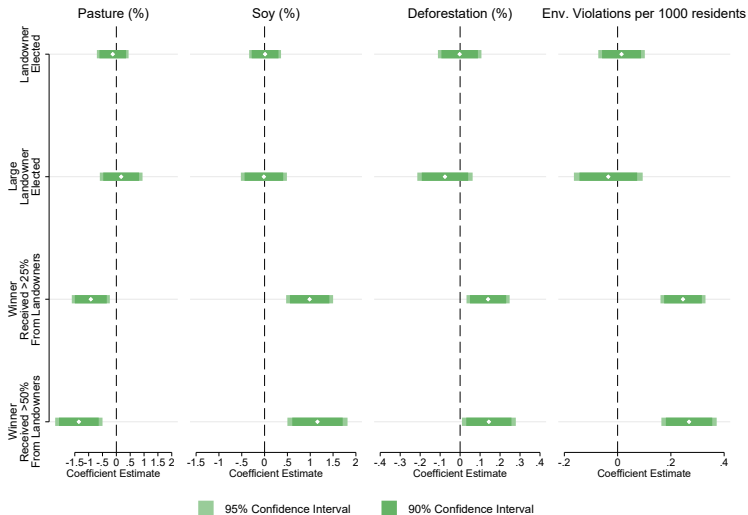


Figure: Municipalities: 10% Close Election Cutoff (Governance)

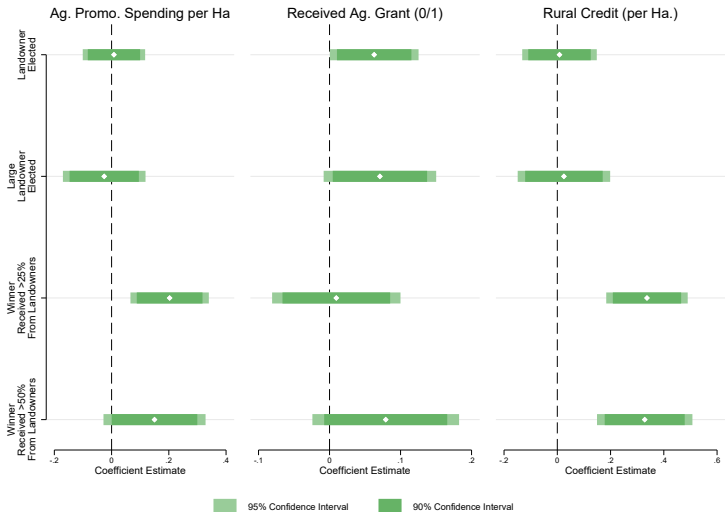


Figure: Municipalities: 10% Close Election Cutoff (Land-Use)

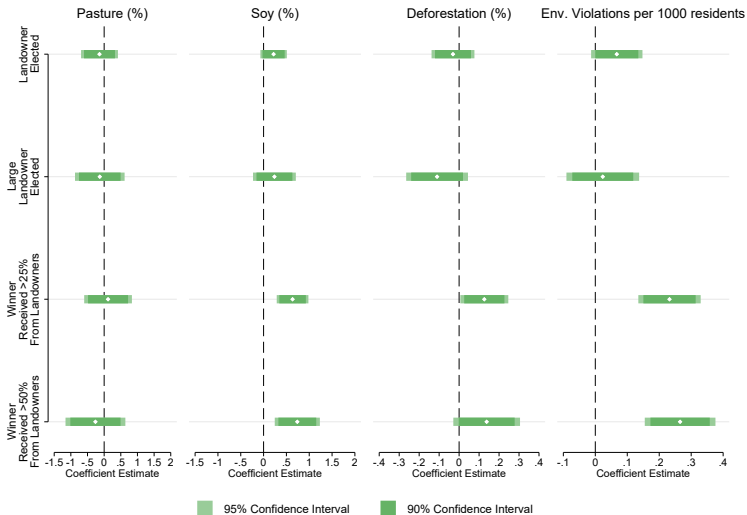


Figure: Municipalities: No Close Election Cutoff (Governance)

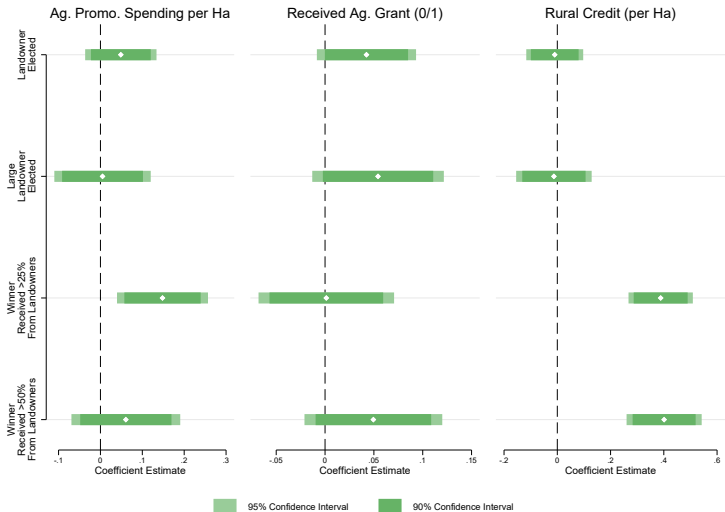


Figure: Municipalities: No Close Election Cutoff (Land-Use)

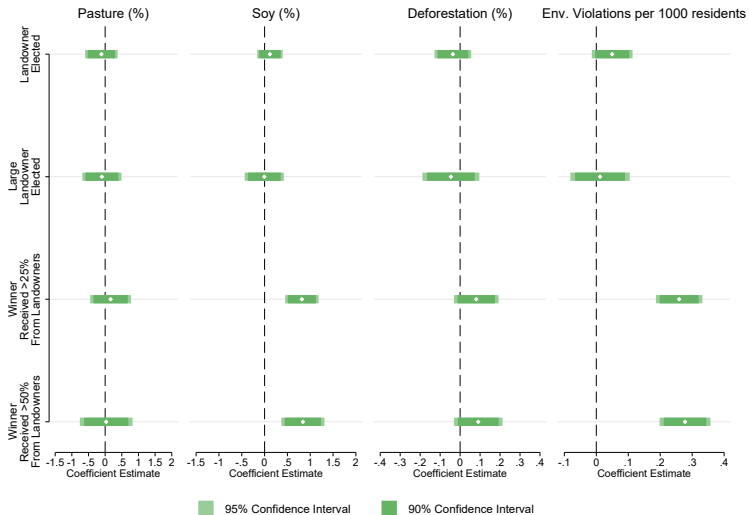
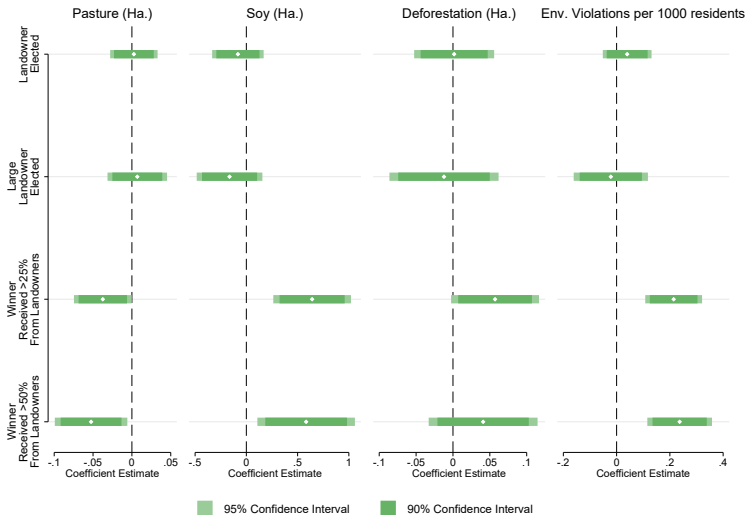
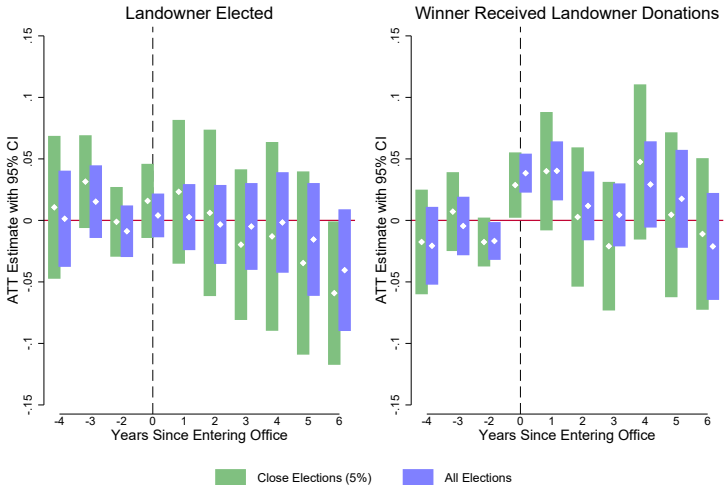
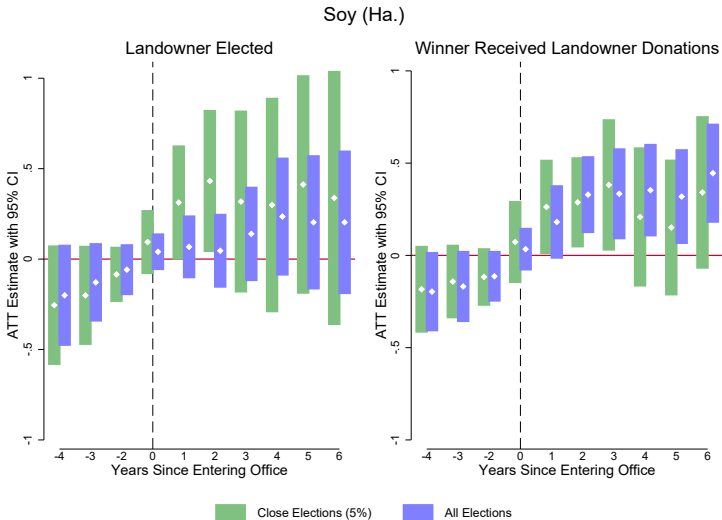


Figure: Municipalities: Land-Use with asinh Transformation

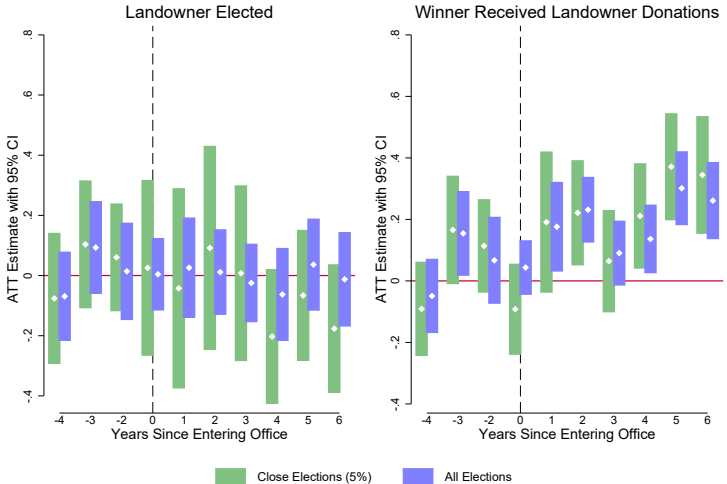


Pasture (Ha.)

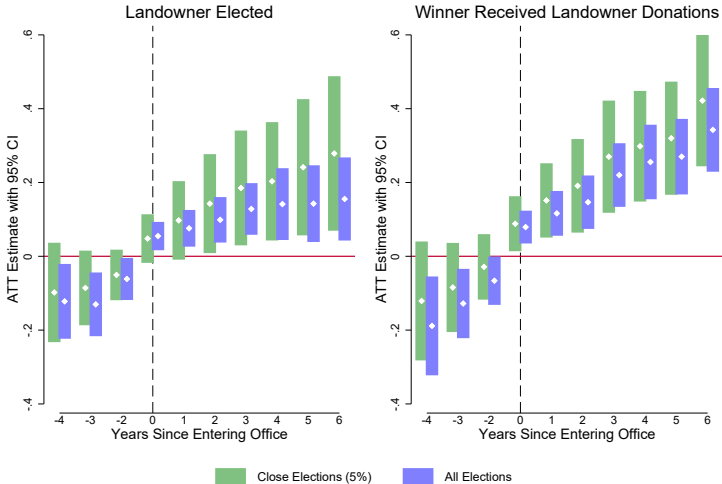




Deforestation (Ha.)



Environmental Violations (per 1000 residents)



Rural Credit (per Ha.)

