

The Economic and Distributional Impacts of Environmental Policies: Winners and Losers in Brazil's Priority Municipalities

Sarah Elven¹

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¹The Grantham Research Institute on Climate Change and the Environment, LSE

Overview

1 Background

2 Design

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Summary

- Economic consequences of deforestation policies on households (employment and income)
 - ▶ Brazil's Priority Municipalities

Method

- DID design to estimate **average** effects
- Changes-in-changes to estimate **distributional** impacts

Results

- No evidence of impact on average
- Evidence of heterogeneous effects across the income distribution

Next Steps

- Mechanisms/future research

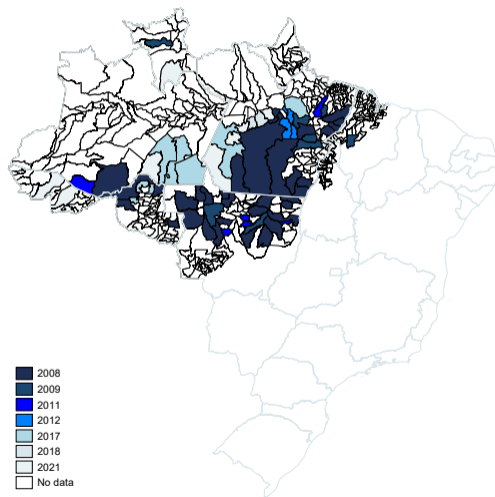
Motivation

- Deforestation contributes 8-20% of GHG emissions - 2/3 from tropical forests
- Tropical forests lie disproportionately in the developing world
- Issues of deforestation and poverty are interconnected
 - ▶ Economic motives drive deforestation
 - ▶ Deforestation has economic impacts
 - ▶ Policies designed to alleviate one issue can affect the other
- These trade-offs especially salient in Brazil

Background: The Priority Municipalities Policy

- First implemented in 2008
 - ▶ Increased monitoring and enforcement in deforestation hotspots
- Impact on deforestation substantial (43% reduction)
- However, large-scale, 'blunt' instrument
 - ▶ Relatively poor areas
 - ▶ High reliance on agriculture/extraction
- Policy could disproportionately impact:
 - ▶ Those who cannot invest in agricultural intensification
 - ▶ Employees of those who switch to a more capital-intensive modes of production

Figure 1: Year assigned priority status



Research Questions

- How did the Priority Municipalities policy affect household employment and income on average?
 - ▶ How were those working in the agricultural sector impacted on average?
- How did impacts differ across the income distribution?
 - ▶ Did impacts differ across the distribution within the agricultural sector?

Contribution

- Literature on the distributional impacts environmental policies:
 - ▶ Land-use policies (*Alix-Garcia et al., 2015; Andam et al., 2010; Bulte et al., 2008; Ferraro et al., 2011; Jack et al., 2008; Villalobos et al., 2023; Baird & Leslie, 2013; Bandyopadhyay & Tembo, 2010; Hu et al., 2023; Richardson et al., 2012; Tumusiime & Sjaastad, 2014*)
 - ★ Focus on PA and PES policies
 - ★ Estimate average effects or effects for a specific subpopulation
 - ▶ Priority Municipalities policy (*Koch et al, 2019; Moffette et al, 2021; Merkus, 2024*)
 - ★ Average economic effects

Contributions

- Explicit consideration of distributional effects
- Use of changes-in-changes at the household level
 - ▶ Allows for use of (cross-sectional) census data
 - ▶ Increased accuracy, detail, scale

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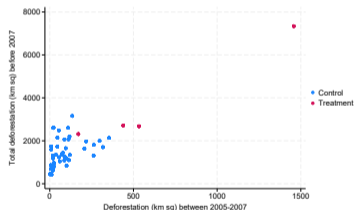
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Data

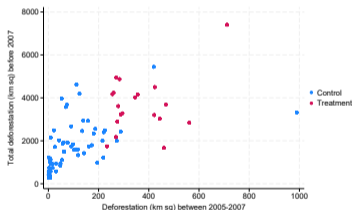
- Dependent Variables:
 - ▶ Income and employment outcomes: *Brazilian Census 2000, 2010*
- Independent Variables:
 - ▶ Priority municipality status: *Ministério do Meio Ambiente (MMA)*
- Eligibility Criteria:
 - ▶ Deforestation prior to policy (total)
 - ▶ Deforestation three years prior to policy: *Assunção et al, 2023*
- Municipality Characteristics (Controls and Robustness):
 - ▶ Distance to Brasilia (proxy for defo. frontier), Muni. GDP, Ag. Value Added, Population Density, Forest Area, Municipality Area: *IBGE; Saldanha, 2024; Assunção et al, 2023*

Priority Municipality Selection

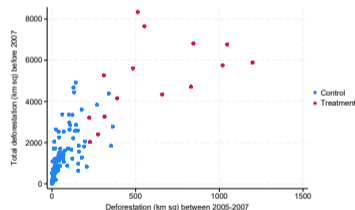
- Decree (6321, 2007) announcing PMs stated allocation would be based on:
 - 1 Total historic municipal deforested area,
 - 2 Total municipal deforestation in the previous three years,
 - 3 Whether deforestation had increased in at least three of the previous five years.
- Assunção et al (2023) find the first two explain allocation with 97% accuracy (2137km², 222 km²)



Rondônia



Mato Grosso



Pará

Figure 2: Eligibility criteria by priority status

Differences in Differences Analysis: Estimation

$$Y_{i,m,s,t} = \beta_0 + \beta_1 \mathit{Threshold}_{m,s} + \beta_2 2010_t + \beta_3 (2010_t * \mathit{Threshold}_{m,s}) + h(\mathit{distance\ from\ threshold})_{m,s,t} + X_{m,s,t} + \varepsilon_{m,s,t} \quad (1)$$

- $Y_{i,m,s,t}$ is the outcome of interest;
- $\mathit{Threshold}_{m,s}$ is the dummy for whether a municipality $>$ the de facto threshold for their state in 2008;
- $h(\mathit{distance\ from\ threshold})$ is the standardized distance to the threshold;
- $X_{m,s,t}$ is a vector of controls;
- $\varepsilon_{m,s,t}$ is the error term, clustered at the municipality level.

B. Changes in Changes Analysis: Intro

- Method introduced by Athey and Imbens in Econometrica (2006)
- Non-linear generalization of DID to the entire distribution of outcomes. For estimating:
 - ▶ Counterfactual distribution of treatment if not treated
 - ▶ Counterfactual distribution of control if treated

Pros:

- ▶ Estimation of effects at different parts of the distribution
- ▶ Counterfactuals more intuitive than QDID
- ▶ Weaker assumptions than QDID: e.g. panel data and parallel trends not needed

Changes in Changes Analysis: Estimation

First Stage

$$Y_{i,m,s,t} = \beta_0 + \beta_1 \textit{Threshold}_{m,s} + \beta_2 2010_t + \beta_3 (2010_t * \textit{Threshold}_{m,s}) + h(\textit{distance from threshold})_{m,s,t} + X_{m,s,t} + \varepsilon_{m,s,t} \quad (2)$$

Second Stage

$$\hat{Y}_{i,m,s,t} = Y_{i,m,s,t} - \hat{X}_{m,s,t} - \hat{h}(\textit{distance from threshold})_{m,s,t} = \hat{\beta}_1 \textit{Threshold}_{m,s} + \hat{\beta}_2 2010_t + \hat{\beta}_3 (2010_t * \textit{Threshold}_{m,s}) + \hat{\varepsilon}_{m,s,t} \quad (3)$$

- $Y_{i,m,s,t}$ is the outcome of interest;
- $\textit{Threshold}_{m,s}$ is the dummy for whether a municipality > the de facto threshold for their state in 2008;
- 2010_t is a dummy =1 if the year is 2010, and 0 otherwise
- $h(\textit{distance from threshold})$ the standardized distance from the threshold for inclusion;
- $X_{m,s,t}$ is the vector of controls;
- $\varepsilon_{m,s,t}$ is the error term, clustered at the municipality level.

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Relevance of the Threshold Variable

	State-level threshold
State-level threshold	0.84*** (0.06)
Standardized distance from threshold	0.02 (0.01)
Mato Grosso	-0.04 (0.04)
Pará	-0.05 (0.04)
Constant	0.04** (0.02)
Observations	104
R-squared	0.76
SEs Clustered Muni	Yes
Cragg-Donald Wald F stat.	287.29
Kleibergen-Paap Wald rk F stat.	222.45

Table 1: OLS regression of the dummy for priority status on a municipality being above the de facto eligibility threshold for the state. The sample is all municipalities in Mato Grosso, Rondônia and Pará that fell above the threshold for at least one of the two eligibility criteria.

DID Results

Table 2: Average (ITT) Effect of Residing in a Municipality above the Threshold for Inclusion

	(1) HH member employed	(2) No. HH members employed	(3) HH member works in ag.	(4) No. HH members in ag.	(5) Total HH income	(6) HH labor income	(7) HH income (labor HH)	(8) HH ag. income	(9) HH income (ag. HH)
Interaction (2010 × Above threshold)	0.00	0.00	-0.01	-0.01	32.76	69.63	61.37	31.79	34.19
Constant	(0.02) 0.84*** (0.01)	(0.04) 1.37*** (0.02)	(0.02) 0.25*** (0.02)	(0.03) 0.31*** (0.03)	(96.70) 1,411.0*** (73.49)	(100.90) 1,630.0*** (77.19)	(95.22) 1,472.2*** (75.94)	(89.10) 916.5*** (59.81)	(80.71) 935.1*** (57.71)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clustered SEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	187,003	187,003	187,003	187,003	187,003	152,616	152,616	40,144	46,512

Notes: Average effect of residing in a municipality that fell above the threshold for inclusion in its state (within 1.5 SD of the threshold for inclusion).

Table 3: Distributional (ITT) Effects of Residing in a Municipality above the Threshold for Inclusion

	(1) Total HH income	(2) HH labor income	(3) Total HH income if labor	(4) HH ag. income	(5) Total HH income if ag.
10th percentile	-29.25* (15.76)	25.51 (16.49)	61.26*** (7.55)	-67.05*** (10.99)	-84.63*** (30.11)
50th percentile	36.88*** (10.31)	40.95** (17.05)	42.36* (22.46)	-71.06*** (18.95)	45.95** (22.91)
90th percentile	73.65 (78.07)	139.1* (78.55)	239.4*** (79.04)	199.7** (85.52)	184.5 (124.1)
P Values: <i>Kolmogorov-Smirnov (KS) and Cramer-von-Mises-Smirnov (CMS) Stats</i>					
No effect	***	**	***	***	**
Constant effect				***	**
Effect > 0 for all				***	**
Effect < 0 for all	***	**	***		*

Notes: Effects at different percentiles of the income distribution of residing in a municipality that fell above the threshold for inclusion in its state (within 1.5 SD of the threshold for inclusion).

Next Steps

- Mechanisms

- ▶ Some evidence negative effects concentrated among agricultural laborers/those in precarious employment
- ▶ Better characterize:
 - ★ Where negative and positive effects are most concentrated
 - ★ Extent to which land, capital and labor are substitutes/complements in this context

- Robustness

- ▶ Robustness
- ▶ Spatial spillovers
- ▶ External validity

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Conclusion

- Economic consequences of deforestation policies on households (employment and income)
 - ▶ Increased regulatory capacity in Brazil's Priority Municipalities

Method

- DID design to estimate local **average** treatment effects
- Changes-in-changes to estimate **distributional** impacts

Results

- No evidence of impact on average
- Evidence of heterogeneous effects across the income distribution

Mechanism

- Substitution from labor- to more capital-intensive agricultural production?