

# 6th JRC Summer School on Sustainable Finance

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— Ispra, Italy



## Save or not save planet earth? A quasi-natural experiment with the Brazilian Amazon

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\* The views expressed are those of the authors and do not represent the views of CEMLA, the Federal Reserve System, or the Halle Institute for Economic Research (IWH).

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# 1. Motivation

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- The **financial sector** holds a pivotal role in reallocating financial capital away from environmentally harmful sectors (UNCTAD,2021; BCBS, 2023; NGFS, 2019, 2021, 2023).
- **Environmental regulation** is key to altering the incentives of banks to reallocate capital towards more environmentally friendly industries.
- Despite a surge in environmental laws, **the enforcement capacity of countries** is often an overlooked dimension.
- Although **banks are increasingly integrating carbon-related risks**, the effect of environmental law enforcement on their risk accountability remains a significant blind spot.

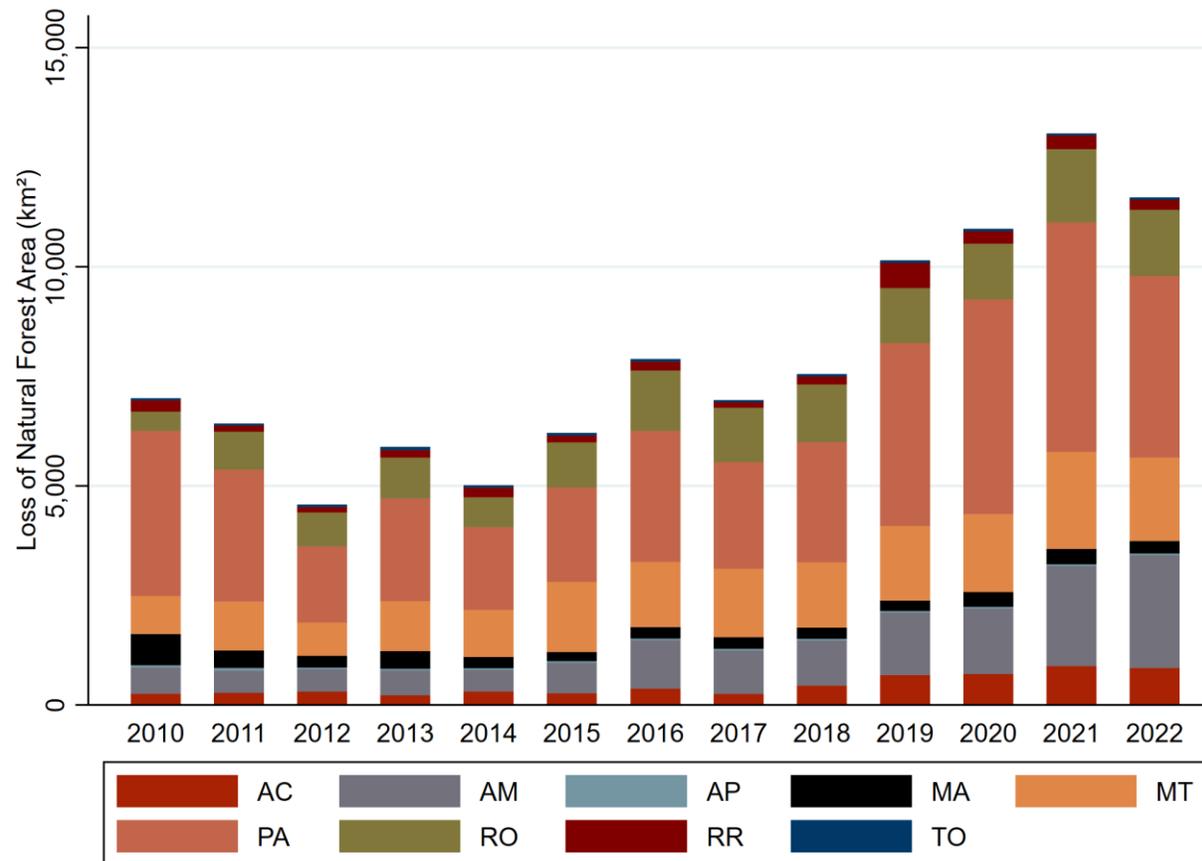
# 1. Motivation

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- This paper addresses this gap by exploring **whether or not a sudden weakening of environmental law enforcement triggers shifts in banks' credit supply towards “brown” deforesting industries in Brazil.**
- In developing nations like Brazil, weak rule of law, often driven by corruption and influential group interests, creates a gap between regulations and enforcement, undermining environmental regulations.
- Brazil provides an ideal laboratory: The Brazilian Amazon is the world's largest forest, covering 67% of global tropical forests and holding unparalleled biodiversity.
- Climate policies in the region are crucial for the planet’s future. So any action taken there is key for global climate change mitigation.

**FIGURE 1:**  
**Loss of Natural Forest Area (In km<sup>2</sup>)**  
**for Brazilian Amazon**

This figure shows the annual loss in natural forest area (in km<sup>2</sup>) for each Federal State in the Brazilian Legal Amazon: Amazonas (AM), Acre (AC), Amapá (AP), Maranhão (MA), MatoGrosso (MT), Pará (PA), Rondônia (RO), Roraima (RR), and Tocantins (TO). This figure draws data from TerraBrasilis, developed by the Brazilian Institute INPE (Instituto Nacional de Pesquisas Espaciais).



# Deforestation is accelerating in Brazil as Bolsonaro's first term ends, experts say

By CNN's Camilo Rocha, Marcia Reverdosa and Rodrigo Pedroso  
Published 8:09 AM EDT, Tue September 20, 2022



ENVIRONMENT AUGUST 28, 2019 / 5:13 AM / UPDATED 4 YEARS AGO

## Exclusive: As fires race through Amazon, Brazil's Bolsonaro weakens environment agency

By Jake Spring, Stephen Eisenhammer

9 MIN READ



BRASILIA (Reuters) - As the world recoils at the sight of fires ravaging Brazil's Amazon jungle, the nation's far-right government is undermining the agency charged with protecting the rainforest, Reuters has learned from interviews with ten current and former employees, public records and a review of internal government reports.



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### The dismantling of environmental agencies

To enable all this destruction, Bolsonaro's administration has been weakening government bodies responsible for monitoring the environment and enforcing laws to protect the forest. IBAMA, a crucial agency responsible for environmental policies in the country, got its funds slashed by 30% from 2019 to 2020, while the budget for the Chico Mendes Institute for the Conservation of Biodiversity (ICMBio) was reduced by 32.7 percent over the same period. In 2021, the Environment Department's overall budget was at its lowest level since 2010.



Ibama agent Rafael Sant'Ana dismantles a wooden sluice used to separate gold from dirt. Photograph: Tom Phillips/The Guardian

# 1. Motivation

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- We exploit the **sudden decline in the IBAMA staff** (responsible for on-the-ground forest oversight) as an **exogenous shock to environmental law enforcement**.
- Our study examines how the relaxation of environmental policy enforcement influences **banks' supply of "brown" agribusiness credit in Brazil**.
- This is particularly crucial given **the agribusiness sector (including agriculture and agroindustry) plays a significant role in large-scale deforestation in the Brazilian Amazon** (Peres, Campos-Silva, and Ritter, 2022, 2023).

## 2. Research Question

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Banks may prioritize **short-term profitability gains and existing lending relationships** (Degryse, Roukny, and Tielens, 2022; De Haas and Popov, 2023; Giannetti, Jasova Loumioti, and Mendicino, 2023) **over longer-term value gains inclusive of prudential, regulatory, and reputational risks** (Reghezza, Altunbas, Marques-Ibanez, Rodriguez d'Acri, and Spaggiari, 2022; Ehlers, Packer, and De Greiff, 2022; Correa, He, Herpfer, and Lel, 2023; Degryse, Goncharenko, Theunisz, and Vadasz, 2023; Ivanov, Kruttli, and Watugala, 2023).

- 1) **Hypothesis 1:** A weakening in environmental law enforcement might enable banks to expand lending to economic activities that benefit from weaker environmental oversight.
- 2) **Hypothesis 2:** Banks could incorporate long-term environmental and reputational risks alongside traditional financial risks in the lending decision-making process. This could signal bank's integrity, reliability, and environmental concerns, potentially leading to increased long-run value gains (Freeman, 1984).

## 3. Data

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1. We collect granular data on the universe of **Brazilian bank branches at the municipal level** from the ESTBAN (Estatística Bancária Mensal por Município) database published by the Central Bank of Brazil.
  - Bank branch: the consolidated assets and liabilities held by a bank within a municipality.
  - We combine branch data with information on banks' call reports containing balance sheet and income statement at the bank group level from the Central Bank of Brazil.
    - ✓ Branches active throughout 2018 and 2019, avoiding the results being influenced by branches entering or exiting the market.
    - ✓ Branches that report active outstanding credit balances in the agricultural sector as of 2018.
    - ✓ We drop the metropolitan areas of Sao Paulo and Rio de Janeiro from the sample, as these regions represent financial centers with little exposure to agriculture activity.
  - Our final sample consists of 3,909 branches operating in 2,093 municipalities and belonging to 20 banking conglomerates.

## 3. Data

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- 2) **Administrative record of the staff employed by IBAMA** in each federal state. (Published by the Brazilian Ministry of Finance).
  - We use this to construct our measure the IBAMA's personnel cuts from 2018 to 2019 under the Bolsonaro administration.
  
- 3) **Municipality's geographical area reported land use** (agriculture, forestry, or being kept as natural rainforest environment) from the Brazilian Annual Land Use and Land Cover Mapping Project (Mapbiomas).
  - We use this information to compute the share of natural environment to total area per municipality as of 2018.

## 4. Empirical framework and identification strategy

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- The **quasi-difference-in-difference (quasi-DID) empirical model** for extension of “brown” agribusiness credit by bank branch (i) in municipality (j), from 2018 to 2019:

$$\Delta AG\ Credit_{i,j,(18-19)} = \beta_1(\Delta IBAMA_{j,(18-19)} \times Av\ Forest_{j,2017}) + \mu_{uf} + \delta_i + \Omega_{ij} + \epsilon_{i,j} \quad (1)$$

Where:

- $\Delta AG\ Credit$  is the change in the bank branch share of agribusiness credit to total credit from 2018 to 2019 at branch-municipality level.
- The quasi-DID term,  $\Delta IBAMA \times Natural\ Forest\ Area$ , and the uninteracted terms  $\Delta IBAMA$  and  $Natural\ Forest\ Area$ , where  $\Delta IBAMA$  is the change in the environmental oversight staff of the Brazil national agency IBAMA from 2018 to 2019 available at federal state level, and  $Natural\ Forest\ Area$ , which is the ex-ante percentage of area available to deforest (forest area in km<sup>2</sup>/total area km<sup>2</sup>) as of 2017, at municipality level.

## 4. Empirical framework and identification strategy

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$$\Delta AG Credit_{i,j,(18-19)} = \beta_1(\Delta IBAMA_{j,(18-19)} \times Av Forest_{j,2017}) + \mu_{uf} + \delta_i + \Omega_{ij} + \epsilon_{i,j} \quad (1)$$

- $\mu_{uf}$ , represents **federal-state fixed effects** and allows us to control for demand factors.
- $\delta_i$  represents bank fixed effects; given the collapsed pre/post periods, this is like quasi-bank-time fixed effects, allowing for a within-bank estimation.
- $\Omega_{ij}$  is a vector of control variables capturing branches' characteristics: size (log assets), branch liquidity ratio (the ratio of liquid assets to total assets ratio), branch profitability (return on assets, ROA), and branch deposit ratio (the ratio of deposits to total liabilities) as controls across all specifications. These variables are computed as 2017 averages from the monthly underlying data.
- $\epsilon_{it}$  represents a white-noise error term.

## 4. Empirical framework and identification strategy

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$$\Delta AG Credit_{i,j,(18-19)} = \beta_1(\Delta IBAMA_{j,(18-19)} \times Av Forest_{j,2017}) + \mu_{uf} + \delta_i + \Omega_{ij} + \epsilon_{i,j} \quad (1)$$

- The coefficient of interest is  $\beta_1$  on the quasi-DID term,  $\Delta IBAMA \times$  Natural Forest Area. It captures whether that the sudden decrease in IBAMA's oversight staff – which lead to a relaxation in environmental law enforcement – combined with a higher percentage of area available to deforest, incentivized banks to increase or reduce credit to agribusiness firms (sector associated with large scale deforestation).
  - ❖ The coefficient on  $\beta_1$  would be negative if Hypothesis 1 dominates Hypothesis 2, that is banks pursue short-term profitability gains instead of longer-term value gains inclusive of prudential, regulatory, and reputational risks.
  - ❖ Conversely, the coefficient on  $\beta_1$  would be positive if Hypothesis 2 dominates Hypothesis 1.

## 6. Empirical results – Main evidence

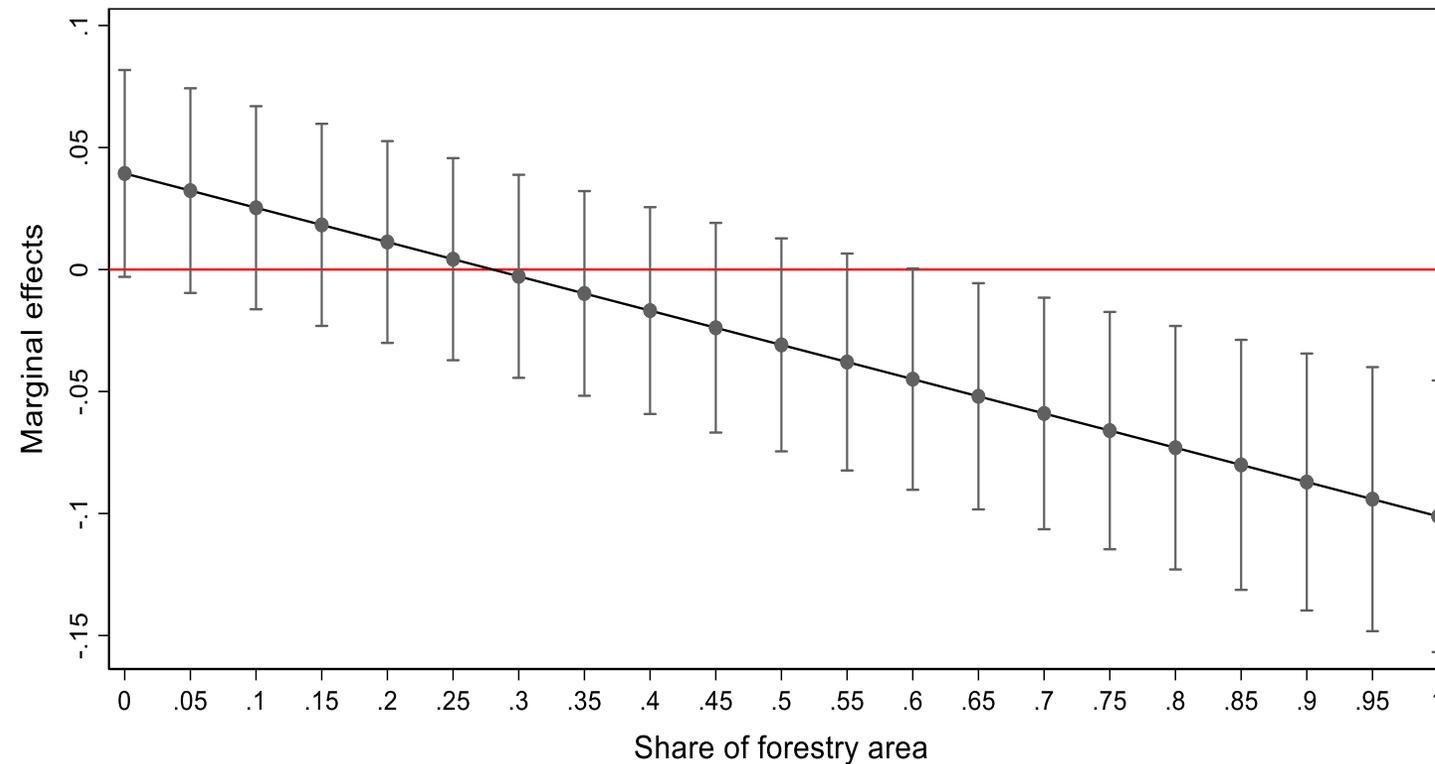
**TABLE 1**  
**– Main Evidence:**  
**Impact of Environmental Law Enforcement Change on Bank Agribusiness Credit**

<b>Dependent Variable</b>	(1)	(2)	(3)	(4)
	$\Delta$ AGCredit	$\Delta$ AGCredit	$\Delta$ AGCredit	$\Delta$ AGCredit
<b>Independent Variables</b>				
<i>Natural Forest Area</i>	0.006 (0.008)	0.002 (0.006)	0.001 (0.007)	0.002 (0.007)
$\Delta$ IBAMA $\times$ <i>Natural Forest Area</i>	-0.111*** (0.029)	-0.199*** (0.047)	-0.209*** (0.045)	-0.207*** (0.051)
<i>Branch size</i>				0.001 (0.002)
<i>Branch liquidity</i>				-0.166** (0.045)
<i>Branch profitability</i>				0.368 (0.864)
<i>Branch deposit ratio</i>				0.011 (0.012)
<hr/>				
<b>FEs &amp; Controls</b>	No	Federal	Federal and Bank	Federal and Bank FEs, Branch Controls
Observations	3,909	3,909	3,909	3,909
R-squared	0.002	0.014	0.031	0.033

Significance at the 10%, 5%, and 1% levels is indicated by \*, \*\*, and \*\*\*, respectively.

## 6. Empirical results – Main evidence

**FIGURE 4**  
**Marginal Effects of Change in IBAMA Personnel ( $\Delta IBAMA$ ) on Agribusiness Credit Growth ( $\Delta AGCredit$ ) across the Distribution of “Natural Forest Area”**



## 6. Empirical results – Main evidence

**TABLE 2**  
**Decomposition of Bank Agribusiness Credit into Subcomponents**

	(1)	(2)	(3)	(4)
<b>Dependent Variable</b>	$\Delta$ Agricultural Credit	$\Delta$ Agricultural Credit	$\Delta$ Agro-Industrial Credit	$\Delta$ Agro-Industrial Credit
<b>Independent Variable</b>				
<i>Natural Forest Area</i>	-0.168*** (0.049)	-0.154** (0.067)	0.001 (0.000)	0.000 (0.000)
$\Delta$ IBAMA $\times$ <i>Natural Forest Area</i>	-0.027* (0.015)	-0.055** (0.024)	0.002** (0.001)	0.003 (0.002)
<b>FEs &amp; Controls</b>	Federal and Bank FEs	Federal and Bank FEs, Branch Controls	Federal and Bank FEs	Federal and Bank FEs, Branch Controls
Observations	3,909	3,909	3,909	3,909
R-squared	0.032	0.073	0.021	0.041

Significance at the 10%, 5%, and 1% levels is indicated by \*, \*\*, and \*\*\*, respectively.

## 6. Empirical results – Heterogeneity analysis

**TABLE 3**  
**Impact of Climate Law Enforcement Change on Bank Agribusiness Credit –**  
**Splits by Ex-Ante Agro-Industrial Importance**

	(1)	(2)	(3)	(4)	(5)
	Baseline Full Sample (repeated for convenience)	<i>High Ex-Ante</i> Agricultural Physical Area Extension	<i>Low Ex-Ante</i> Agricultural Physical Area Extension	<i>High Ex-Ante</i> Agricultural Production	<i>Low Ex-Ante</i> Agricultural Production
<b>Dependent Variable</b>	$\Delta$ AGCredit	$\Delta$ AGCredit	$\Delta$ AGCredit	$\Delta$ AGCredit	$\Delta$ AGCredit
<i>Natural Forest Area</i>	0.002 (0.007)	-0.003 (0.006)	0.007 (0.010)	-0.003 (0.008)	0.004 (0.008)
$\Delta$ IBAMA $\times$ <i>Natural Forest Area</i>	-0.207*** (0.051)	-0.314** (0.120)	-0.0730 (0.138)	-0.458** (0.164)	-0.0546 (0.166)
FEs & Controls	Federal and Bank FEs, Branch Controls	Federal and Bank FEs, Branch Controls	Federal and Bank FEs, Branch Controls	Federal and Bank FEs, Branch Controls	Federal and Bank FEs, Branch Controls
Observations	3,909	2,727	1,176	2,139	1,769
R-squared	0.033	0.045	0.041	0.036	0.053
Controls	Yes	Yes	Yes	Yes	Yes

Significance at the 10%, 5%, and 1% levels is indicated by \*, \*\*, and \*\*\*, respectively.

## 6. Empirical results – Triple interaction model

**TABLE 4**  
**Impact of Climate Law Enforcement Change on Bank Agribusiness Credit –**  
**Heterogeneity by Branch Traits**

	(1)	(2)	(3)	(4)
Branch Trait	<i>Branch</i> Size	<i>Branch</i> Deposit Ratio	<i>Branch</i> Liquidity Ratio	<i>Branch</i> ROA
<b>Dependent Variable</b>	$\Delta$ AGCredit	$\Delta$ AGCredit	$\Delta$ AGCredit	$\Delta$ AGCredit
<b>Independent Variables</b>				
<i>Natural Forest Area</i>	0.007 (0.012)	-0.012 (0.008)	-0.005 (0.007)	0.003 (0.012)
<i>Branch Trait</i>	0.004 (0.003)	-0.017*** (0.002)	-0.008 (0.007)	0.005 (0.009)
$\Delta$ IBAMA $\times$ <i>Natural Forest Area</i>	-0.112 (0.104)	-0.336*** (0.071)	-0.171* (0.082)	-0.119 (0.206)
$\Delta$ IBAMA $\times$ <i>Branch Trait</i>	0.111 (0.093)	-0.097* (0.052)	-0.026 (0.073)	0.030 (0.087)
<i>Natural Forest Area</i> $\times$ <i>Branch Trait</i>	-0.012 (0.012)	0.025 (0.015)	0.015 (0.014)	-0.001 (0.007)
$\Delta$ IBAMA $\times$ <i>Natural Forest Area</i> $\times$ <i>Branch Trait</i>	-0.209** (0.083)	0.190*** (0.038)	-0.051 (0.152)	-0.127 (0.273)
	Federal and Bank FEs, Branch Controls			
FEs & Controls				
Observations	3,909	3,909	3,909	3,909
R-squared	0.034	0.037	0.035	0.034

## 6. Empirical results – Channel: Internal capital markets reallocation and profitability

**TABLE 5**  
**Internal Capital Markets Reallocation and Profitability Analyses**

	(1)	(2)	(3)	(4)
	<i>Narrow</i> ICM	<i>Narrow</i> ICM	<i>Extended</i> ICM	<i>Extended</i> ICM
Intra-bank capital movements				
<b>Dependent Variable</b>	$\Delta$ ICM Reallocation	$\Delta$ ICM Reallocation	$\Delta$ ICM Reallocation	$\Delta$ ICM Reallocation
<b>Independent Variables</b>				
<i>Natural Forest Area</i>	-0.003 (0.003)	-0.005 (0.004)	0.001 (0.002)	-0.001 (0.003)
<i><math>\Delta</math> IBAMA <math>\times</math> Natural Forest Area</i>	-0.107* (0.053)	-0.116** (0.051)	-0.107** (0.046)	-0.107** (0.046)
<b>FEs &amp; Controls</b>	Federal and Bank FEs	Federal and Bank FEs, Branch Controls	Federal and Bank FEs	Federal and Bank FEs, Branch Controls
Observations	3,909	3,909	3,909	3,909
R-squared	0.125	0.141	0.129	0.136

Significance at the 10%, 5%, and 1% levels is indicated by \*, \*\*, and \*\*\*, respectively.

## 6. Empirical results – Real Effects

**TABLE 7**  
**Real Effects: Deforestation Analysis**

	(1)	(2)	(3)
Sample	<i>Full Sample</i>	<i>Full Sample</i>	<i>Only Amazonia</i>
<b>Dependent Variable</b>	$\Delta$ Natural Forest Area 2018-2019	$\Delta$ Natural Forest Area 2018-2019	$\Delta$ Natural Forest Area 2018-2019
<b>Independent Variables</b>			
<i>Natural Forest Area</i>		-0.008 (0.007)	0.008 (0.007)
<i><math>\Delta</math> IBAMA <math>\times</math> Natural Forest Area</i>		0.097** (0.046)	0.210** (0.078)
<i><math>\Delta</math> AG Credit</i>	-0.018** (0.008)		
<b>FEs &amp; Controls</b>	Federal State FEs, Branch Controls	Federal State FEs, Branch Controls	Federal State FEs, Branch Controls
Observations	2,085	2,085	318
R-squared	0.150	0.162	0.173

Significance at the 10%, 5%, and 1% levels is indicated by \*, \*\*, and \*\*\*, respectively.

# Conclusions and policy implications

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1. Our results illuminate a concerning trend: a relaxation in environmental law enforcement corresponds to a notable surge in banks' allocation of "brown" (agribusiness) credit, especially in regions prone to deforestation.
2. These findings support the hypothesis on a preference for short-term gains over long-term value and regulatory considerations by banks, contributing to the persistence of deforestation and its associated environmental and social consequences.
3. Our findings clearly suggest that any financial incentives to lessen deforestation are not sufficient on their own.
4. A realignment between financial incentives provided to private-sector actors and the broader societal goals is needed.
5. Ideally, policy makers would weigh policies with more financial incentives for banks and private-sector agents that would lessen the need for law enforcement resources.

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