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

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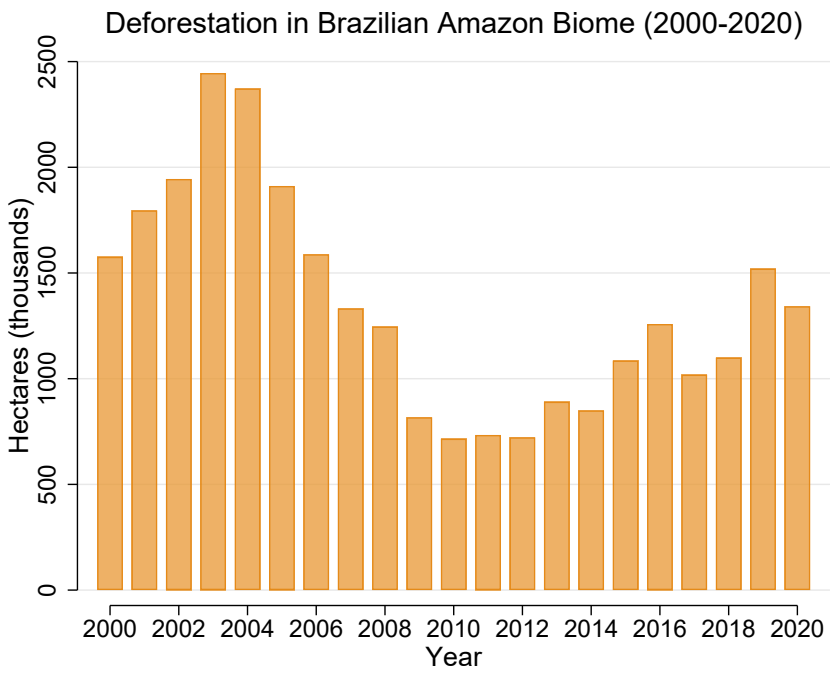
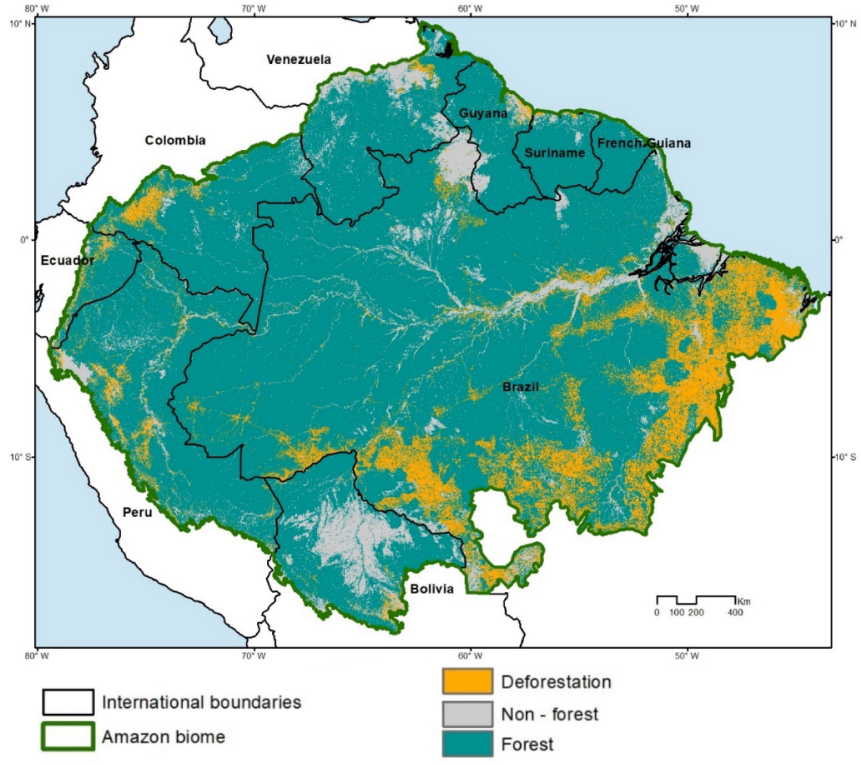
February 1st, 2024

Deforestation in the World's Largest Tropical Forest



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., 2021)

▸ Carbon Emissions from Land-Use Change

Amazon Deforestation is an Urgent Environmental Challenge

- 75% of Amazon is losing resilience to dry season stress
  (Bolton, Lenton, and Boers, 2022)
- Continued deforestation could double wildfires by 2050
  (Brando et al., 2020)

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Local Impacts:

- Biodiversity loss (Giam, 2017)
- Extreme temperatures (Zeppetello et al., 2020)
- Agricultural revenues ↓ (Leite-Filho et al., 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)

What Drives Deforestation in the Amazon?

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

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

- Land conversion to agriculture progresses in stages:
  1. **FOREST** $\Rightarrow$ low-input, low-productivity **PASTURE**
  2. **PASTURE** $\Rightarrow$ 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)

Land-Use Change and **Local Politics** are Connected in the Amazon

- 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)

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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)

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   - **Extensive Margin:** help landholders clear forest for cattle pasture
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   - > **Finding:** Landholding mayors weakly increase personal soy cultivation; no effects at municipal-level

Contributions

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

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1 **Patronage:** Toral (2022), Colonelli et al. (2020); Boas et al. (2014)

> We identify a novel channel of **agricultural patronage**

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3 **Politician Identity:** Bragança and Dahis (2022); Gulzar and Pasquale (2019); Brollo and Troiano (2016); Bhalotra et al. (2014)

> Landholder identity does not affect municipal governance or land-use

Municipal Governance:

- Local elections for mayor and legislature every 4 years; voting is obligatory
- Municipalities responsible for public goods provision; **limited role in environmental regulation**

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Federal Environmental Regulation:

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

Source: O Globo (2021)

Building the Dataset: Identified Land Registries

- 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
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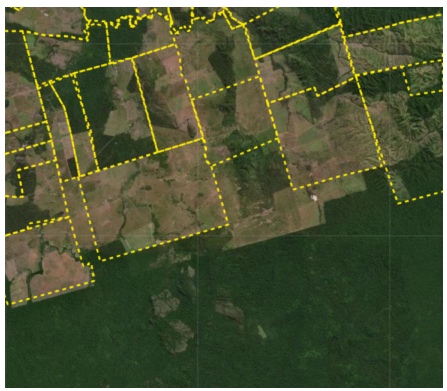
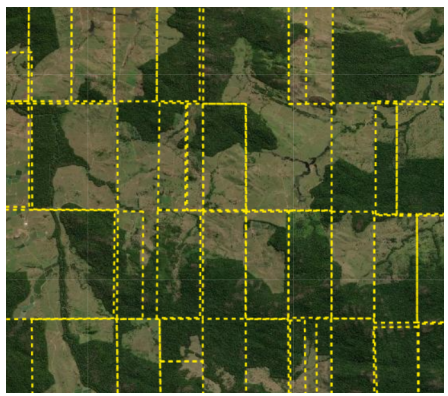
- Result: **611,506 unique properties** with personal IDs (names/ID numbers)



CAR Property Boundaries



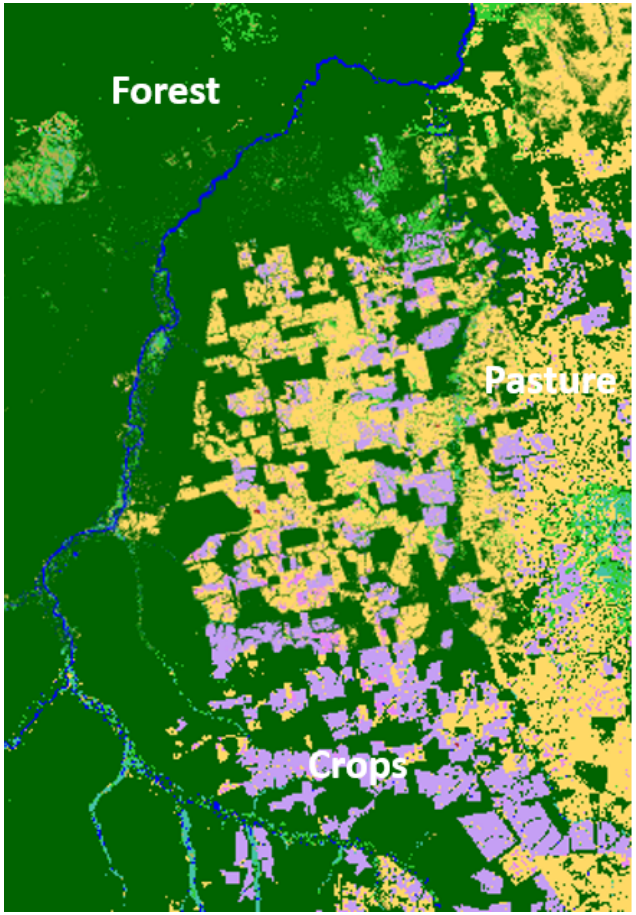
- **Remote Sending Data:**
  Annual pixel-level (30×30m) land use data from MapBiomas Version 5 (2000-2020).

- **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

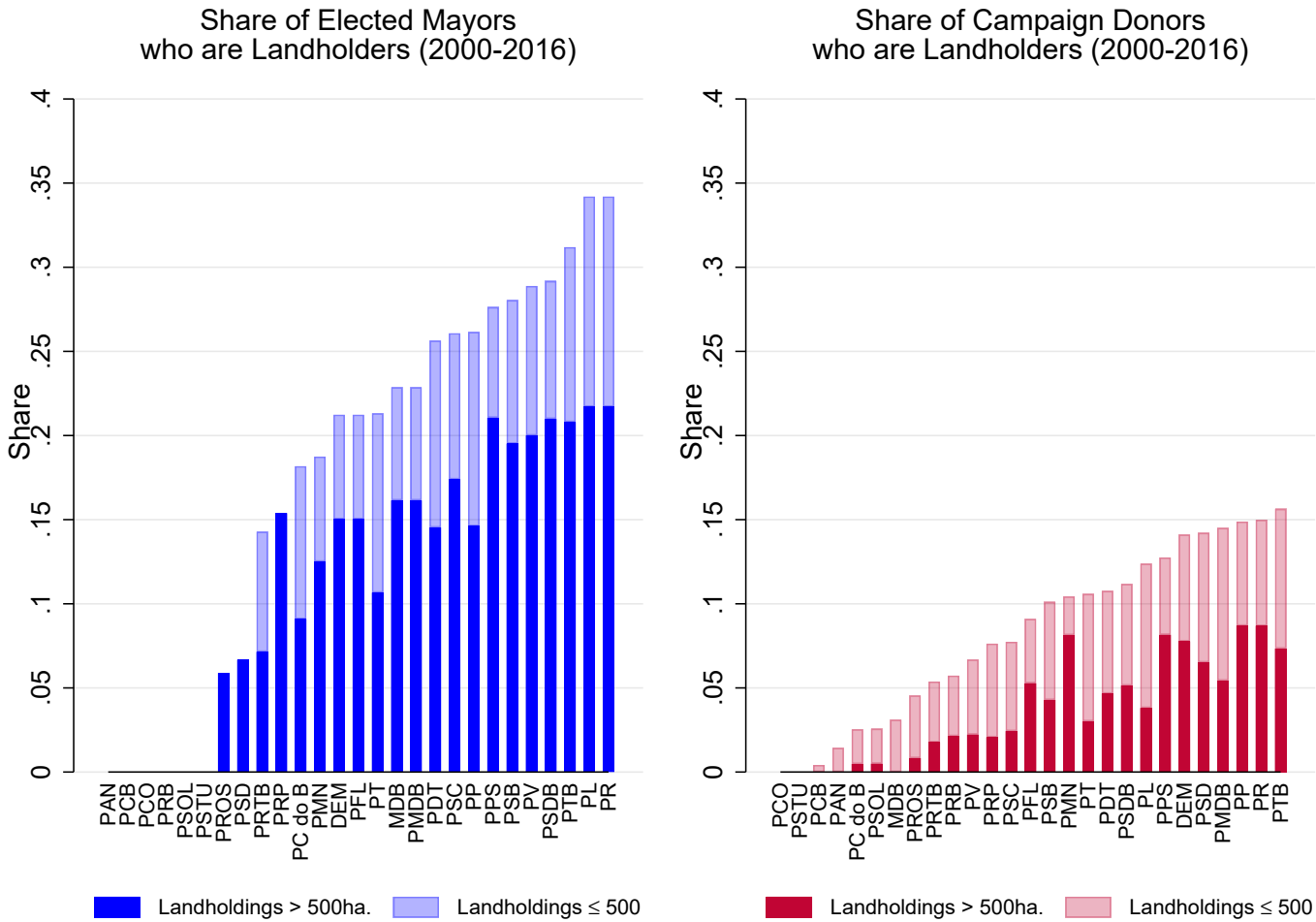
  ▸ Data Limitations



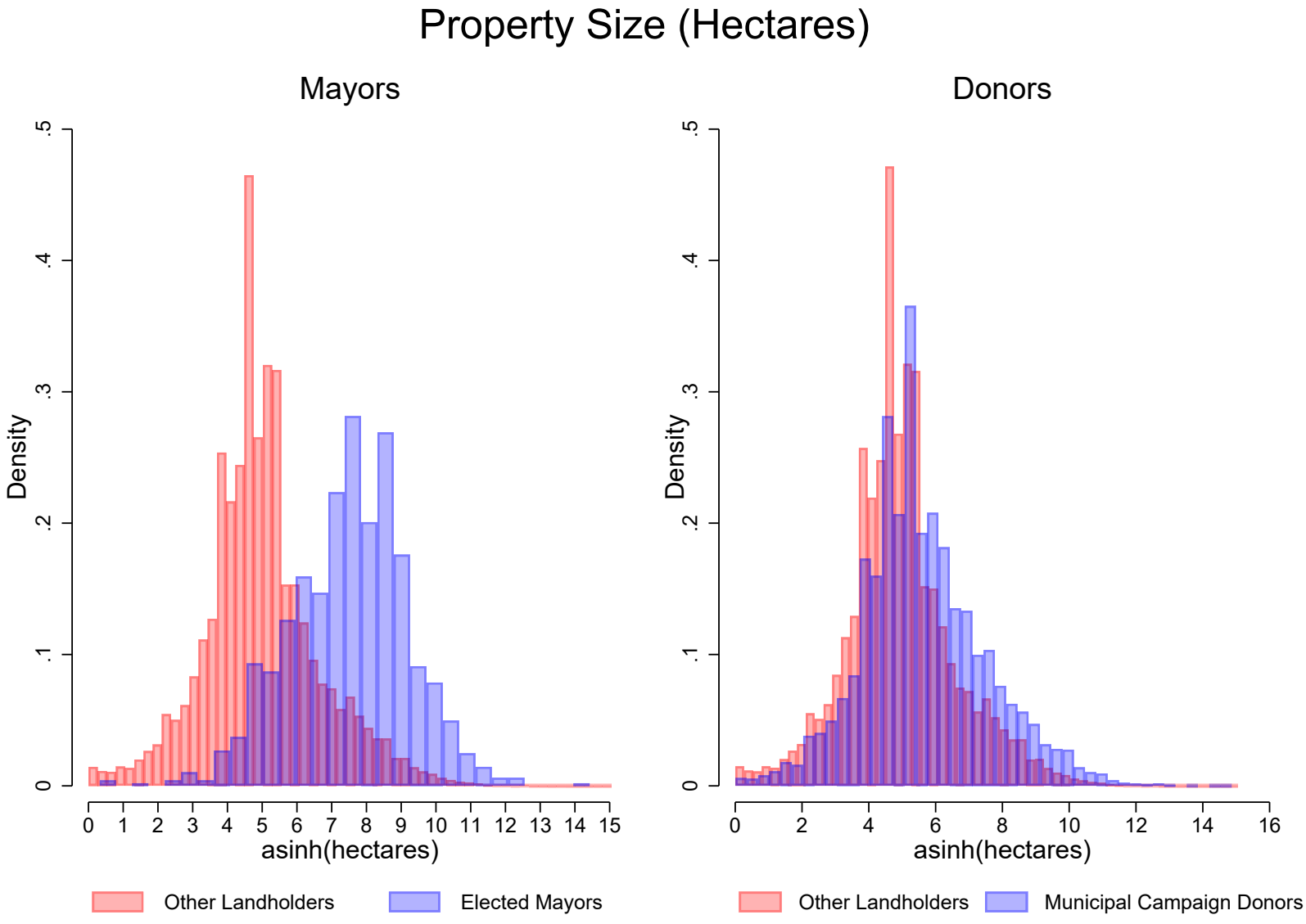
Source: MapBiomas (2023)

What Do We Learn?

- **Landholding is widespread among politicians and donors:** we match 25% of winning candidates and 8% of donors to properties ▸ Spatial Variation in Match Rates
- Large landholders are **28x over-represented** among mayors



Candidates and Donors are Disproportionately **Largeholders**



▸ Additional Descriptive Evidence

Is there "agricultural patronage" in the Amazon?

Do mayors help their supporters at **extensive margin** (deforestation) or **intensive margin** (intensification)?

Property-Level Empirical Strategy

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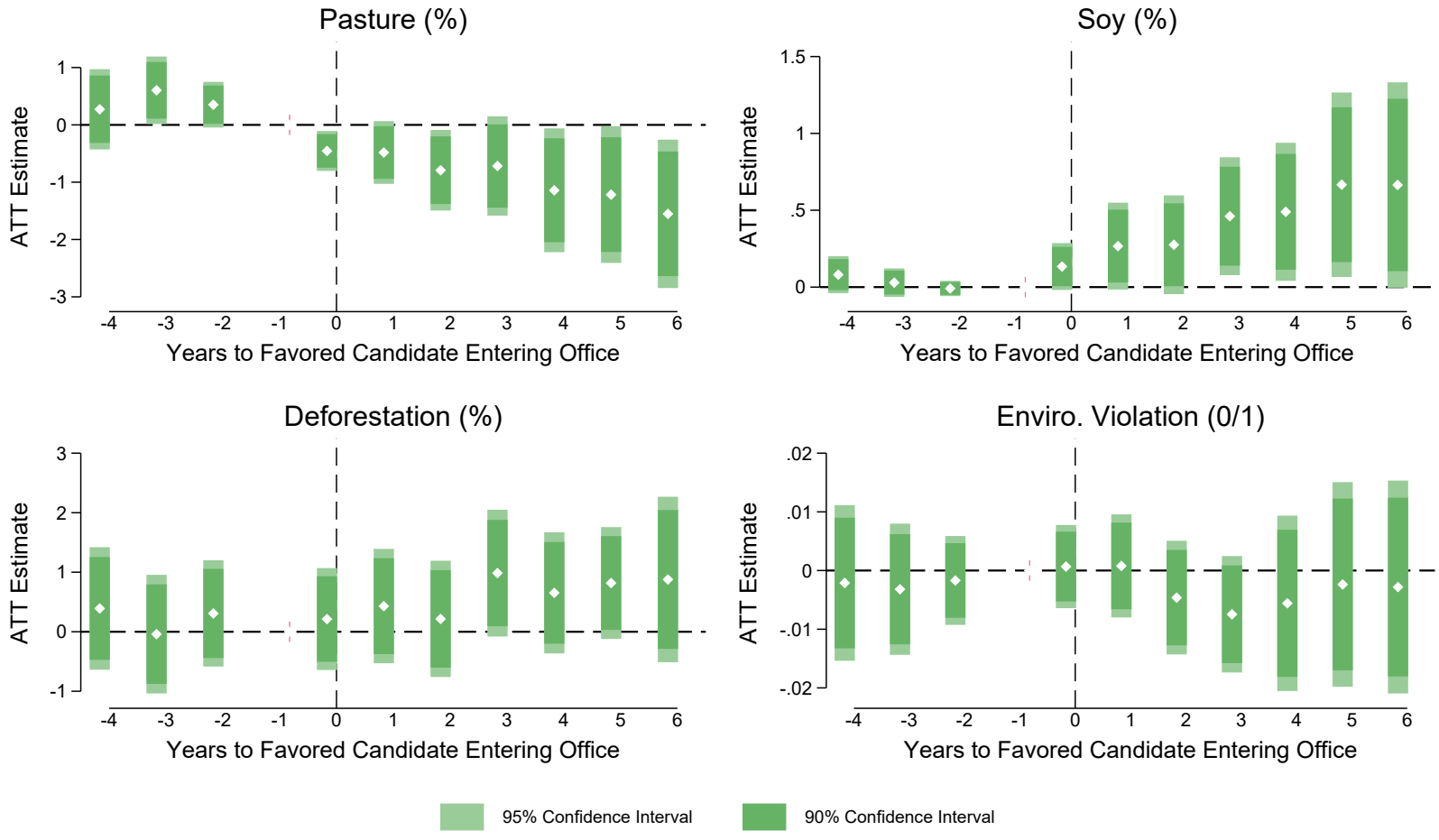
$$y_{it} = \theta_i + \lambda_t + \sum_{k \neq -1} [\mathbb{1}(K_{it} = k)]\beta_k + \epsilon_{it}$$

- 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

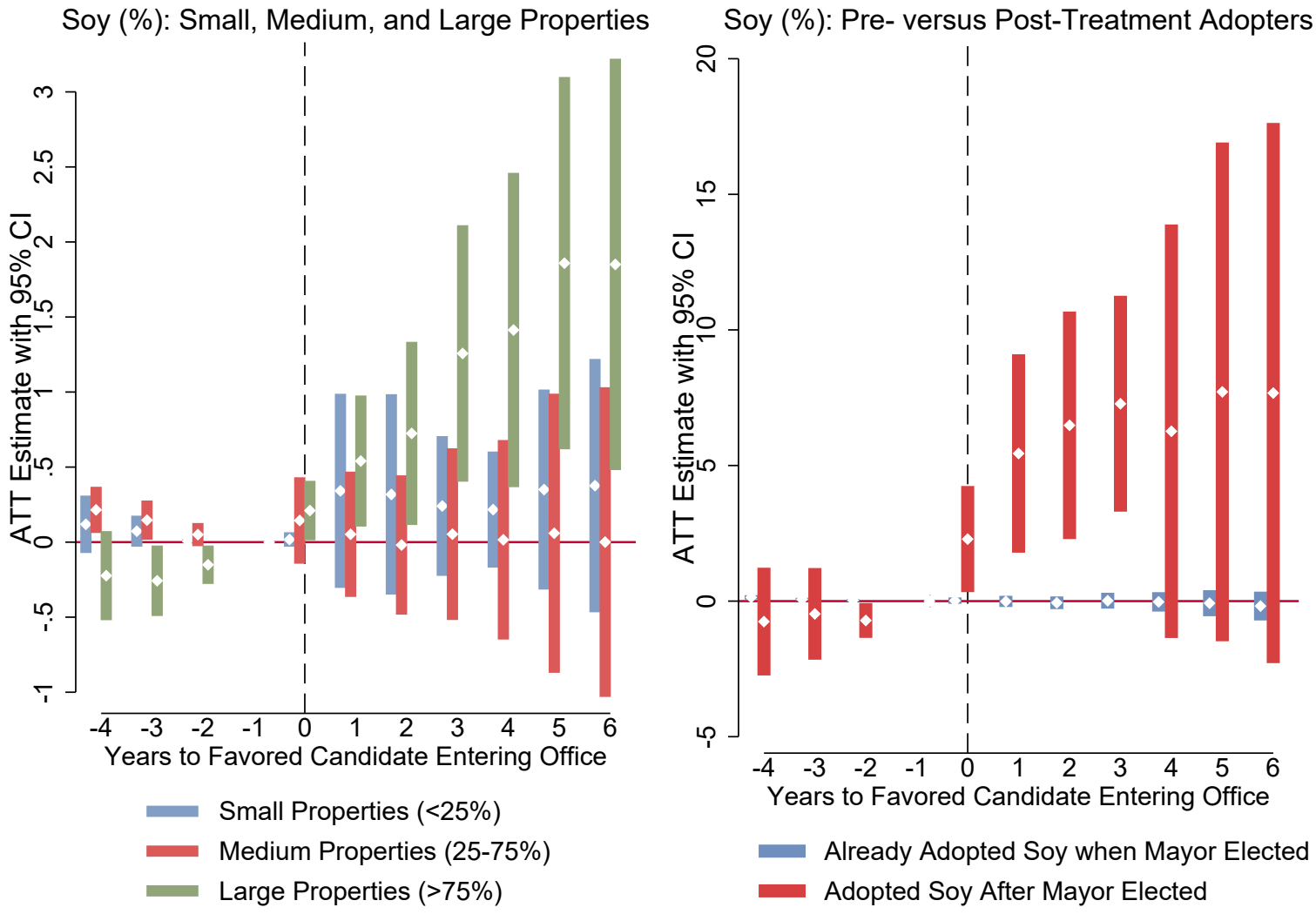
- Define close elections using **5% win margin** ▸ Map: # of Close Elections per Municipality

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



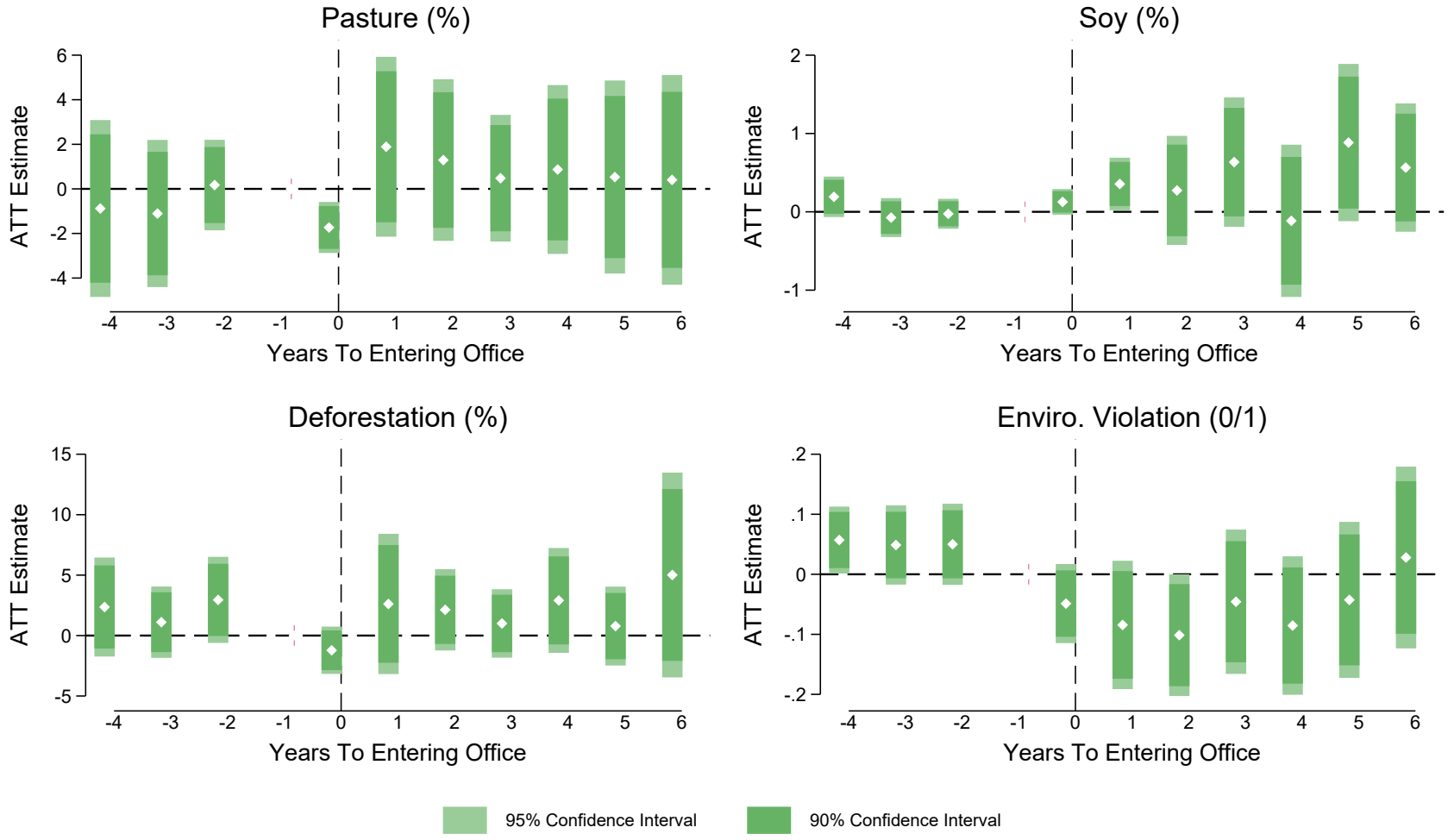
Note: Figure reports ATT estimates and 90 and 95% confidence intervals from Callaway and Sant'Anna (2021) estimator. Sample consists of donors to successful and runner-up mayoral candidates in close mayoral elections ($\leq$ 5% win-margin) in Amazon biome (2004-2016).

Shift to Soy is Driven by **Large Properties** and **New Adopters**



▸ Heterogeneity by Mayor Type and Level of Electoral Competition

Candidates' Properties: No Clear Evidence of Self-Enrichment



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Are landholders an influential interest group?

Do donations from landholders affect municipal **policymaking** and **land-use**?

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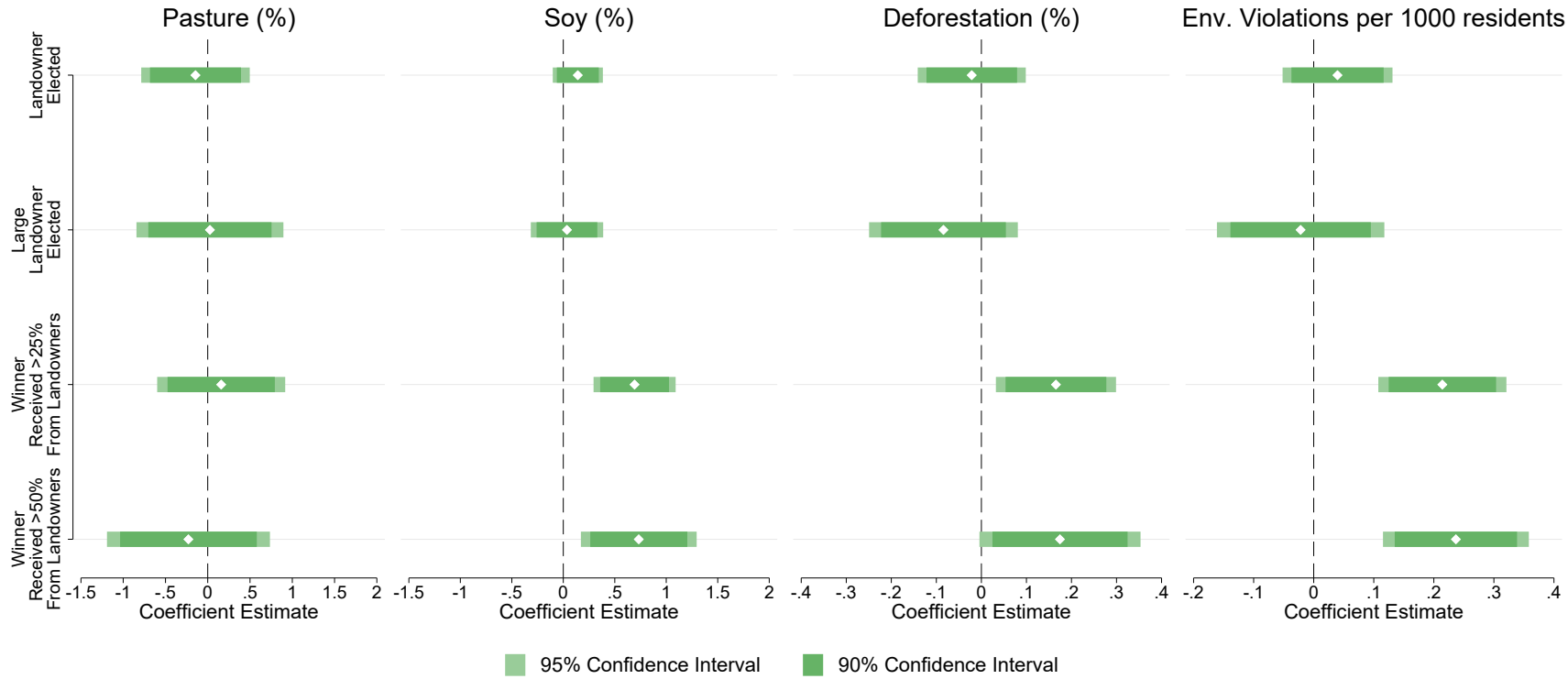
$$y_{me} = \beta T_{me} + \mathbf{X}'_{me}\mu + \delta_m + \theta_e + \epsilon_{me}$$

- 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 ($\geq$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)

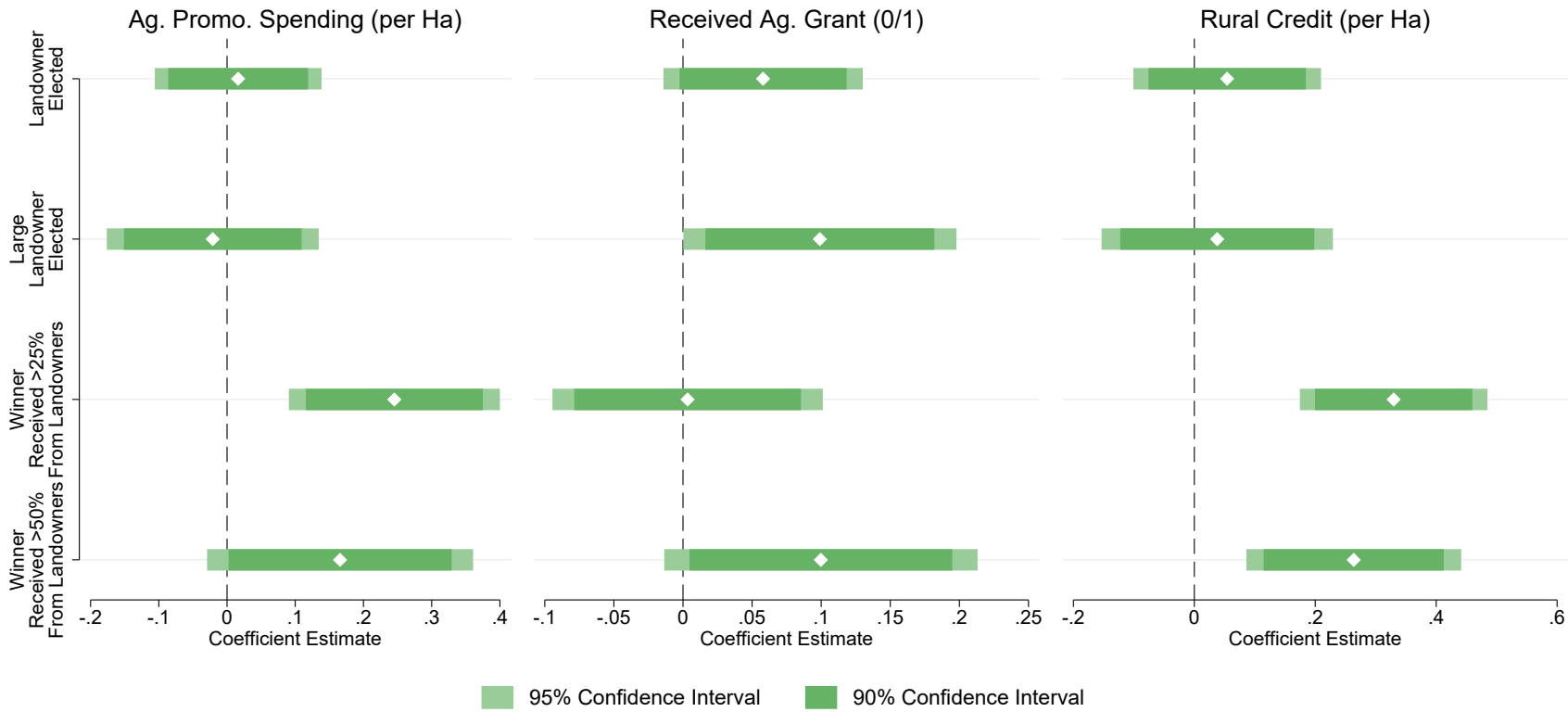
Election of a Landholder-Financed Mayor Increases Municipal Soy, Deforestation, and Environmental Violations



Note: Figures report coefficient estimates and 90 and 95% CIs from regression of outcome on municipality-election treatment dummies (landholder in office, large landholder ($\geq$ 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.

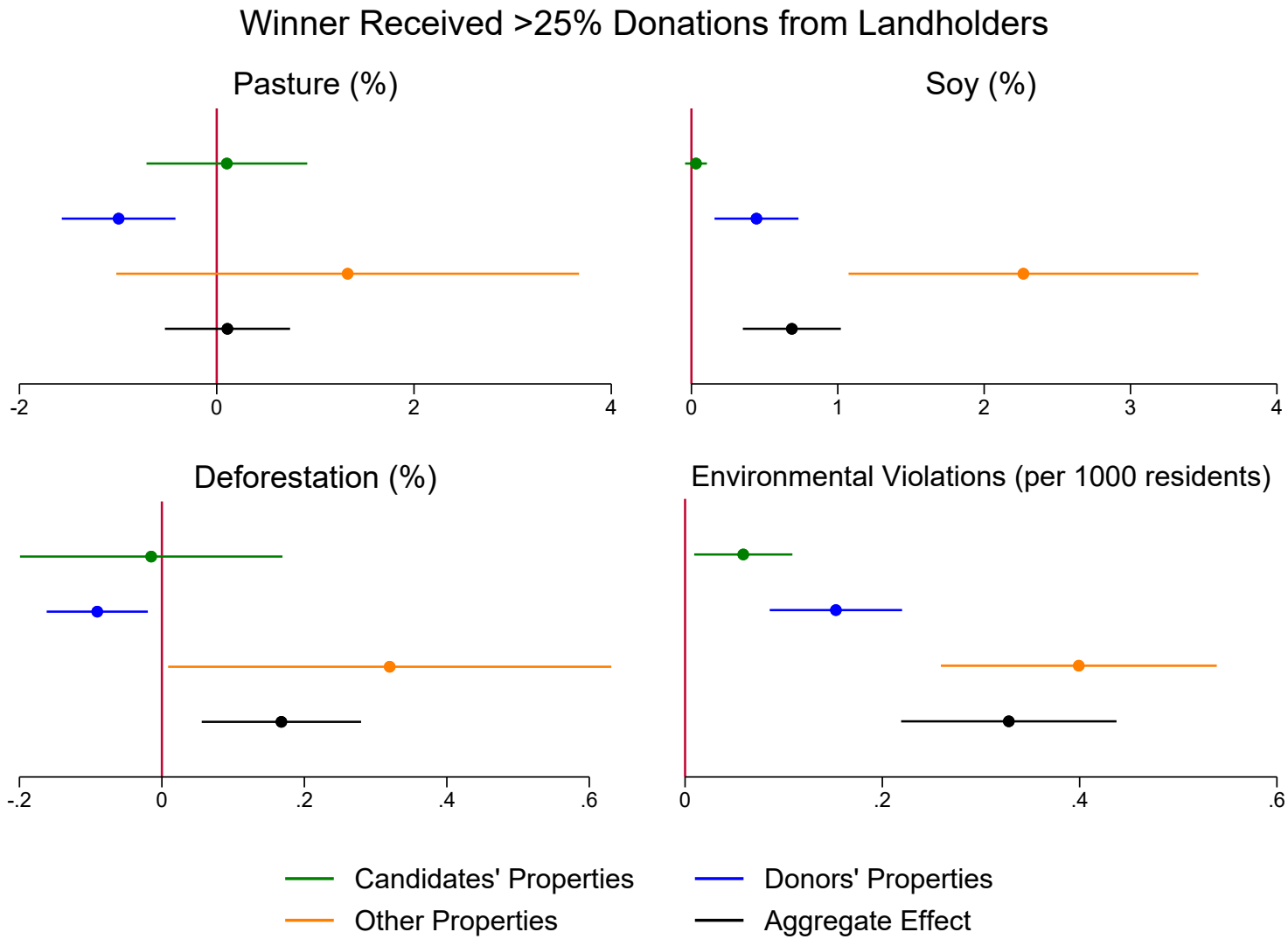
- Test for Spurious Landholder Effect
- Effects on Specific Land-Use Transitions

Mechanisms: Landholder-Financed Mayors Promote Agriculture



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



Robustness

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 asinh(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

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- Use asinh(hectares) instead of % of property area ▸ IHS Transformation
- Annual event studies using csdid ▸ Municipal-Level Event Studies

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  - > 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

Main Takeaways

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

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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 $\rightarrow$ adopt policies favorable to the sector, creating spillovers to non-donors

Broader Implications

- **Agricultural intensification** (cattle pasture $\rightarrow$ 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

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- **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)

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

Thank you!

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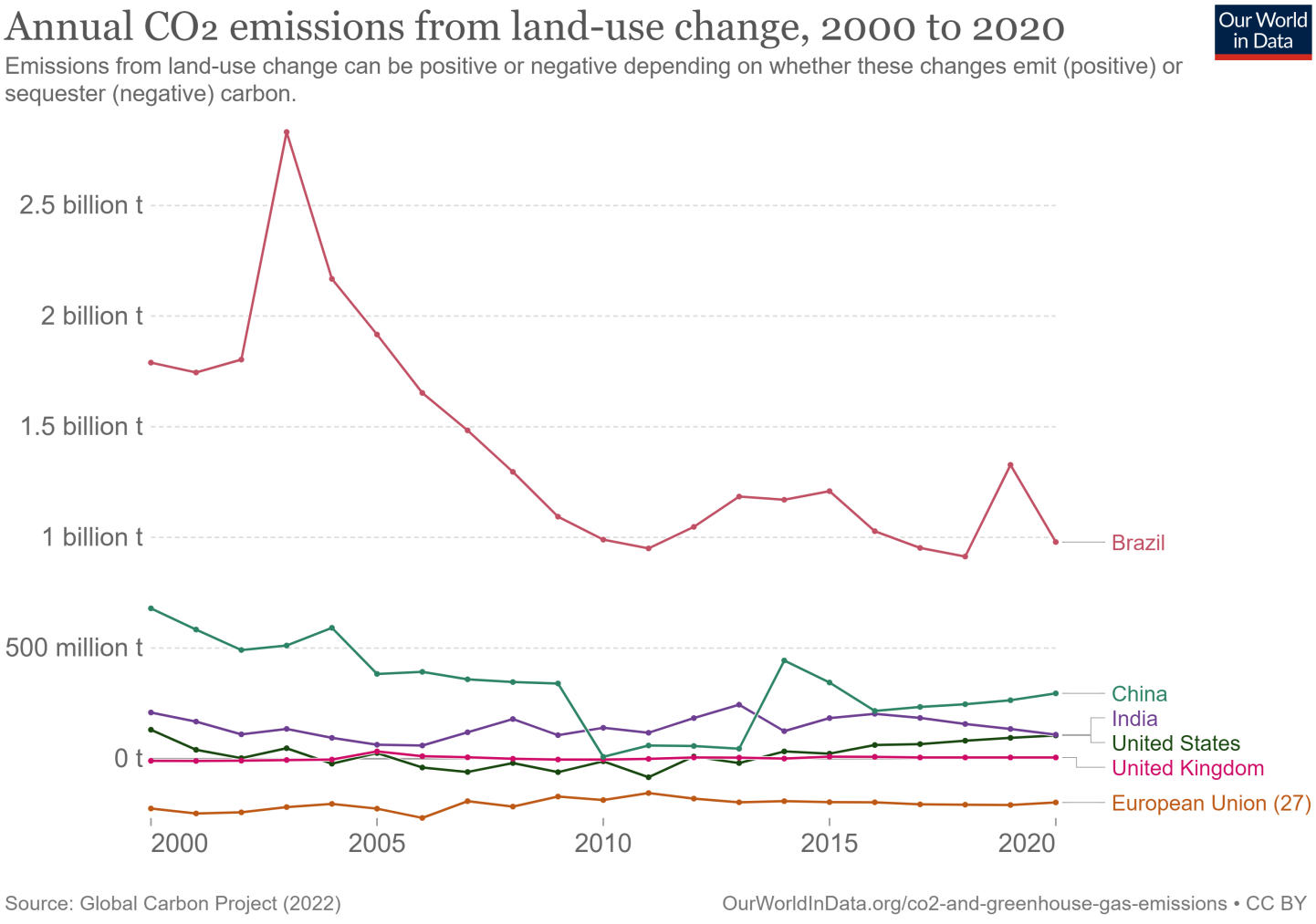
Carbon Emissions from Land-Use Change



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Data Sources

Data	Source	Years	Raw Level	Analysis Level
Deforestation & Land Use	MapBiomas	2000-2019	Pixel	Property/Mun.
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/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

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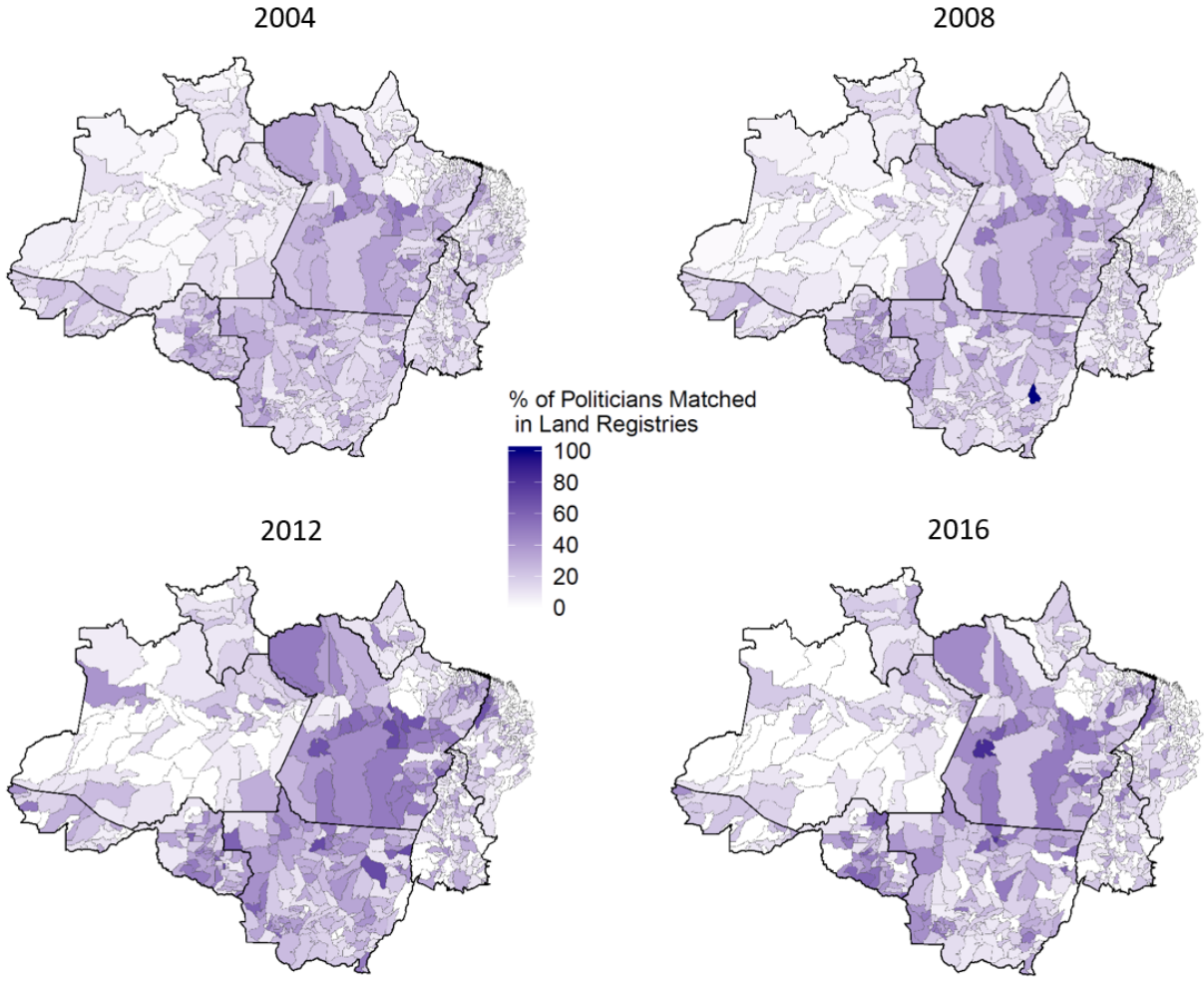
  Response: Land transactions in the Amazon are infrequent – involving only 0.51% of properties during 2019-2020 (Moffette et al., 2023)

- **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

▸ Return

Percent of Politicians Matched in Land Registries



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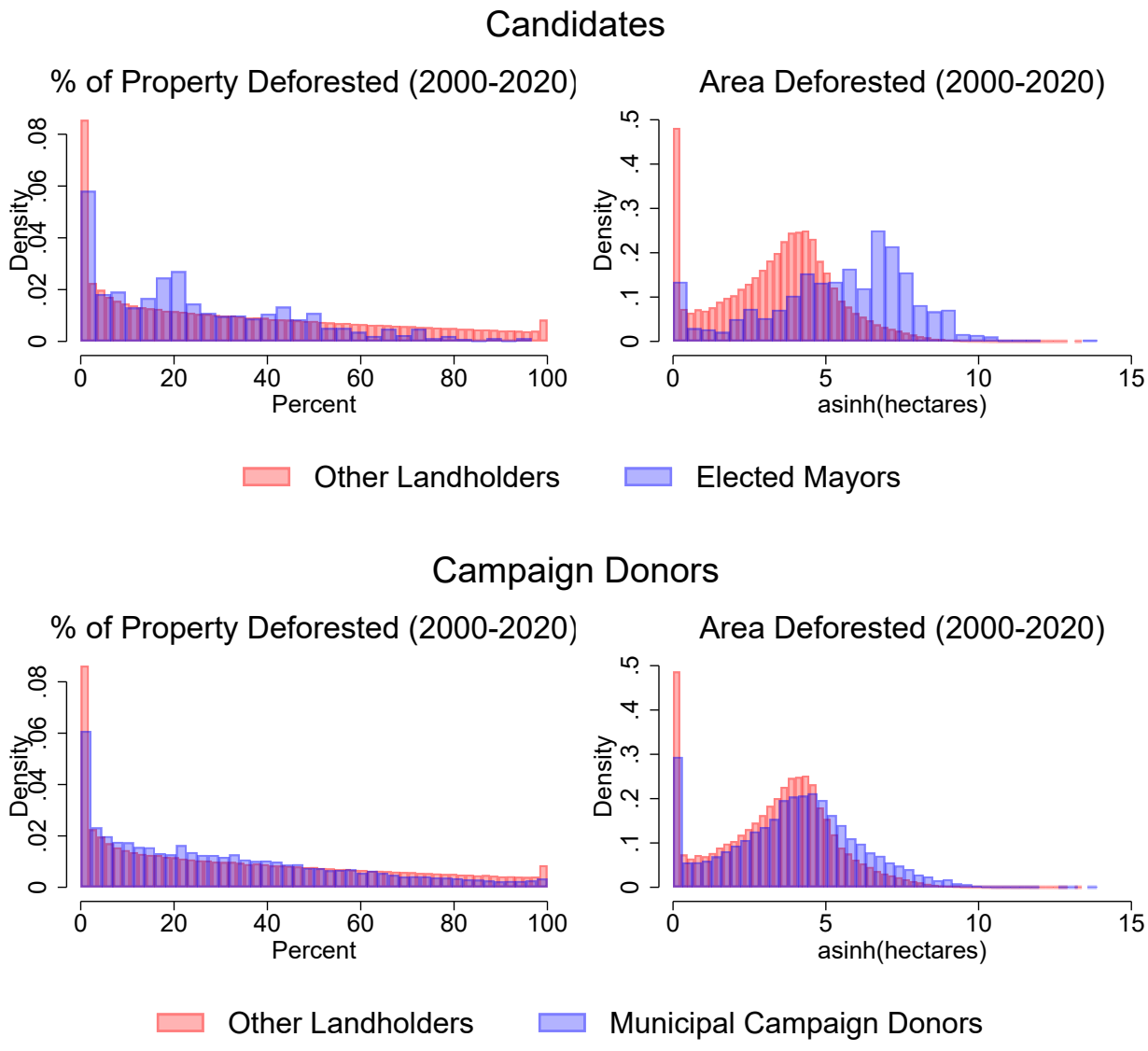
Candidates/Donors Deforest Smaller % of Properties, but More Overall



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Landholding Mayors & Donors vs. Other Landholders

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

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

▸ Return

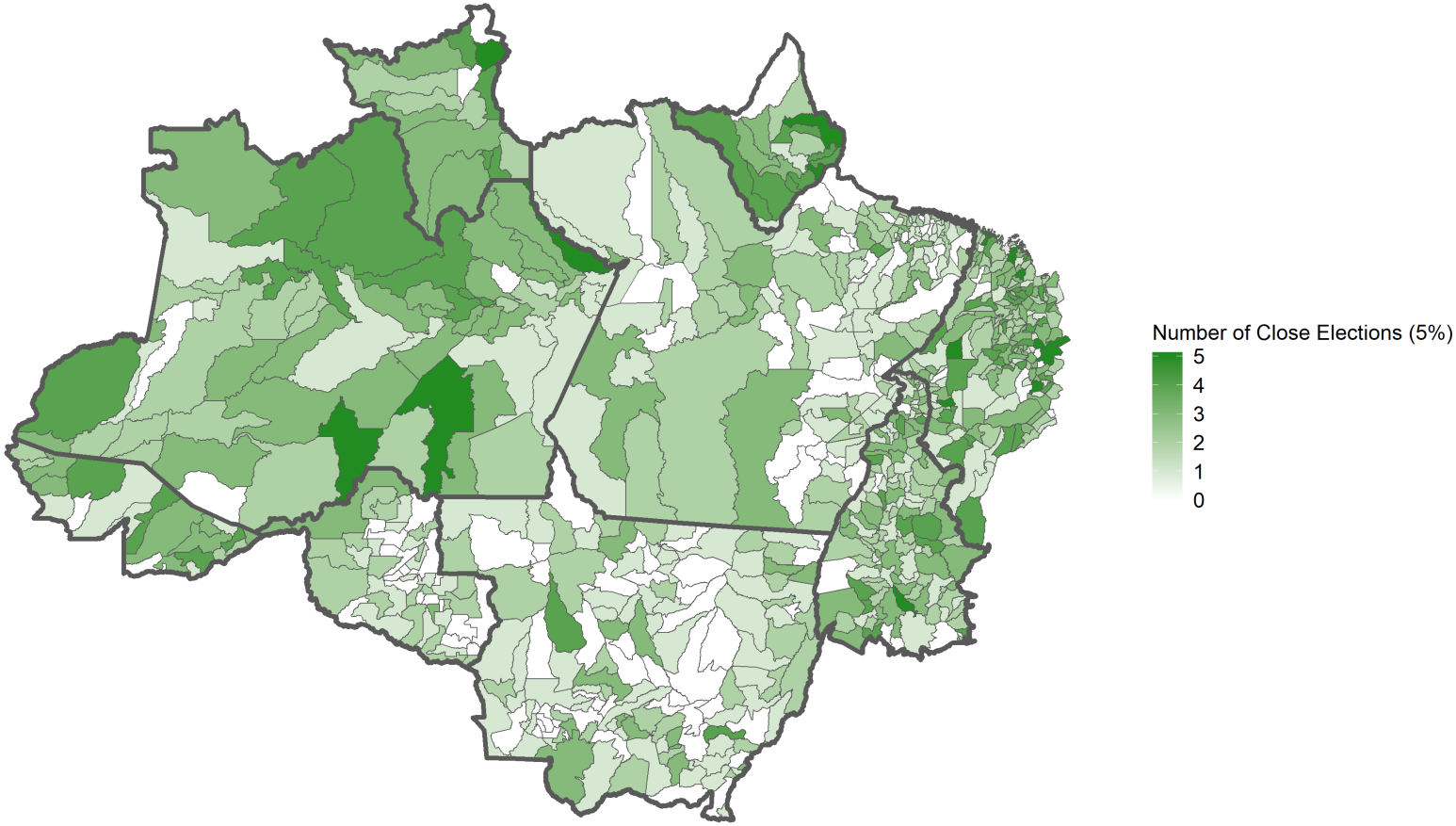
Landholding vs. Non-Landholding Mayors & Donors

	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)

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

Return

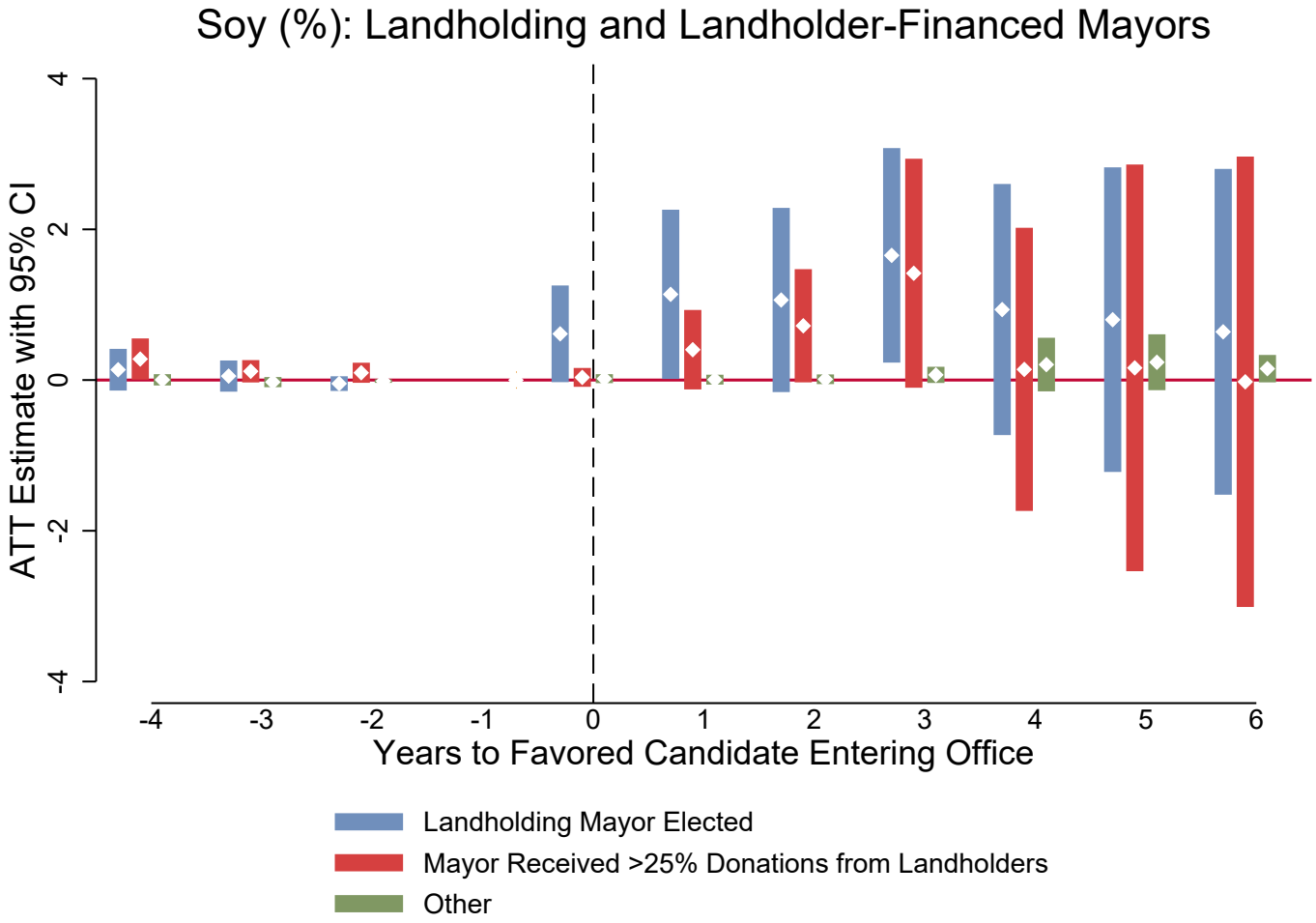
Number of Close Elections ($\leq$ 5% Win Margin) per Municipality (2000-2016)



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%.

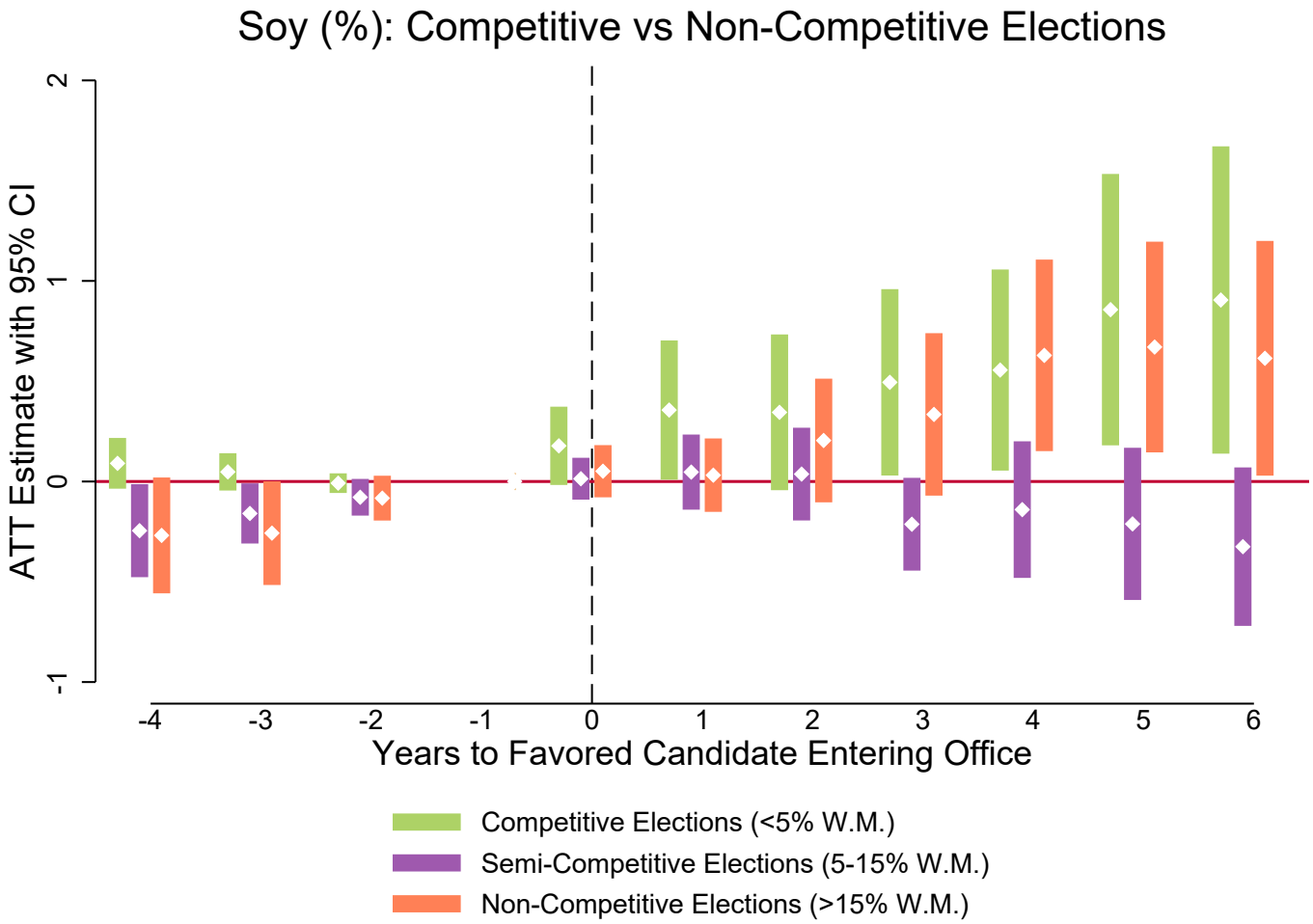
▸ Return

Heterogeneity by Landholding or Landholder-Financed Status



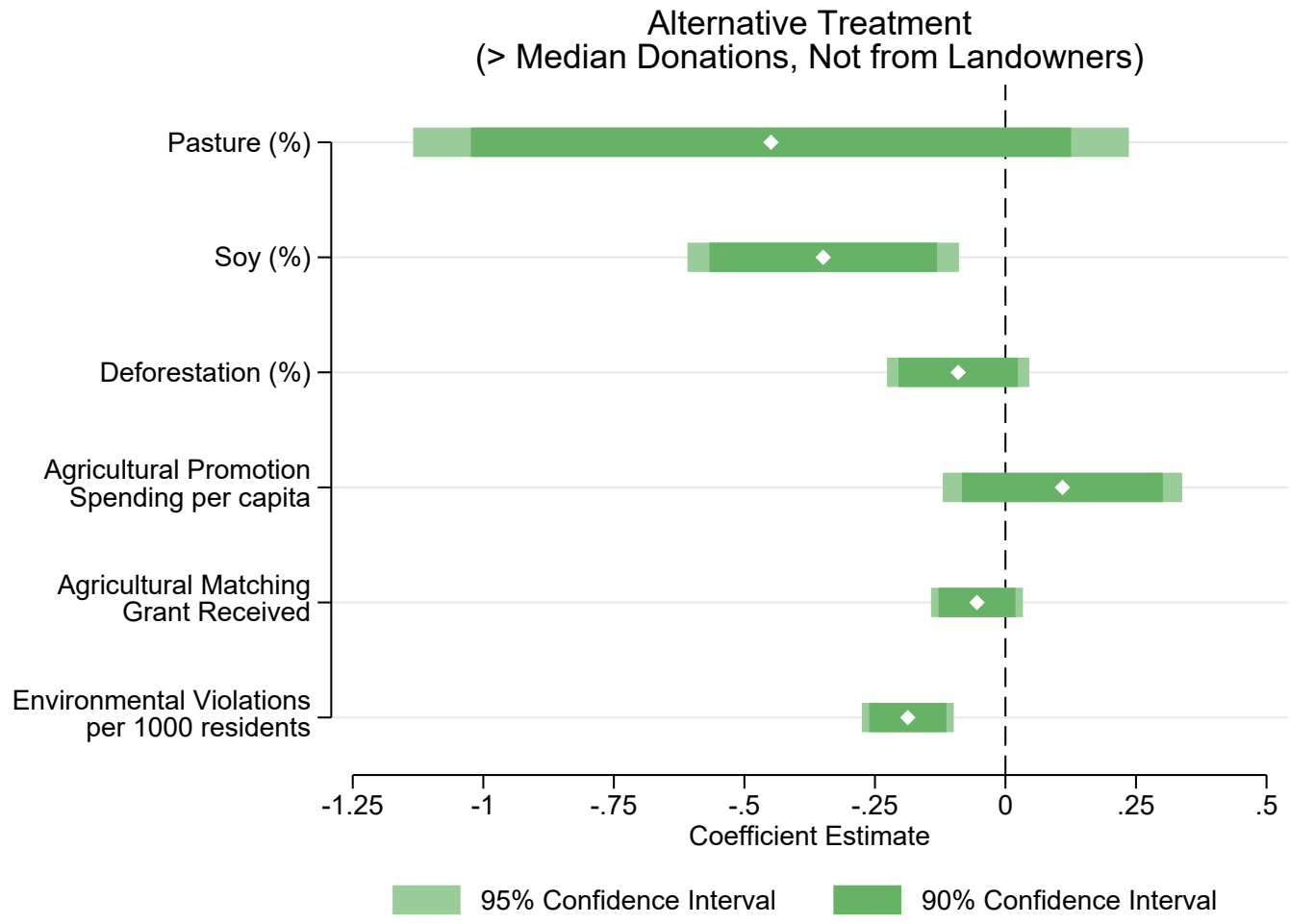
▸ Return

Heterogeneity by Level of Electoral Competition



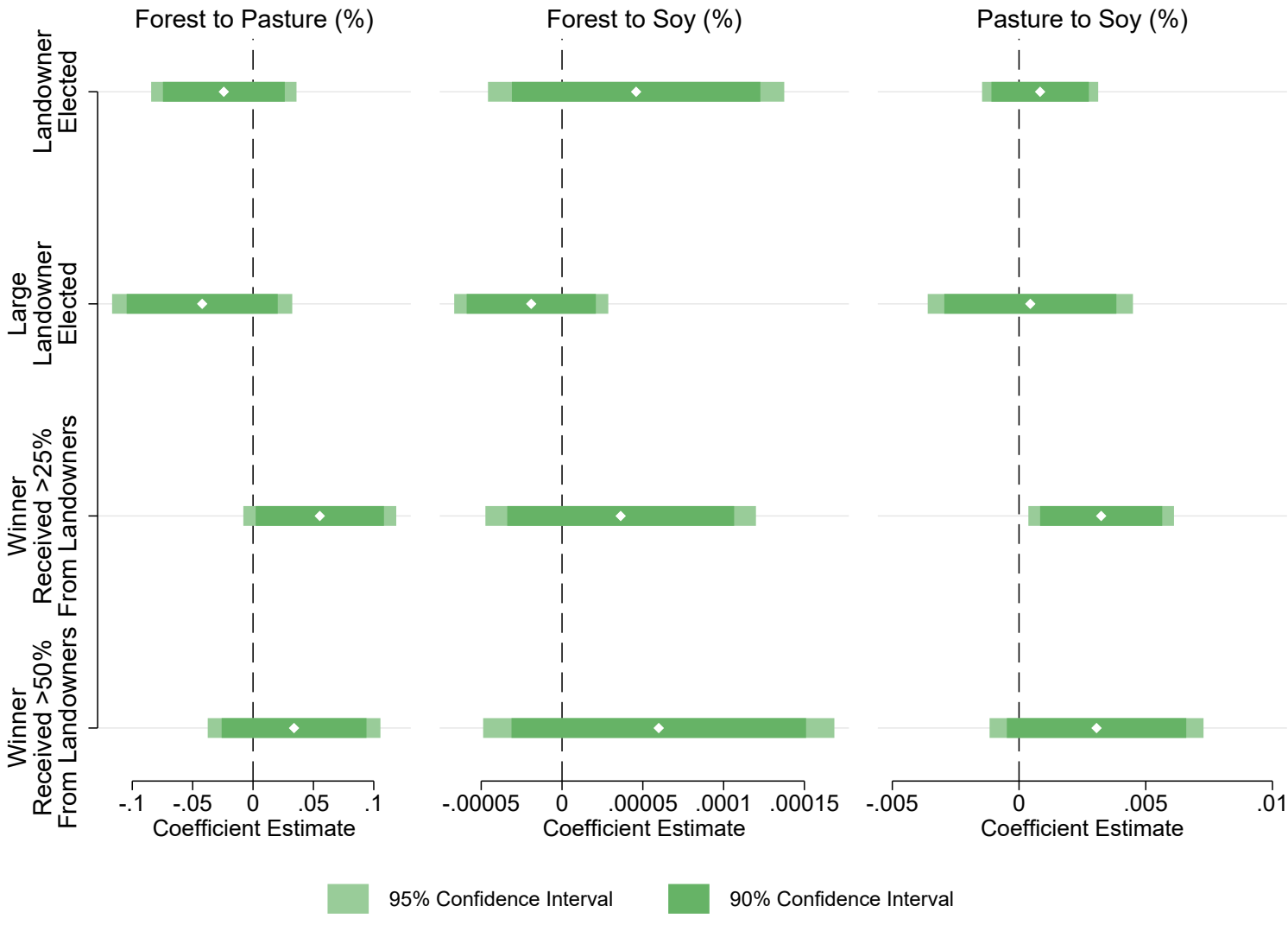
▸ Return

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



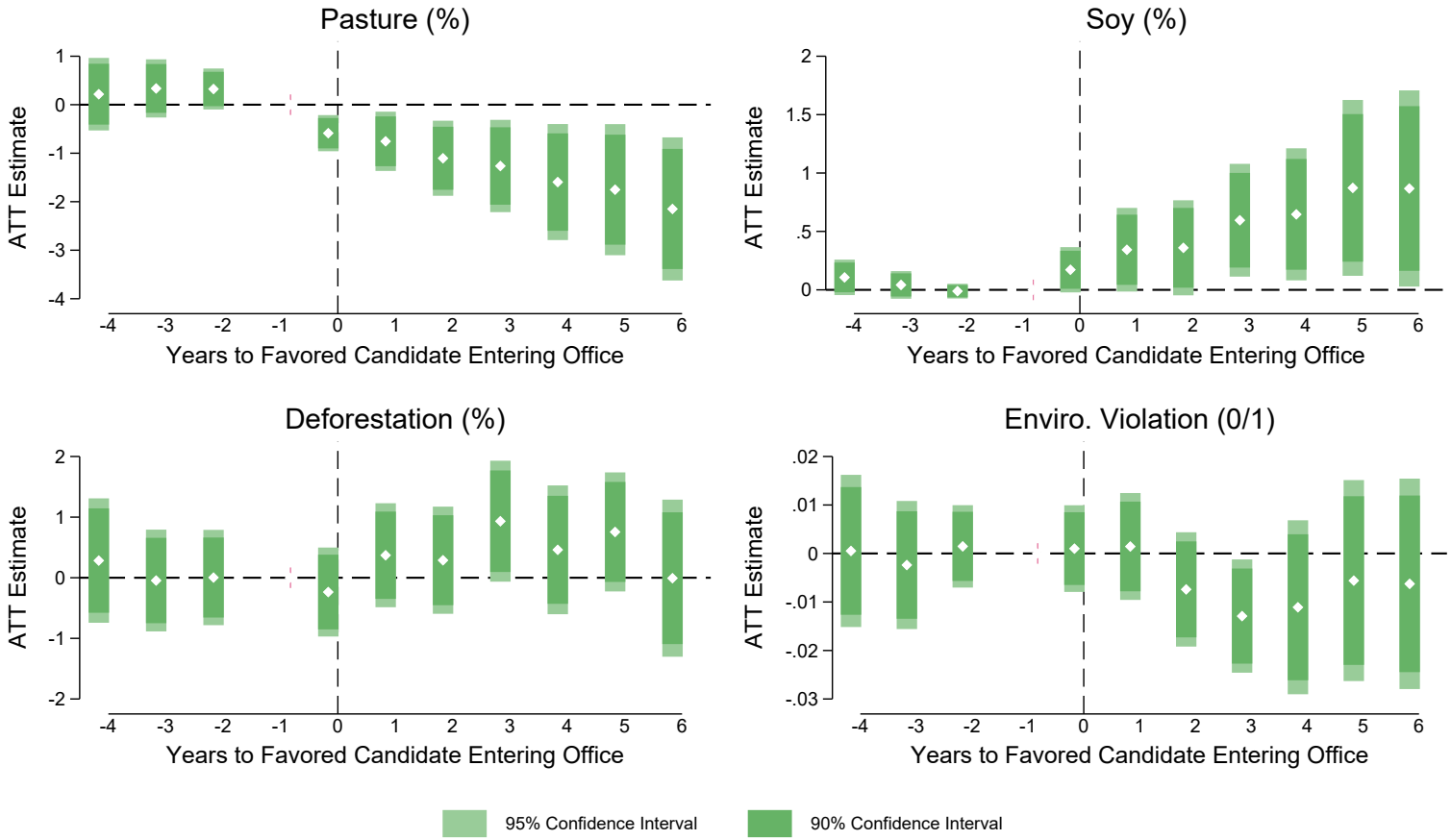
Note: Figure reports coefficient estimates and 90 and 95% CIs from regression of outcome on municipality-election treatment dummy (mayor who received $\geq$ median value of total campaign donations but no donations from landowners). Specifications are otherwise analogous to main results. ▸ Return

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

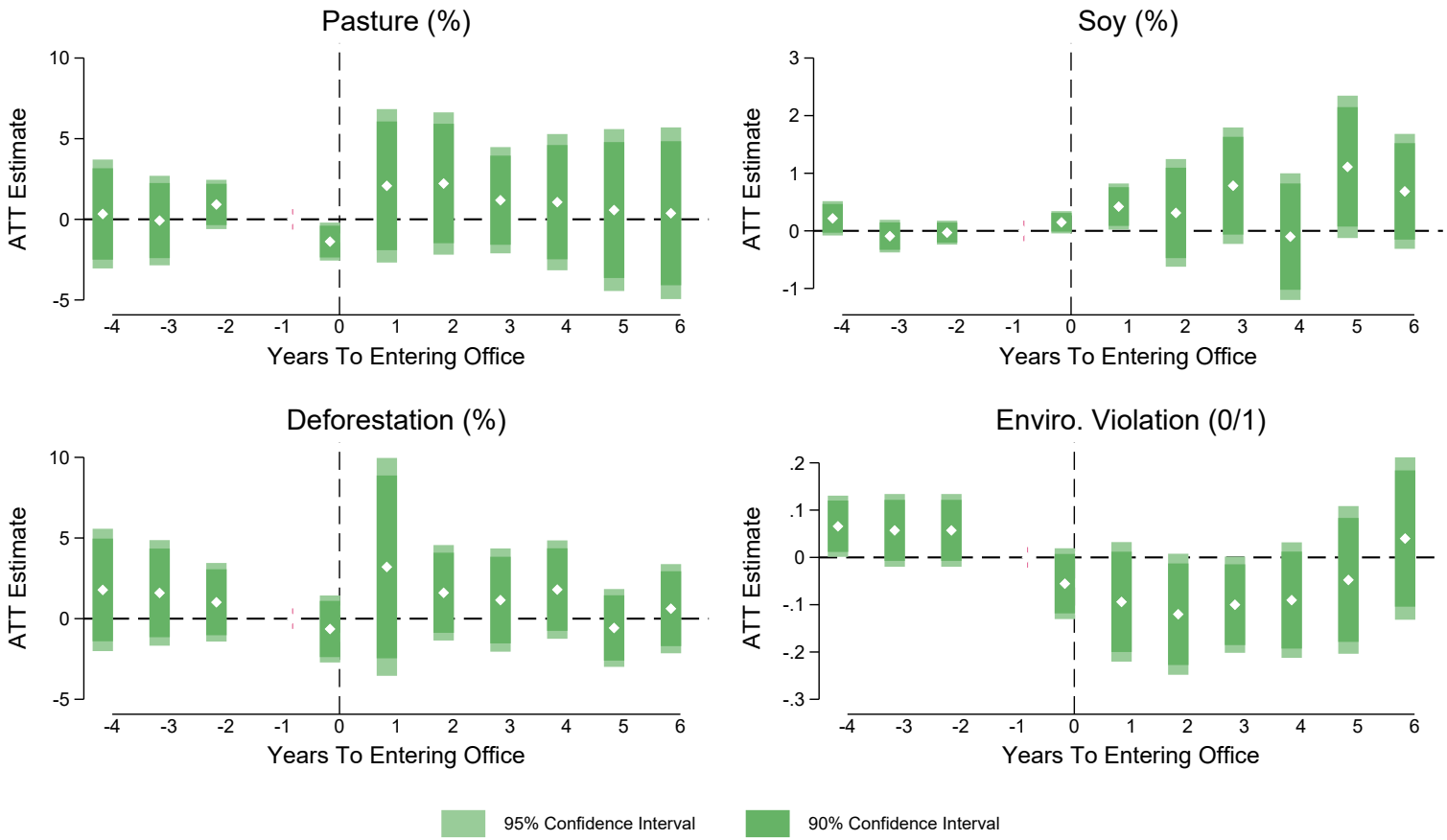


▸ Return

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

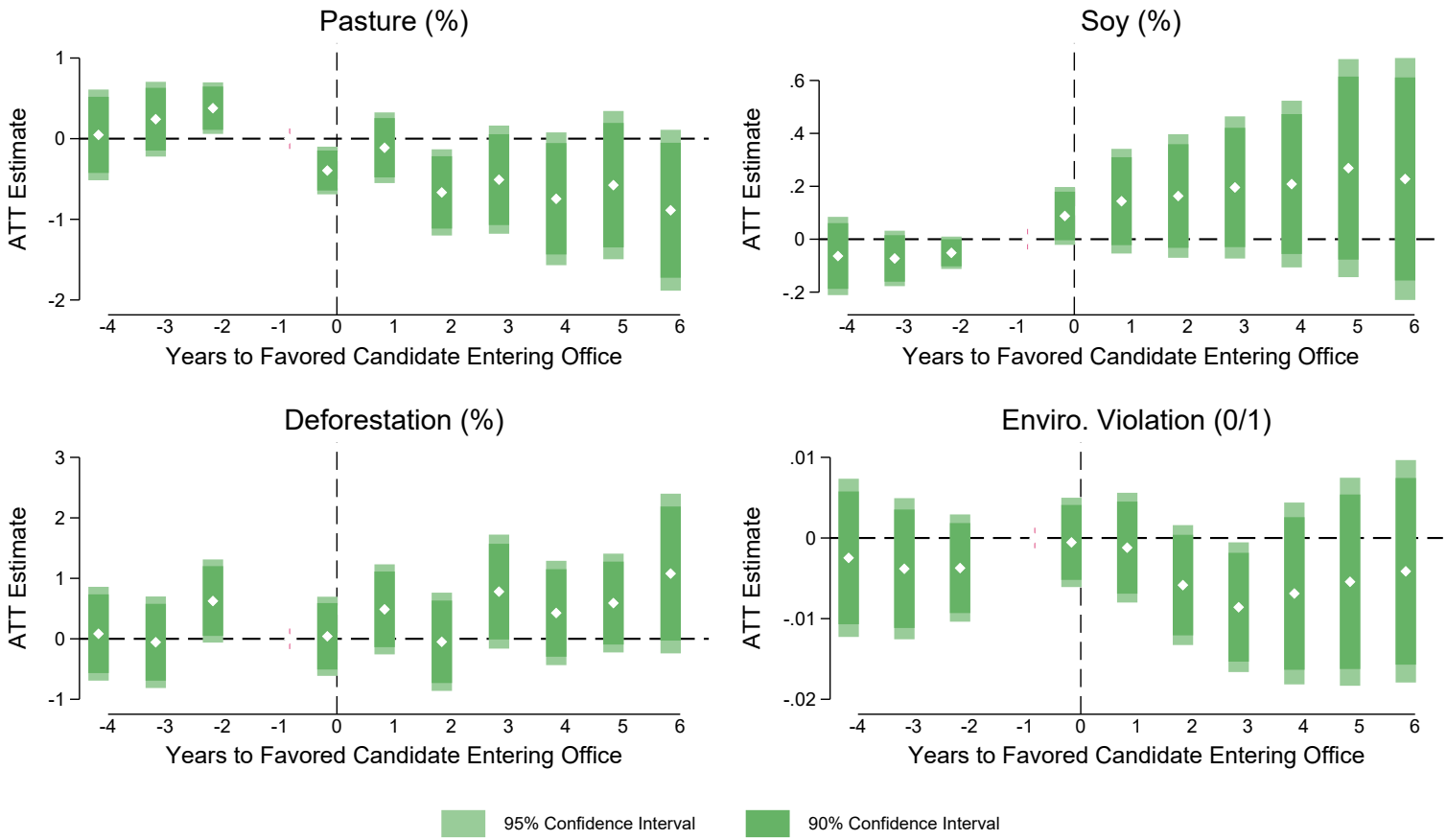


Robustness: Candidate Properties, 5% Win Margin, MT/PA/RO

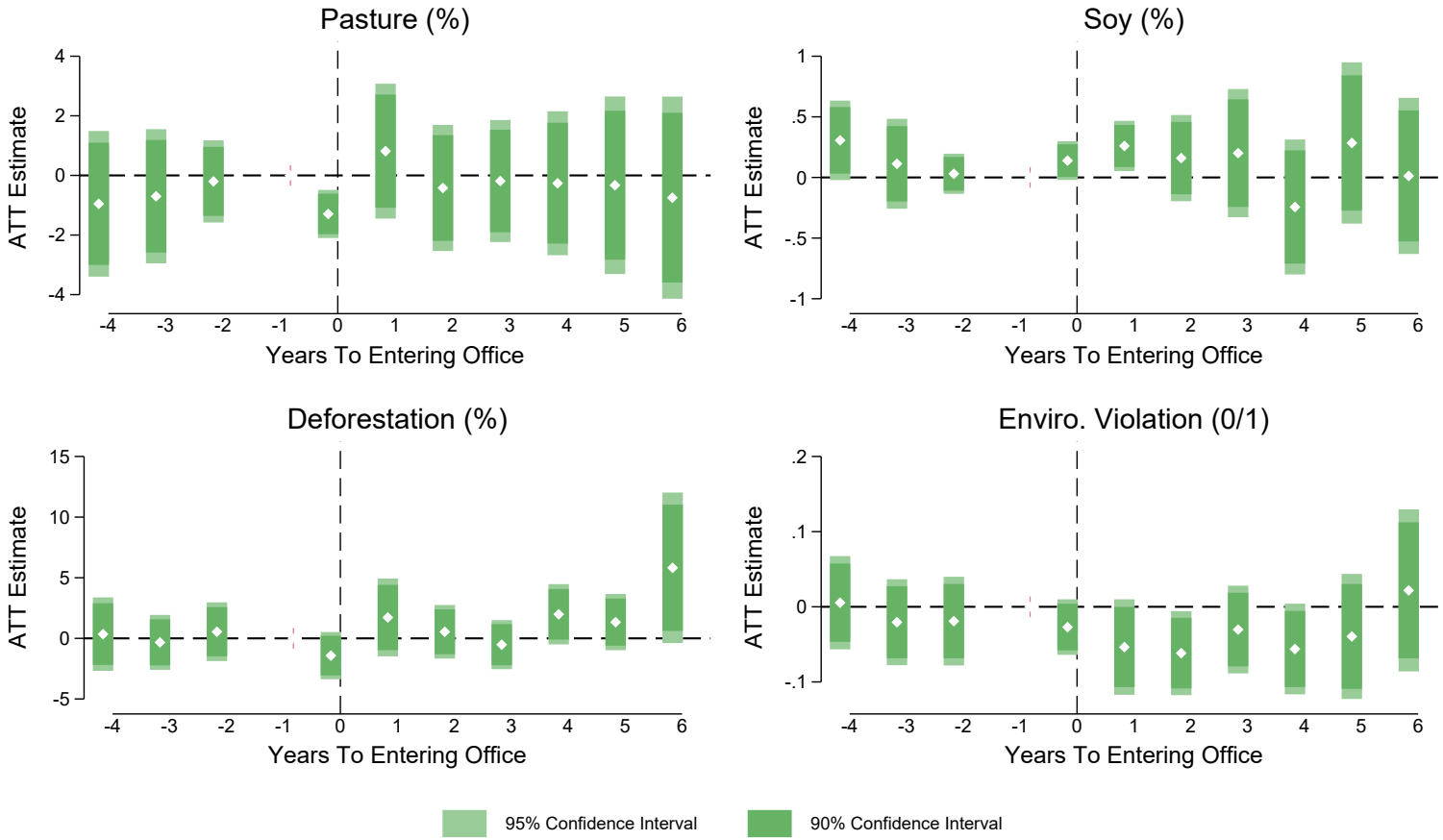


▸ Return

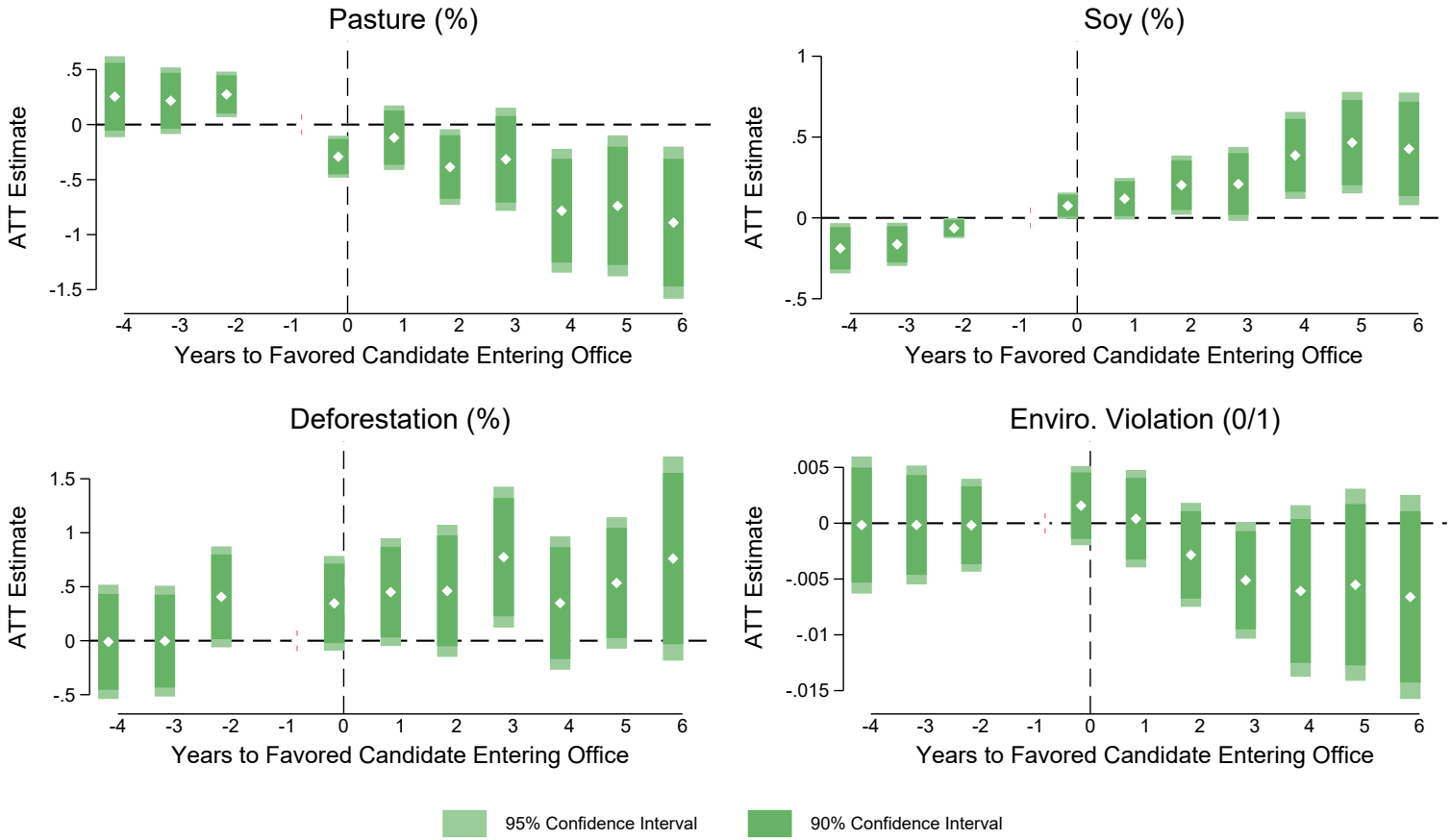
Robustness: Donor Properties, 10% Win Margin, Amazon



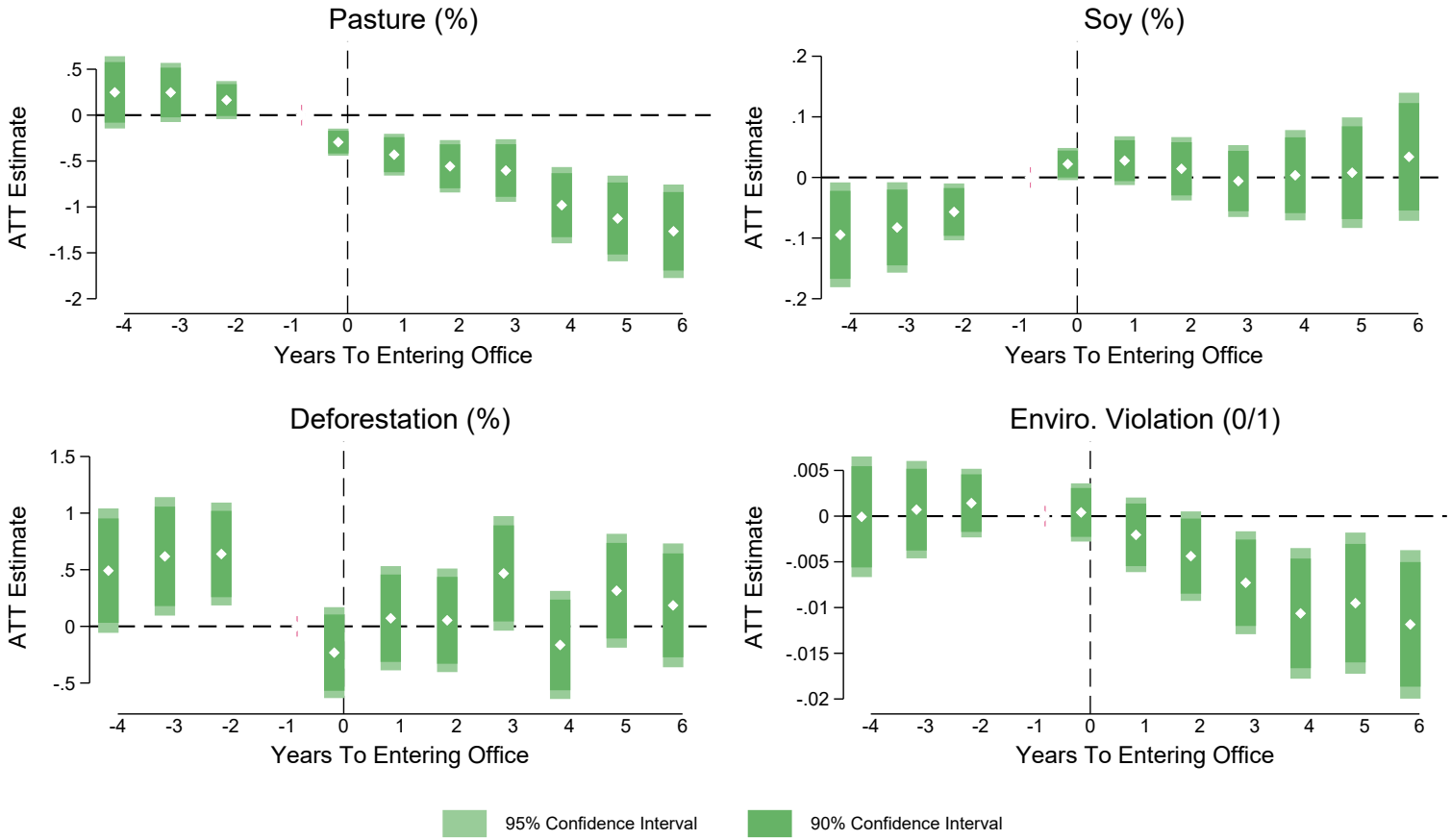
Robustness: Candidate Properties, 10% Win Margin, Amazon



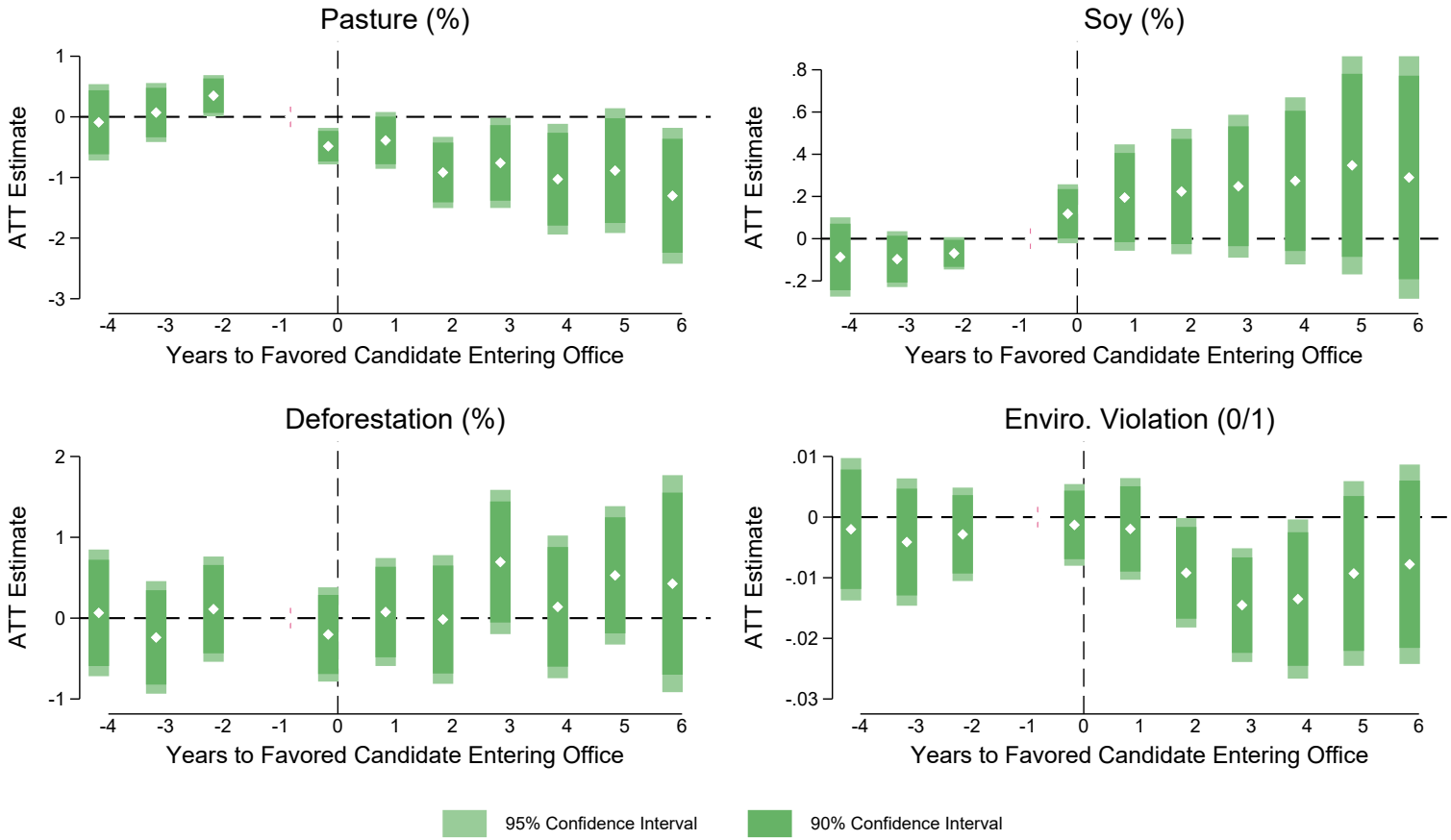
Robustness: Donor Properties, All Elections, Amazon



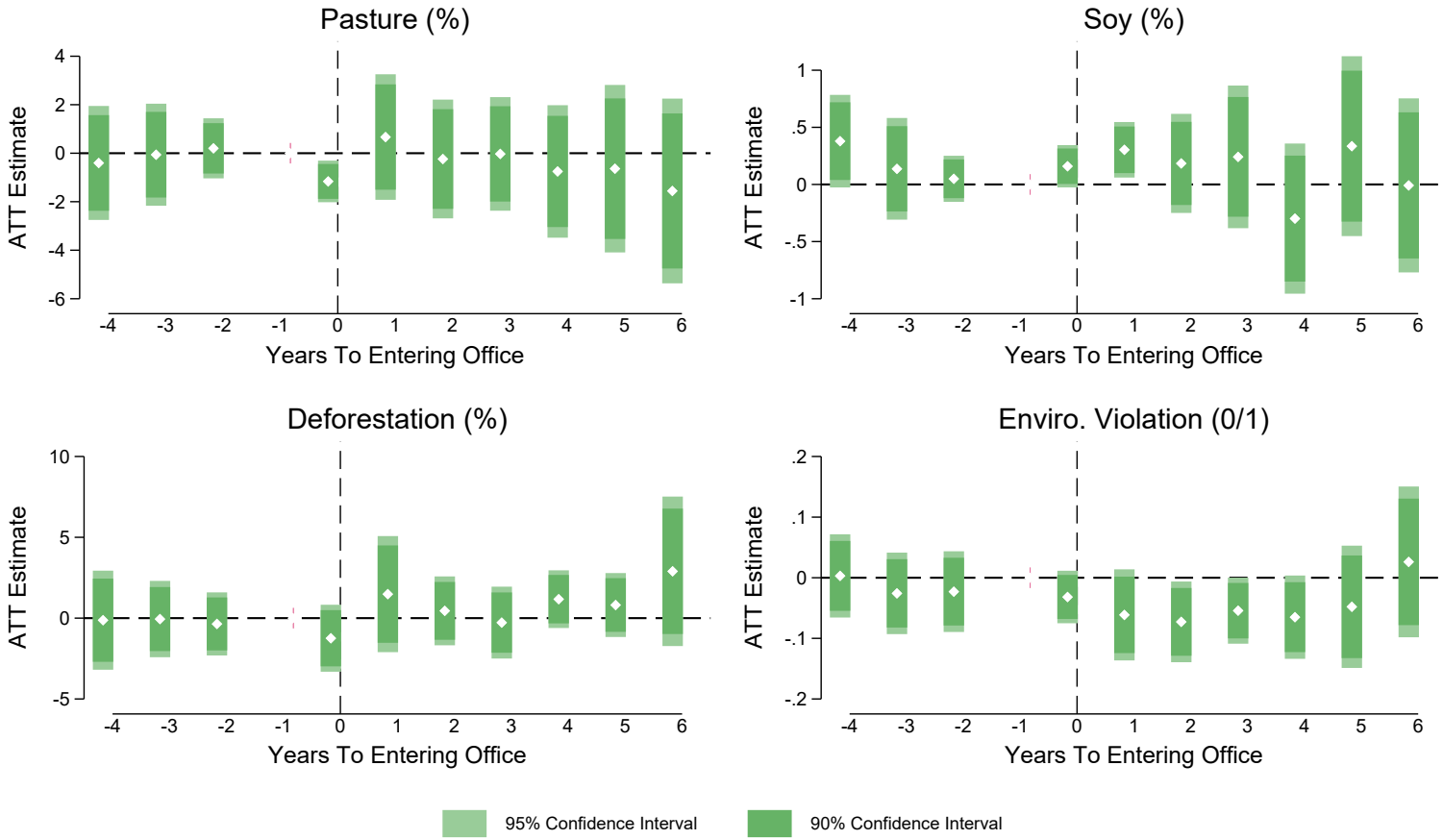
Robustness: Candidate Properties, All Elections, Amazon



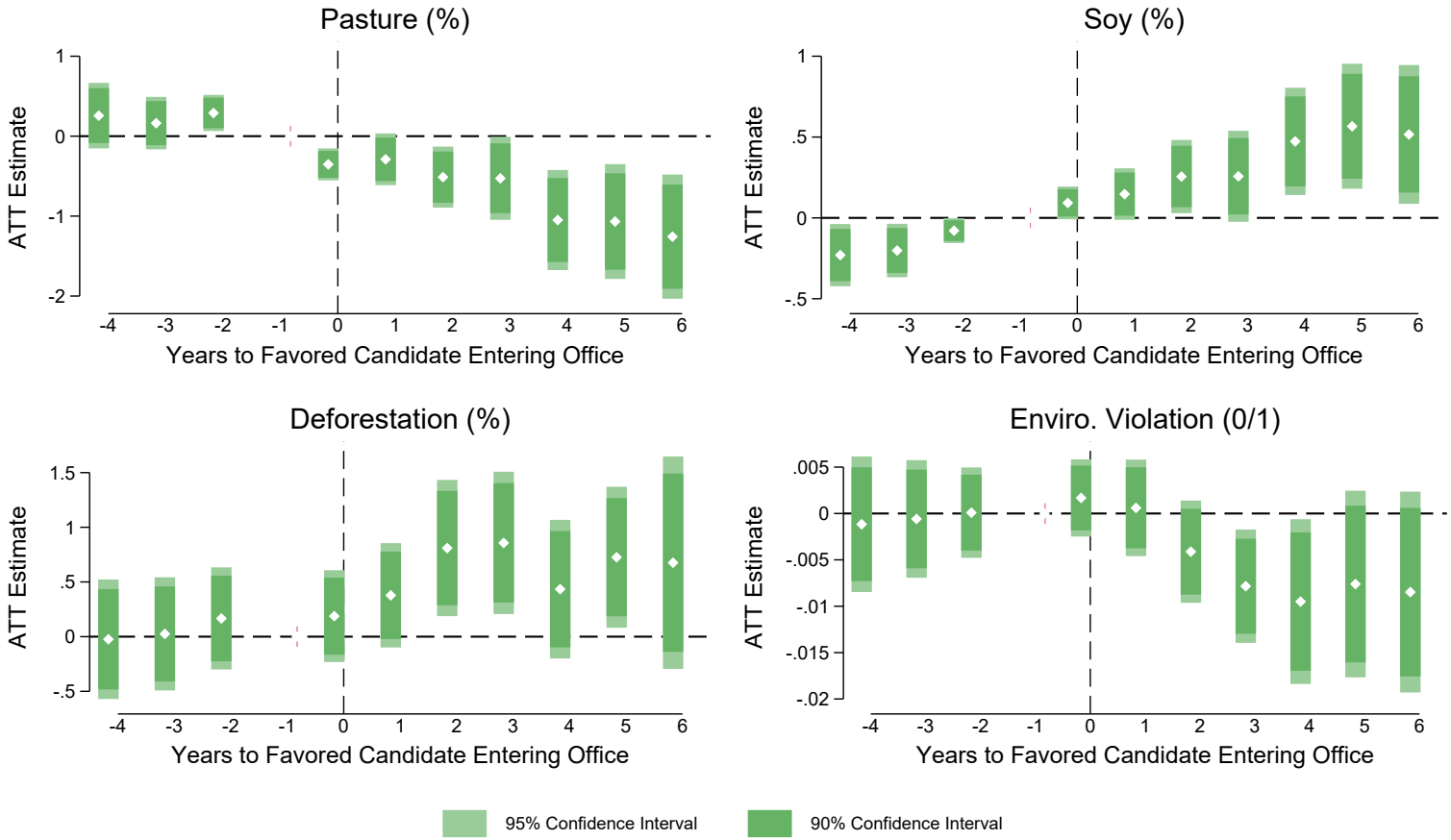
Robustness: Donor Properties, 10% Win Margin, MT/PA/RO



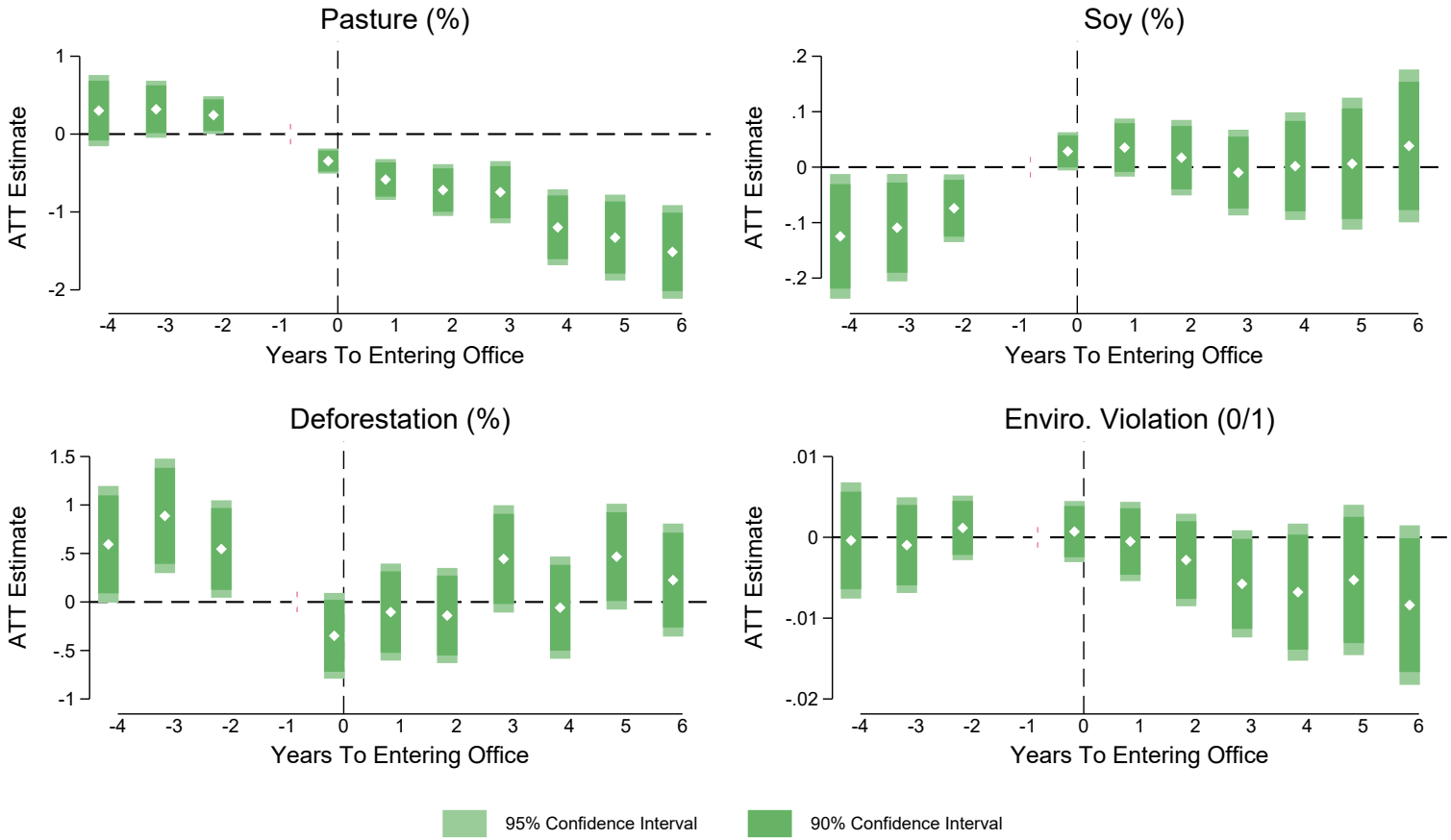
Robustness: Candidate Properties, 10% Win Margin, MT/PA/RO



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

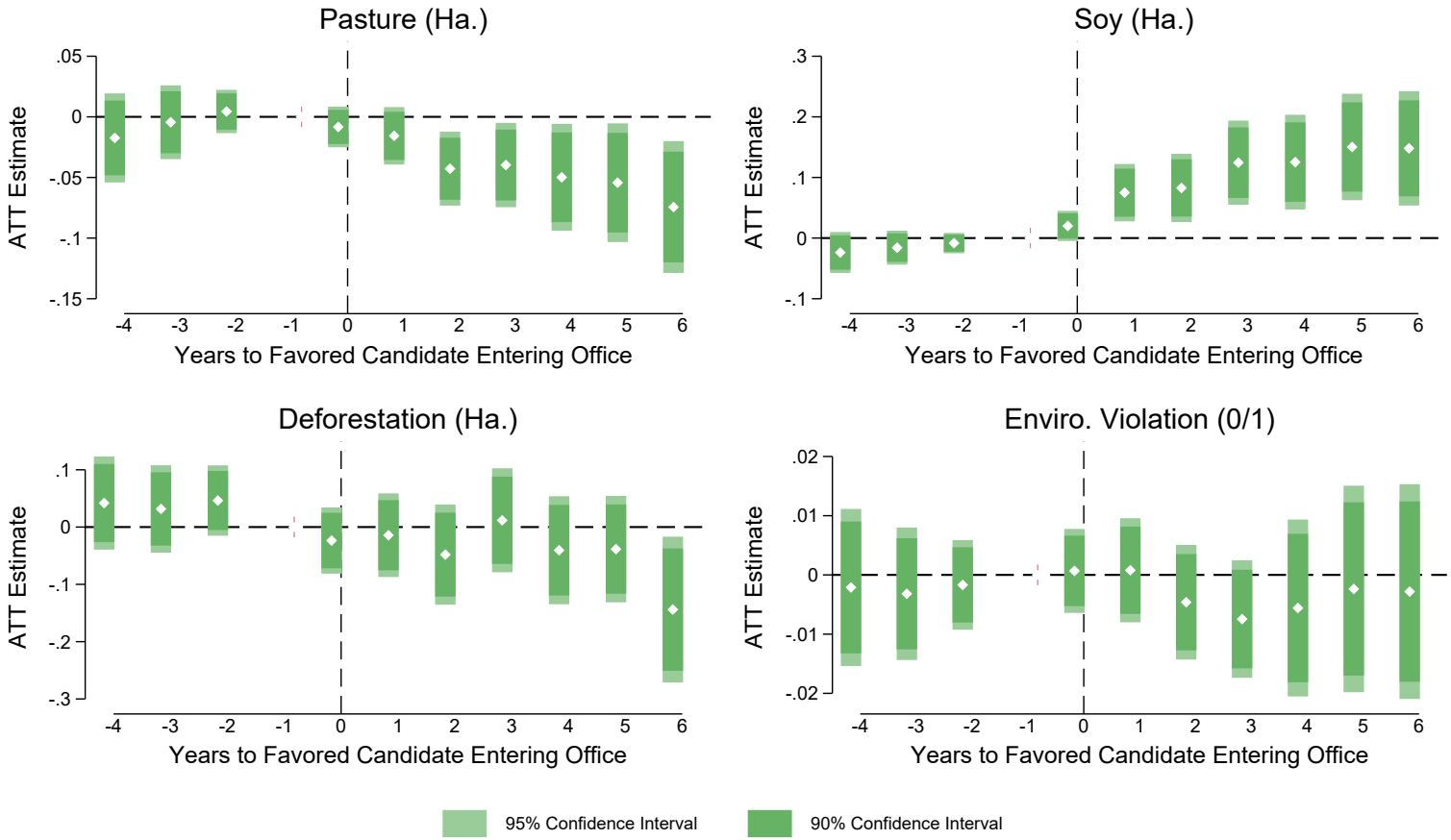


Robustness: Candidate Properties, All Elections, MT/PA/RO

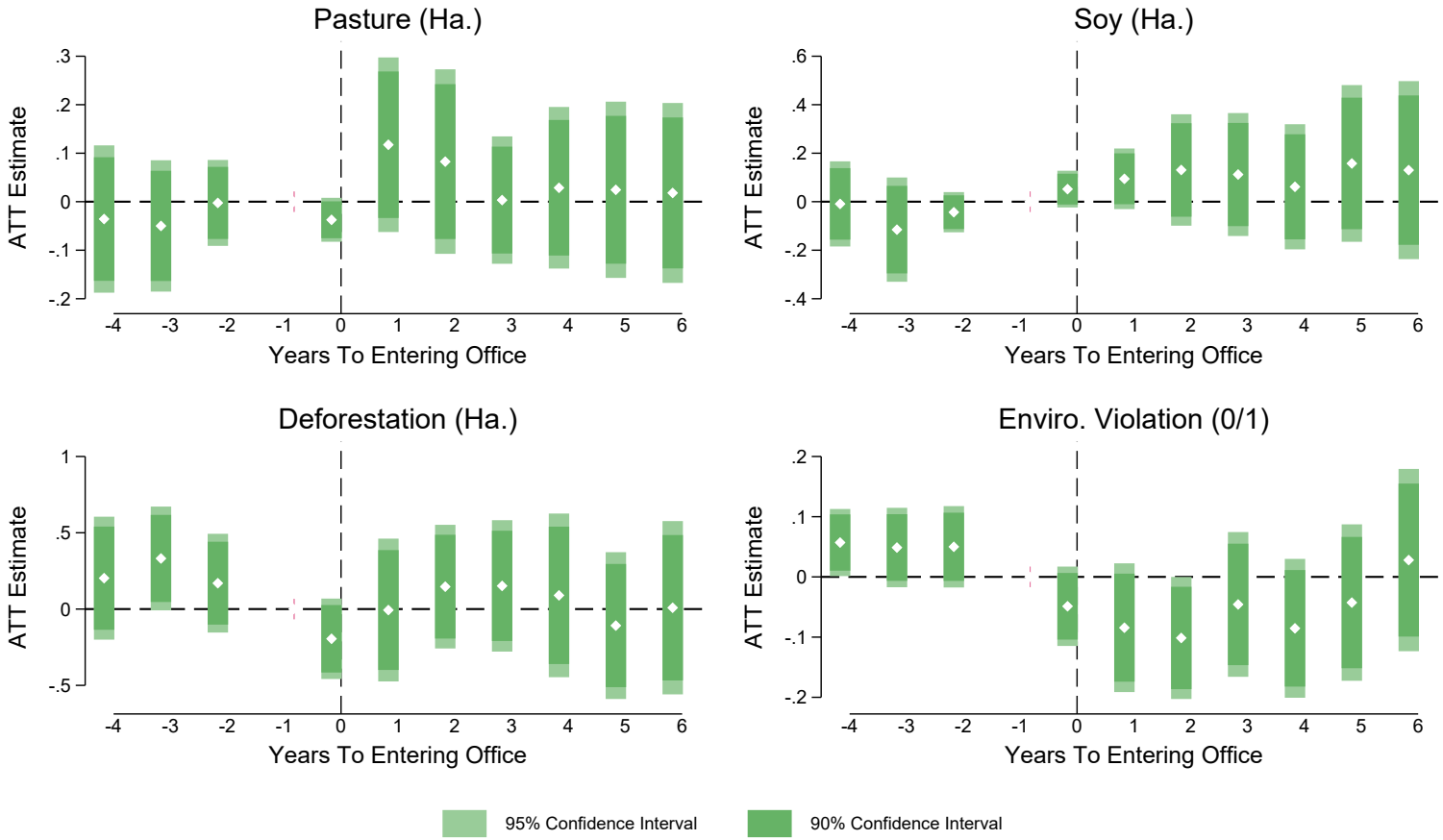


▸ Return

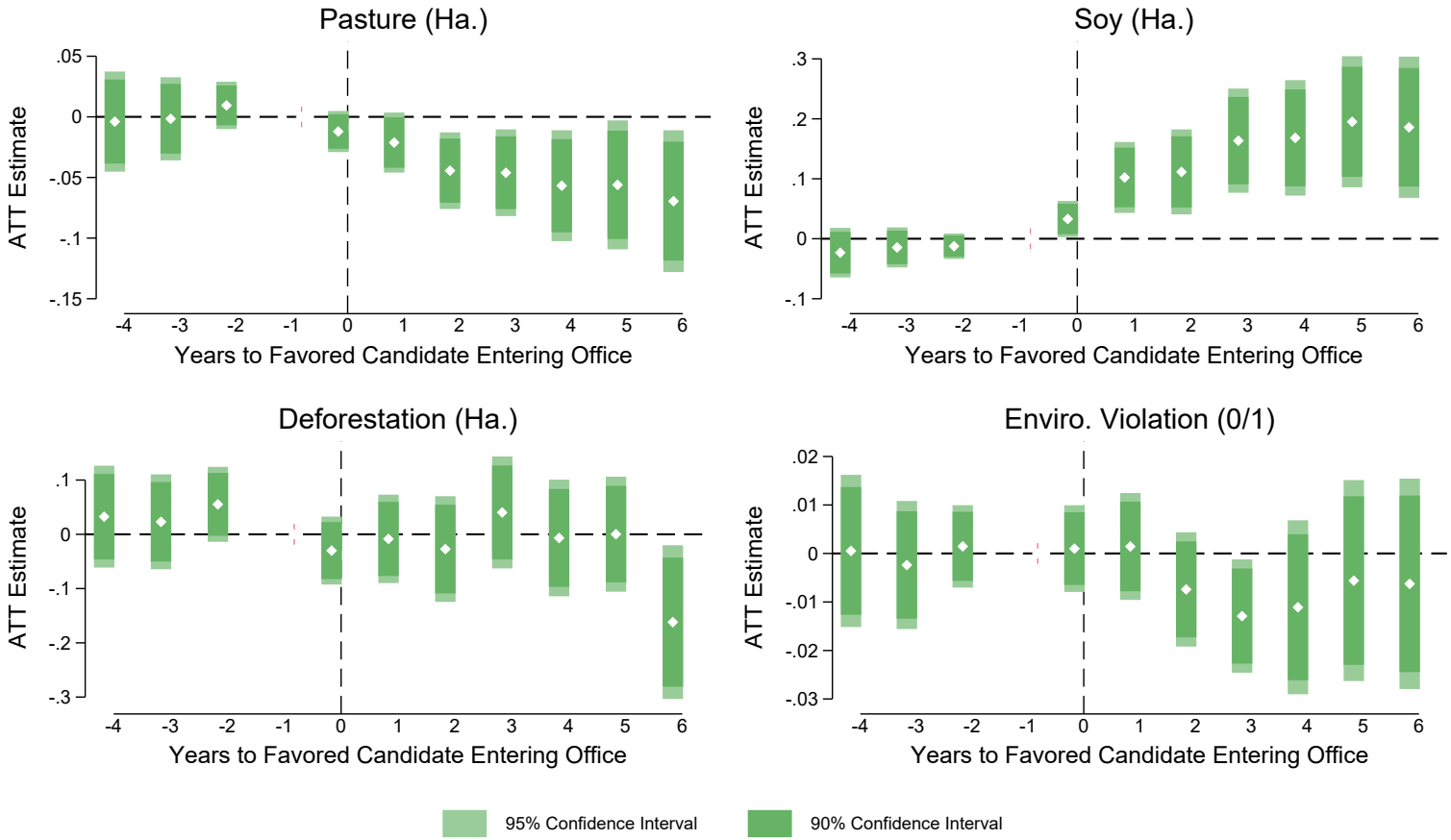
Robustness: Donor Properties, 5% Win Margin, Amazon, asinh



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



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



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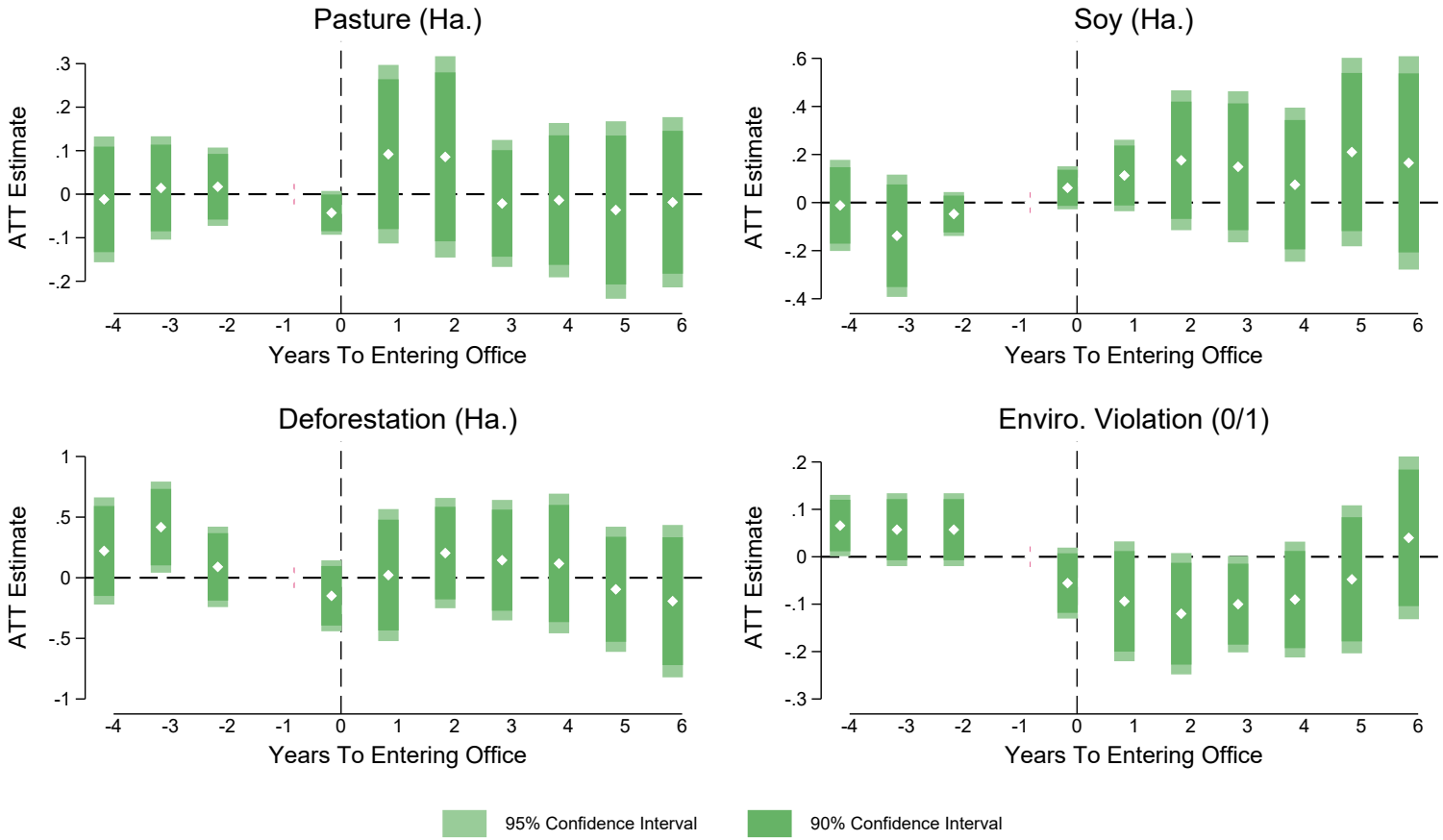
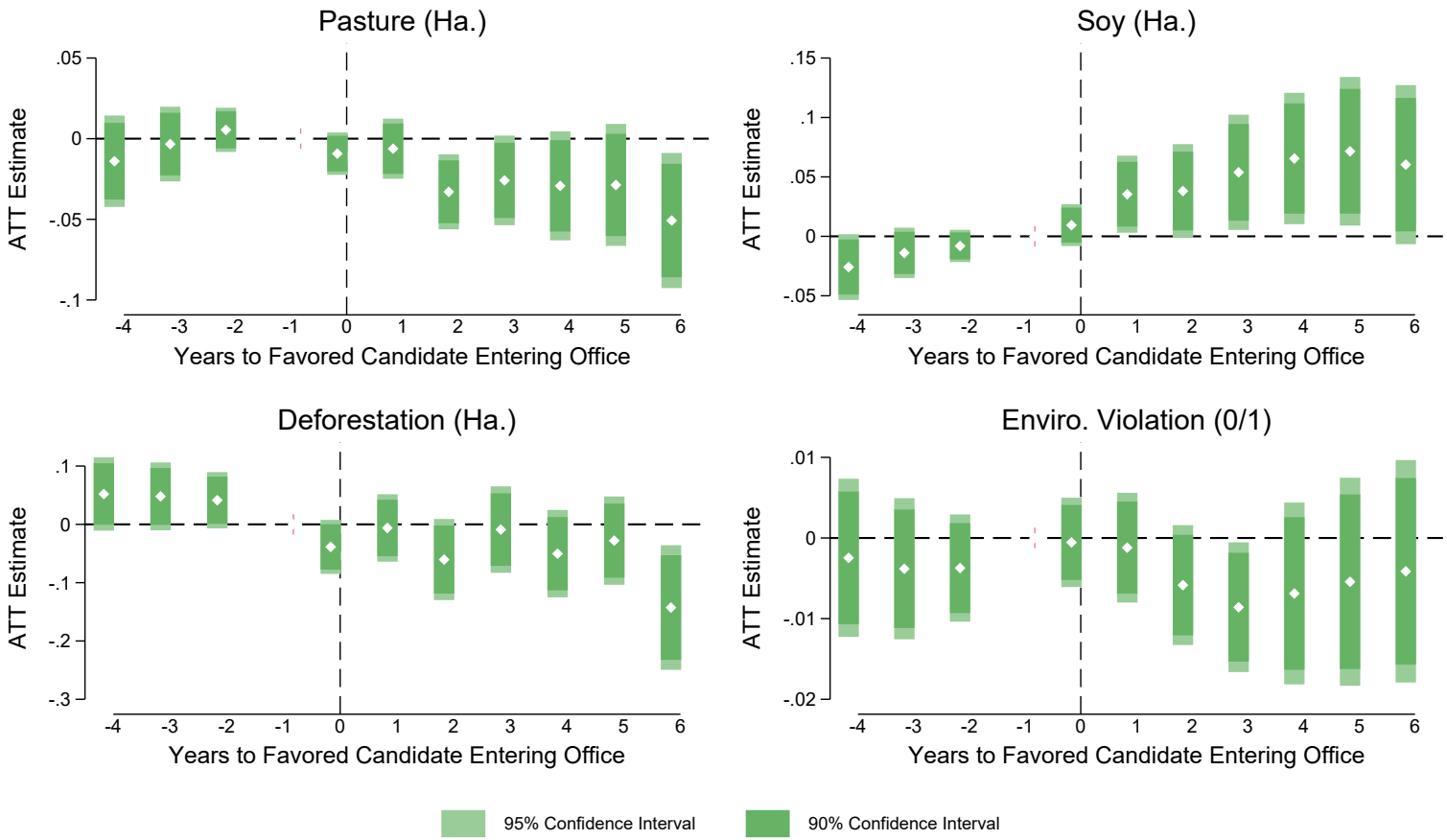
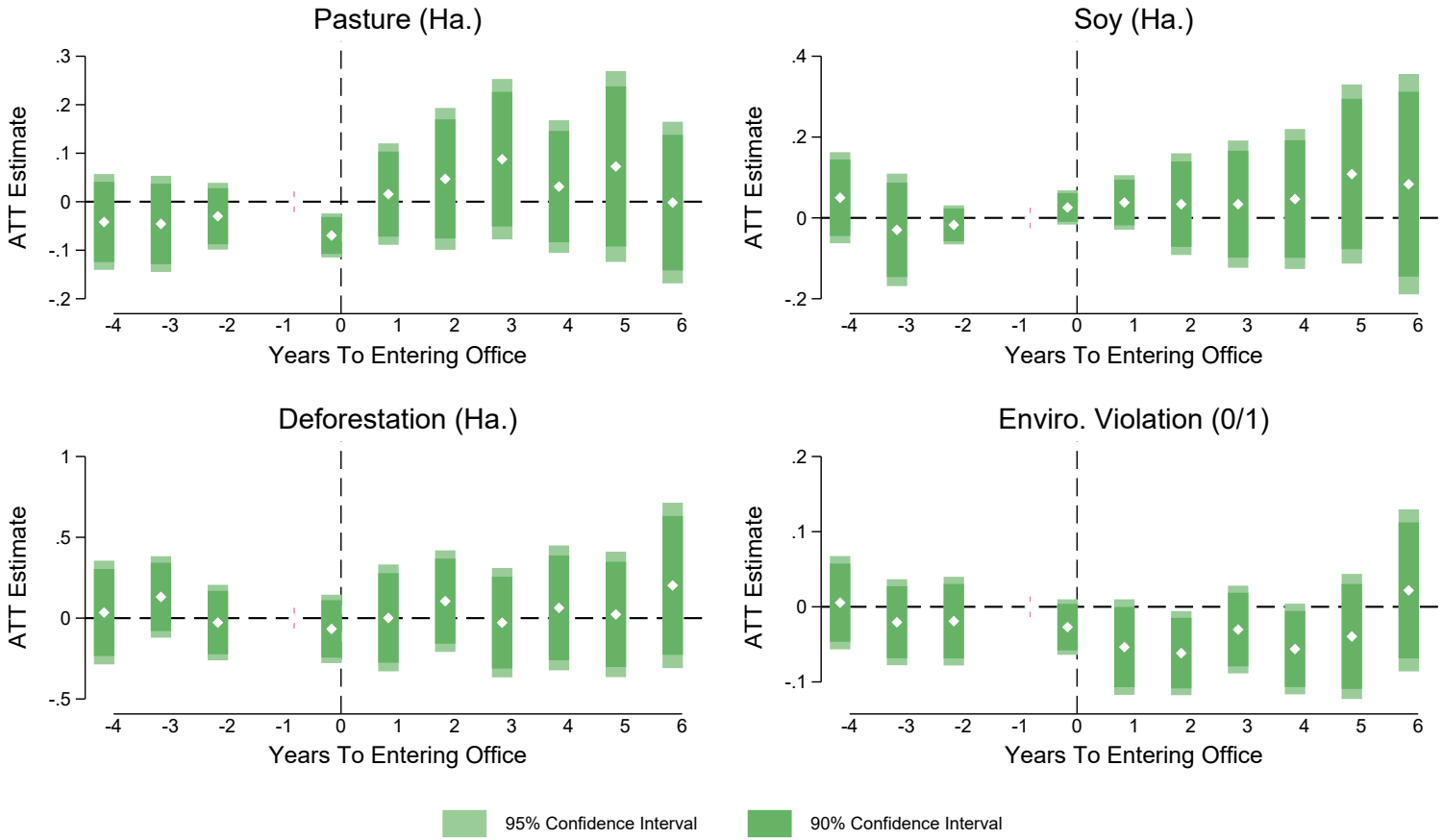


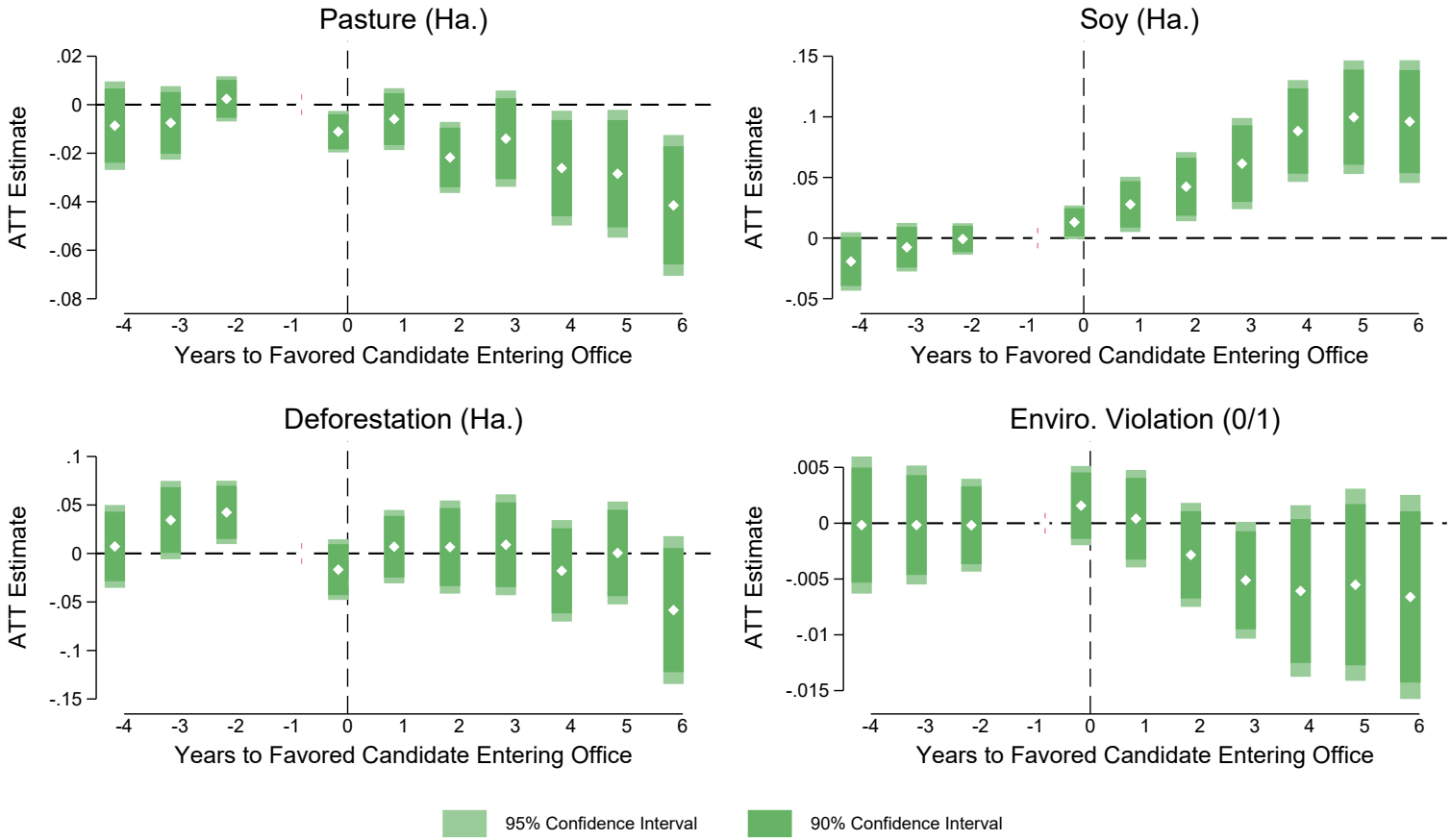
Robustness: Donor Properties, 10% Win Margin, Amazon, asinh



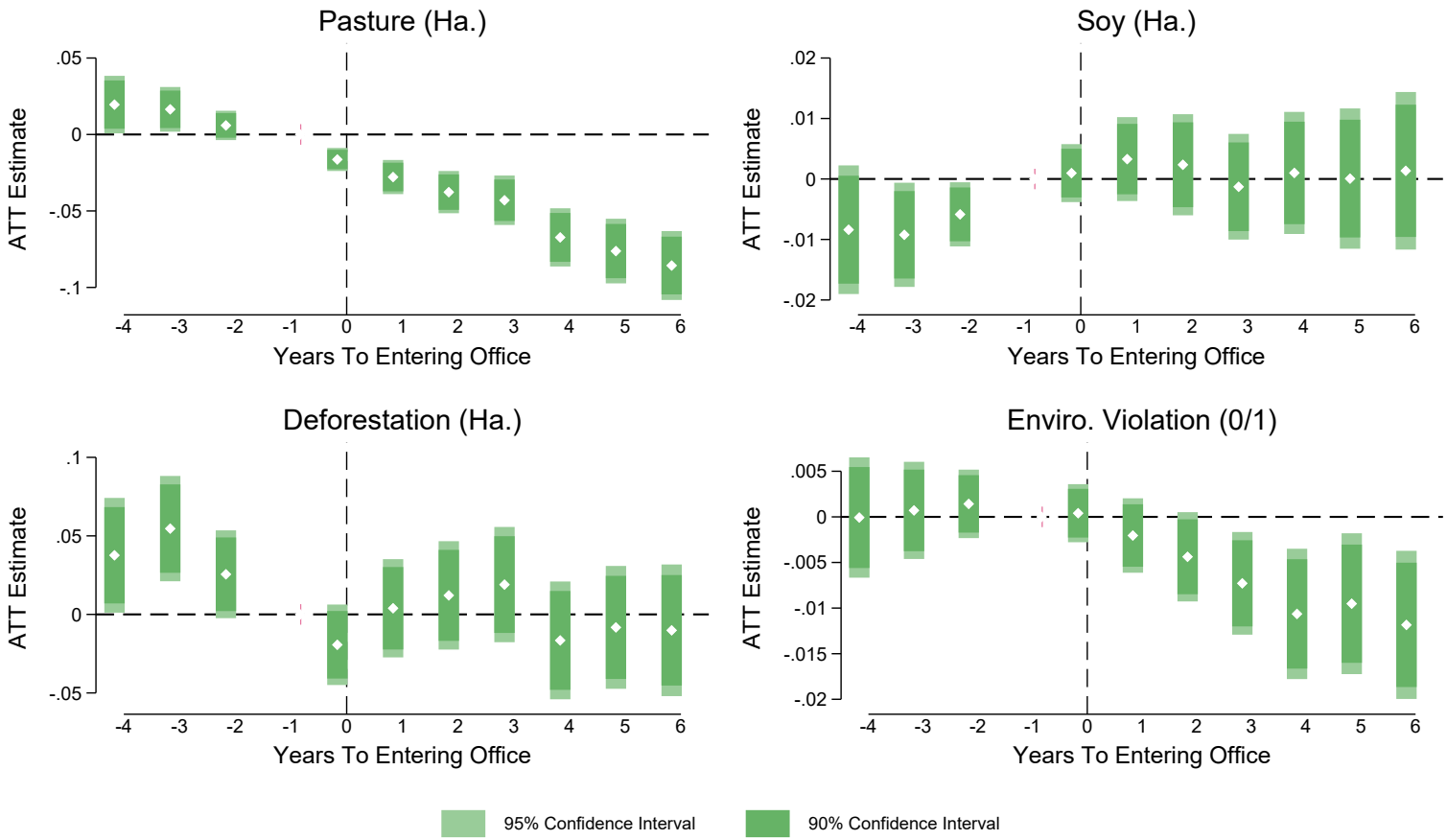
Robustness: Candidate Properties, 10% Win Margin, Amazon, asinh



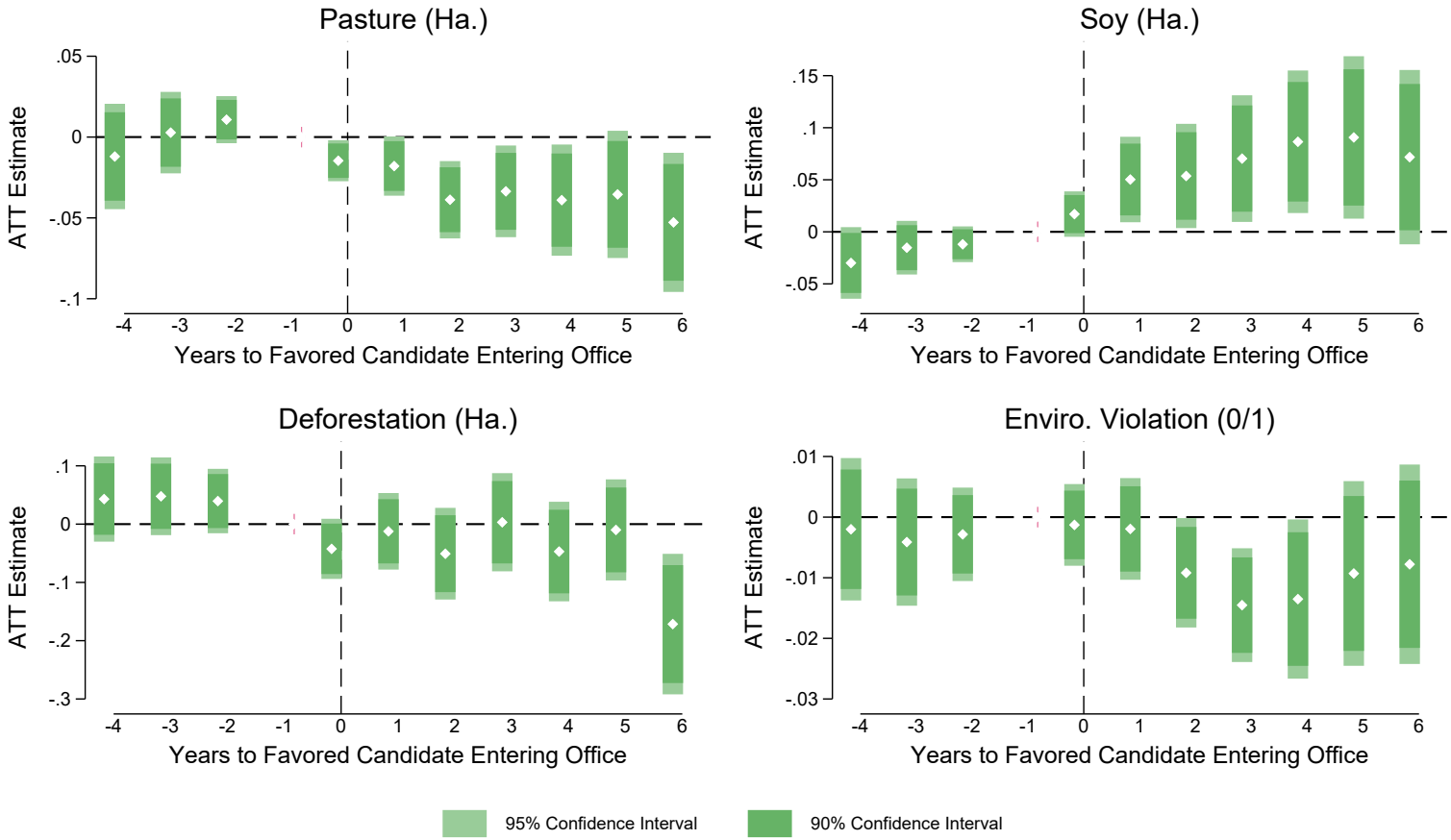
Robustness: Donor Properties, All Elections, Amazon, asinh



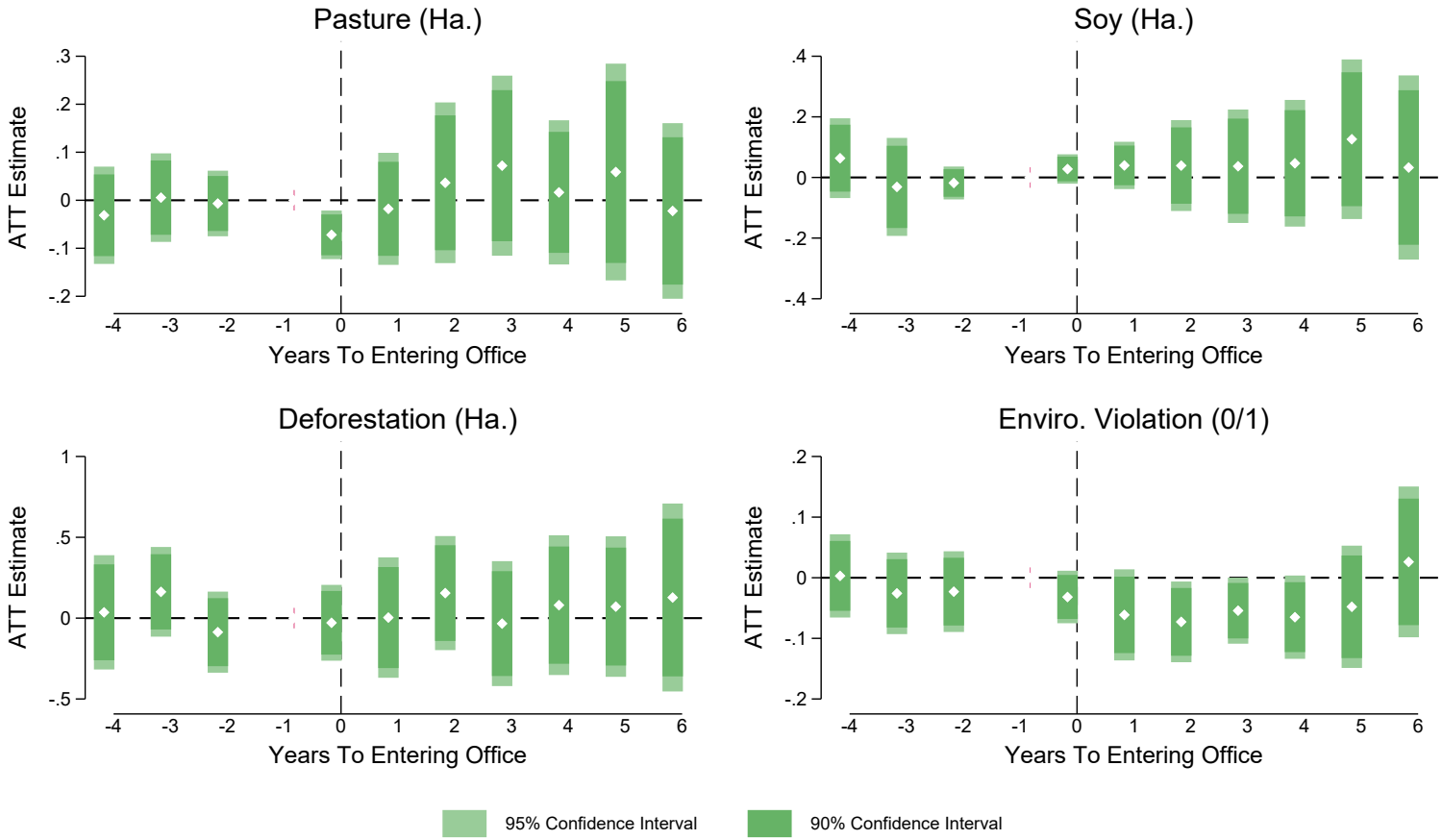
Robustness: Candidate Properties, All Elections, Amazon, asinh



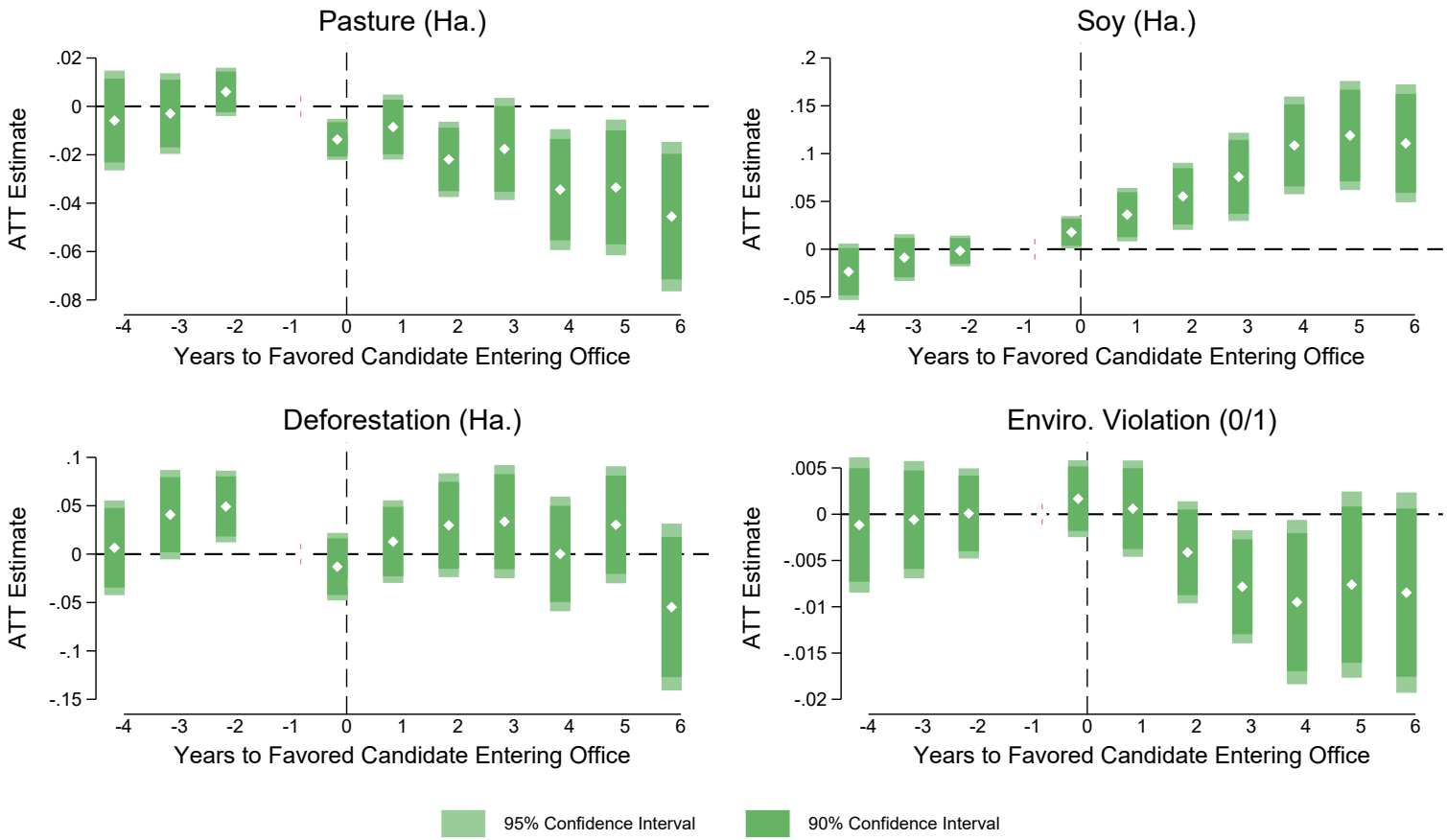
Robustness: Donor Properties, 10% Win Margin, MT/PA/RO, asinh



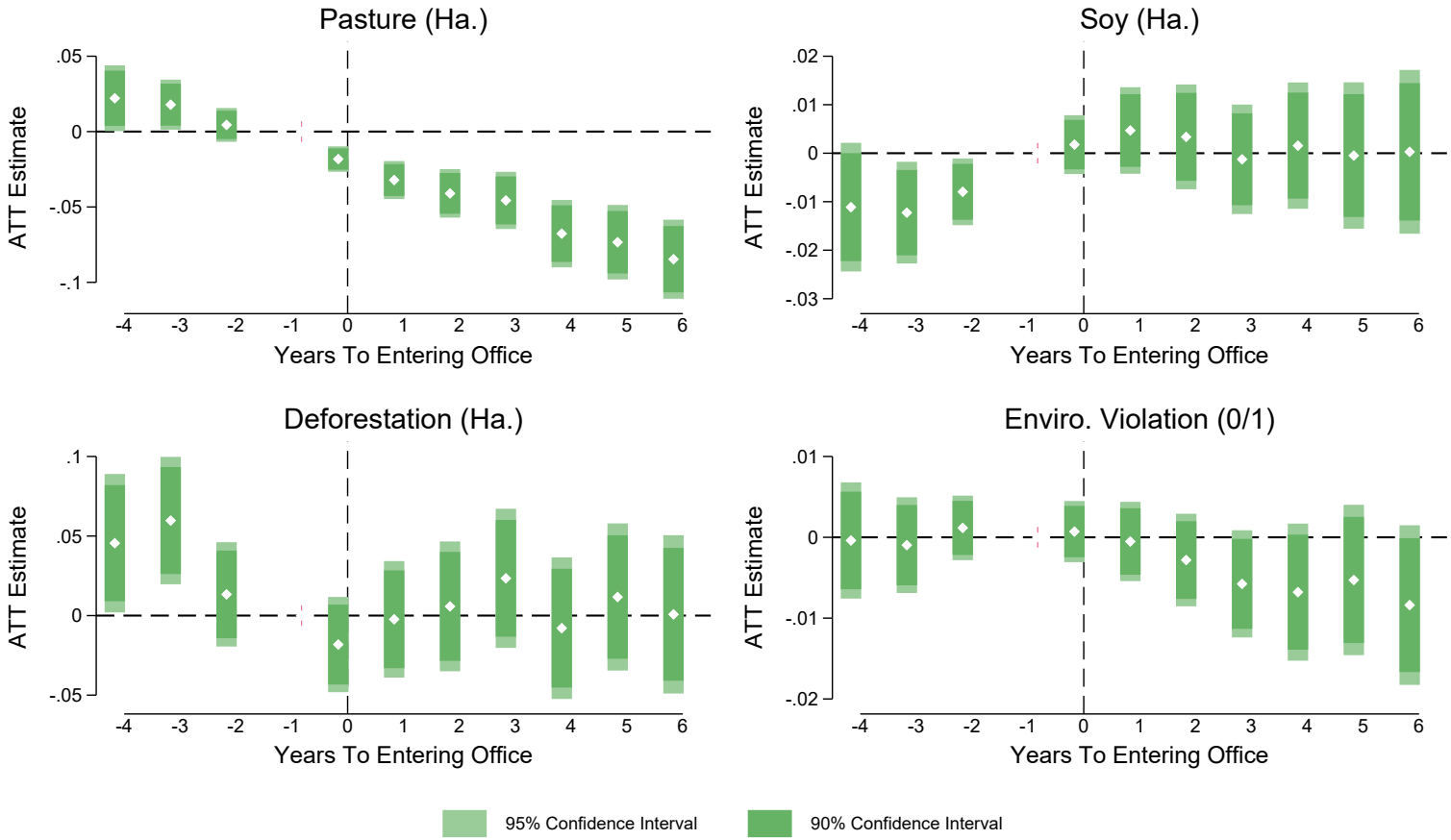
Robustness: Candidate Properties, 10% Win Margin, MT/PA/RO, asinh



Robustness: Donor Properties, All Elections, MT/PA/RO, asinh

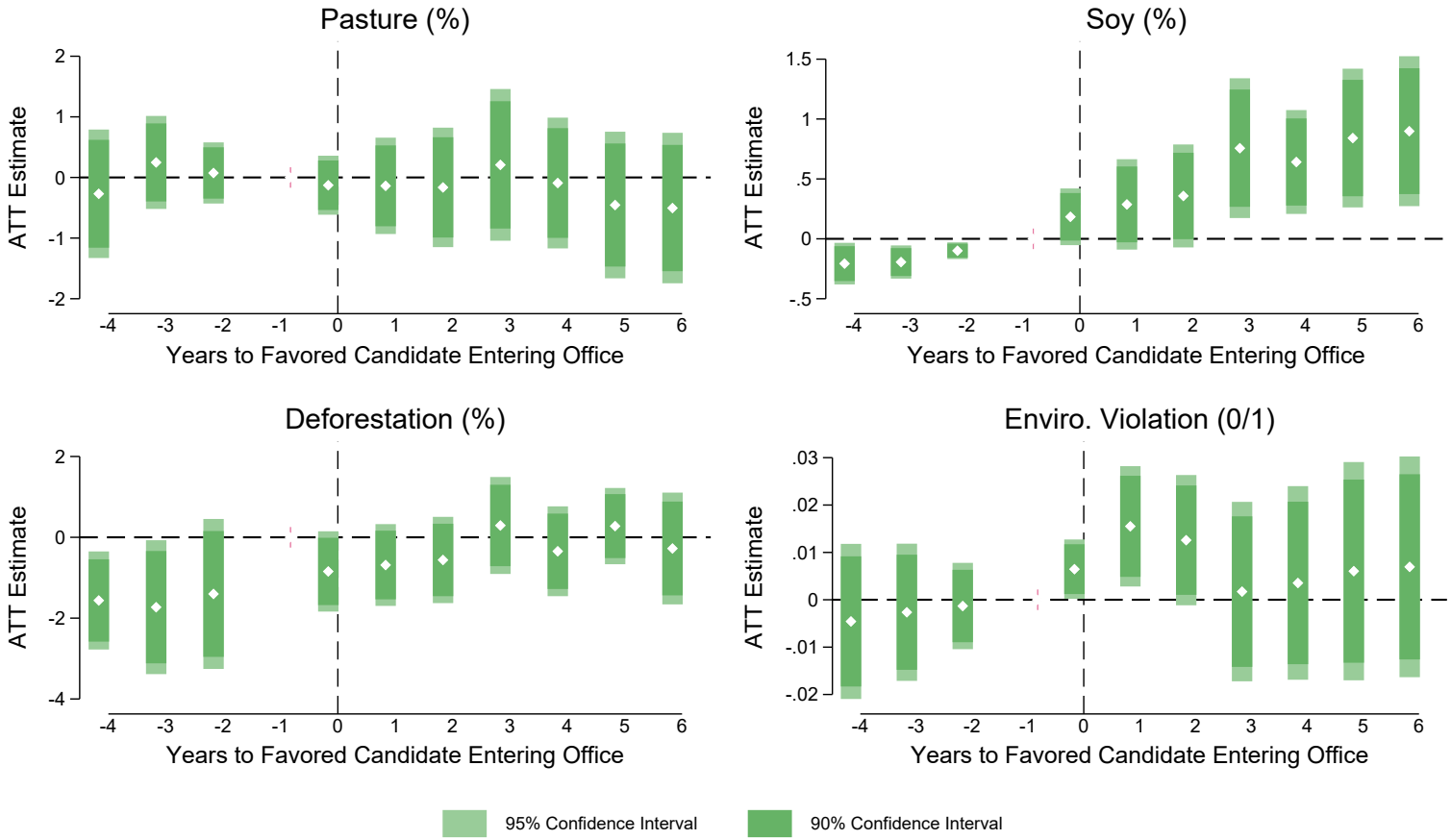


Robustness: Candidate Properties, All Elections, MT/PA/RO, asinh

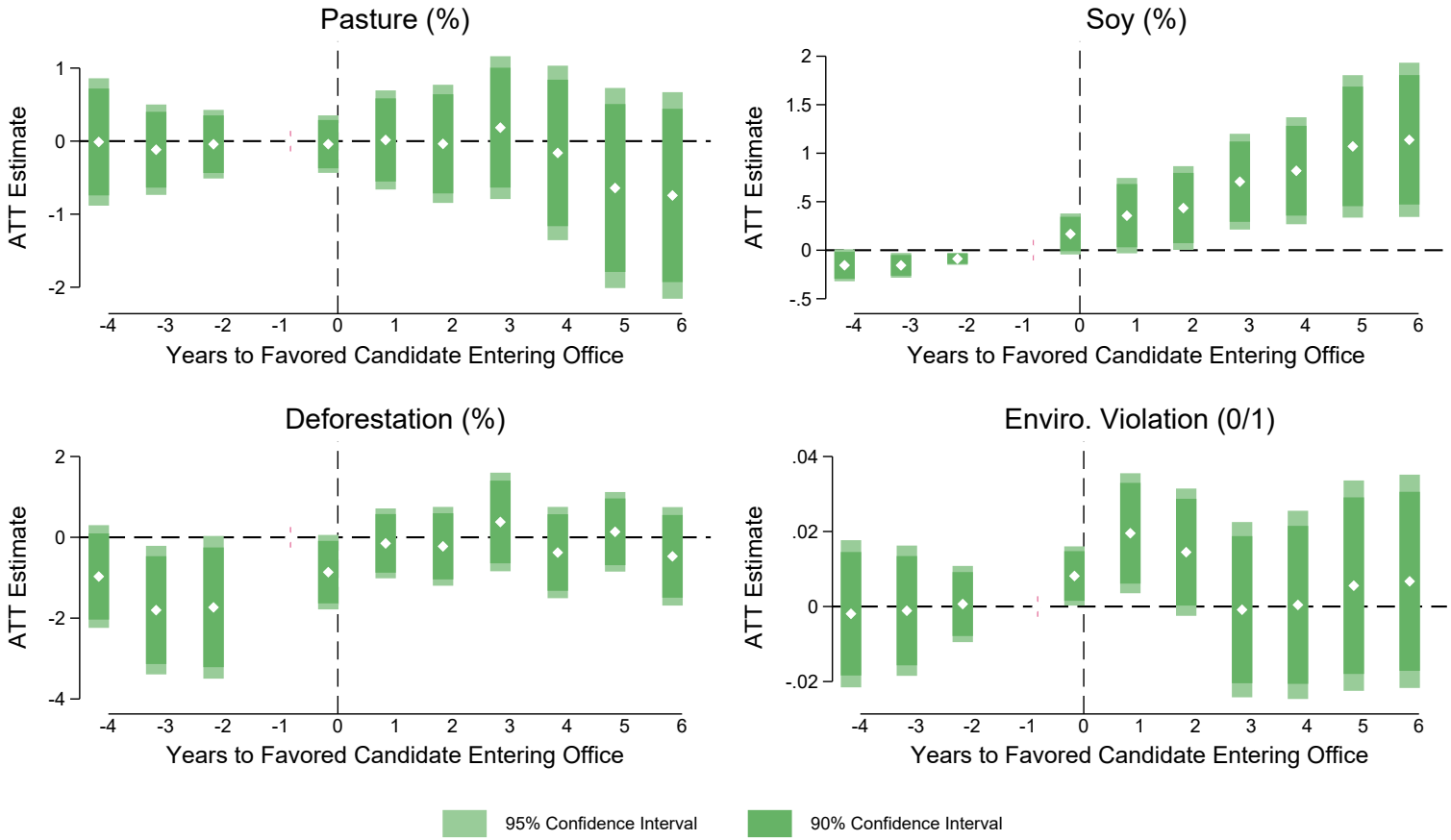


▸ Return

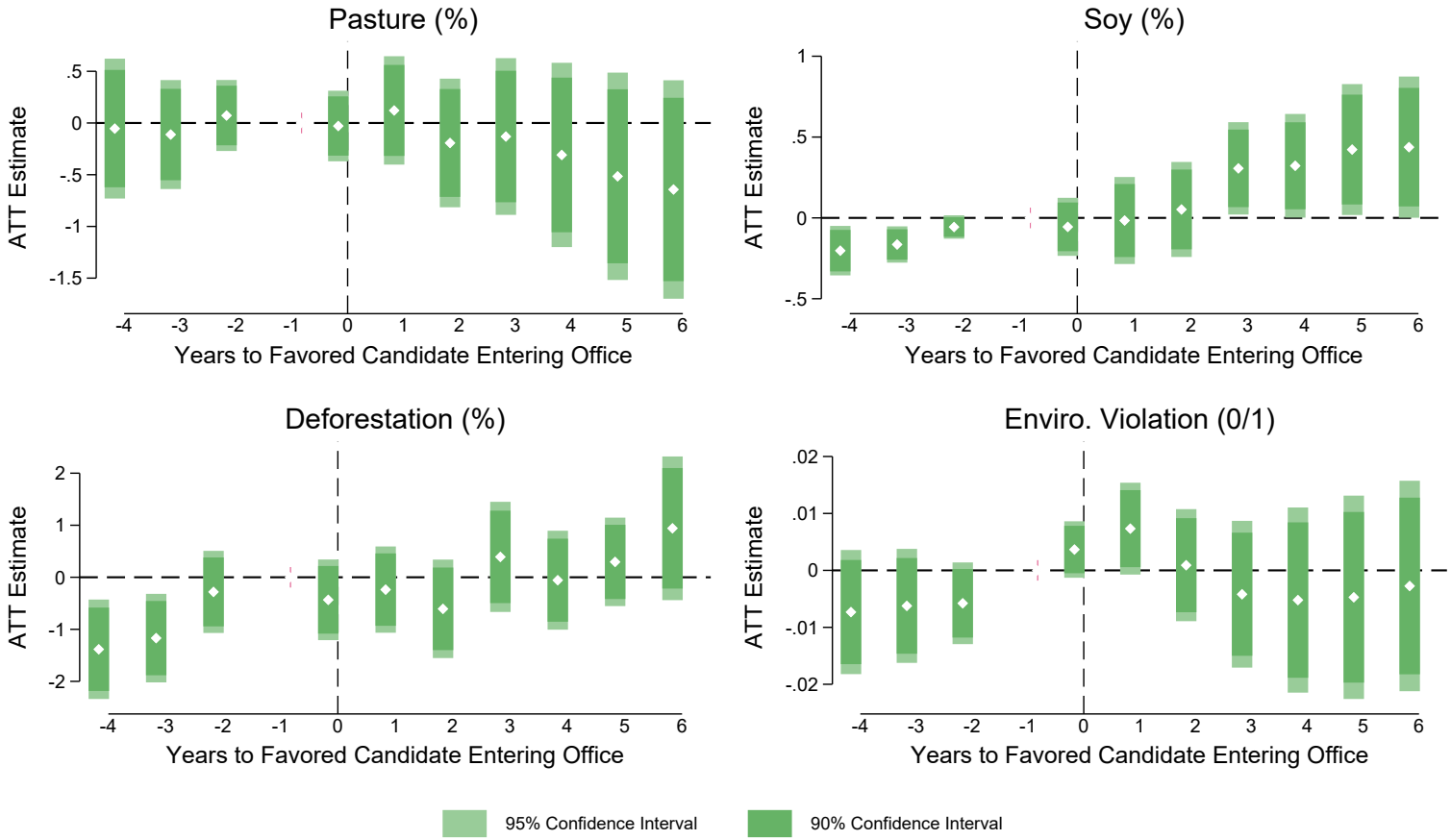
Robustness: Donor Properties, 5% Win Margin, Amazon, M-E FEs



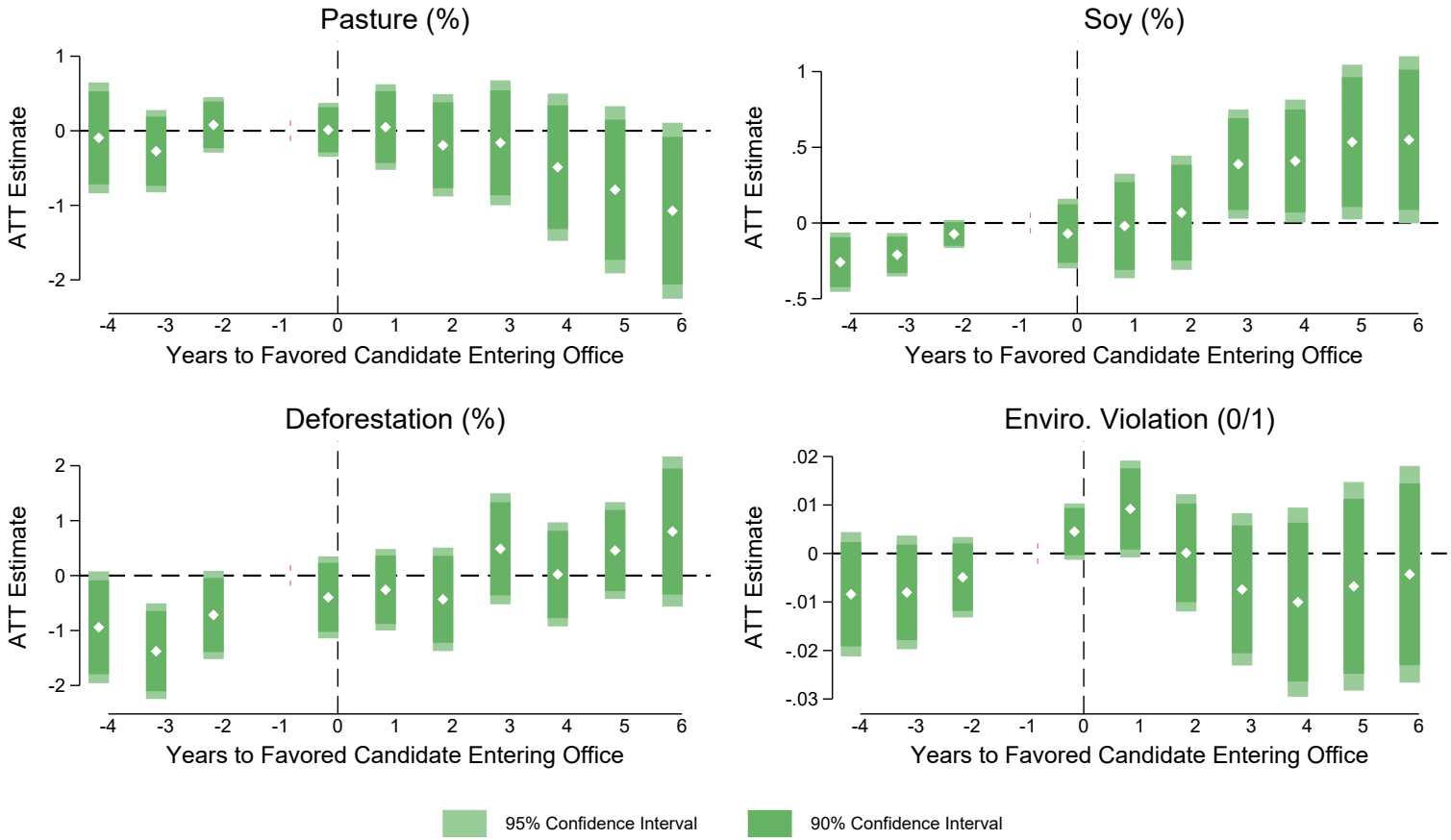
Robustness: Donor Properties, 5% Win Margin, MT/PA/RO, M-E FEs



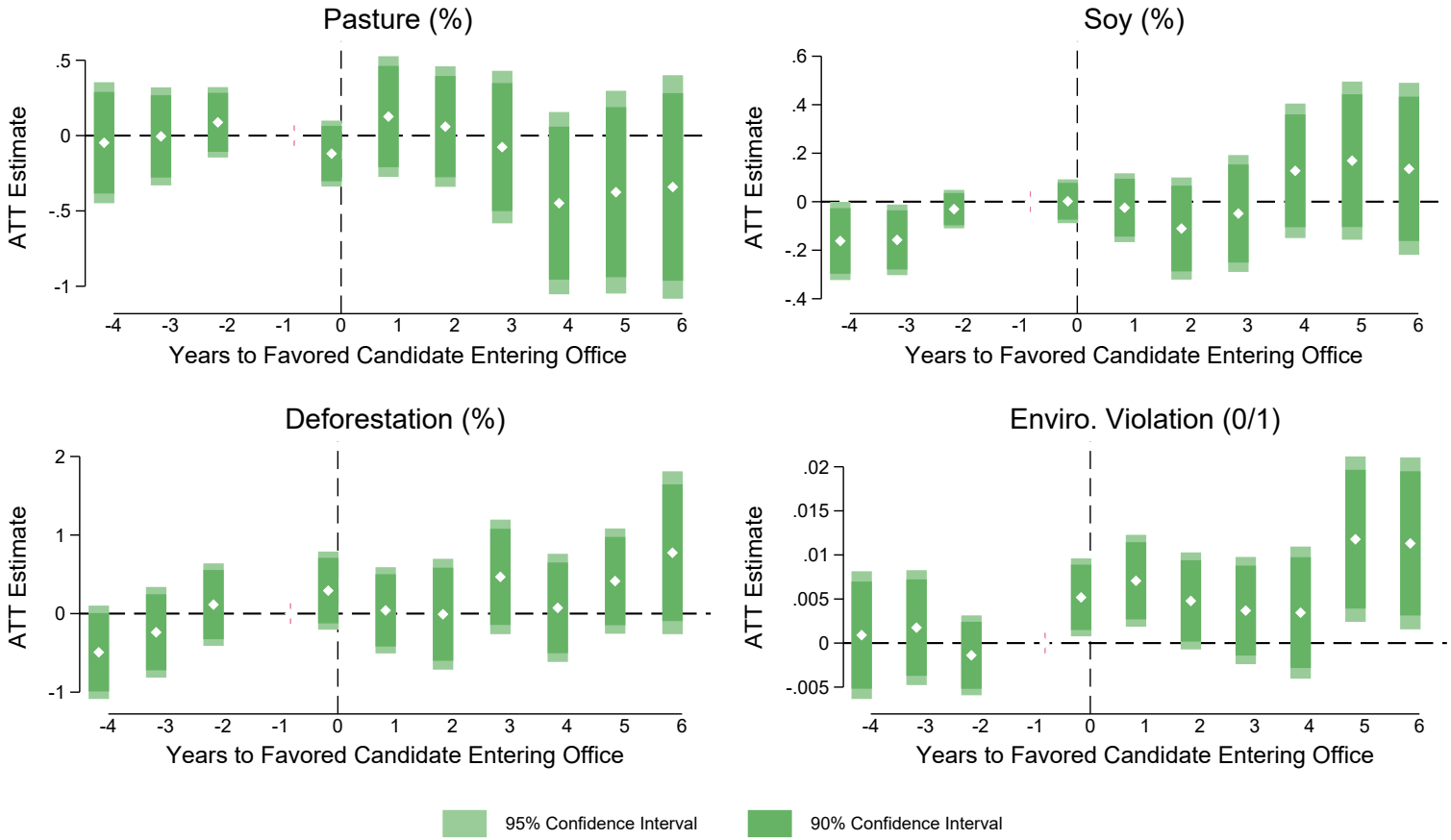
Robustness: Donor Properties, 10% Win Margin, Amazon, M-E FEs



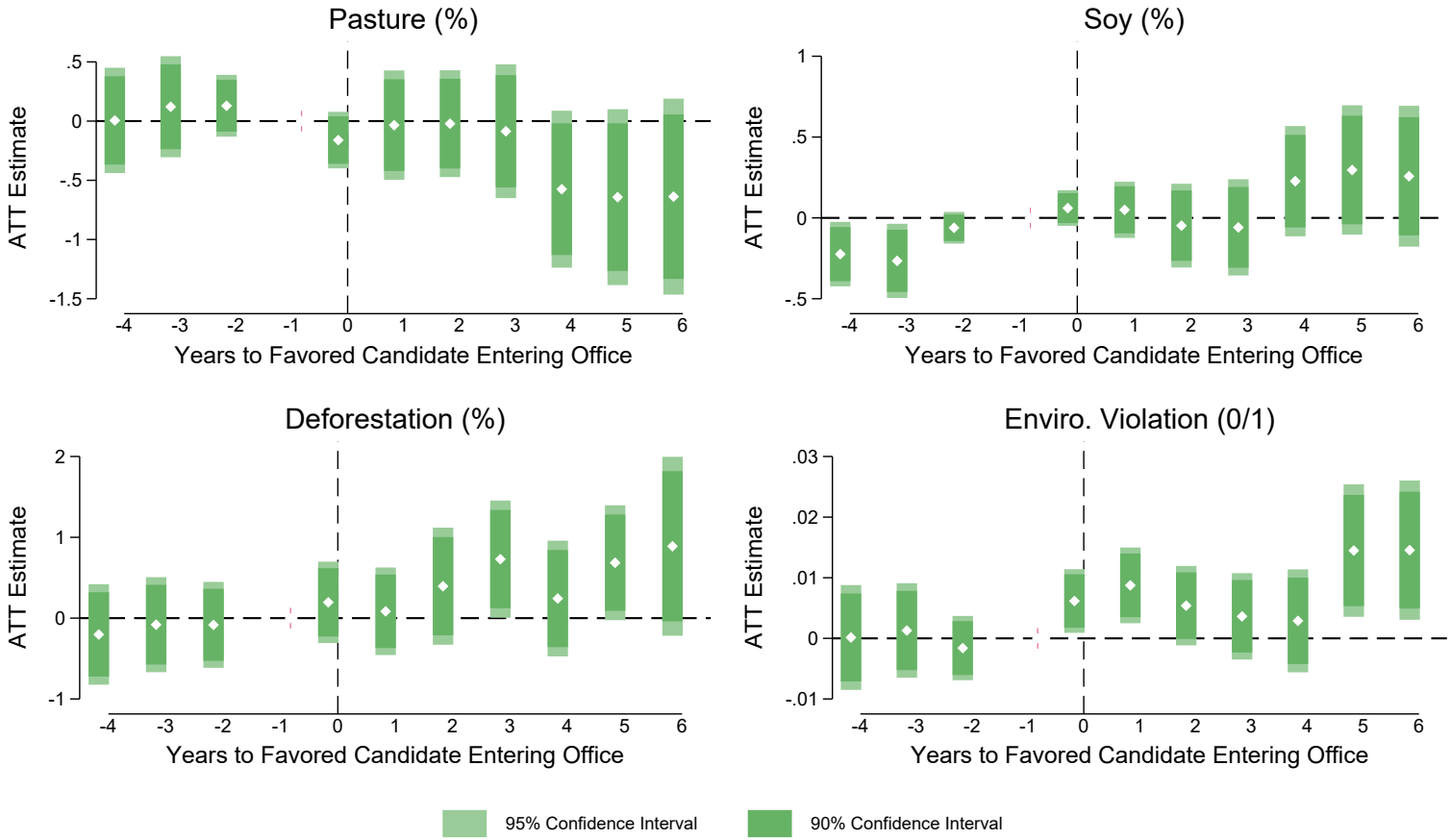
Robustness: Donor Properties, 10% Win Margin, MT/PA/RO, M-E FEs



Robustness: Donor Properties, All Elections, Amazon, M-E FEs

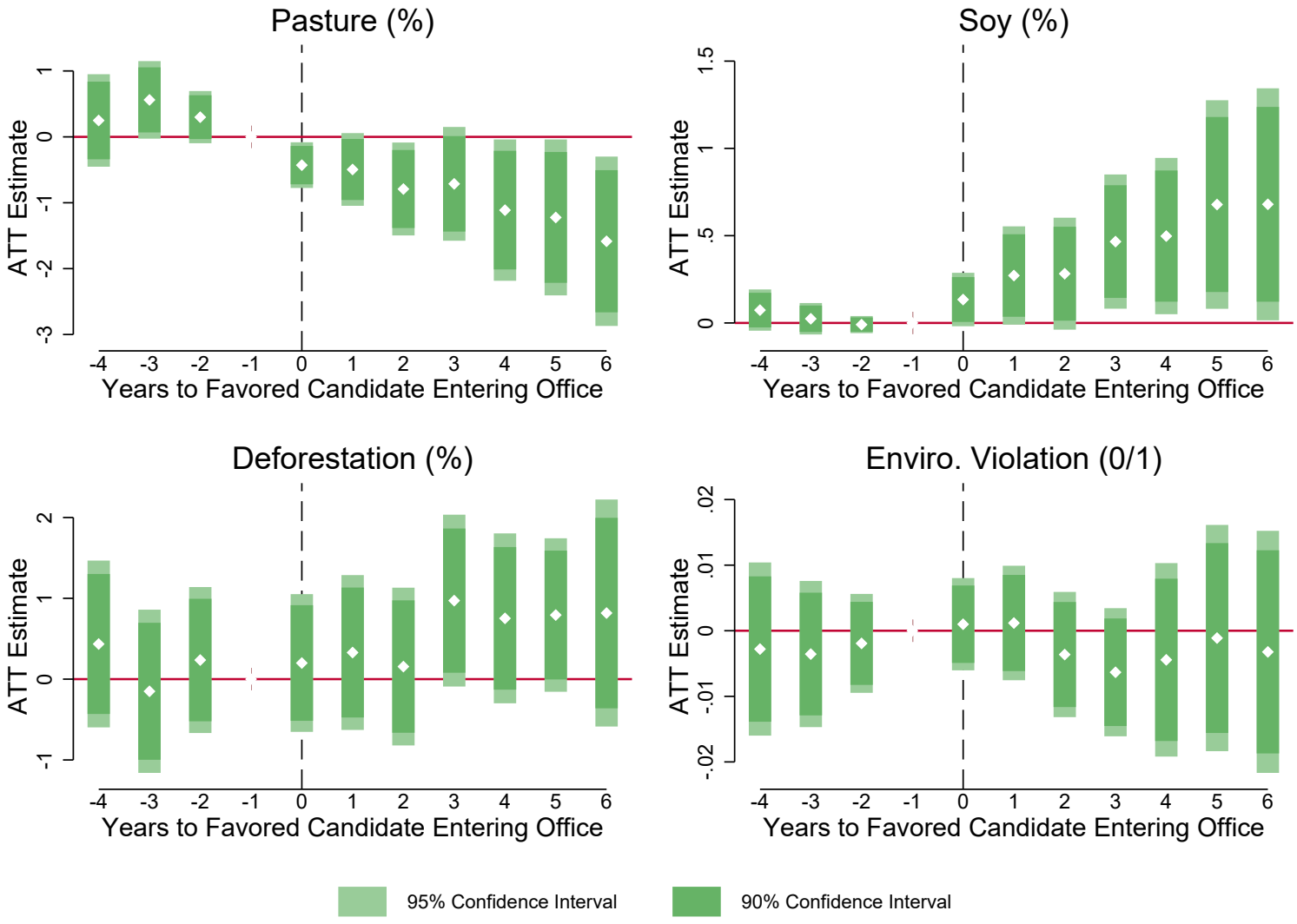


Robustness: Donor Properties, All Elections, MT/PA/RO, M-E FEs



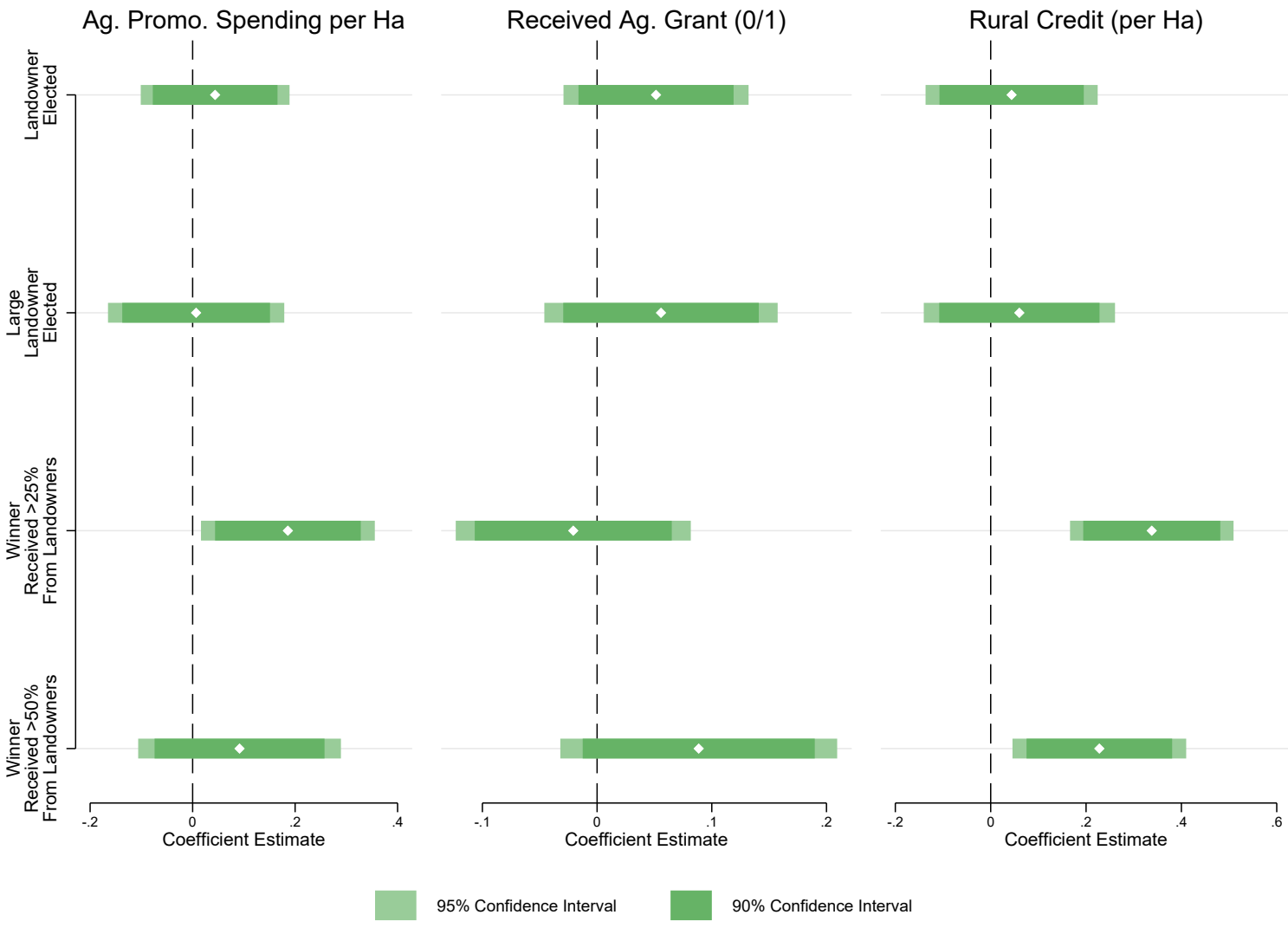
▸ Return

Figure: Donors: Inclusion of Win-Margin Running Variable



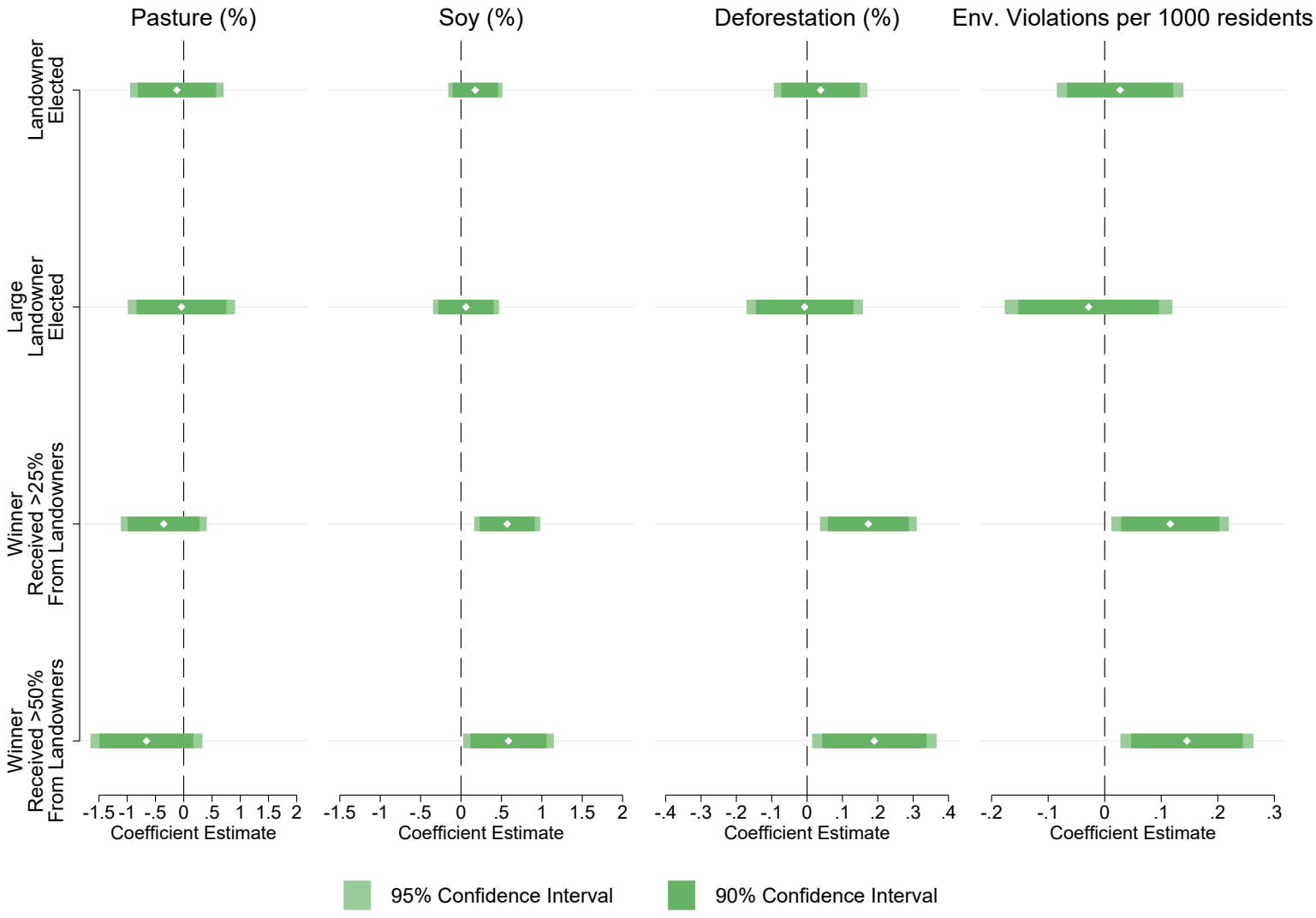
Return

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



▸ Return

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



Return

Figure: Municipalities: Legal Amazon (Governance)

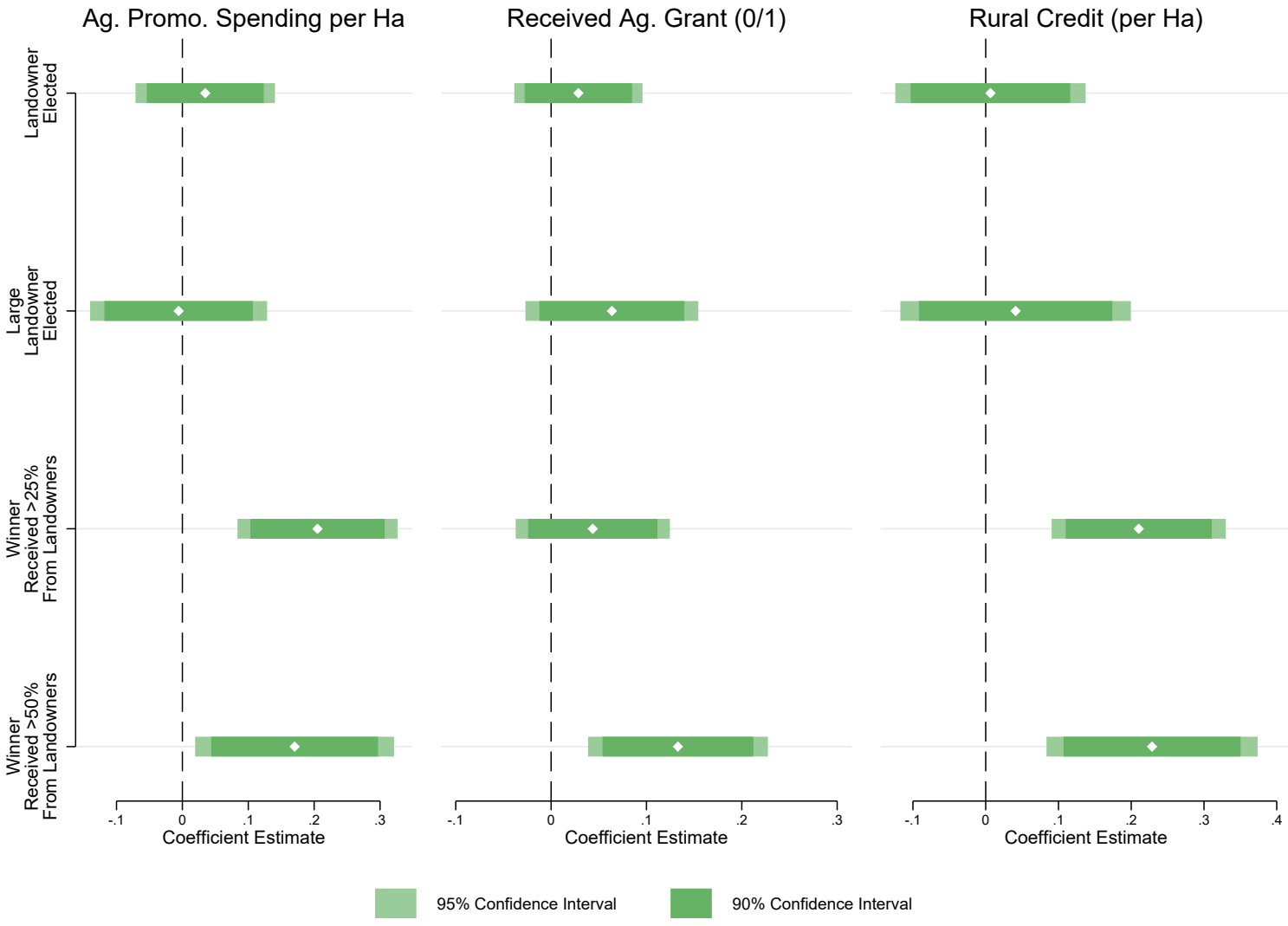


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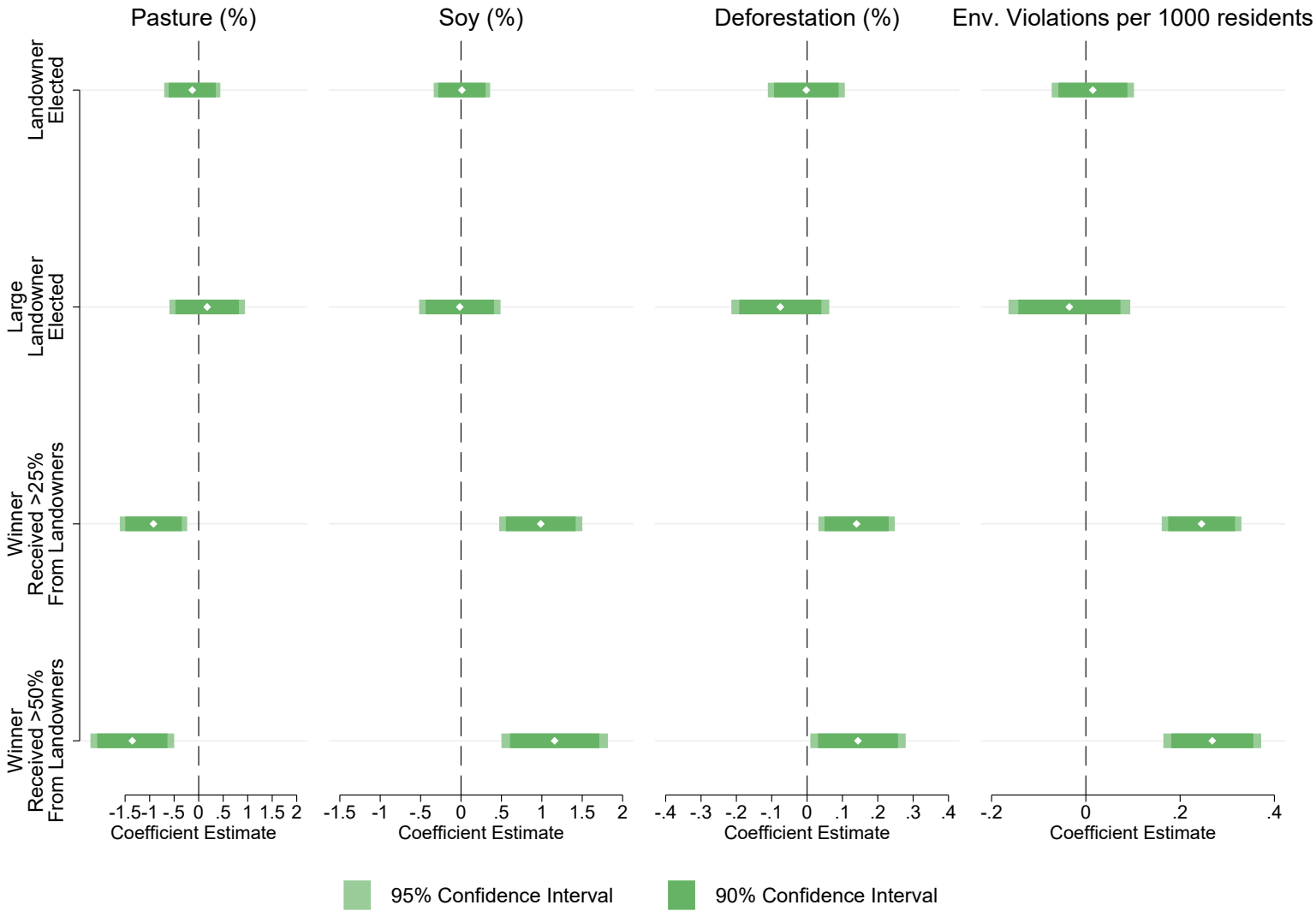
Figure: Municipalities: Legal Amazon (Land-Use)

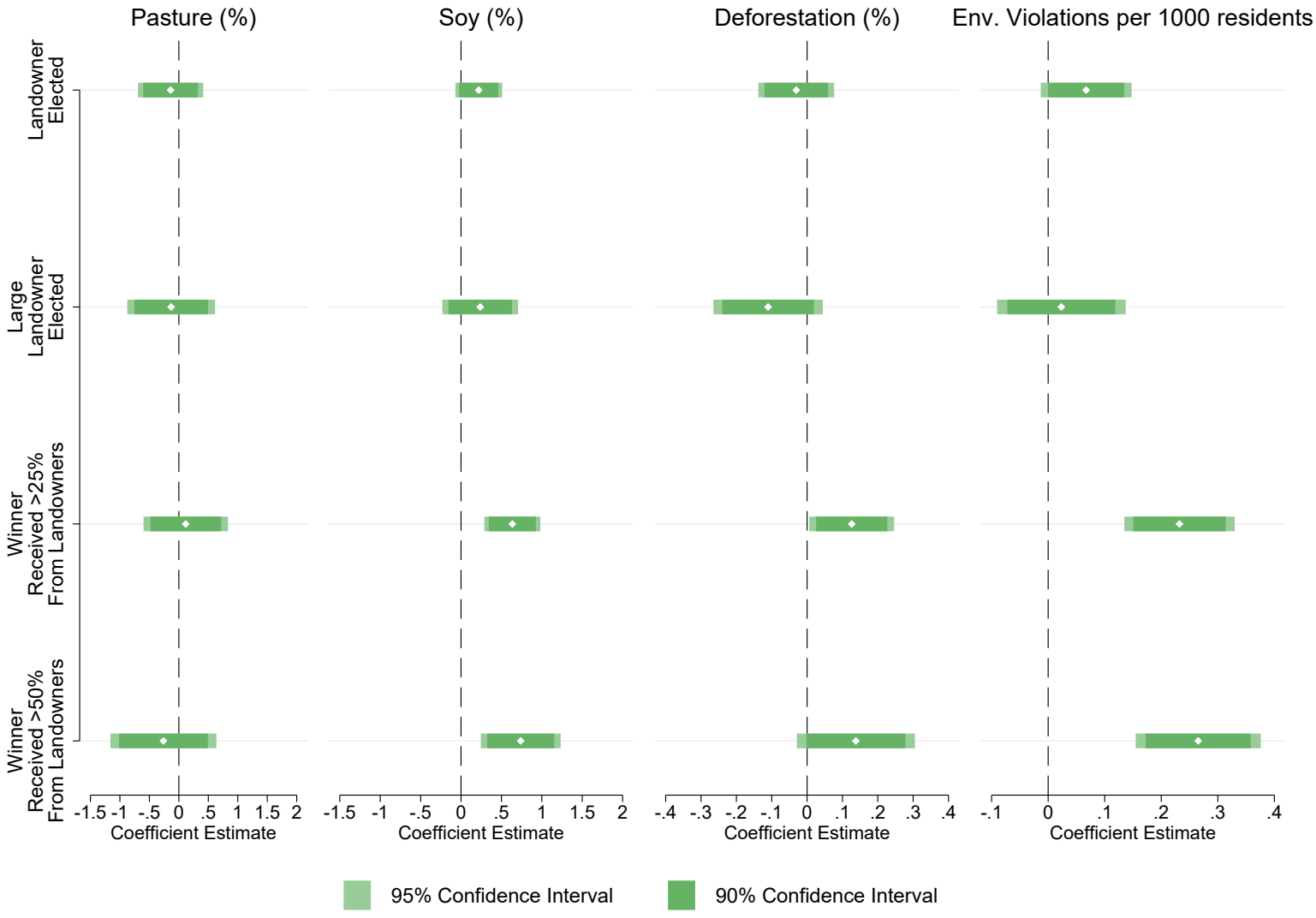


Return

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

Return

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

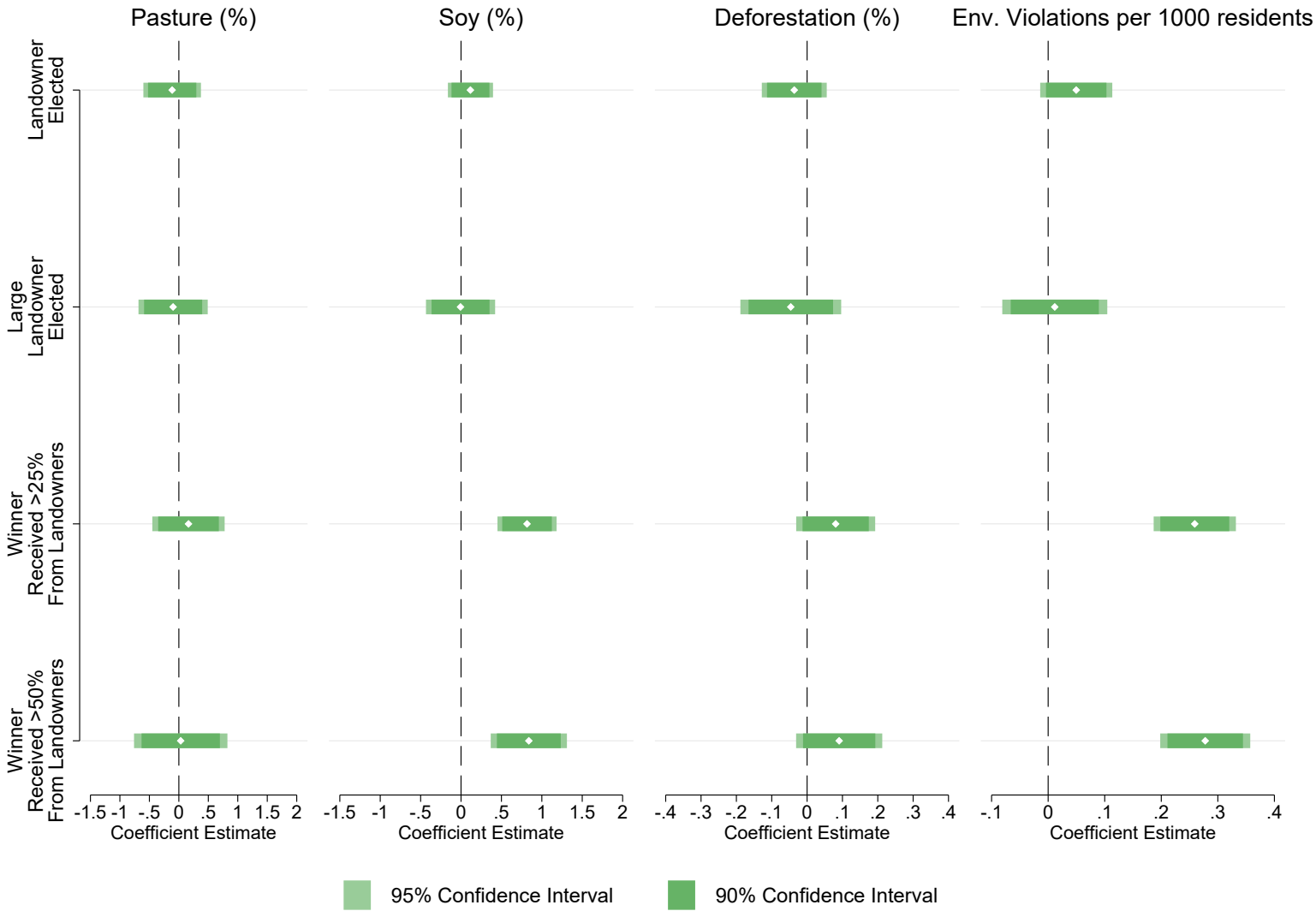


Return

Figure: Municipalities: No Close Election Cutoff (Governance)

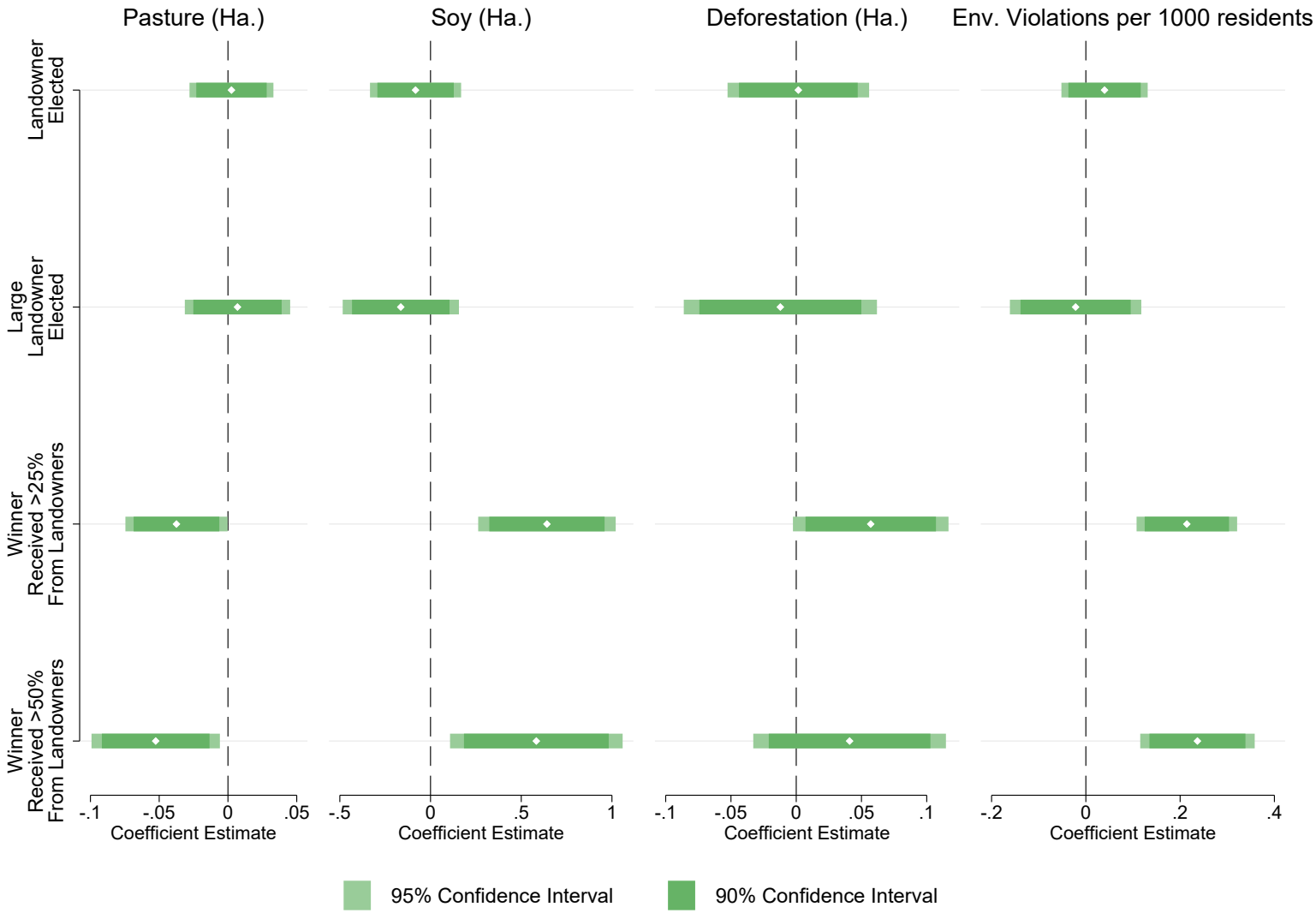
Return

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



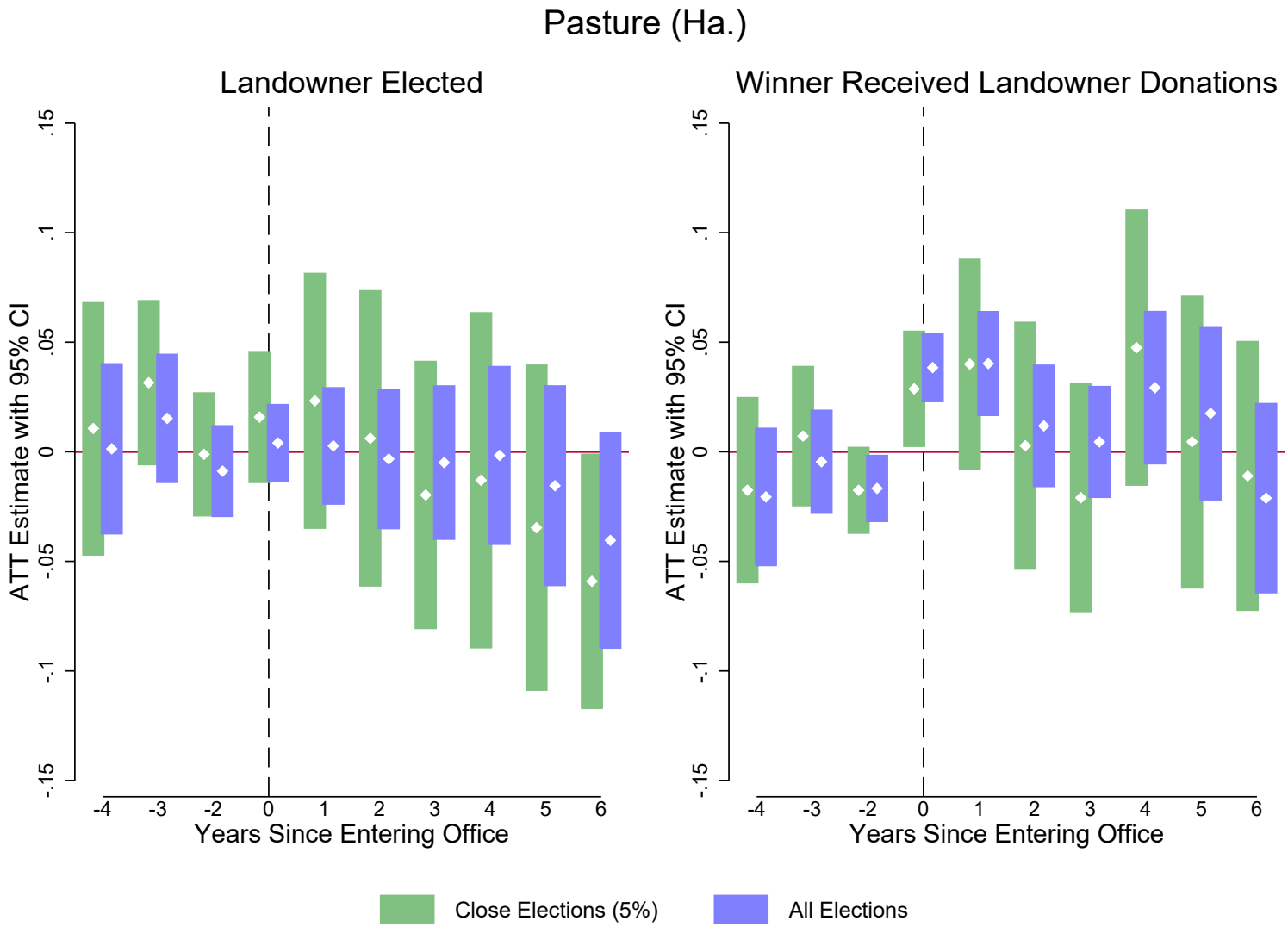
Return

Figure: Municipalities: Land-Use with asinh Transformation

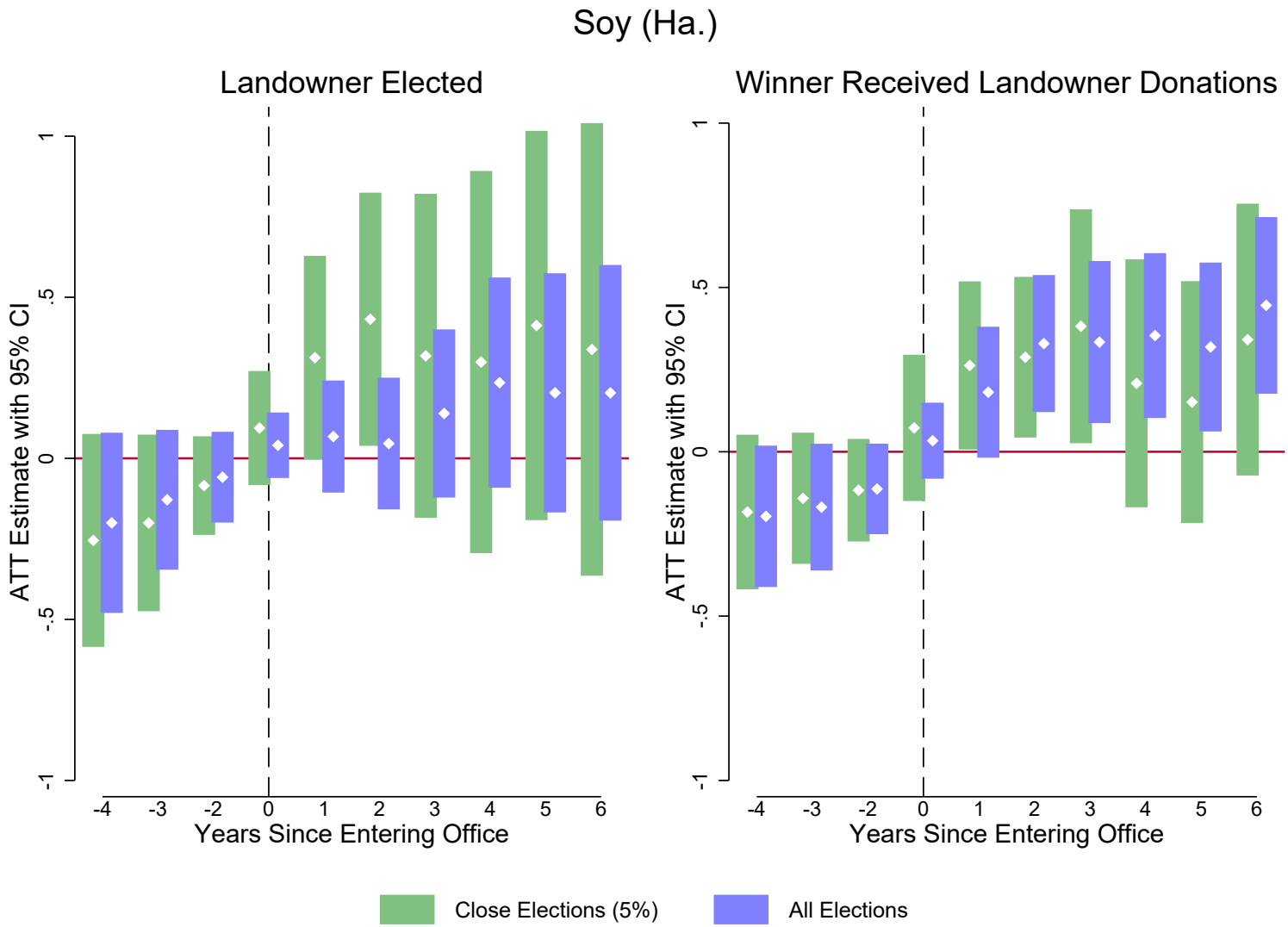


Return

Municipal Event Study: Pasture

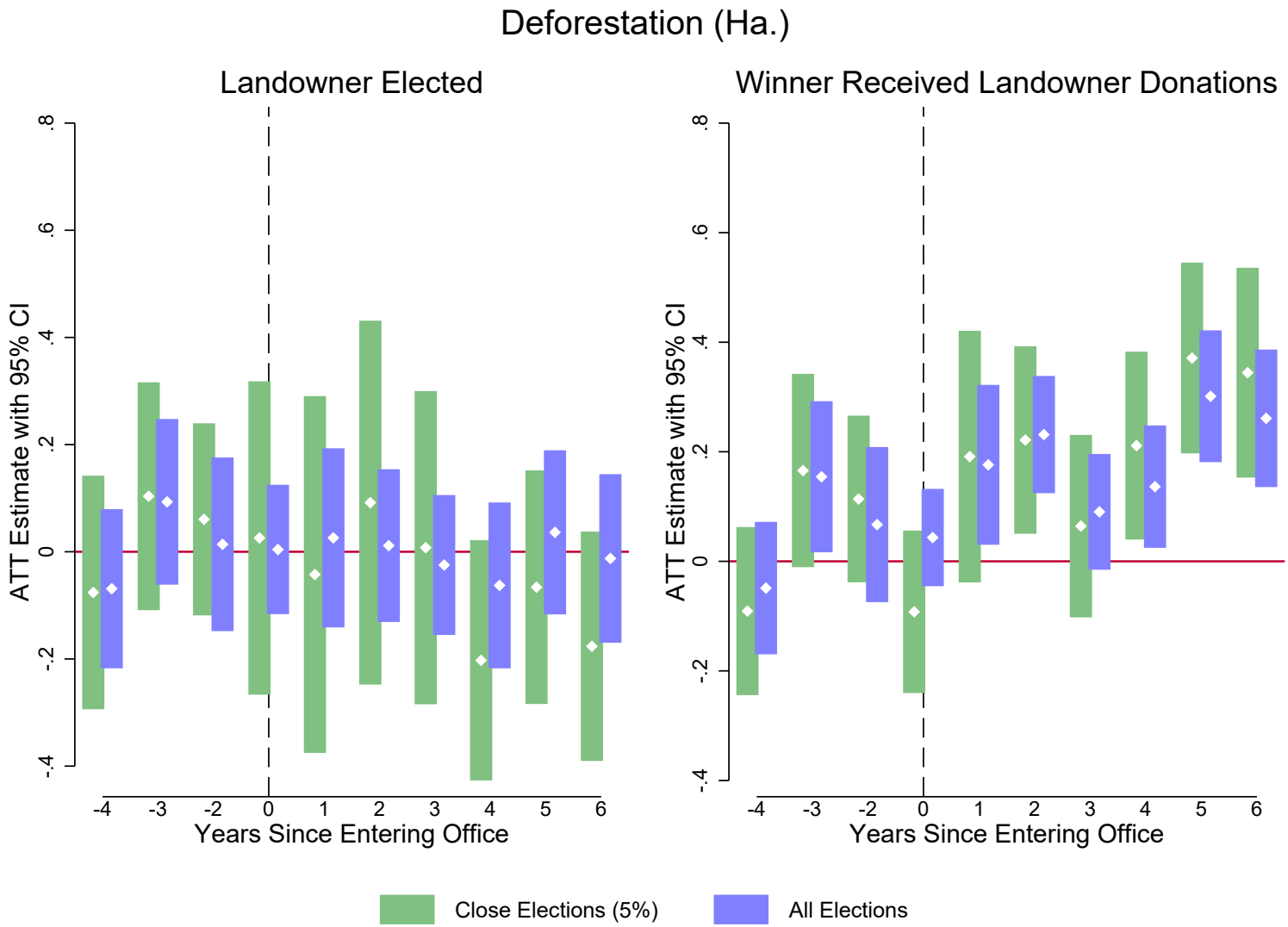


Municipal Event Study: Soy

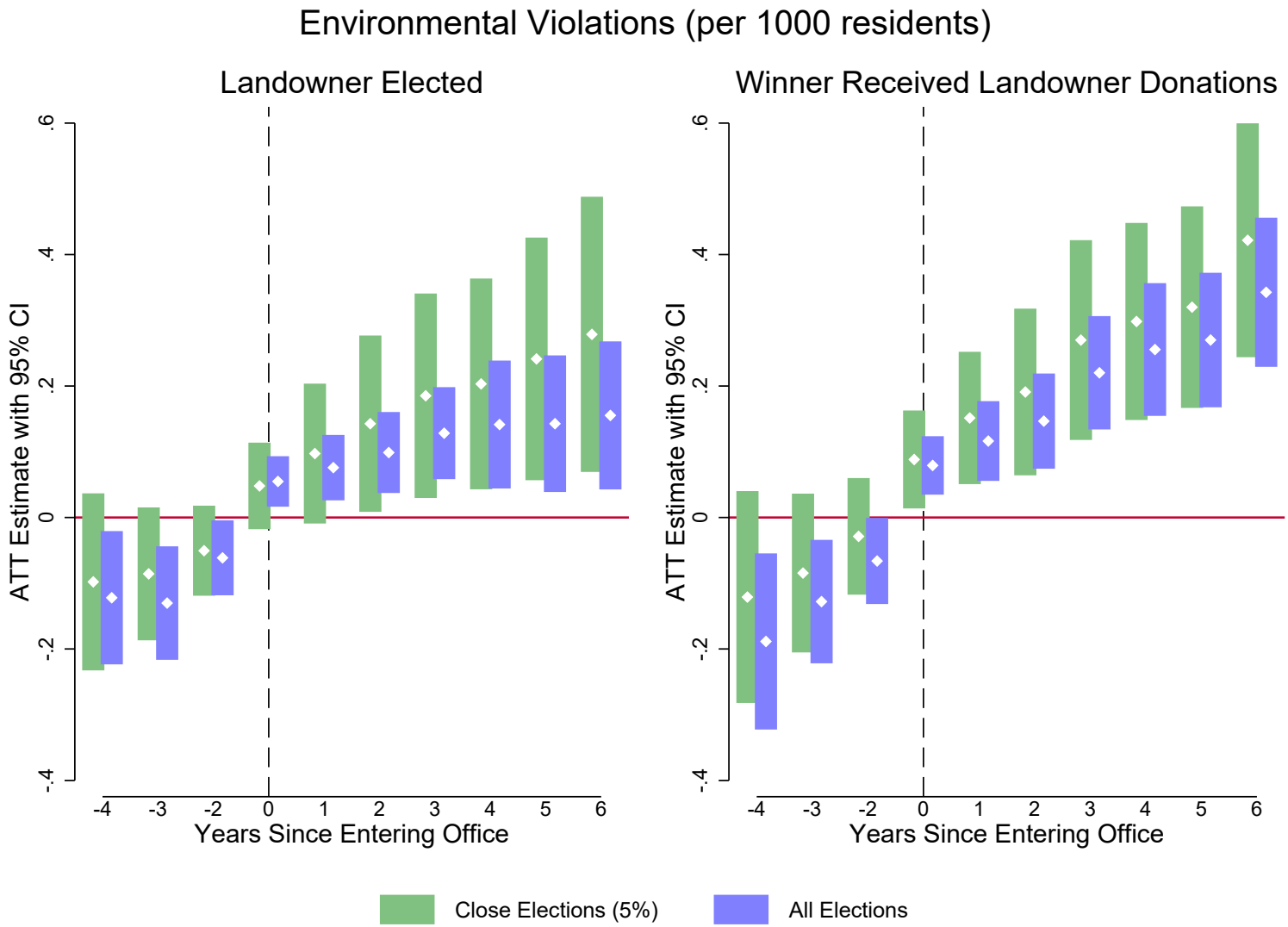


Return

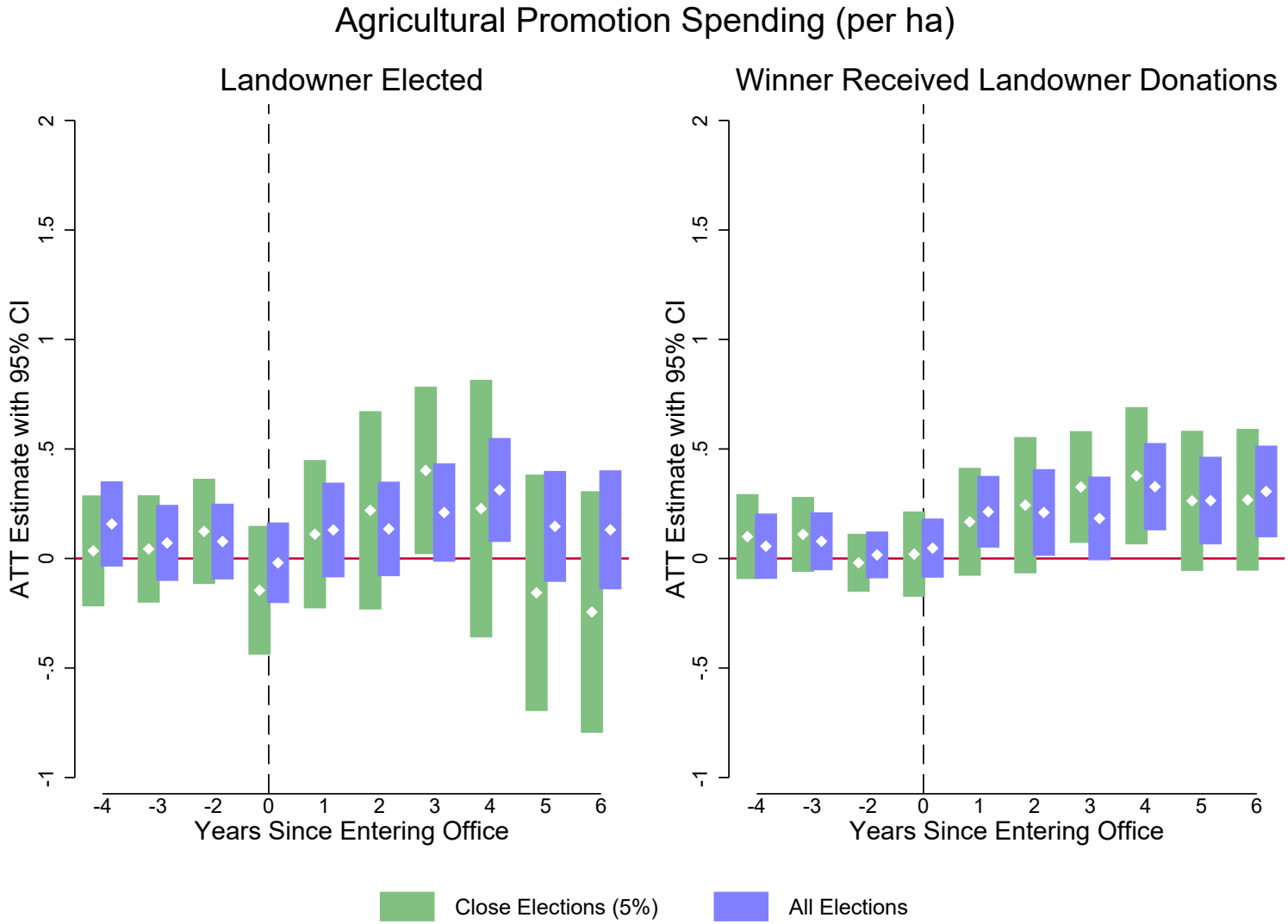
Municipal Event Study: Deforestation



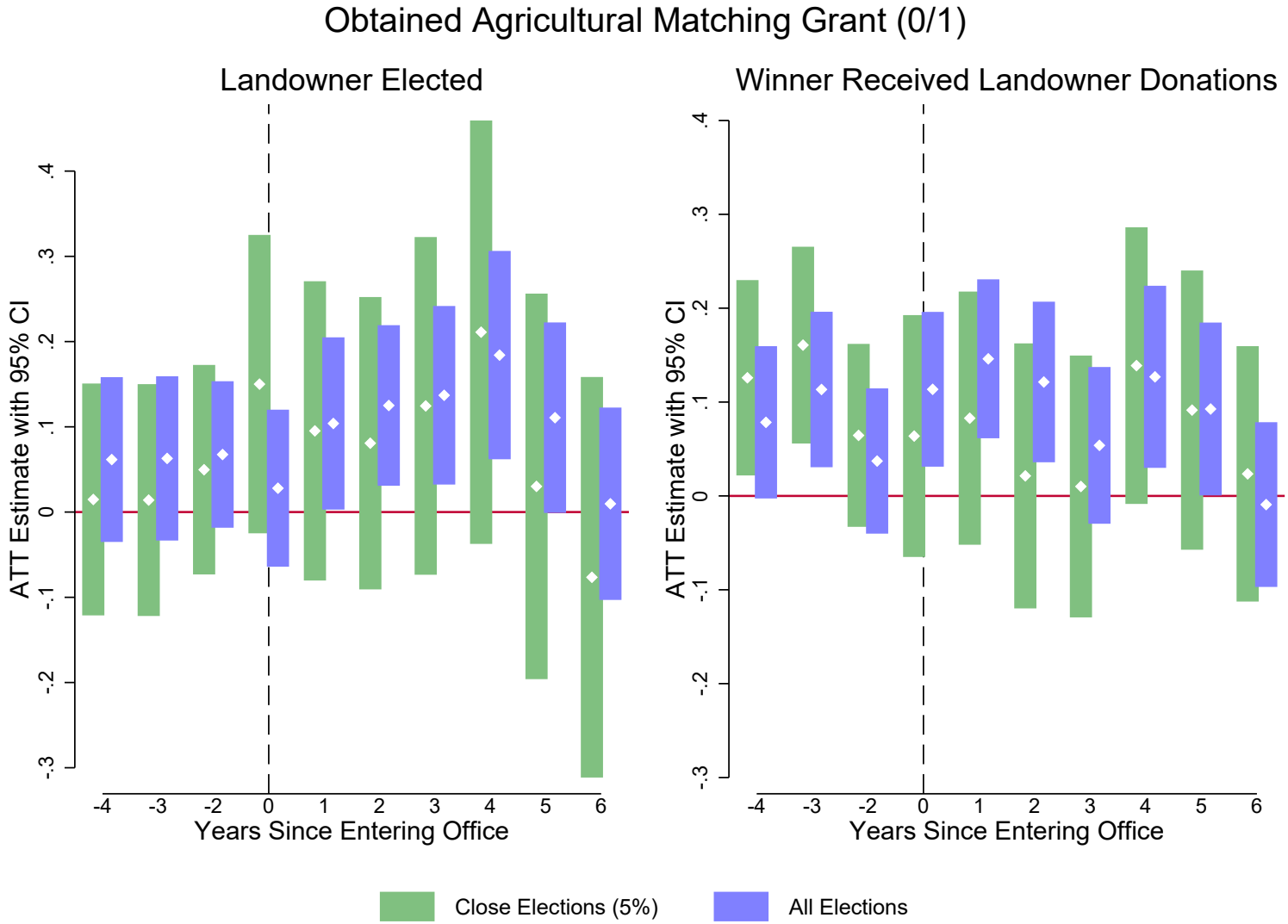
Municipal Event Study: Environmental Violations



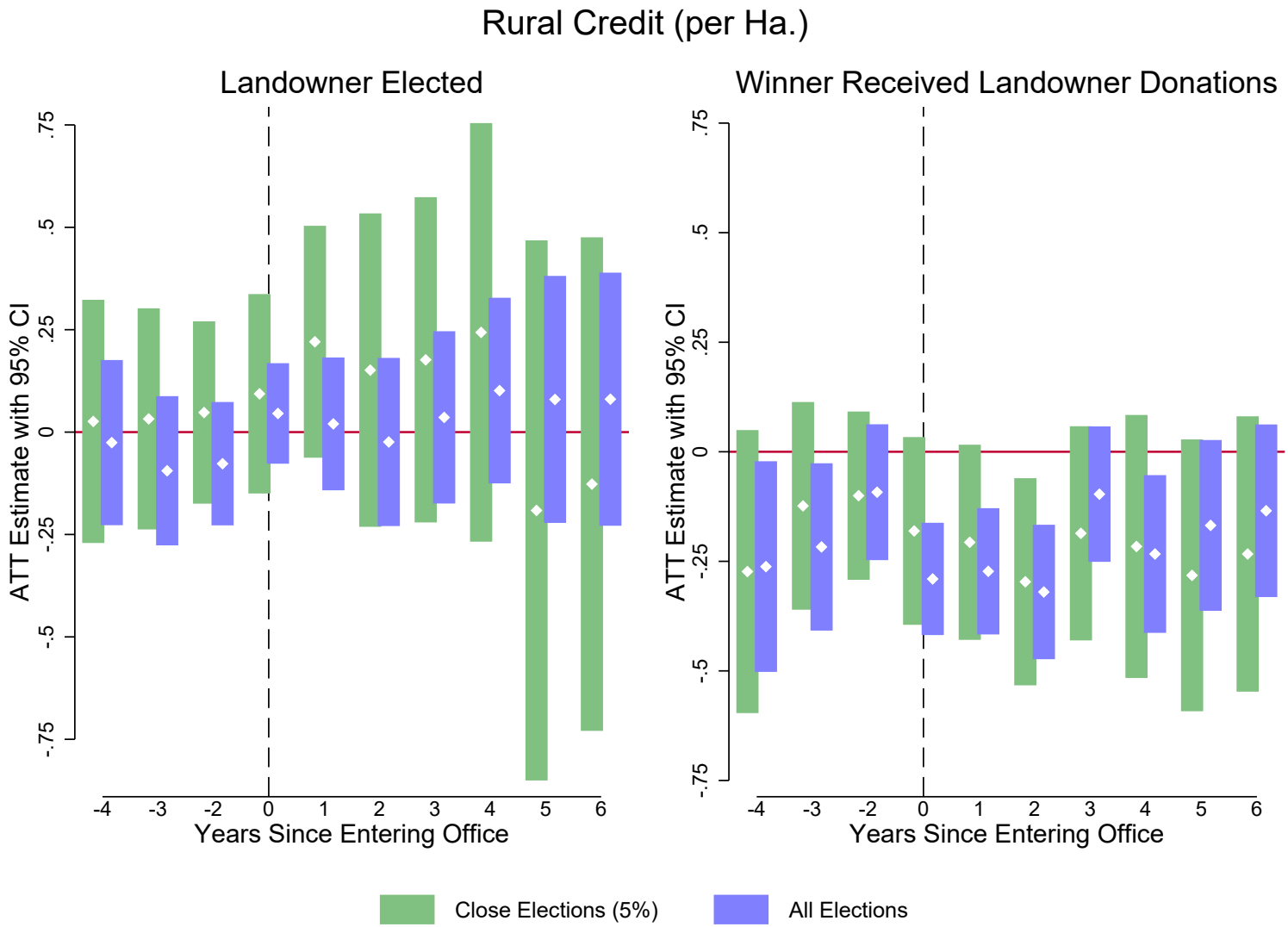
Municipal Event Study: Ag. Promo. Spending



Municipal Event Study: Ag. Grants



Municipal Event Study: Rural Credit



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