Green finance and deforestation reduction in Brazil: a PVAR analysis of the Amazon Fund

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Disclaimer: the views expressed in this document are those of the authors and do not necessarily reflect those of Banque de France or the Eurosystem

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Green finance effectiveness to fight deforestation is often controversial

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- In 2019, the Amazon Fund stopped contracting new projects : Bolsonaro publicly doubted the real capacity of the fund to reduce deforestation. Lula reactivated it in January 2023.

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- Officially, the main objective is to "reduce the annual deforestation rate in the Amazon rainforest"
- In 2019, the Amazon Fund stopped contracting new projects : Bolsonaro publicly doubted the real capacity of the fund to reduce deforestation. Lula reactivated it in January 2023.
- Still in 2019, the president of the fund stated: "Although there is clear evidence that the Amazon Fund has contributed to reducing deforestation in the Amazon rainforest, **it is a great challenge to estimate this contribution quantitatively**"

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To estimate the effectiveness of a large-scale REDD+ fund

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What are the most effecient types of projects?

Methodology

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  - Thanks to **web scrapping**...
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  - 19 years (2002-2020)

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- **Panel dataset** :
  - 760 municipalities of the Brazilian "Legal Amazon"
  - 19 years (2002-2020)
- **Panel-VAR** :
  - Inspired from Macroeconometrics
  - It enables to create a system of endogenous variables that can influence each other

Results

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- Projects that are the most efficient are those:
  - led by states
  - dedicated to indigenous lands, conservation units...

Related literature and contribution

1. **Analyzing the Amazon Fund:**
   - Political and organizational qualitative studies: Bidone (2021), Correa et al. (2019), Hoff, Rajão, and Leroy (2018)
   - Very few quantitative studies: Correa et al. (2020)

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2. **Empirical assessments of REDD+ finance:**
   - In **Brazil**, Carrilho et al. (2022) or West et al. (2020)
   - Jayachandran et al. (2017) in **Uganda**, Ellis et al. (2020) in **Mexico** or Roopsind, Sohngen, and Brandt (2019) in **Guyana**.

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3. **Determinants of the amazonian deforestation:**
   - Economic and financial determinants: **prices** (Assunção, Gandour, and Rocha (2015) and Silva et al. (2010)), **agricultural credit** (Assunção et al. (2020))...
   - Public policies: **blacklisting municipalities** (Assunção and Rocha (2019) and Cisneros, Zhou, and Börner (2015)), **land registration** (Alix-Garcia et al. (2018)), **protected areas** (Soares-Filho et al. (2010)) and **law enforcement** (Assunção, Gandour, and Rocha (2014))

Outline

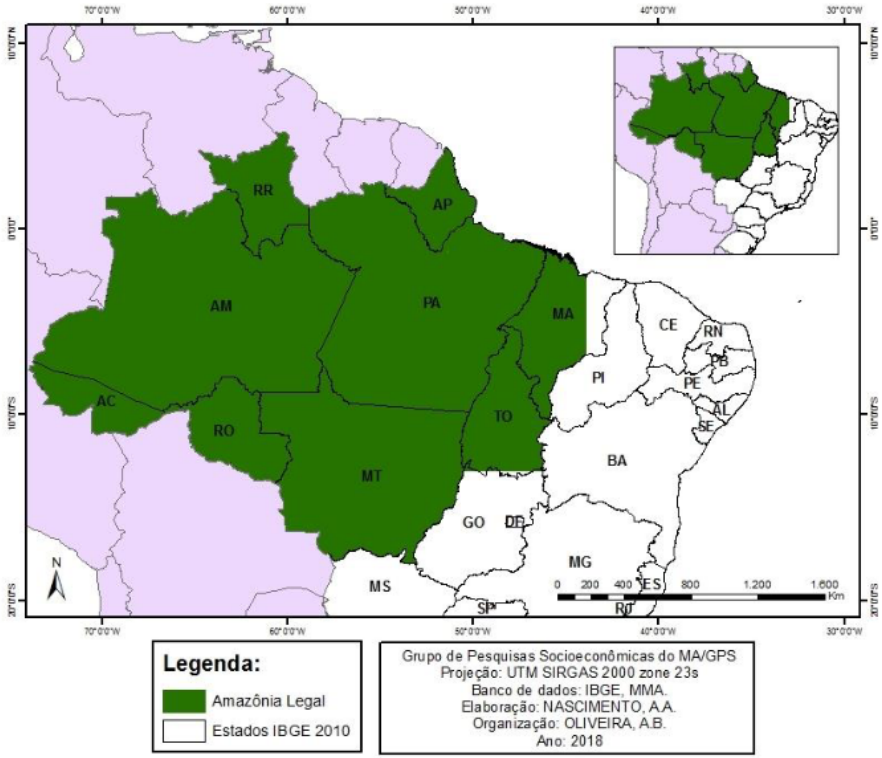
Tracking disbursements from the world's largest REDD+ fund...

...operating in a specific legal and agricultural context

Methodology: trying to disentangle the roles of green finance and law enforcement

Results

The Legal Amazon

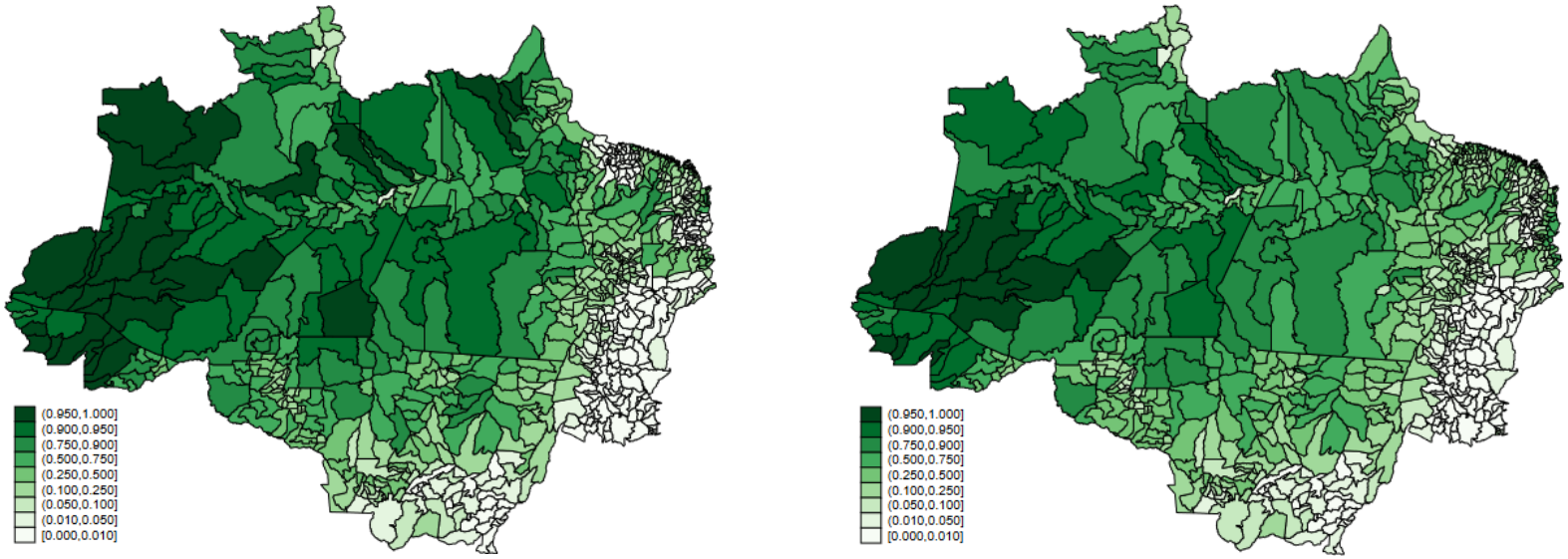


Source: Oliveira Bezerra (2019)

- 64 % of the Amazon Biome is in Brazil
- spread over 9 states
- 28 million inhabitants
- 55 % of indigenous Brazilian population

Loss of forest cover: -7,4% in 18 years

Amazon rainforest density (remaining share of primary forest)



(a) in 2002

(b) in 2020

Source: INPE and authors calculations

Amazon Fund: the largest REDD+ fund in the world...

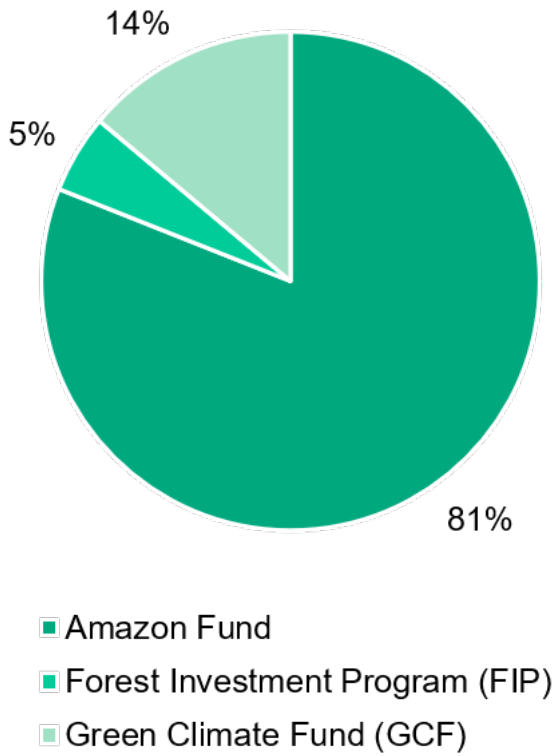
Exhaustive list of REDD+ funds over the world

Fund	Fund Type	Pledge	Deposit	Approval	Disbursement	Nb proj.
Amazon Fund	Multi Donor National	1288.23	1288.23	719.69	528.89	103
BioCarbon Fund ISFL	Multilateral	349.898	219.35	107	0	5
Central African Forest Initiative (CAFI)	Multi Donor Regional	478.76	319.59	182.24	182.24	11
Congo Basin Forest Fund (CBFF)	Multi Donor Regional	186.021	164.6525	83.11	58.91	37
FCPF-RF	Multilateral	466.54	466.54	311.24	253.47	46
FCPF-CF	Multilateral	874.5	874.5	0	0	0
Forest Investment Program (FIP)	Multilateral	735.86	735.86	573.73	249.18	48
UN-REDD Programme	Multilateral	329.04	323.94	323.52	315.56	35

Source: Climate Funds Update (March 2021)

...and in the Legal Amazon

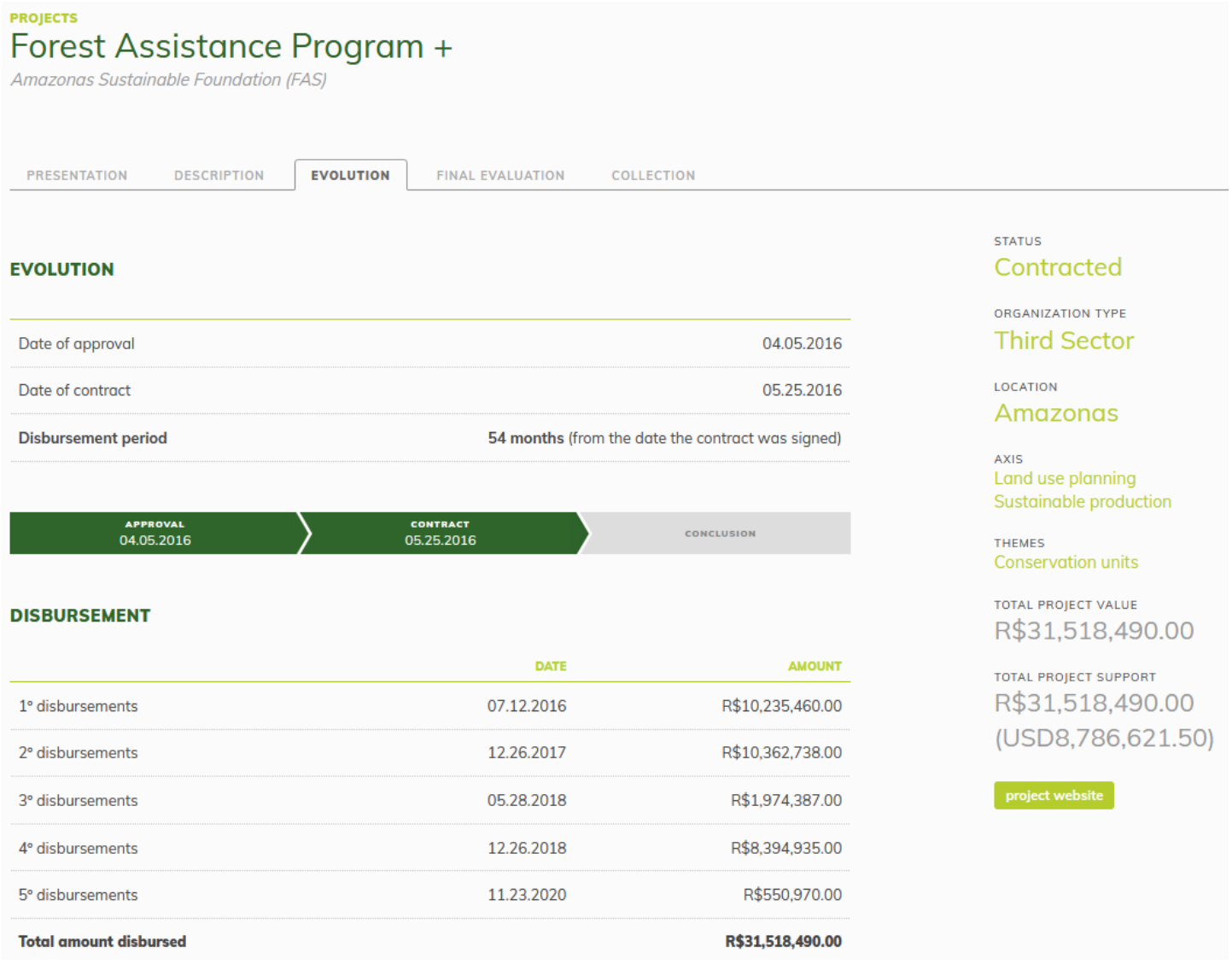
Breakdown of REDD+ funds disbursed in Brazil since 2009



Source: Climate Funds Update (May 2022)

Recovering disbursements from the Amazon Fund

An example of project



PROJECTS

Forest Assistance Program +

Amazonas Sustainable Foundation (FAS)

PRESENTATION | DESCRIPTION | **EVOLUTION** | FINAL EVALUATION | COLLECTION

EVOLUTION

Date of approval	04.05.2016
Date of contract	05.25.2016
Disbursement period	**54 months** (from the date the contract was signed)

APPROVAL 04.05.2016 | CONTRACT 05.25.2016 | CONCLUSION

DISBURSEMENT

	DATE	AMOUNT
1° disbursements	07.12.2016	R$10,235,460.00
2° disbursements	12.26.2017	R$10,362,738.00
3° disbursements	05.28.2018	R$1,974,387.00
4° disbursements	12.26.2018	R$8,394,935.00
5° disbursements	11.23.2020	R$550,970.00
Total amount disbursed		**R$31,518,490.00**

STATUS
Contracted

ORGANIZATION TYPE
Third Sector

LOCATION
Amazonas

AXIS
Land use planning
Sustainable production

THEMES
Conservation units

TOTAL PROJECT VALUE
R$31,518,490.00

TOTAL PROJECT SUPPORT
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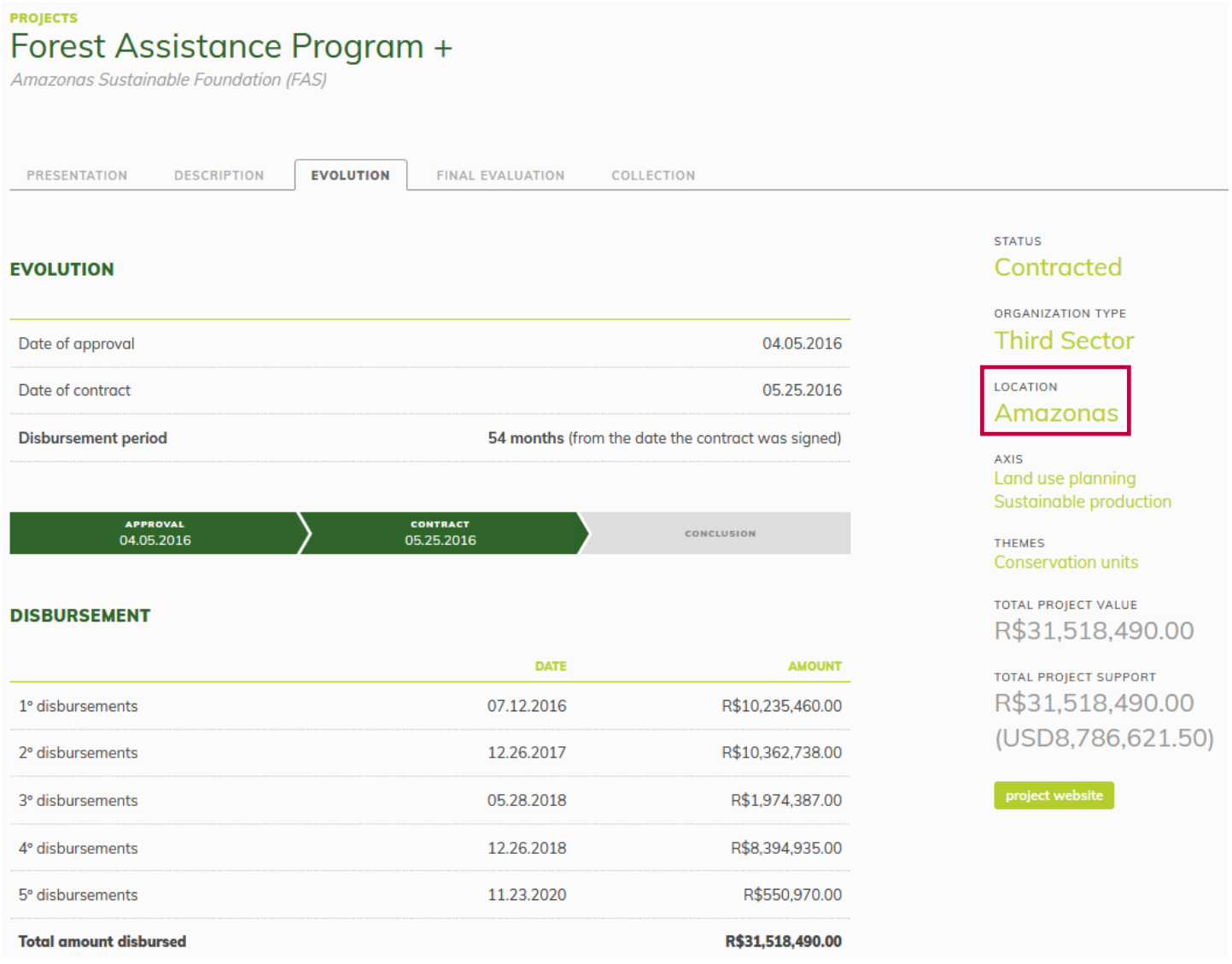

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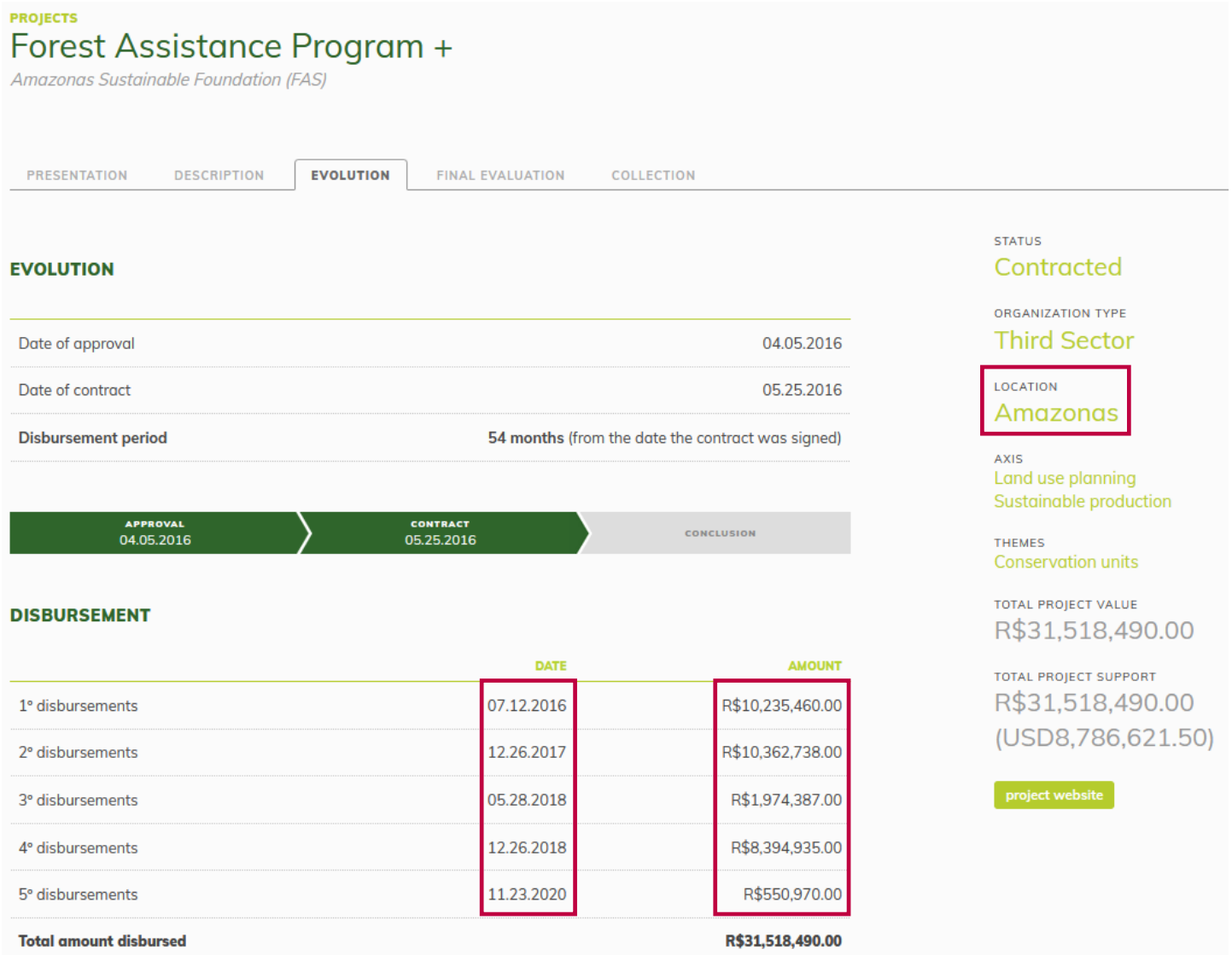

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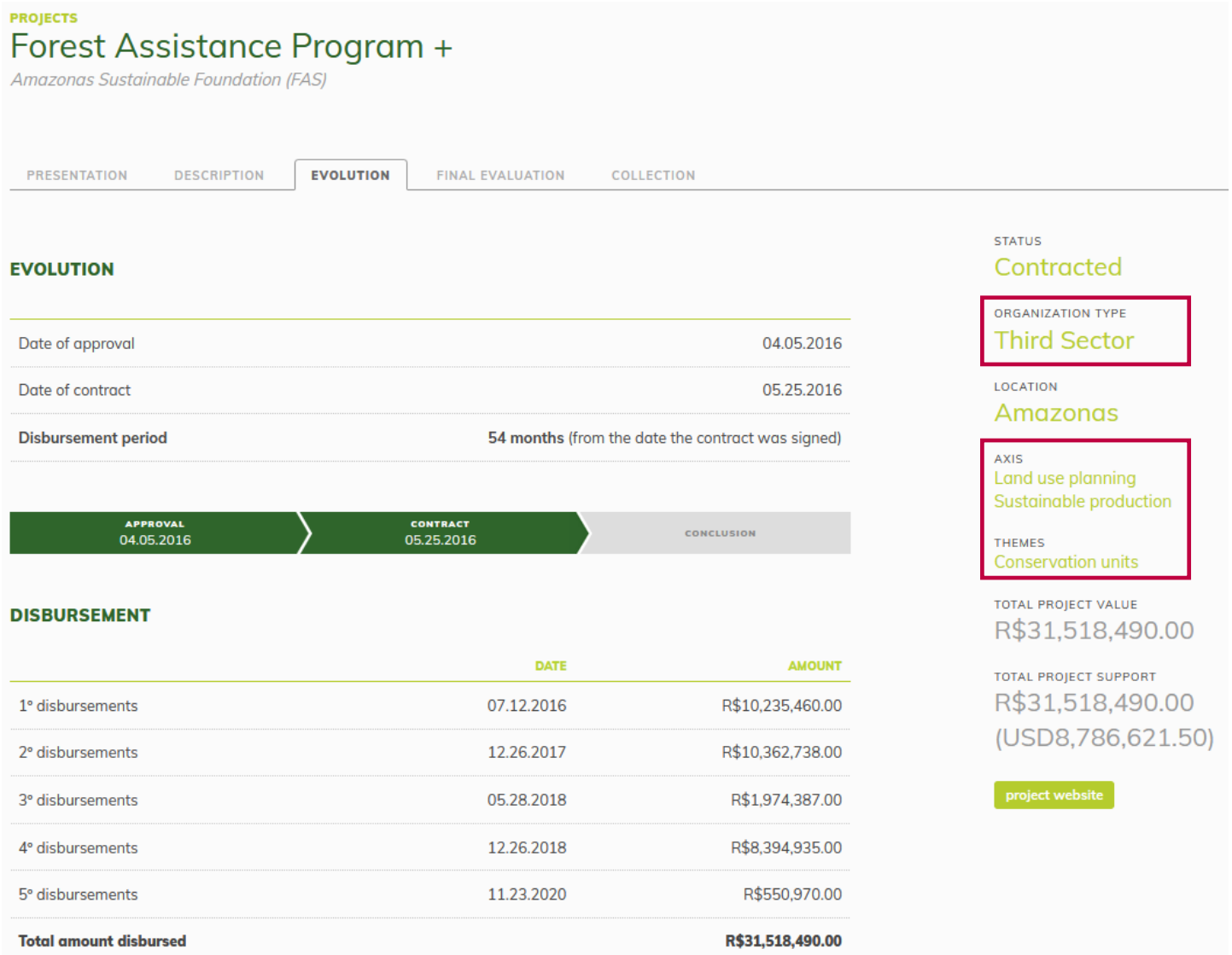

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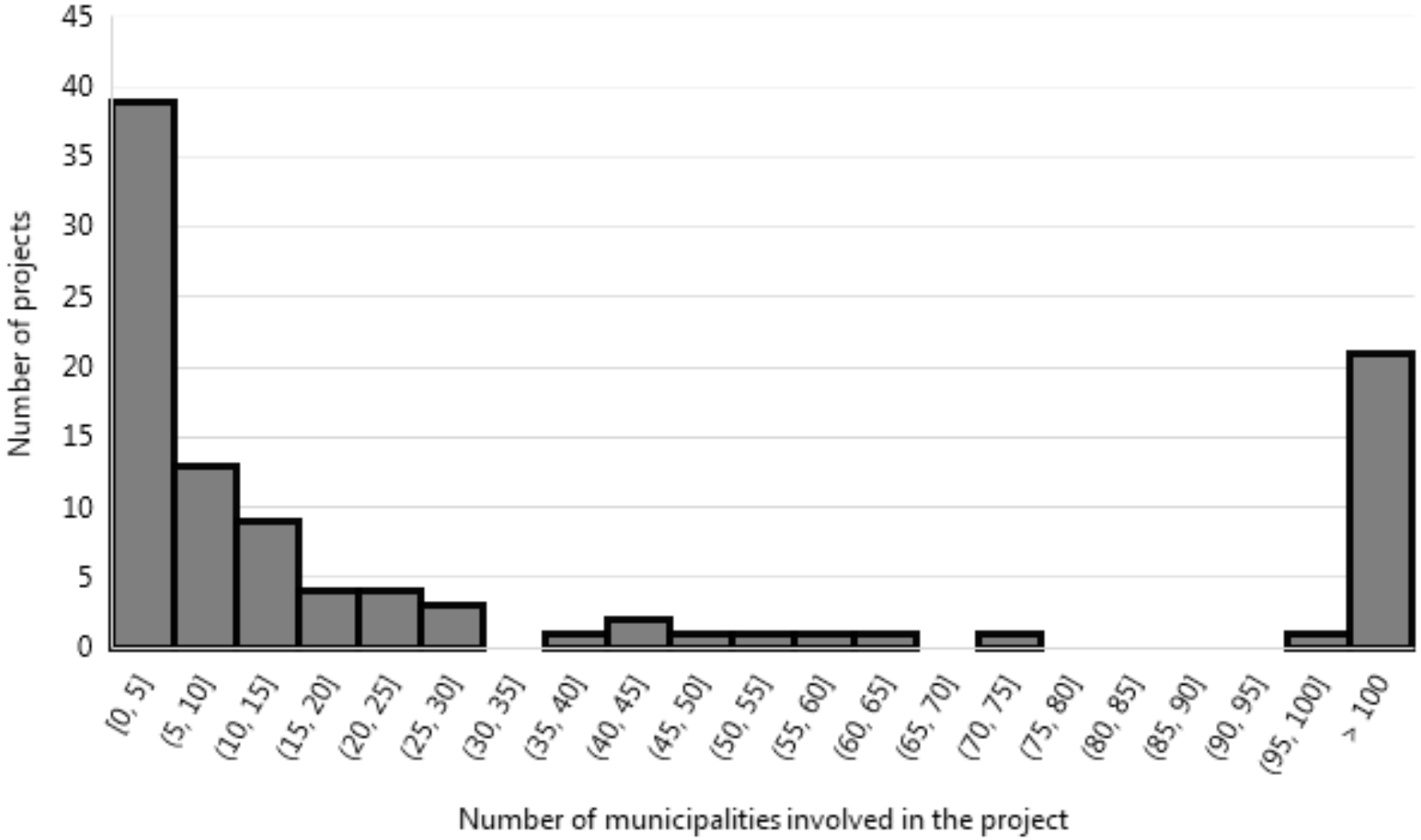
How concentrated is the fund's action ?



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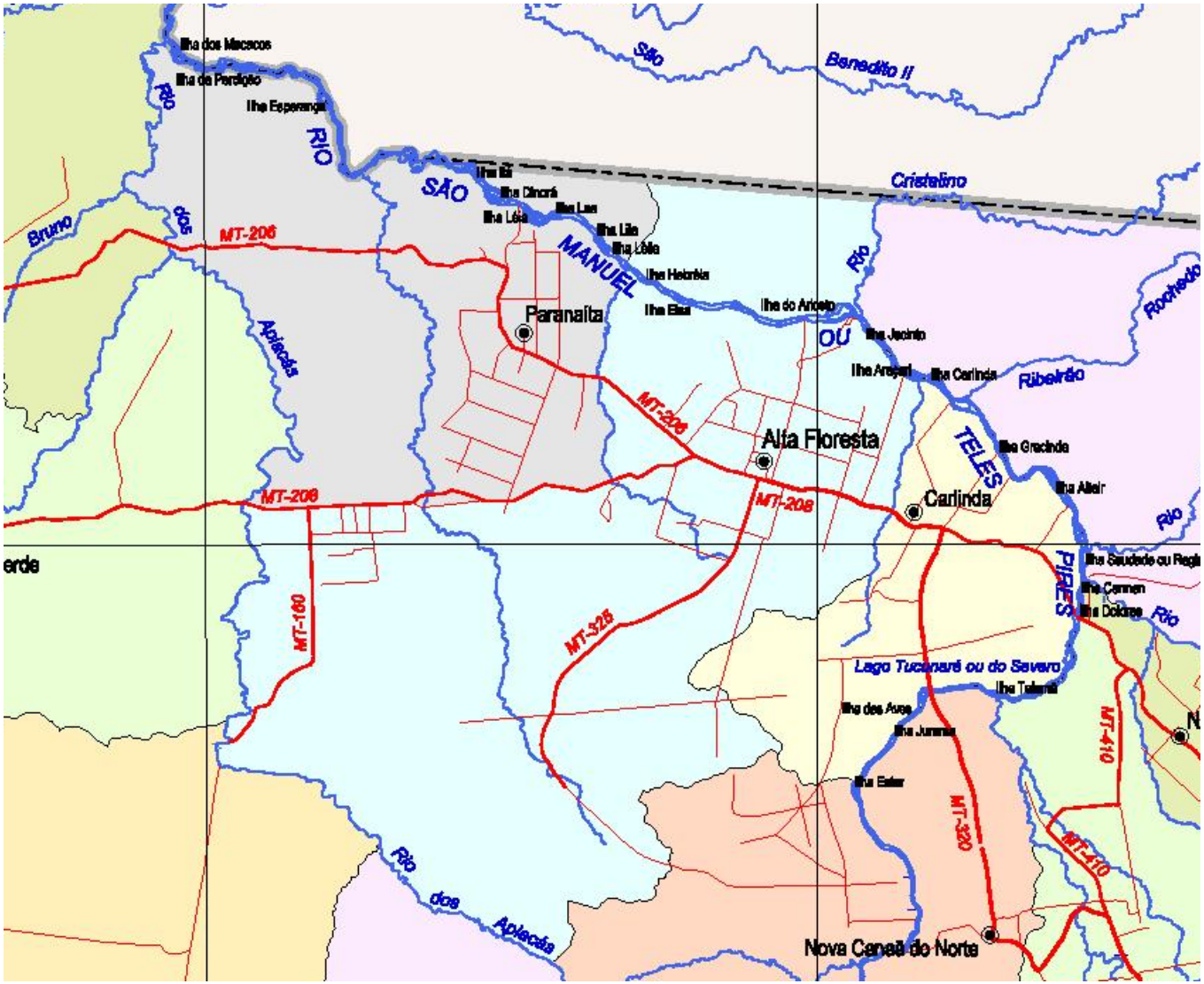


Recovering disbursements from the Amazon Fund

An example

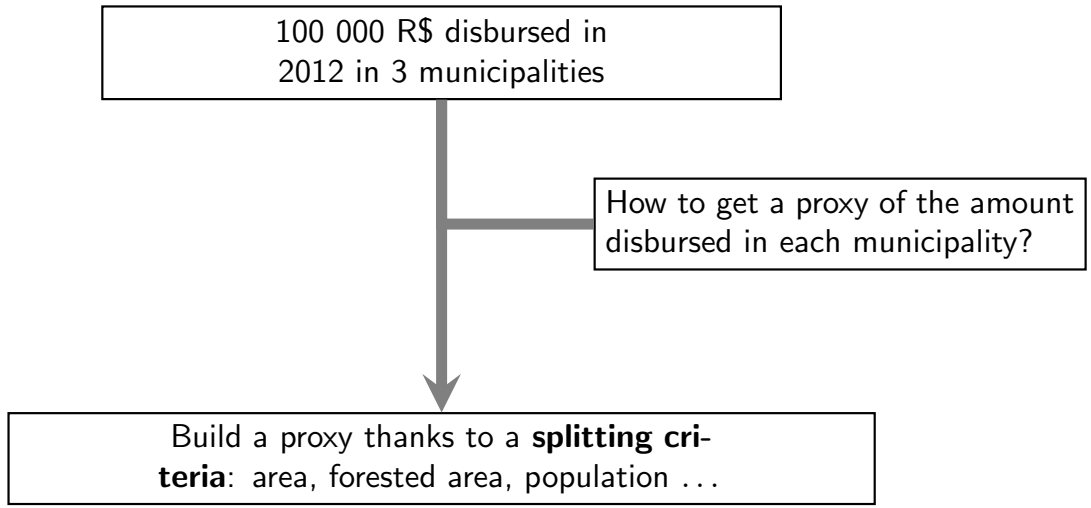
Recovering disbursements from the Amazon Fund

An allocation process

100 000 R$ disbursed in
2012 in 3 municipalities

Recovering disbursements from the Amazon Fund

An allocation process



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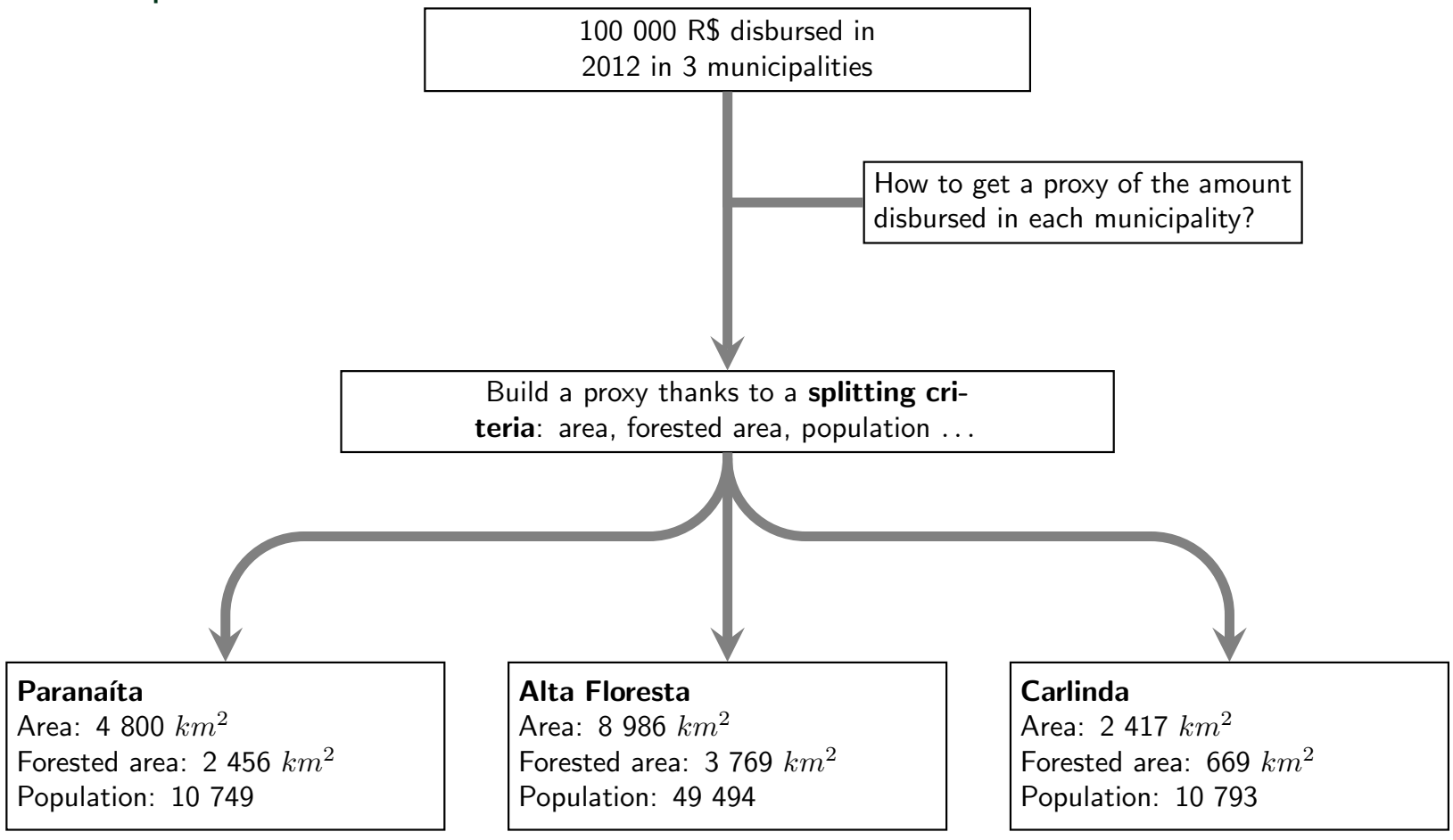

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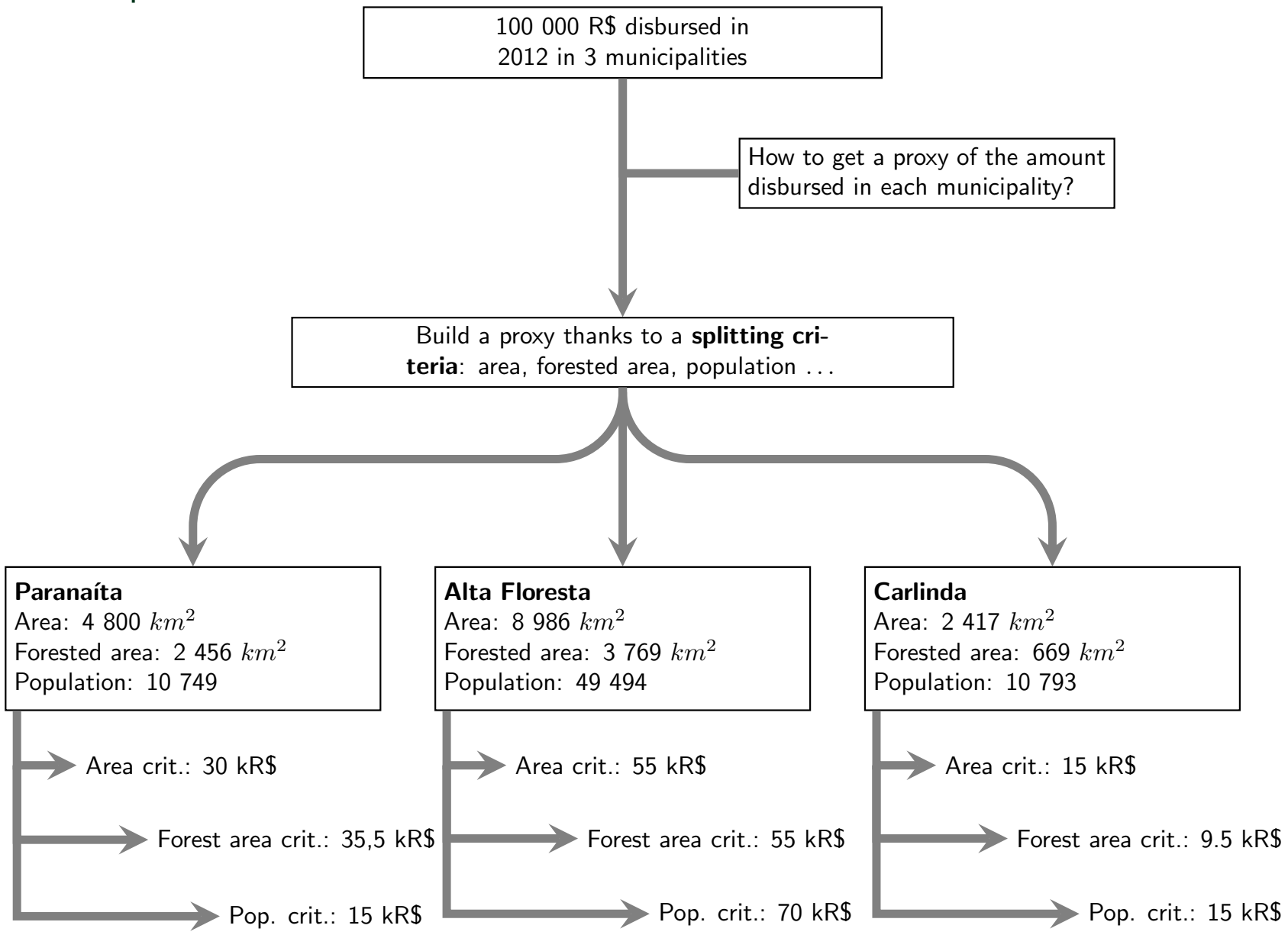
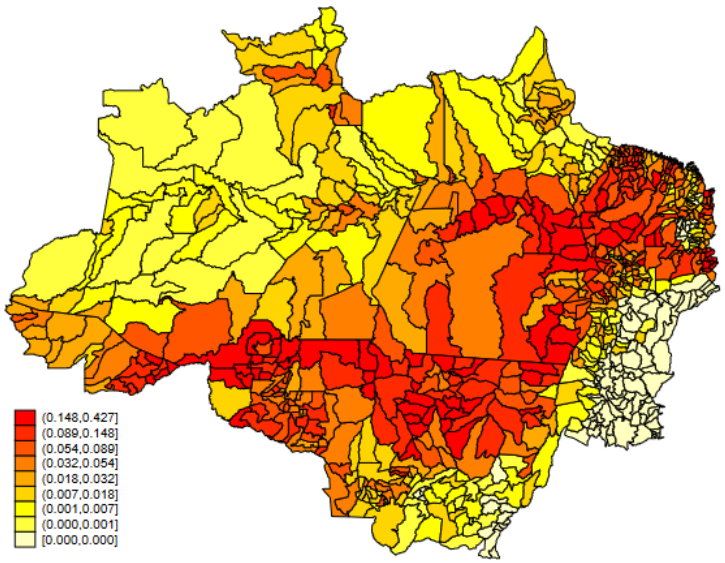
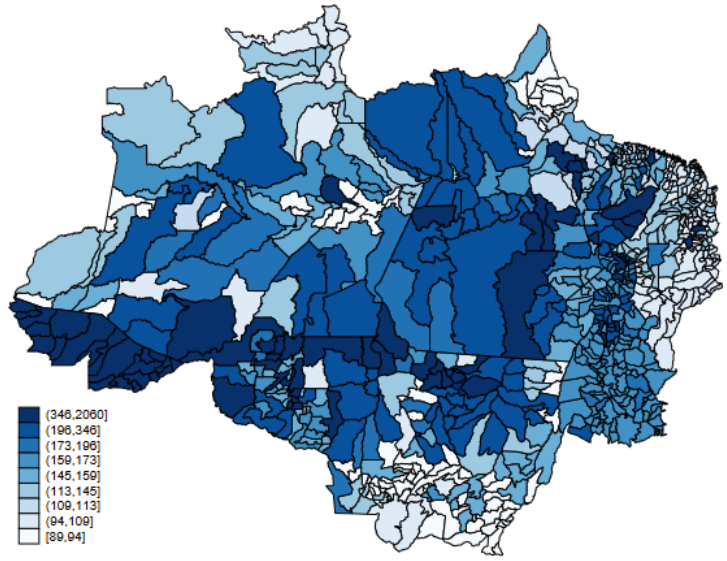


Amazon Fund disbursements are concentrated in the arc of deforestation



(a) Deforestation rates



(b) AF disbursements ($R\$/km^2$)

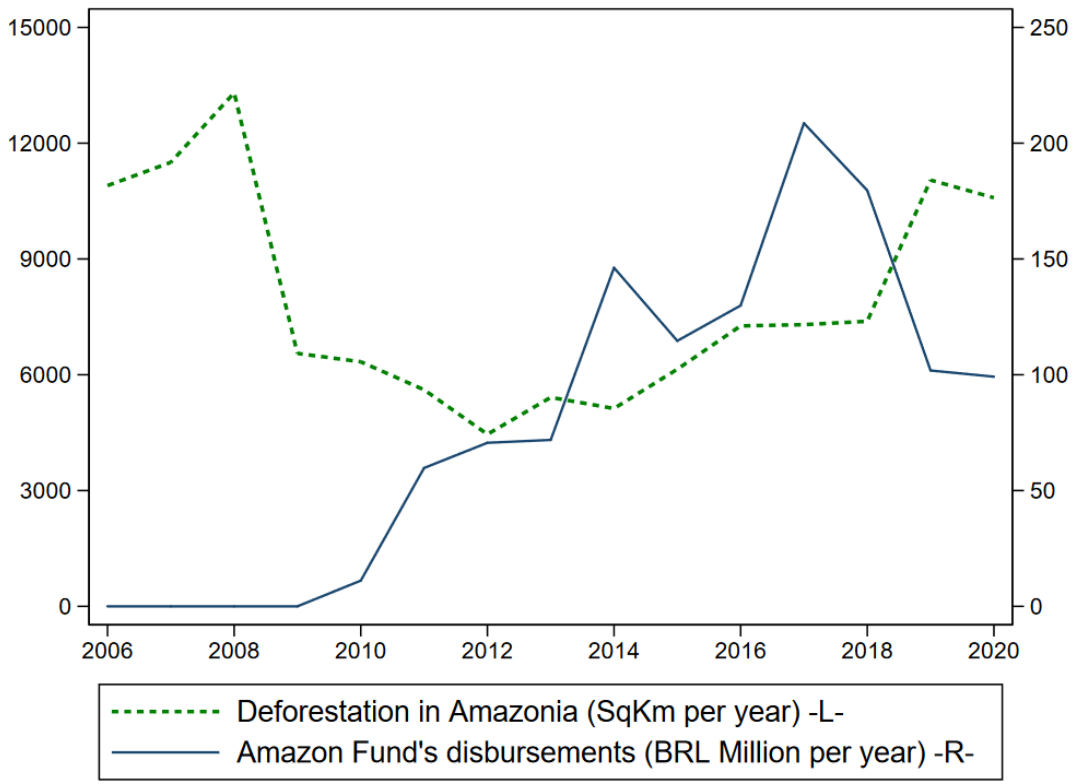
Source: INPE and authors calculations for deforestation; BNDES and authors calculations for Amazon Fund disbursements

What are the projects supported by the Amazon Fund ?

AXIS	Monitoring and control systems	42
	Science, innovation and economic instruments	25
	Land use planning	27
	Sustainable production	59
THEME	Rural Environmental Registry (CAR)	19
	Settlement	16
	Indigenous lands	28
	Conservation units	28
	Combat to illegal fires and burn-offs	6
RECIPIENT	Third Sector	58
	Federal Government	8
	States	22
	Municipalities	7
	Universities	6
	International	1

Context: a huge drop of Amazon Fund disbursements since 2018

Deforestation and disbursements of the Amazon Fund in the legal Amazon between 2006 and 2020



Sources: INPE for deforestation rates; BNDES and authors calculations for Amazon Fund's disbursements.

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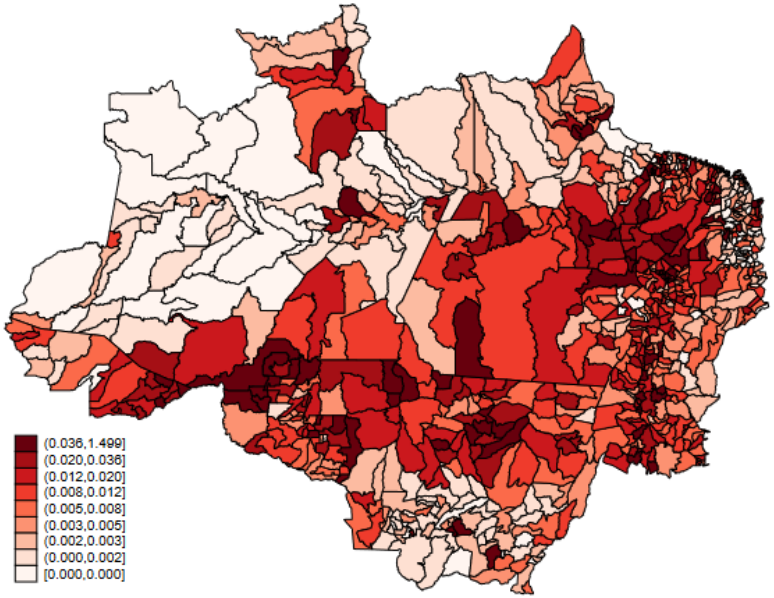
Methodology: trying to disentangle the roles of green finance and law enforcement

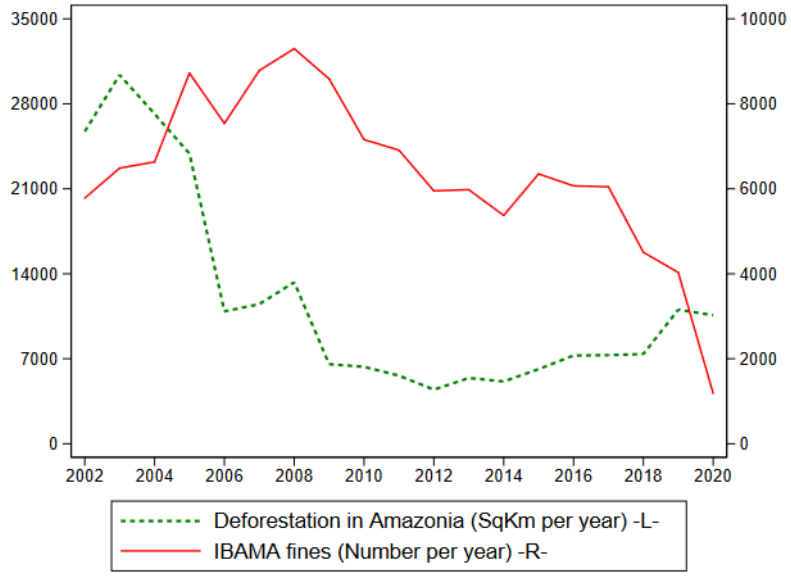
Results

Weakening of law enforcement

Number of IBAMA's sanctions



(a) Number of infractions per km^2 between 2010 and 2020

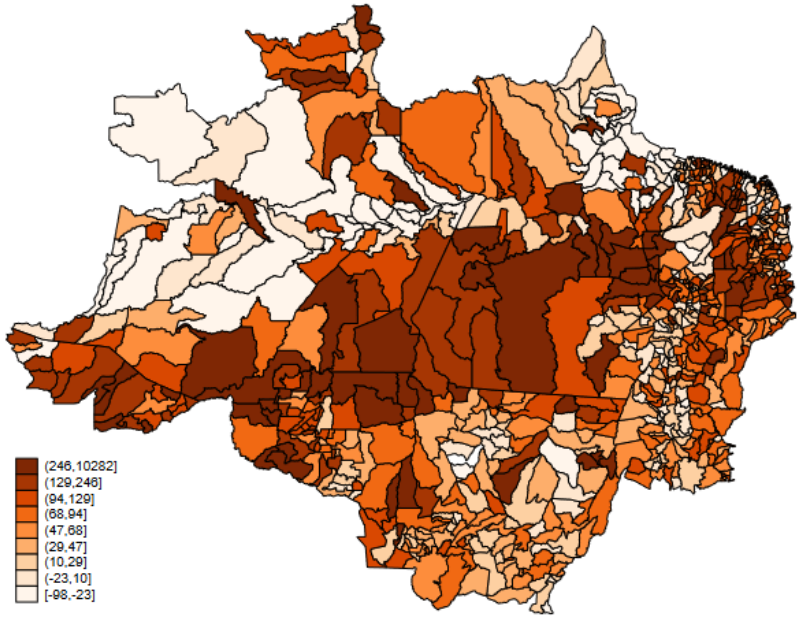


(b) Number of infractions in the legal Amazon between 2002 and 2020

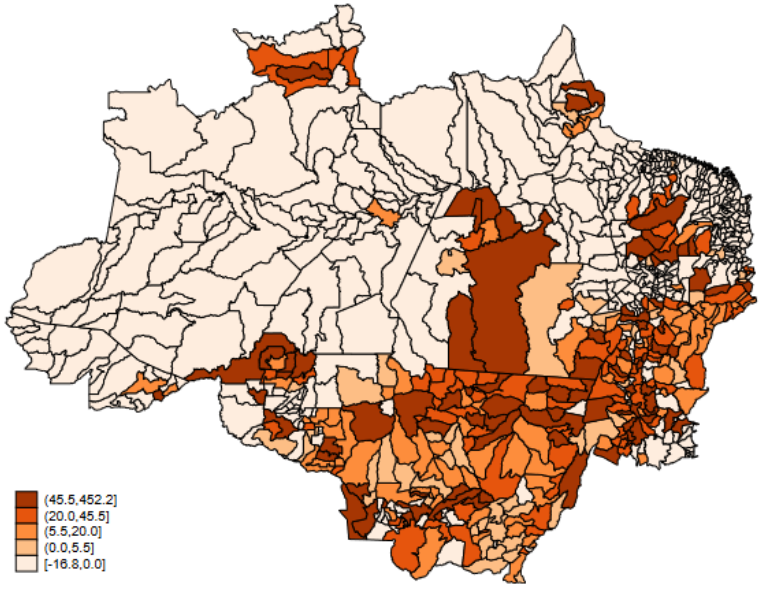
Source: IBAMA and authors calculations
Disclaimer: according to the IBAMA, the data on infractions committed in 2019 and 2020 are not complete due to a change in the data collection application

Agricultural production: cattle ahead of soybean

Growth of agricultural production between 2001 and 2020



(a) Steer livestock (number of heads)



(b) Soybean production (tons)

Source: IBGE and authors calculations

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Panel VAR approach

System of linear equations (with p=2 lags for the benchmark case):

$$Y_{it} = \mathbf{A}_p(L)Y_{it} + \mathbf{B}X_{it} + f_i + e_{it}$$
$$i \in \{1, ..., 760\}$$
$$t \in \{2002, ..., 2020\}$$

Where,

- Y_{it} is $1 \times k$ vector of endogenous variables (k=5): **Amazon Fund, Ibama, deforestation, steer prod., soybean prod.**
- X_{it} is $1 \times l$ vector of exogenous covariates (l=3): rural credit, steer price, soybean price
- f_i and e_{it} are $1 \times k$ vectors of unobserved panel specific fixed-effects and idiosyncratic errors

Estimation through GMM (Arellano and Bover, 1995)

SVAR identification scheme: policy - deforestation - agriculture

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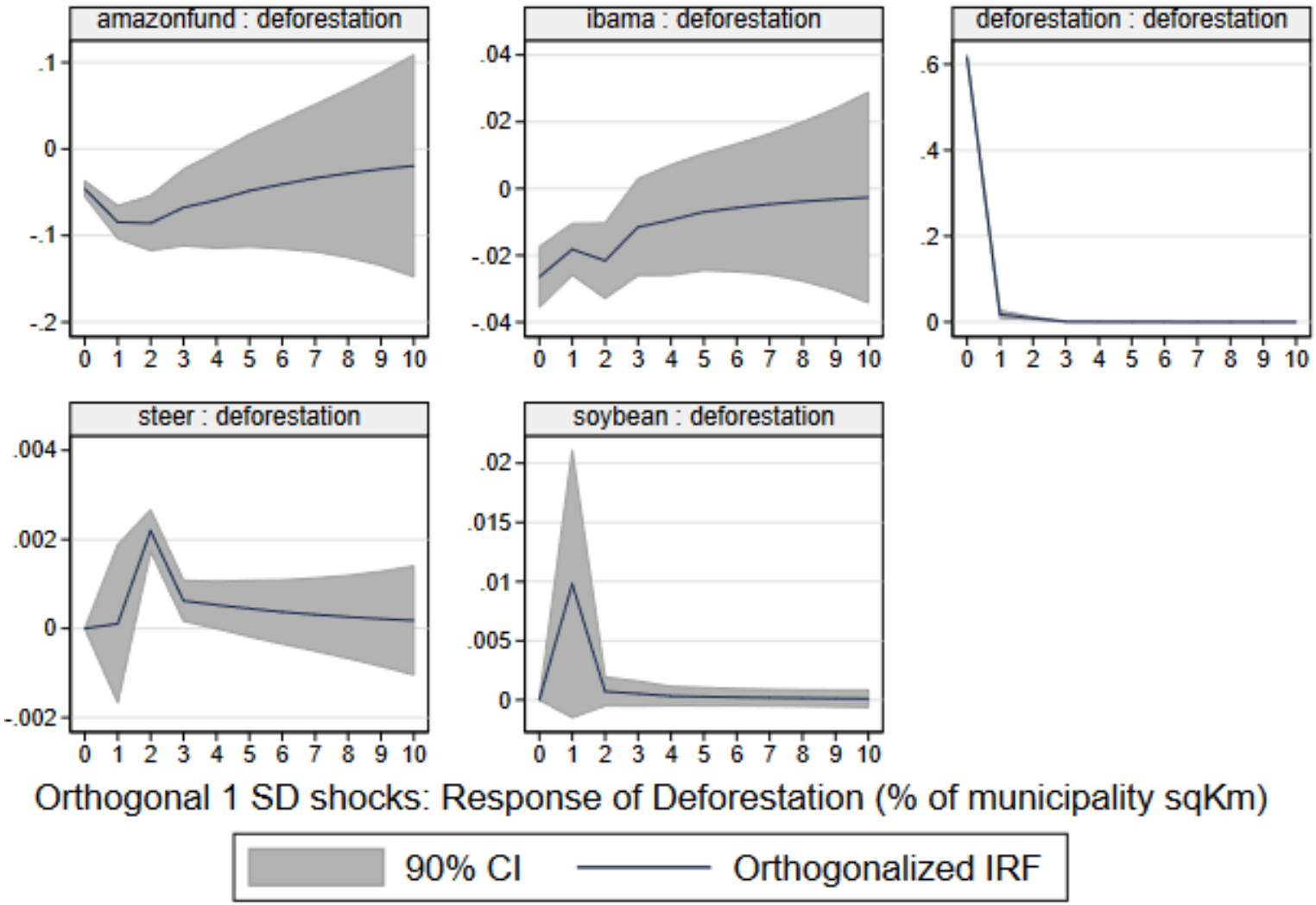
Baseline results

Response: Deforestation rate (ratio/SqKm)	(1)	(2)	(3)	(4)
Endogenous variables [lags]:				
Deforestation rate (ratio/SqKm) [-1]	0.0302***	0.0299***	0.0290***	0.0290***
	(3.47)	(3.38)	(3.29)	(3.29)
[-2]	0.0136***	0.0138***	0.0132***	0.0132***
	(4.57)	(4.53)	(4.51)	(4.51)
Amazon Fund disbursement (BRL/SqKm) [-1]	-0.00374***	-0.00372***	-0.00370***	-0.00369***
	(-7.08)	(-7.14)	(-7.12)	(-7.11)
[-2]	-0.00223***	-0.00222***	-0.00221***	-0.00220***
	(-4.84)	(-4.86)	(-4.87)	(-4.85)
Ibama_fines (BRL/SqKm) [-1]		-0.00000766***	-0.00000751***	-0.00000744***
		(-3.73)	(-3.68)	(-3.66)
[-2]		-0.00000689***	-0.00000676***	-0.00000672***
		(-2.96)	(-2.93)	(-2.92)
Steer stock (growth) [-1]			9.51e-08	0.000000109
			(0.10)	(0.11)
[-2]			0.00000144***	0.00000144***
			(7.81)	(7.80)
Soybean tons (growth) [-1]				0.0000511
				(1.43)
[-2]				-0.000000206
				(-0.73)
Exogenous variables:				
Credit to agriculture (real growth)	0.0118***	0.0118***	0.0114***	0.0115***
	(8.26)	(8.21)	(7.99)	(8.01)
Steer price (real growth)	-0.000949**	-0.000938**	-0.000870**	-0.000848**
	(-2.45)	(-2.41)	(-2.24)	(-2.19)
Soybean price (real growth)	-0.000876***	-0.000877***	-0.000927***	-0.000923***
	(-3.08)	(-3.08)	(-3.30)	(-3.28)
N. observations.	13680	13608	13522	13522
N. municipalities	760	756	755	755

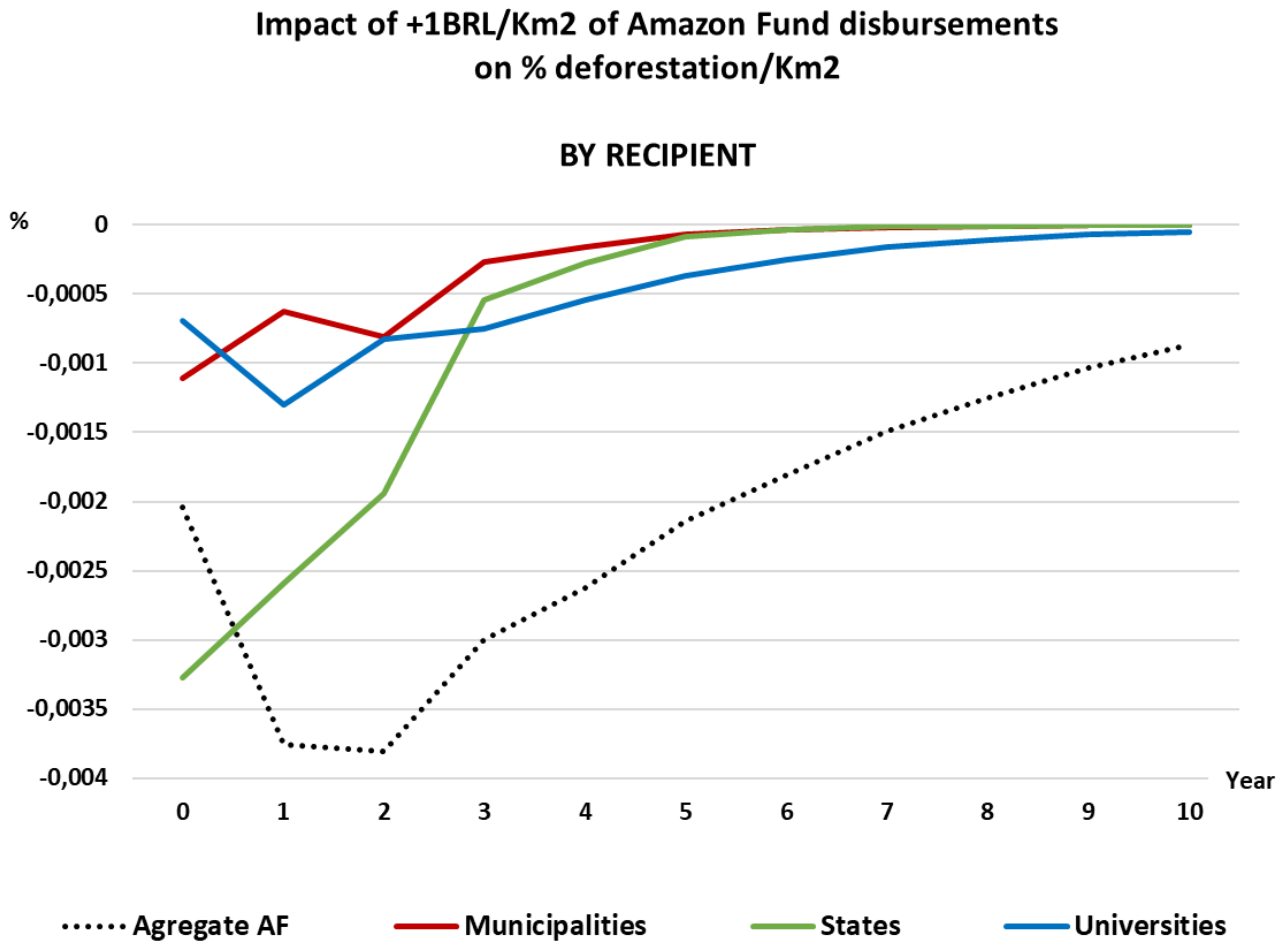
t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

OIRFs: Amazon Fund and IBAMA are effective in curbing deforestation



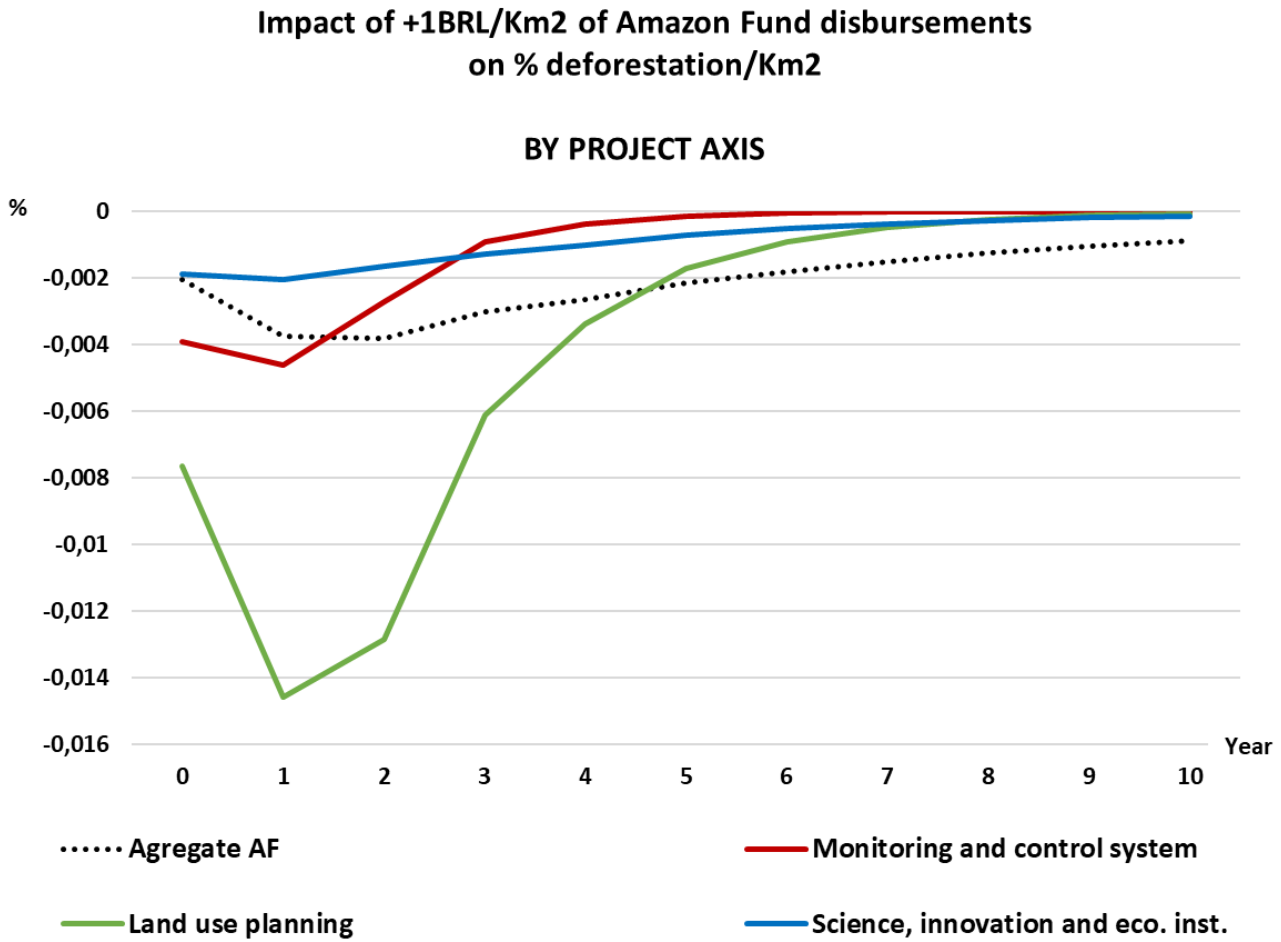
All IRFs

OIRFs: Projects led by states are more effective than those of municipalities and universities



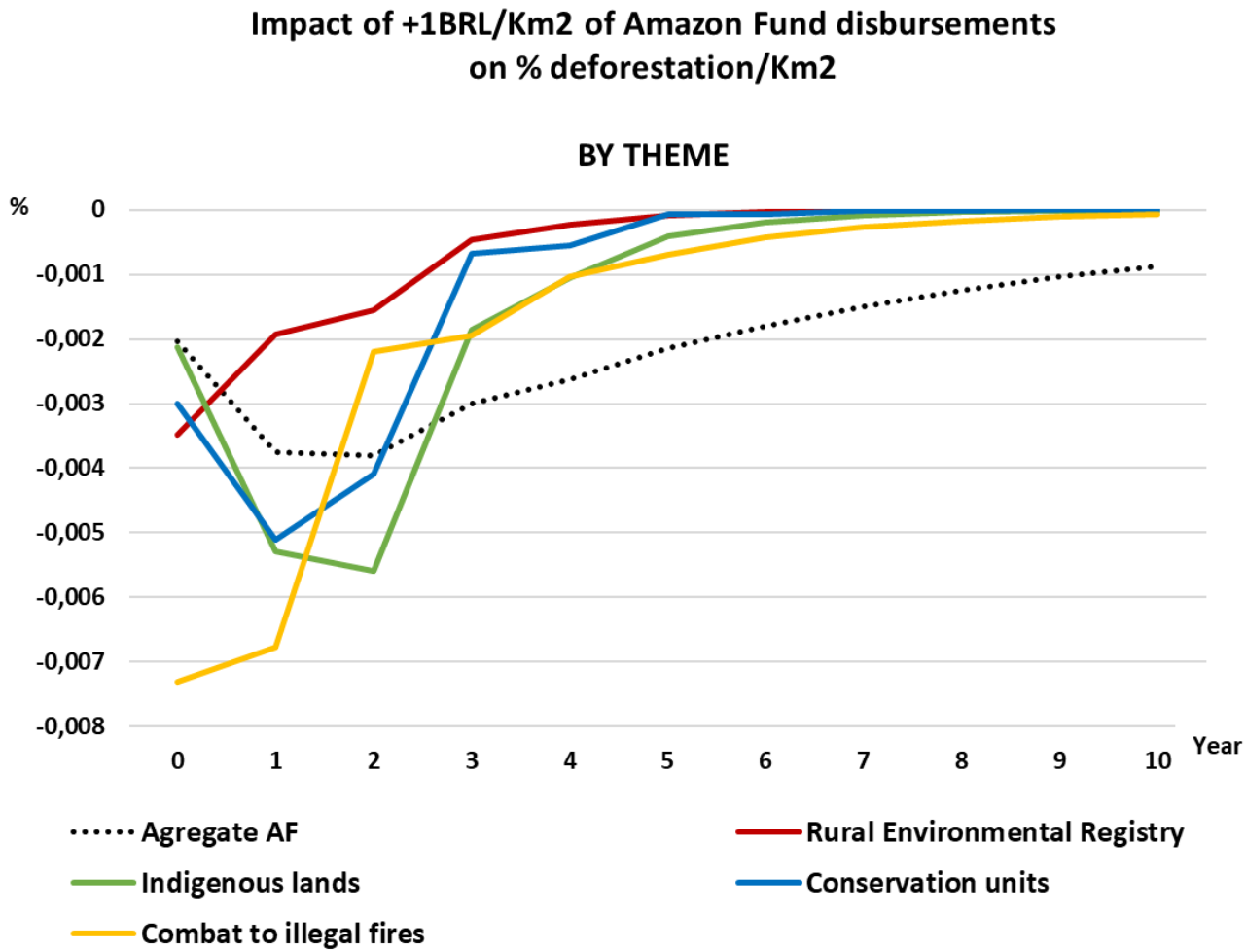
Number of projects

OIRFs: Land use planning projects are the most effective



Number of projects

OIRFs: Protecting indigenous lands and combatting illegal fires work well



Number of projects

Results

Estimating an abatment cost

Conventionally, clearing one hectare of primary forest releases 367 tCO_2

Estimation through IRFs IRFs

- Using the effect of one standard deviation disbursement on deforestation leads to an abatement cost of **0.22** $\$R/tCO_2$ (0.07 $/tCO_2$)

Estimation through counterfactual analysis Counterfactual

- Using the GMM estimation GMM and setting disbursements of the Fund to 0 leads to an abatement cost of **0.56** $\$R/tCO_2$ (0.18 $/tCO_2$)

Key takeaways

- The Amazon Fund is **effective and efficient** : less than 1$R makes it possible to avoid the release of 1 tCO_2.
- Its **impact depends on the type of project supported**. State-led projects and those aimed at combating illegal fires or protecting indigenous lands are particularly effective.

What's next ?

- Robustness checks: allocation process, pre-ordering...
- Spillover effects ?

Thank you !

Bibliography I

[1] Jennifer Alix-Garcia et al. "Avoided Deforestation Linked to Environmental Registration of Properties in the Brazilian Amazon". In: *Conservation Letters* (2018). DOI: 10.1111/conl.12414.

[2] Juliano Assunção, Clarissa Gandour, and Romero Rocha. "Deterring deforestation in the Brazilian Amazon: Environmental monitoring and law enforcement". In: *null* (2014). DOI: null.

[3] Juliano Assunção, Clarissa Gandour, and Rudi Rocha. "Deforestation slowdown in the Brazilian Amazon: prices or policies?" In: *Environment and Development Economics* (2015). DOI: 10.1017/s1355770x15000078.

[4] Juliano Assunção and Romero Rocha. "Getting greener by going black: the effect of blacklisting municipalities on Amazon deforestation". In: *Environment and Development Economics* (2019). DOI: 10.1017/s1355770x18000499.

Bibliography II

[5] Juliano Assunção et al. "The Effect of Rural Credit on Deforestation: Evidence from the Brazilian Amazon". In: *The Economic Journal* (2020). DOI: 10.1093/ej/uez060.

[6] Francisco Bidone. "Driving governance beyond ecological modernization: REDD+ and the Amazon Fund". In: *Environmental Policy and Governance* (2021). DOI: 10.1002/eet.1969.

[7] Cauê Carrilho et al. "Permanence of avoided deforestation in a Transamazon REDD+ project (Pará, Brazil)". In: *Ecological Economics* (2022). DOI: 10.1016/j.ecolecon.2022.107568.

[8] Elias Cisneros, Sophie Lian Zhou, and Jan Börner. "Naming and Shaming for Conservation: Evidence from the Brazilian Amazon.". In: *PLOS ONE* (2015). DOI: 10.1371/journal.pone.0136402.

[9] Juliano Correa et al. "Amazon Fund 10 Years Later: Lessons from the World's Largest REDD+ Program". In: *Forests* (2019). DOI: 10.3390/f10030272.

Bibliography III

[10] Juliano Correa et al. "Evaluating REDD+ at subnational level: Amazon fund impacts in Alta Floresta, Brazil". In: *Forest Policy and Economics* (2020). DOI: 10.1016/j.forpol.2020.102178.

[11] Edward A. Ellis et al. "Mixed Effectiveness of REDD+ Subnational Initiatives after 10 Years of Interventions on the Yucatan Peninsula, Mexico". In: *Forests* (2020). DOI: 10.3390/f11091005.

[12] Richard van der Hoff, Raoni Rajão, and Pieter Leroy. "Clashing interpretations of REDD+ "results" in the Amazon Fund". In: *Climatic Change* (2018). DOI: 10.1007/s10584-018-2288-x.

[13] Seema Jayachandran et al. "Cash for carbon: A randomized trial of payments for ecosystem services to reduce deforestation". In: *Science* (2017). DOI: 10.1126/science.aan0568.

[14] Anand Roopsind, Brent Sohngen, and Jodi S. Brandt. "Evidence that a national REDD+ program reduces tree cover loss and carbon emissions in a high forest cover, low deforestation country.". In: *Proceedings of the National Academy of Sciences of the United States of America* (2019). DOI: 10.1073/pnas.1904027116.

Bibliography IV

[15] Jorge Hargrave Gonçalves da Silva et al. "Economic causes of deforestation in the Brazilian Amazon: A panel data analysis for the 2000s". In: *Environmental and Resource Economics* (2010). DOI: 10.1007/s10640-012-9610-2.

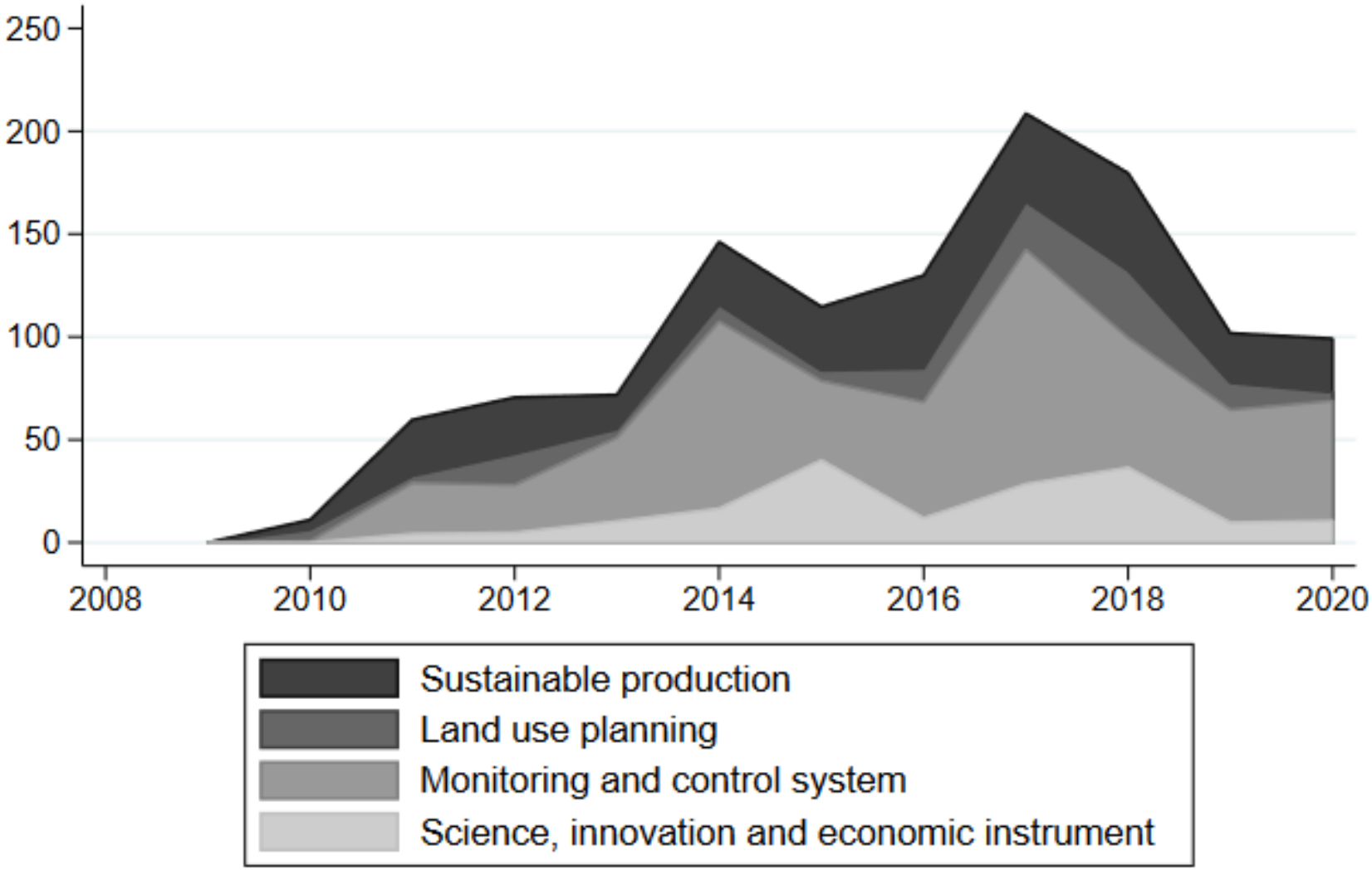
[16] Britaldo Soares-Filho et al. "Role of Brazilian Amazon protected areas in climate change mitigation". In: *Proceedings of the National Academy of Sciences of the United States of America* (2010). DOI: 10.1073/pnas.0913048107.

[17] Thales A.P. West et al. "Overstated carbon emission reductions from voluntary REDD+ projects in the Brazilian Amazon.". In: *Proceedings of the National Academy of Sciences of the United States of America* (2020). DOI: 10.1073/pnas.2004334117.

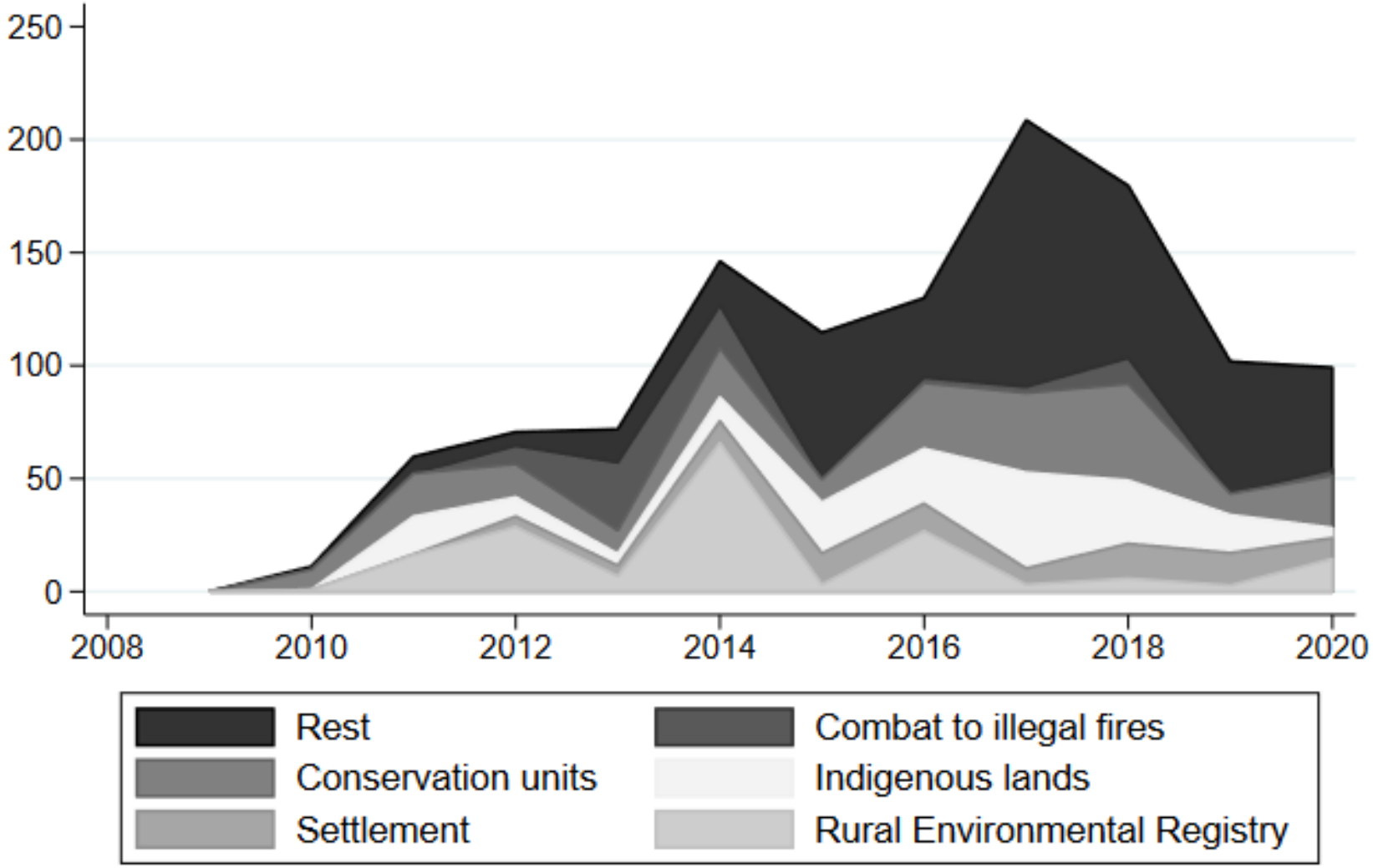
Main variables and data sources

- Amazon Fund disbursements: Banco National de Desenvolvimento Economico (BNDES)
- Deforestation rates: Instituto Nacional de Pesquisas Espaciais (INPE)
- Law enforcement: Instituto Brasileiro do Meio Ambiente (IBAMA)
- Agricultural production: Instituto Brasileiro de Geografia e Estatística (IBGE)
- Agricultural prices: Centro de Estudos Avançados em Economia Aplicada (CEPEA)
- Rural credit: Banco Central do Brasil (BCB)

Disbursements - Axis



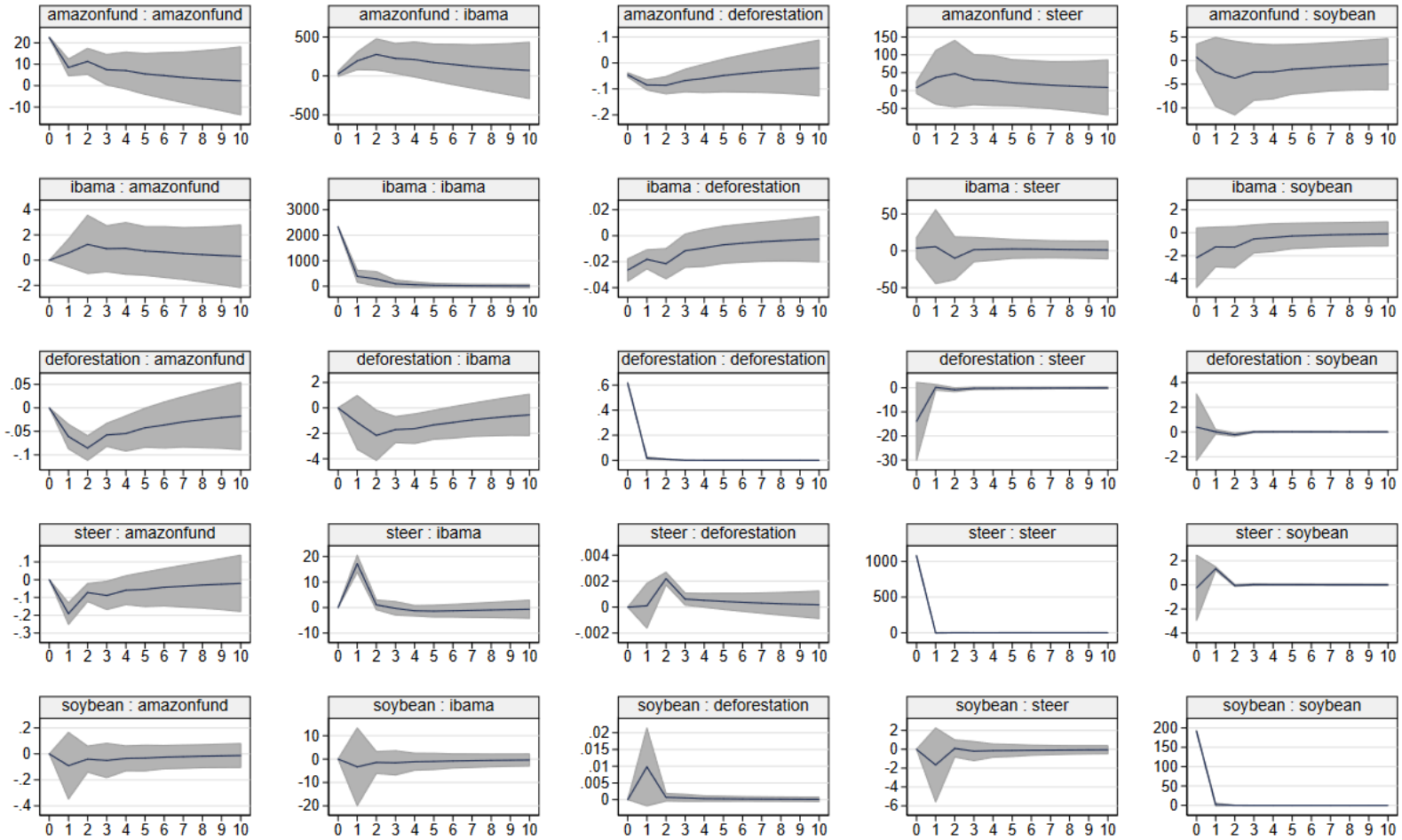
Disbursements - Theme



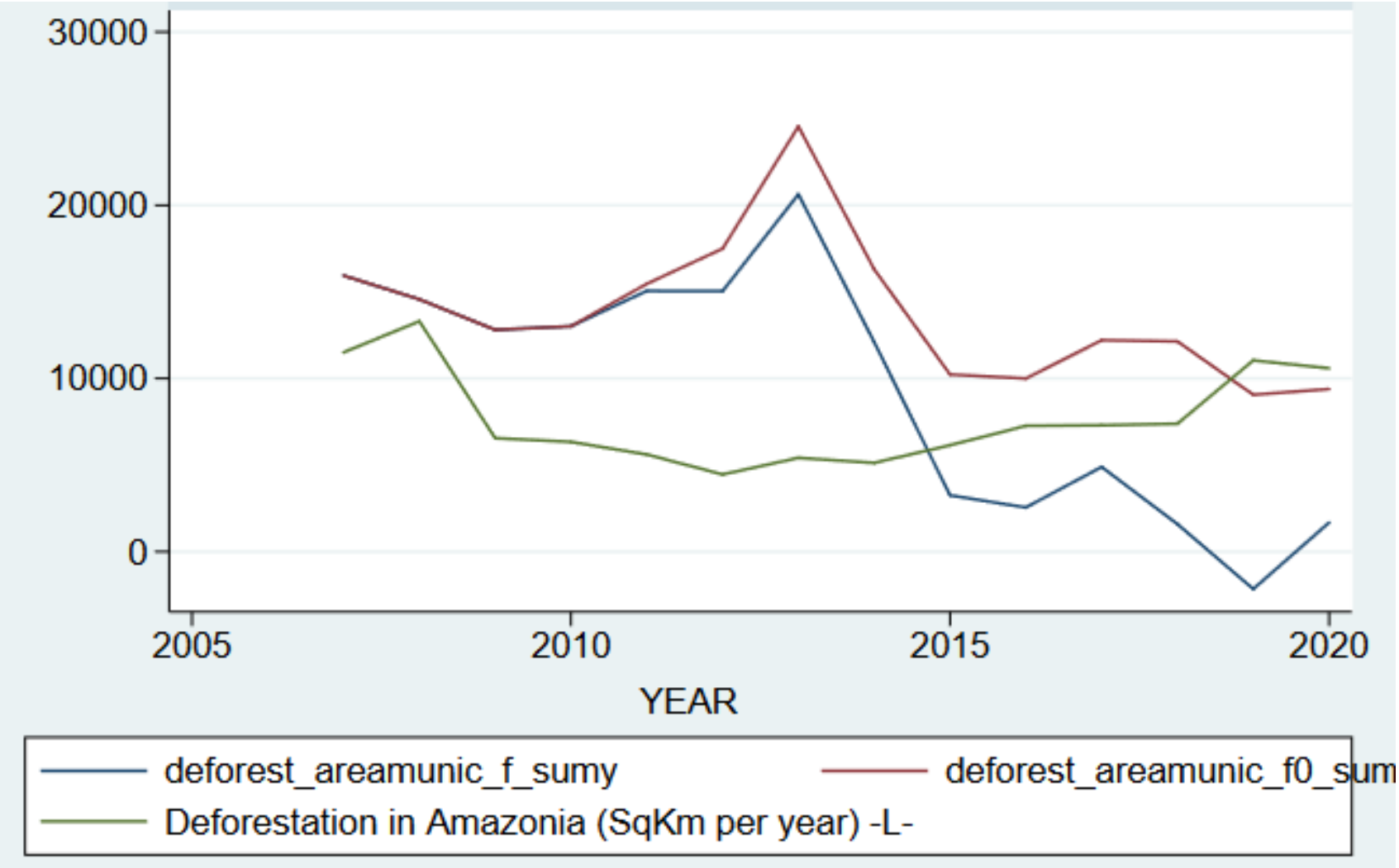
Correlation matrix

		AXIS				THEME					RECIPIENT					
		Monitoring and	Science, innova	Land use plann	Sustainable pr	Rural Environm	Settlement	Indigenous land	Conservation u	Combat to illeg	Third Sector	Federal Gover	States	Municipalities	Universities	International
AXIS	Monitoring and control systems	100,0%	19,0%	16,7%	28,6%	45,2%	2,4%	2,4%	9,5%	14,3%	16,7%	14,3%	50,0%	16,7%	0,0%	2,4%
	Science, innovation and economic instruments	32,0%	100,0%	12,0%	40,0%	4,0%	16,0%	12,0%	32,0%	0,0%	48,0%	20,0%	4,0%	0,0%	24,0%	4,0%
	Land use planning	25,9%	11,1%	100,0%	77,8%	7,4%	7,4%	55,6%	44,4%	0,0%	81,5%	0,0%	14,8%	3,7%	0,0%	0,0%
	Sustainable production	20,3%	16,9%	35,6%	100,0%	8,5%	27,1%	44,1%	35,6%	0,0%	84,7%	0,0%	5,1%	10,2%	0,0%	0,0%
THEME	Rural Environmental Registry (CAR)	100,0%	5,3%	10,5%	26,3%	100,0%	0,0%	0,0%	5,3%	0,0%	15,8%	0,0%	73,7%	10,5%	0,0%	0,0%
	Settlement	6,3%	25,0%	12,5%	100,0%	0,0%	100,0%	31,3%	50,0%	0,0%	100,0%	0,0%	0,0%	0,0%	0,0%	0,0%
	Indigenous lands	3,6%	10,7%	53,6%	92,9%	0,0%	17,9%	100,0%	39,3%	0,0%	92,9%	0,0%	3,6%	0,0%	3,6%	0,0%
	Conservation units	14,3%	28,6%	42,9%	75,0%	3,6%	28,6%	39,3%	100,0%	0,0%	82,1%	3,6%	10,7%	0,0%	3,6%	0,0%
	Combat to illegal fires and burn-offs	100,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	100,0%	0,0%	16,7%	83,3%	0,0%	0,0%	0,0%
RECIPIENT	Third Sector	12,1%	20,7%	37,9%	86,2%	5,2%	27,6%	44,8%	39,7%	0,0%	100,0%	0,0%	0,0%	0,0%	0,0%	0,0%
	Federal Government	75,0%	62,5%	0,0%	0,0%	0,0%	0,0%	0,0%	12,5%	12,5%	0,0%	100,0%	0,0%	0,0%	0,0%	0,0%
	States	95,5%	4,5%	18,2%	13,6%	63,6%	0,0%	4,5%	13,6%	22,7%	0,0%	0,0%	100,0%	0,0%	0,0%	0,0%
	Municipalities	100,0%	0,0%	14,3%	85,7%	28,6%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	100,0%	0,0%	0,0%
	Universities	0,0%	100,0%	0,0%	0,0%	0,0%	0,0%	16,7%	16,7%	0,0%	0,0%	0,0%	0,0%	0,0%	100,0%	0,0%
	International	100,0%	100,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	100,0%

Correlation matrix



Counterfactual analysis



Descriptive statistics

Variables	(1) N. obs	(2) Mean	(3) S.D.	(4) Min	(5) Max
Deforestation rate (% ratio/km^2 per Year)	15,960	0.451	3.137	0	97.50
Amazon Fund disbursement (BRL/km^2 per Year)	15,960	9.791	26.01	0	615.5
Ibama fines (BRL/km^2 per Year)	15,876	353.8	2,486	0	122,215
Steer stock (heads, % Y/Y growth)	15,893	170.2	7,702	-100	720,528
Soybean production (tons, % Y/Y growth)	15,960	25.58	1,251	-100	155,803
Credit to agriculture (BRL, % Y/Y real growth)	20	5.230	8.793	-12.77	21.94
Steer price (BRL, % Y/Y real growth)	20	2.221	12.66	-15.30	33.02
Soybean price (BRL, % Y/Y real growth)	20	3.516	19.10	-30.88	44.34

Note: The table displays the transformation of variables used in our regressions. While the descriptive statistics refer to the whole available dataset, a lower number of observations are used in estimation due to lags in the VAR system

Variables used in estimations and main descriptive statistics of the dataset (2000-2020)

Source: IBGE and authors calculations

Descriptive statistics