



INITIATIVE ON
Livestock and Climate



The impact of agricultural credit on the cattle inventory and deforestation in Colombia: a spatial analysis

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Motivation

- The **relationship between agricultural credit and agricultural production** as well as the impacts on sustainable development (i.e., poverty alleviation, reduction of inequalities, food and nutrition security, and stimulation of economic growth) (Lozano, 2009; Echavarría et al., 2018).
- Producers who have **access to formal credit** are, for example, better situated regarding quality of life, productive capacity, social status, and some covariates of poverty (Goldberg, 2005; Chen, 2025; Benti, 2019).
- One of main **limitations for rural development is access to formal credit**, developing countries need alternatives for improving financial inclusion within rural populations (Kraay & McKenzie, 2014; Okamoto et al., 2021).
- Most **formal credits involve high transaction costs**, information asymmetries, high interest rates, and numerous formal requirements (e.g., collateral) (Boucher et al., 2009; Hazari et al., 2025; Carrer et al., 2020).
- **Finagro and Agricultural Bank** are two key actors in agricultural credit in Colombia. Around 75% of agricultural credits have been granted through FINAGRO (Estrada et al, 2016, Echavarría et al., 2028).

Overview

Cattle farming is among the most important activities within the agricultural sector in Colombia (Fedegan, 2023):

- Contributes **1.4%** of the national, **21.8%** of the agricultural, and **48.7%** of the livestock GDP of the country.
- Generates around **1.1 million** direct jobs.
- About **23 million** hectares of land are used for pastures and forage production and the transformation of native landscapes and forests into pastures generates impacts on the different ecosystems of the country.
- The cattle sector is held responsible for approximately **60%** of the country's deforestation.

Sustainable intensification **increase** cattle production and mitigate negative environmental externalities, promoting ecosystem services and environmental benefits (Flórez et al. 2023; Sandoval et al. 2023).

Agricultural credit could promote sustainable intensification.

Objective: *Analyze the impact of credit on cattle production and deforestation in Colombia through spatial panel data models.*



In addition, by using spatial panel data models, the study analyzes if **spatial effects of credit distribution** come along with spillover effects on the cattle herd and deforestation.

Contributes to two major political debates currently on-going in Colombia,

- How to **sustainably intensify cattle production systems** considering a constantly increasing demand for animal-sourced foods and the negative impacts of cattle production on the environment.
- How to **reduce deforestation rates** and contribute to ecological conservation of fragile and threatened ecosystems, such as the Amazon.

Data and variables

- Departmental data panel was constructed for the period 2011–2020.
- Two dependent variables are proposed:
 - **Cattle herd size** as indicator for cattle production and
 - **Deforestation rate** at a specific moment in time.
- Independent and control variables
 - **Access to credit:** The total amounts and values of credits disbursed by FINAGRO by department are considered, both in terms of overall agricultural credits and credits specifically granted to the cattle sector.
 - **Land use:** The use of agricultural land is defined as the use of suitable land for a wide variety of crops due to its favorable conditions such as temperature, soil PH, fertility, and texture, among other factors.
 - **Coca:** The number of hectares planted with coca at the departmental level are considered to observe the relationship of illicit crops with deforestation and cattle production.
 - **Sociodemographic control variable:** The percentage of rurality is considered as a control variable.

Methodological approach

- spatial panel data model to credit and cattle production, considering that our individuals (n) are the **32 Colombian departments**, the appropriate specification is **Fixed Effects (FE)**.
- To modeling the **annual deforestation rate**, the appropriate specification is **Random Effects (RE)** (Hausman test).
- To model **spatial interdependencies**, we use **weight matrix** or contiguity matrix (W), which is made up of 1 and 0 and shows the contiguity between two geographic units by having at least one limit in common.

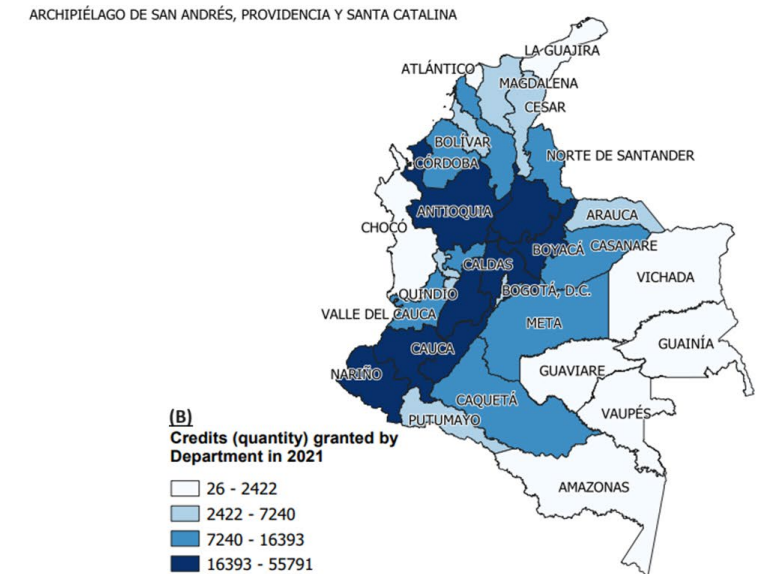
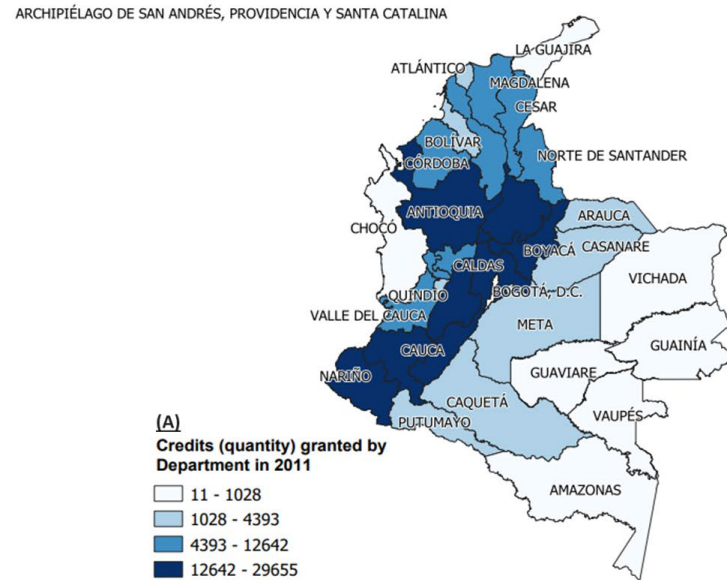
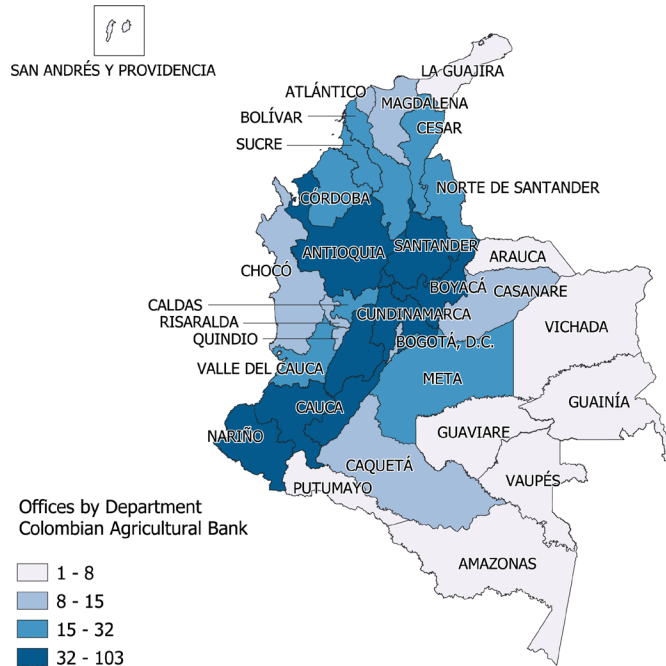
$$\text{SAR} : y_{it} = \rho W y_{it} + \beta_1 \text{CreditAccess}_{it} + \beta_2 \text{LandUse}_{it} + \beta_3 \text{Sociodemographics}_{it} + \varepsilon_{it}$$

$$\text{SEM} : y_{it} = \beta_1 \text{CreditAccess}_{it} + \beta_2 \text{LandUse}_{it} + \beta_3 \text{Sociodemographics}_{it} + U_{it}$$
$$U_{it} = \lambda W U_{it} + \varepsilon_{it}$$

$$\text{SARAR} : y_{it} = \rho W y_{it} + \beta_1 \text{CreditAccess}_{it} + \beta_2 \text{LandUse}_{it} + \beta_3 \text{Sociodemographics}_{it} + U_{it}$$
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Spatial panel data models

Agricultural credit by Agricultural Bank



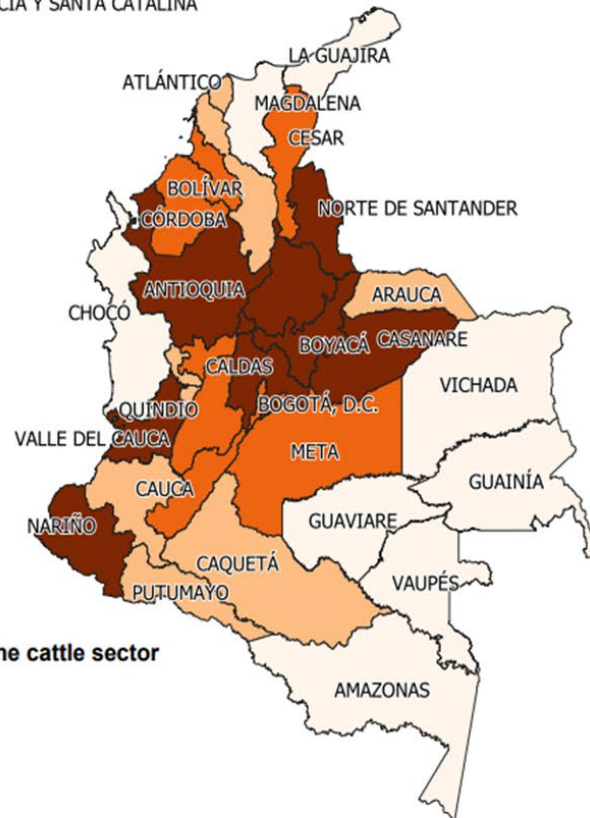
- National center periphery structure.
- Agricultural credits manage to cover only about 38% of the country's rural producers.

The year 2020 meant a considerable increase in the number of credits placed. Consequently, the agricultural sector in 2020 received the highest credit placement since statistics are available, with an increase in 2020 of 26% in credit value and 24% in the number of credits compared to 2019.

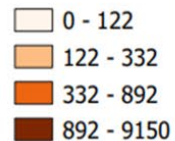
Cattle credit and cattle production

The **distribution of credits** disbursed to the cattle sector coincides with the main **cattle production regions** and thus a relationship between these variables can be intuited.

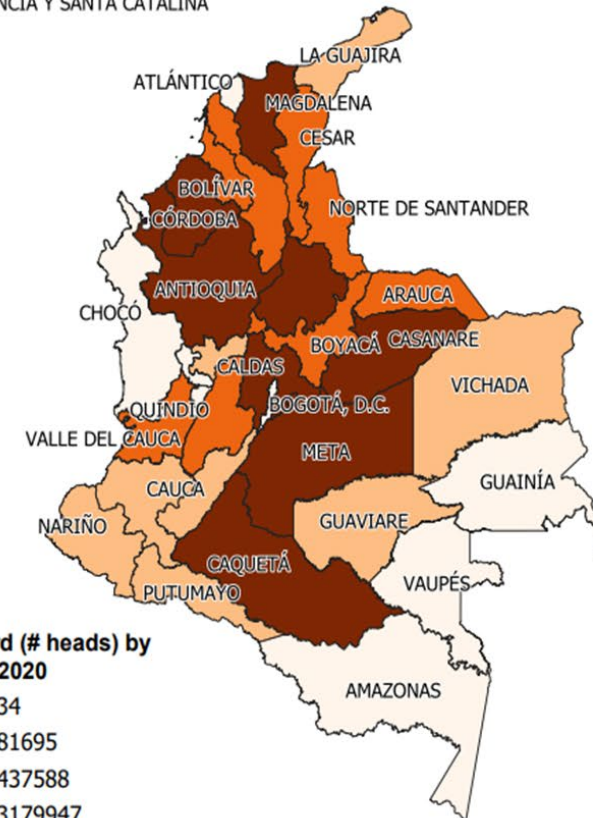
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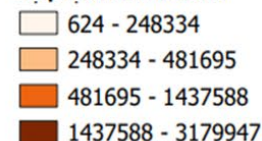
(A)
Credits (quantity) granted to the cattle sector by Department in 2020



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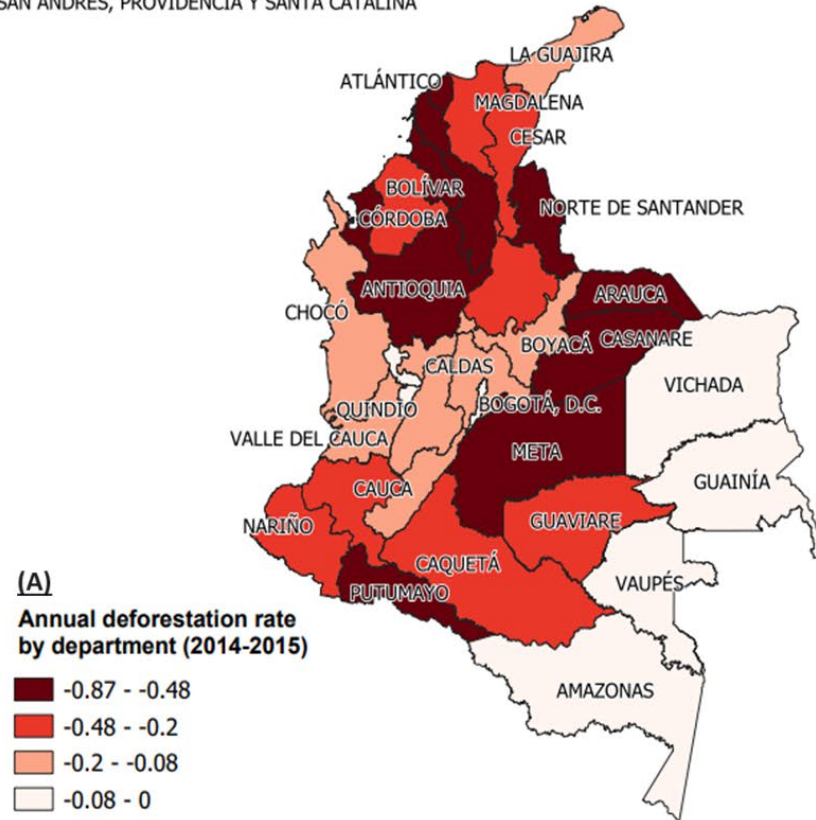
(B)
Total cattle herd (# heads) by Department in 2020



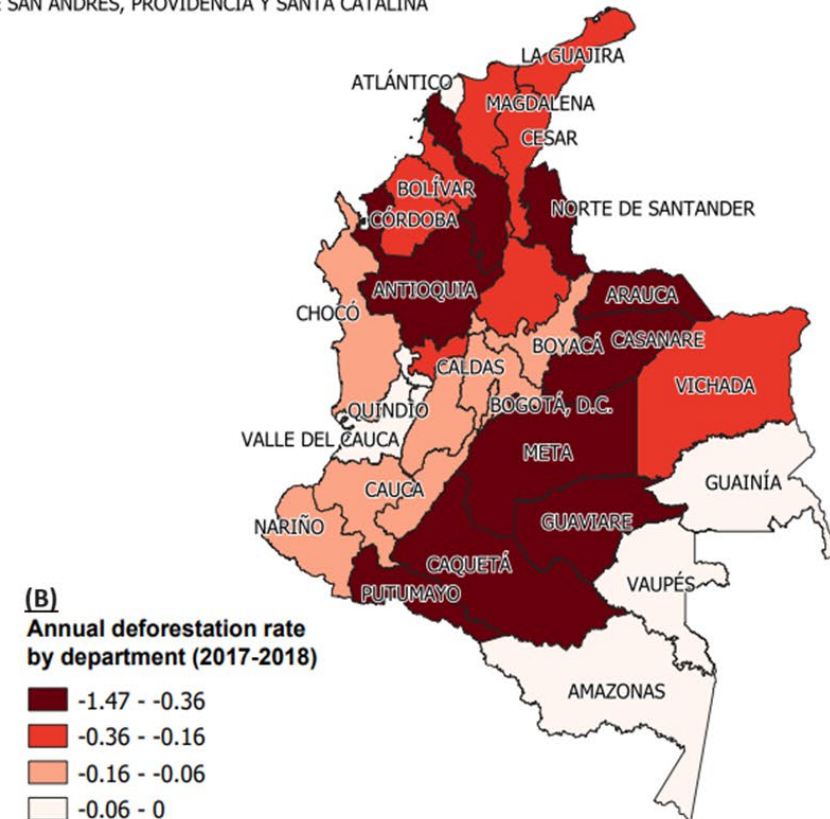
Deforestation

Between the periods 2014–2015 and 2017–2018, the loss of natural forest in the Amazon and Orinoco regions, which are subject to the extension of the local cattle sector, increased considerably.

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Agricultural credit and cattle production

Dependent variable: cattle production (herd size)					
Variables	OLS	FE	SAR	SEM	SARAR
Number of agricultural credits		11.1174**	7.7976*		7.6494*
		(4.3180)	(4.0731)		(4.20E+00)
Total credit value agricultural credits	-0.3429***		-3.0070e-01**	-0.29719**	-0.30548**
	(0.1192)		(0.10846)	(0.10888)	(1.10E-01)
Number of cattle credits	-111.6304***		-1.4431e+02***	-1857.89***	-151.76***
	(33.4814)		(29.532)	(30.262)	(3.03E+01)
Total credit value cattle credits	3.0620***	1.0002*	2.5421e+0**	2.6107***	2.6055**
	(0.8548)	(0.5238)	(0.78966)	(0.77541)	(7.92E-01)
Coca (hectares)					
Agricultural land use			-7.3207e-01*	-1.0126*	-0.85427*
			(0.42241)	(0.44366)	(0.43611)
Cattle land use	0.3001***	-0.0481*	2.8863e-01***	0.29898***	0.29884***
	(0.0354)	(0.0265)	(0.03125)	(0.033735)	(0.032774)
Agricultural Bank of Colombia offices (#)	12,005.1045***		12612***	13022***	13017***
	(2,167.6712)		(1978.9)	(2023.4)	(2021.6)
% Rurality	-527513.5352**	1730356.7720**	-6.7552e+05***	-863290***	-764350***
	(240,876.1994)	(819,586.8440)	(190630)	(225750)	(207470)
Rho			0.320157***		0.210559*
			(0.052533)		(0.093001)
Lambda				(0.062277)	
				0.436734***	
R-squared	0.5274				
LM Test (lag)	2.3287				
Robust LM Test (lag)	5.9633**				
LM Test (error)	0.90077				
Robust LM Test (error)	4.5353**				

Standard errors (robust) in parentheses.

The variables that do not appear in the table do not show statistical significance.

Source: Author's elaboration.

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

In the period 2011-2020, the levels of access to credit presented a clear correspondence with the increases in the cattle herd, bringing with it spatial effects between departments.

We observe that credit for cattle has a greater impact on the cattle herd in departments with more Agricultural Bank offices.

Agricultural credit and deforestation

Variables	OLS	RE
Cattle herd size (heads)	-1.6E-07*** 4.57E-08	-9.3E-08* 4.97E-08
Agricultural land use	6.5E-07* 3.7E-07	
Cattle land use	-6.64E-08** 2.84E-08	-5.21E-08* (3.12E-08)
Number of agricultural credits		
Total credit value agricultural credits	3.1E-07*** 1.1E-07	
Number of cattle credits	6.8E-05* 2.7E-05	
Total credit value cattle credits		
% Rurality	0.8722*** (0.1911)	0.5812* (0.3047)
Coca (hectares)	-1.3E-05*** 3.2E-06	-8.5E-06** 4.0E-06
Constant	-0.5857*** (0.0723)	-0.4905*** (0.1159)

Standard errors (robust) in parentheses.

The variables that do not appear in the table do not show statistical significance.

Source: Author's elaboration

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

- Cattle production has a negative and significant effect on the annual departmental deforestation rates, meaning that if the cattle herd increases and more land is used for cattle production, deforestation rates also increase.
- Cattle credit does **not seem to cause greater changes in deforestation levels** caused by this activity.
- Deforestation could be explained by **external phenomena not taken into account in this work**, such as the peace process, the limitations caused by the Covid-19 pandemic or the change of land use for the land appropriation.

Conclusions and recommendations

- Both an increase in the number of credits placed in a department as well as in the credit values destined to the cattle sector also **increase cattle production in the same department.**
- The study further provides evidence on the negative effect of cattle production on deforestation rates but also highlights that **cattle production is not the only cause** of it.
- Strategies aimed at **expanding the coverage of credits**, i.e., in (remote) **rural areas**, is recommended and could be achieved, e.g., through **increasing the number of bank branches** in the peripheral departments.
- The exploration of alternative strategies, such as **alliances with local microcredit institutions, financial cooperatives, and municipal administrations**, is recommended to expand the coverage of Agricultural Bank credits in remote regions.



The credits can effectively reach those who need them most and are no more concentrated mostly among large producers from the interior of the country

Conclusions and recommendations

- The expansion of cattle credit should be linked to pre-conditions that help assuring a sustainable growth of the sector and ecological conservation.
- It is thus recommended that **prior to granting credit**, a verification of no deforestation in the registered properties is assured.
- It is also recommended that the reduction of negative environmental impacts of cattle production is incentivized through the **access to specific credit lines for sustainable intensification**.
- You can consult our study in njp Climate Action journal <https://doi.org/10.1038/s44168-024-00107-3>



Establishment of silvo-pastoral system and improved pastures which comprise reduced interest rates that are dependent on the compliance with environmental criteria.



Thanks!



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