Branches and roots: banking presence and deforestation in Amazonian Indigenous lands*

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Abstract

Indigenous lands in the Brazilian Amazon contain some of the densest remaining tropical forest, yet face growing pressure from illegal deforestation. We show that local bank branches reduce that pressure: each additional branch in bordering municipalities lowers cumulative forest loss inside the Indigenous land by roughly 2.5 square kilometers within three years, an effect that persists for at least five years. The transmission channel is social capital: branch entry raises civic participation and employment in civic associations, and exogenous variation in these proxies lowers forest loss. Alternative channels such as local economic conditions, employment, and capital availability for clearing do not mediate the effect. We identify these effects using local projections that instrument branch dynamics in bordering municipalities with branch dynamics in an outer ring; the mediation analysis is disciplined by a structural model of the choice between legitimate and illegal activity.

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1 Introduction

Brazil, home to the largest portion of the Amazon rainforest, accounts for a disproportionately large share of observed deforestation in the biome (Ferreira (2026)). Indigenous lands, which comprise roughly one quarter of the Brazilian Legal Amazon (BLA) area[1], act as buffers against forest loss. This outcome results mainly from strict access restrictions to outsiders and sustainable forest management by the local Indigenous governance (Fetzer and Marden (2017); Amin et al. (2019); Walker et al. (2020); Sze et al. (2022); Qin et al. (2023); Virtanen et al. (2025)). Despite that, these Indigenous territories still suffer substantial deforestation, mainly associated with criminal activities such as illicit artisanal mining (Silva-Junior et al. (2023)), which in turn is likely shaped by local institutional conditions in surrounding areas.

In this paper, we show how banking presence in the Brazilian Amazon shapes deforestation inside Indigenous territories. In particular, we estimate how bank branch openings in nearby municipalities affect forest loss within Indigenous lands. Bank branches are a key local institution in remote areas such as the Brazilian Amazon, where financial access has been chronically limited (Beck et al. (2010); Fonseca and Matray (2024)).

Despite being historically underbanked, the region's branch network expanded throughout the 2000s and first half of the 2010s as federal initiatives led government-owned banks to open branches in poorer, remote areas. As these programs were discontinued and banking services increasingly digitalized, branch presence in the region began to decline. We exploit this variation in bank branches in our empirical analysis.

Because bank branches are located in the urban centers of surrounding municipalities rather than within Indigenous territories themselves, we build our unit of analysis as the Indigenous Land Territorial Footprint (ILTF): the set of municipalities that intersect or immediately border a given Indigenous land. This allows us to analyze the influence of banking presence in the municipalities immediately adjacent to an Indigenous land on deforestation inside the protected territory.

To address endogeneity in the placement of bank branch openings, we instrument changes in ILTF bank presence with changes in branch activity in an outer ring of municipalities surrounding the ILTF. Branch dynamics in this outer ring track regional expansion and contraction of branch networks, but are unlikely to affect deforestation inside Indigenous lands through any channel other than their influence on nearby ILTF branch presence.

Since effects on deforestation may unfold gradually, we use local projections (Jordà (2005)) in a panel setting to estimate the banking presence effect up to five years. The period of analysis ranges from 2008 to 2024, covering federal administrations with contrasting environmental policies and three full business cycles.

We find that each additional branch in an ILTF *reduces* forest loss inside the Indigenous land by about 2.5 km^2 within three years, an effect that persists through five years. Because bank branches cannot directly influence deforestation inside Indigenous lands, the estimated effect must operate through *indirect* channels. To identify the transmission paths, we use mediation analysis following Heckman and Pinto (2024) disciplined by a simple structural choice model in which potential perpetrators weigh the expected returns from illegal deforestation against the payoffs from legitimate activity.

The most natural candidate channels are economic conditions and availability of capital. Bank presence raises local economic activity, increasing the opportunity cost of criminal behavior (Becker (1968); Fonseca and Matray (2024)). Alternatively, local branches could ease access to the heavy machinery that forest clearing requires.[2] We test both channels and find no evidence that either transmits the effect: bank presence does improve local economic conditions and stimulates capital acquisition, but neither predicts deforestation inside Indigenous lands.

[1] Collectively, these Indigenous lands correspond to an area of 1,158,701 km^2, or approximately three times the area of Germany.

[2] Heavy machinery is often found by law enforcement and environmental surveillance in illegal deforestation sites. In fact, there are heavy machinery dealerships in some areas in the Amazon that suffer from illegal mining but without legitimate economic activity requiring such machinery (Hofmeister and Campos, 2022).

The operative channel is social capital: the stock of trust, civic norms, and social ties within a community (Coleman, 1988; Putnam et al., 1993). Higher social capital is associated with lower crime (Buonanno et al. (2009)), and is particularly relevant here since the forest is a public good whose protection depends on collective action. We proxy social capital with the first principal component of valid vote share and non-profit association employment, following the approach of Rupasingha et al. (2006) and the social capital proxies proposed by Guiso et al. (2004b). Higher bank presence increases social capital, which is in turn linked to reduced forest loss. On average across the five year horizon, the social capital pathway explains approximately XXX percent of the total effect.

How do bank branches build social capital? We document two complementary mechanisms. First, the Brazilian Amazon is extremely sparsely populated, and many municipalities received their first bank branch during the period we study. Because bank branches are typically located in the urban centers of predominantly rural municipalities, we argue that branch entry increases the frequency of interactions among local residents, thereby fostering social ties that would otherwise not form. Second, bank branches facilitate access to finance for local firms: we provide supporting evidence that increased banking presence stimulates the creation of small businesses, such as restaurants, which in turn promote community cohesion.

Our paper makes three contributions. First, we provide the first causal evidence that local banking infrastructure shapes deforestation outcomes inside Indigenous lands. Second, and more surprisingly, we show that this effect operates through social capital rather than the economic channels that prior literature on banking and local development would predict. Third, by documenting bank branch presence as a new determinant of social capital formation, our results carry implications for how the ongoing retreat of physical banking in remote areas may affect collective action and environmental outcomes well beyond finance.

Related literature Thanks to the availability of satellite data, research on the drivers of Amazon deforestation dates back to the 1990s, with important works such as Pfaff (1999) showing that major determinants are land characteristics and transportation infrastructure. The latter has been revisited in more recent work by Araujo et al. (2025), who show that improved transport connectivity increases incentives to clear forest, especially in remote areas. Other drivers include commodity prices (Assunção et al. (2015)) and institutional conditions such as property-rights insecurity, which weakens deterrence (Araujo et al. (2009)). Balboni et al. (2023)'s comprehensive review covers infrastructure, commodity prices, and governance, but does not examine local banking infrastructure, a gap this paper addresses. The closest antecedent is Assunção et al. (2020), which studies a rural-credit policy conditioned on environmental compliance and finds large reductions in deforestation driven by a contraction in credit to cattle ranching.

Deforestation dynamics inside Indigenous lands, however, have received much less attention in the literature. While many studies document the forest conservation capacity of Indigenous territories (Blackman and Veit, 2018; Walker et al., 2020; Qin et al., 2023), far less is known about the drivers of deforestation within these areas. Da Silva et al. (2023a) use spatial analysis to show that active fires, unofficial roads, and illegal mining activities are key drivers of deforestation inside Indigenous lands. In particular, illicit economic activities, such as illegal gold mining in protected areas, have emerged as a growing threat to Indigenous territories (Mataveli et al., 2022; Da Silva et al., 2023b). We contribute to this literature by providing the first causally identified evidence that institutional conditions in surrounding municipalities, specifically local banking infrastructure, shape deforestation outcomes inside Indigenous territories.

A substantial literature shows that branch presence and branching reforms shape local economic conditions. Jayaratne and Strahan (1996) exploit a intrastate branching reform in the United States fostered real income growth mainly through improved screening and monitoring rather than higher lending volumes. Similarly, Guiso et al. (2004a) shows that financial development fosters entrepreneurship and regional growth. In developing countries, the evidence points in the same direction. In Brazil, Fonseca and Matray (2022) document that a financial inclusion program targeting banking deserts increased firm entry, employment, and wages. In India, Barboni et al. find that randomized branch placement reduced poverty and informal borrowing, while Burgess and Pande (2005) show that rural branch expansion raised non-agricultural output.

In Mexico, Bruhn and Love (2014) exploit the opening of 800 bank branches and find higher labor market activity and household incomes in previously underbanked areas. We add to this literature by showing that branch effects extend beyond economic outcomes to environmental ones, and operate through a social rather than an economic mechanism.

Social capital shapes a wide range of economic and social outcomes (Putnam et al. (1993); Dasgupta (2005)). Most relevant to our setting, higher social capital is associated with lower crime (Buonanno et al. (2009); Akçomak and ter Weel (2012)), an effect rationalized by Glaeser et al. (1996) through the social dimension of criminal behavior. Social capital is also a precondition for governing common-pool resources such as forests (Ostrom (1990)): communities with higher social capital achieve better management of shared natural resources (Mertens et al. (2011); Auer et al. (2020)). We contribute to this literature by documenting bank branch presence as a determinant of social capital formation, a link not previously identified. We show that this channel accounts for a large portion of the causal effect of banking on Indigenous land deforestation.

2 Background

2.1 Institutional setting

According to the United Nations, there are nearly half a billion Indigenous people living in 90 countries worldwide. These groups are often socially marginalized and face threats to their land rights. The main legally binding international instrument addressing these challenges is the Indigenous and Tribal Peoples Convention of 1989 (ILO Convention No. 169), which obliges ratifying states to recognize and protect Indigenous peoples' ownership of the lands they traditionally occupy (International Labour Organization (1989)). The constitution of Brazil, one of the 24 countries ratifying ILO 169, explicitly acknowledges indigenous peoples' rights over their lands, and charges the federal government with demarcating and protecting those territories and their resources.

As of 2024, the Brazilian government had formally recognized X Indigenous lands nationwide, of which 381 are located in the Legal Amazon, covering approximately 25 percent of the region's total area. Figure 1 illustrates the geographic distribution of these Indigenous lands. Together, these territories are home to at least 421,655 people (IBGE, 2022) and exhibit substantial cultural diversity, encompassing at least 319 distinct ethnic groups and 157 different languages ISA (2026).

While not their primary objective, demarcated Indigenous lands have also functioned as effective barriers to the expansion of deforestation in the Amazon rainforest Blackman and Veit (2018). Walker et al. (2020) shows that Indigenous lands suffered 63% lower carbon stock losses compared to the rest of the Amazon over the period between 2003 and 2016. Related evidence indicates that demarcation is also linked to reduced deforestation in areas surrounding Indigenous lands De Assis Barros et al. (2022). These outcomes reflect a combination of governance and institutional mechanisms. Indigenous governance structures tend to align long run incentives with forest conservation Virtanen et al. (2025) In parallel, legal restrictions prohibit unauthorized economic activities within ILs, with enforcement formally assigned to the National Foundation for Indigenous Peoples (FUNAI).

However, despite their protective role, deforestation still occurs inside Indigenous lands. Figure 2 compares deforestation trends inside Indigenous lands with those in non-protected areas of the Legal Amazon, showing that forest loss, though lower, persists within Indigenous territories. The main known drivers of deforestation in these areas include illegal mining, clandestine airstrips, and the expansion of unofficial roads that facilitate access for extractive activities (Da Silva et al., 2023b,a). Given the illicit nature of the activity, and the fact that it tends to be capital-intensive, local economic conditions may play an important role. This motivates an examination of how banking presence in municipalities surrounding indigenous territories affect to deforestation dynamics within these lands.

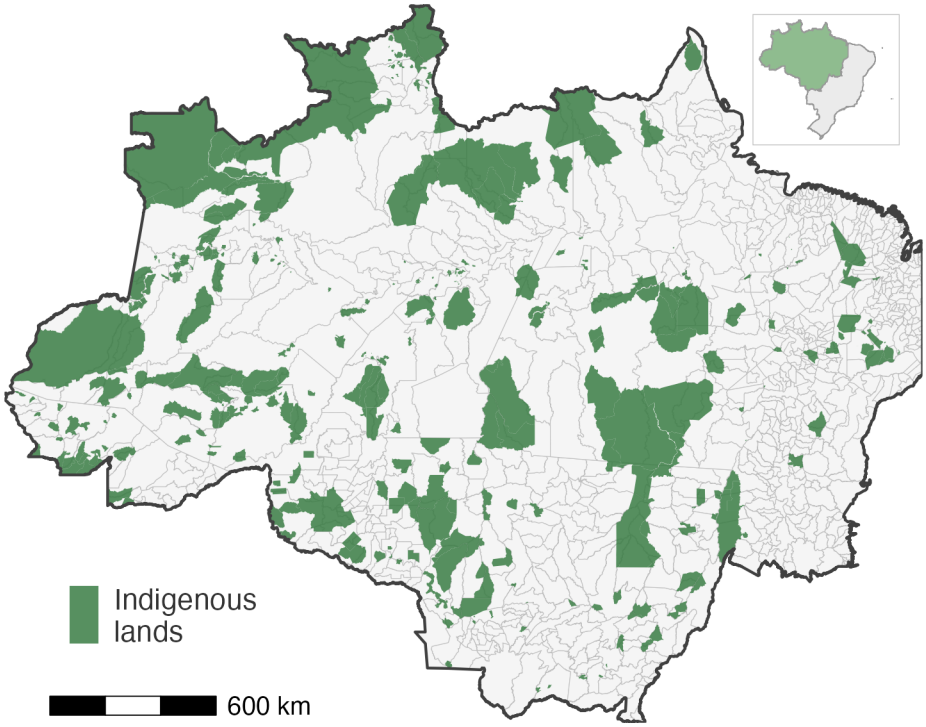


Figure 1: Spatial distribution of Indigenous lands across the Brazilian Legal Amazon

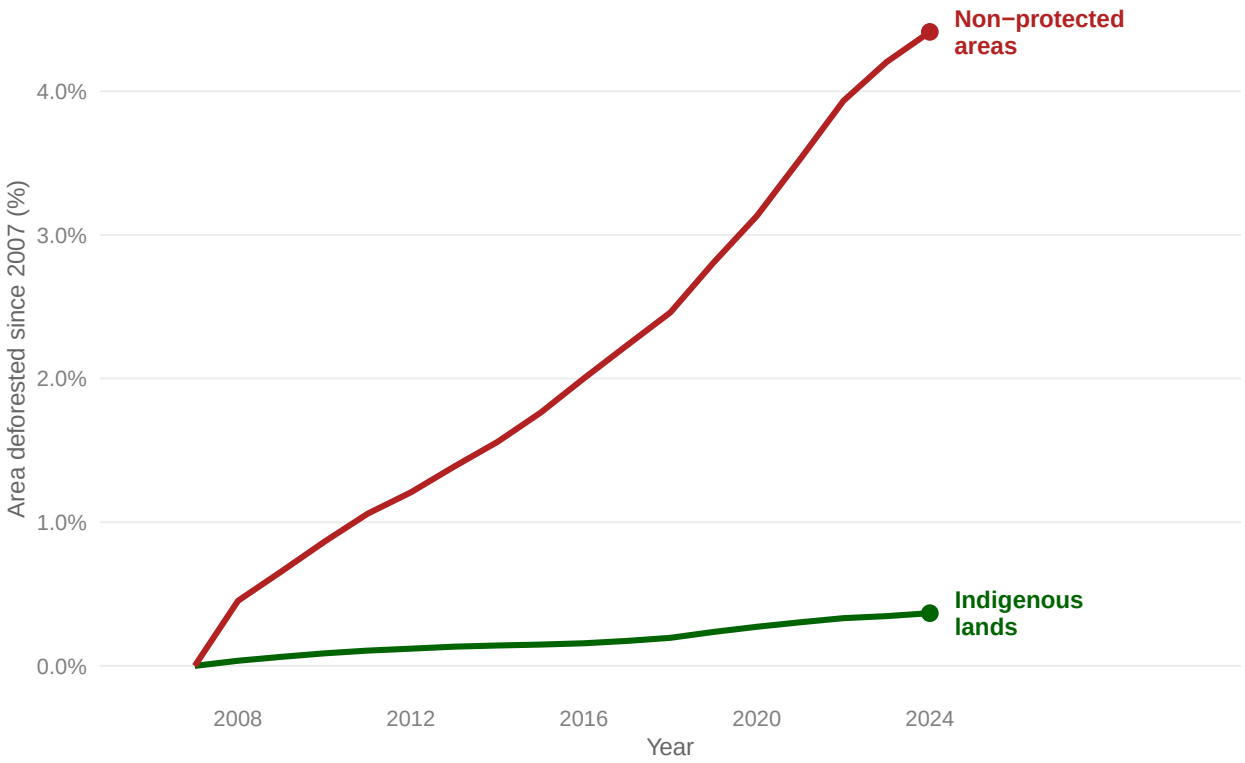


Figure 2: Cumulative Deforestation: Indigenous Lands vs Non-Protected Areas

2.2 Trends in banking in the Amazon

The spatial configuration of commercial banking in the Brazilian Legal Amazon changed markedly between 2008 and 2024. Figure 3 contrasts branch density across municipalities at the beginning and end of the sample, while Figure 4 reports the evolution of the regional branch stock. In 2008, 420 municipalities, corresponding to 54% of those in the study region, had no physical bank branch. By 2024, this number had fallen to 346 (45%). At the same time, the total number of branches in the region declined. The regional branch stock expanded rapidly during the commodity boom, reached a peak in 2015, and then declined steadily thereafter. This inflection aligns with the rapid diffusion of mobile banking, a shift that has been particularly pronounced in Brazil.

3 Data

All data used in this study is publicly available, and originates from a variety of Brazilian institutions. Deforestation figures were sourced from the Project for Monitoring Deforestation in the Legal Amazon by Satellite (PRODES), conducted by the National Institute for Space Research of Brazil. The PRODES dataset provides annual, wall-to-wall maps of clear-cut deforestation across the Legal Amazon, produced through visual interpretation of high-resolution satellite imagery from the Landsat series. Each detected deforestation event is represented as a geo-referenced polygon, with a minimum mapping unit of 0.065 km^2. Shapefiles delineating the municipal boundaries within the Legal Amazon were obtained from the cartographic database of the Brazilian Institute of Geography and Statistics (IBGE). Spatial layers identifying officially recognized Indigenous Lands and coordinates of FUNAI field offices were sourced from the Geoprocessing and Mapping Division of FUNAI.

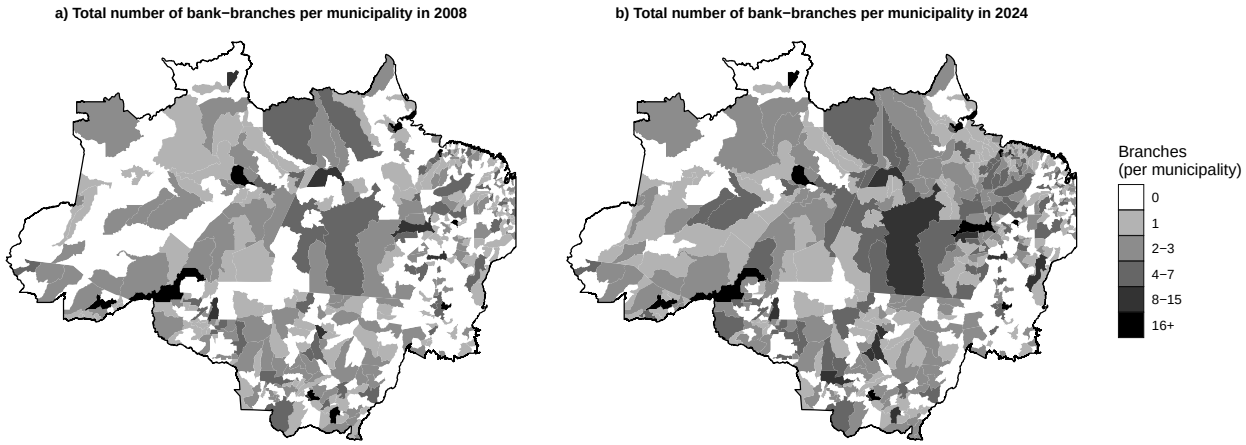


Figure 3: Bank-branch coverage across Legal-Amazon municipalities: a) 2008 vs. b) 2024

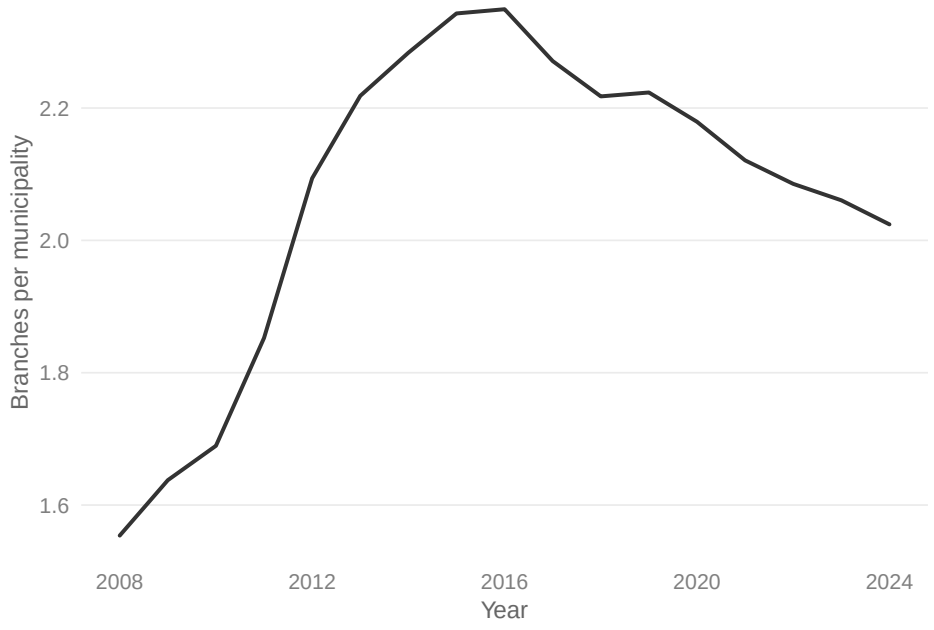


Figure 4: Average number of bank branches per municipality in the Legal Amazon

Information on bank branches comes from the Central Bank of Brazil and is based on mandatory monthly reports submitted by financial institutions at the municipality level. We aggregate these monthly observations into an annual average stock of branches for each municipality, smoothing transient openings and closures within a given year. The resulting dataset provides a municipality-level time series of average bank branch stocks for the Amazon region covering the period from 2008 to 2024.

The analysis further incorporates a set of economic, demographic, and spatial covariates. Gross Domestic Product, population counts, and municipal land area are also obtained from IBGE. Spatial layers on federal and state highways, navigable rivers, and other transport infrastructure come from Brazil's National Department of Transport Infrastructure and from *MapBiomas*. Sectoral variables such as rural credit are sourced from the Ministry of Agriculture and affiliated agencies. Table 27 in the Appendix summarizes all variable definitions and data sources used in the paper.

Indigenous Land Territorial Footprint (ILTF)

While some Indigenous lands are entirely inserted within a single municipality, others extend across multiple municipalities. Their legal status and governance, however, are independent of municipal boundaries. Local bank branches, on the other hand, are located in the urban centers of surrounding municipalities. In this context, to capture the effect of banking presence in the municipalities that have direct access to a given Indigenous territory, we construct the concept of Indigenous land territorial footprint (ILTF), which is our unit of analysis. For each Indigenous land, its respective ILTF is defined as the set of municipalities that either intersect it or whose boundaries lie within 1 km of the Indigenous land boundary. Figure 5 illustrates this construction using the *Andirá-Marau* Indigenous Land as an example. In the left panel, the central green area corresponds to the Indigenous land, while the surrounding dark gray area delineates its ILTF. The right panel shows the spatial distribution of clear cut deforestation polygons within the Indigenous land over the period 2008 to 2024. The light-grey municipalities form the outer ring, defined as the first-order neighbors of the ILTF that share a border with, but do not intersect, the Indigenous land itself. Branch dynamics in this outer layer will serve as the instrument for branch dynamics inside the ILTF, more details on that in Section 4. White areas denote other BLA municipalities that neither intersect the Indigenous Land nor belong to its outer ring.

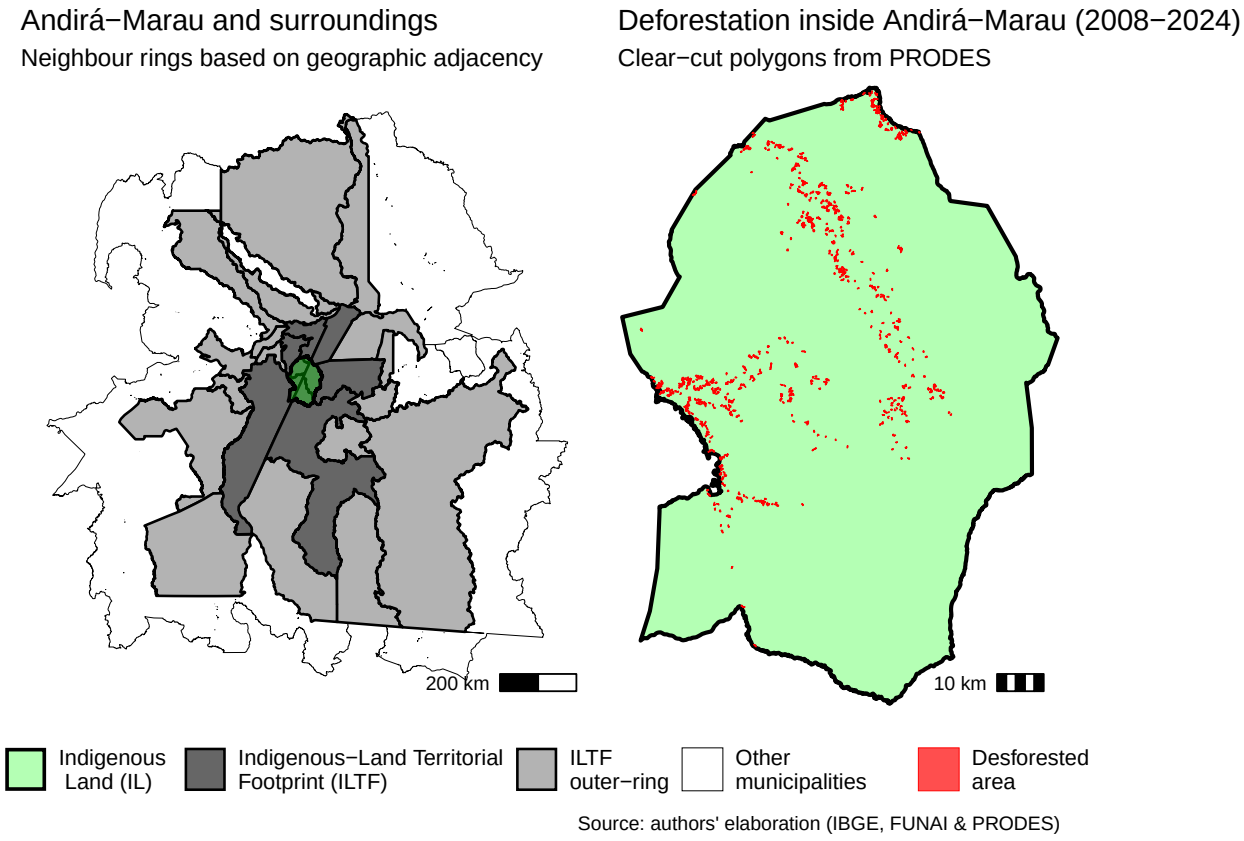


Figure 5: Left: Andirá-Marau Indigenous Land and neighboring municipality rings. Right: Clear-cut deforestation polygons inside the IL (2008–2024, PRODES imagery).

Using the ILTF as the unit of analysis, we aggregate bank branch counts across municipalities belonging to a given ILTF. The resulting measure captures the intensity of local banking presence in the municipalities with direct access to each Indigenous land and forms the main explanatory variable in the baseline analysis. The dependent variable, deforestation inside Indigenous lands, is measured using the clear-cut polygons that spatially intersect the Indigenous land boundaries. For each year and ILTF, deforestation is computed as the total area of polygons falling within the Indigenous land perimeter.

Table 1 summarizes the scale of ILTFs in our sample, showing that Indigenous lands average about 3,041 km^2 but vary widely in size, with the largest territory comparable in area to Portugal. The Brazilian Amazon is a sparsely populated region overall, which is reflected in the low average population density across ILTFs. Within this low density setting, Indigenous lands exhibit higher population density than their surrounding footprints. Using the 2022 Indigenous Population Census, population measures are available for 358 of the 381 lands in our sample. Among those, average density inside Indigenous lands is 14.5 pop/km^2, compared with 3.7 pop/km^2 in the corresponding ILTFs. Bank branch coverage is likewise thin. In 2019, the average municipality had 2.4 branches, and the average ILTF aggregated to 5.7 branches. Yet branchless regions remain common, evidenced by the presence of zero branch areas even at the ILTF-level. Deforestation inside Indigenous lands is also highly heterogeneous. Average annual forest loss is 0.7 km^2, and cumulative deforestation over 2008 to 2024 averages 11.2 km^2.

	N	Mean	SD	Min	Median	Max
Indigenous Land area (1000 km²)	381.0	3.0	9.3	0.0	0.4	96.6
ILTF area (1000 km²)	381.0	52.0	58.6	2.1	28.6	424.0
Indigenous Land population (2022, thousands)	358.0	1.2	3.0	0.0	0.4	27.2
ILTF population (2022, thousands)	381.0	88.7	98.9	4.1	54.2	727.4
Indigenous Land population density (2022, pop./km²)	358.0	14.5	116.8	0.0	0.8	1996.7
ILTF population density (2022, pop./km²)	381.0	3.6	5.9	0.2	1.6	72.4
Number of municipalities per ILTF	381.0	2.3	1.7	1.0	2.0	14.0
Average annual IL deforestation (km²)	381.0	0.7	2.3	0.0	0.1	28.6
Accumulated IL deforestation (2008–2024, km²)	381.0	11.2	39.7	0.0	1.3	485.8
Average branches per municipality (2022)	381.0	2.4	3.1	0.0	1.9	34.1
Total branches per ILTF (2022)	381.0	5.3	6.6	0.0	3.0	48.0

Table 1: Descriptive statistics for Indigenous Land Territorial Footprints (ILTFs) and associated Indigenous lands. Areas and populations are reported in thousands. Population variables use the 2022 IBGE census and therefore have smaller observations than the full ILTF sample.

4 Baseline results

This section documents the reduced form relationship between local banking presence and deforestation inside Indigenous Lands. The analysis is conducted at the level of the Indigenous Land Territorial Footprint (ILTF). For each ILTF and year, we measure bank presence as the total number of branches across all municipalities that intersect the footprint. Our main regressor, $\Delta B_{i,t}$, is the year on year change in branch stock.

We estimate local projection regressions (Jordà (2005); Jordà and Taylor (2025)) of cumulative deforestation outcomes up to horizon H on contemporaneous changes in bank branches. The specification includes ILTF and year fixed effects and controls for lagged deforestation inside Indigenous lands and in non protected areas. Formally, we estimate

$$\sum_{h=1}^{H} D_{i,t+h} = \alpha_t + \alpha_i + \beta \Delta \hat{B}_{i,t} + \gamma \mathbf{X}_{i,t} + \nu_{i,t+h}, H \in \{1, \ldots, 5\}, \tag{1}$$

where $D_{i,t}$ denotes the annual clear-cut area measured strictly inside the Indigenous land boundary associated with ILTF i. The dependent variable $\sum_{h=1}^{H} D_{i,t+h}$ aggregates deforestation over the subsequent H years, so β is interpreted as the change in cumulative Indigenous land deforestation up to horizon H following a one-unit increase in the number of local branches in year t. The regressor $\Delta \hat{B}_{i,t}$ denotes the instrumented yearly change in ILTF branch stock (the instrumental variable strategy is described below). The control vector $\mathbf{X}_{i,t}$ includes lagged deforestation inside Indigenous lands and in surrounding non-protected areas, capturing persistence and common local deforestation dynamics.

To address endogeneity in branch location and dynamics, we instrument $\Delta B_{i,t}$ with the contemporaneous change in bank branches in the outer ring of ILTF i, defined as the set of municipalities that share a border with the ILTF but do not intersect the indigenous land itself. The identifying assumption is that outer ring branch changes affect deforestation inside the Indigenous land only through their impact on branch presence within the ILTF. This exclusion restriction is plausible because outer ring branch openings and

closures mainly reflect network wide expansion or contraction driven by institutional factors and regional trends, rather than conditions inside the protected territory. Moreover, deforestation is measured strictly from PRODES polygons that fall inside the Indigenous land boundary, while outer ring branches are outside that boundary by construction. Year fixed effects and lagged deforestation controls absorb common shocks to forest loss that could otherwise be correlated with branch dynamics in the surrounding municipalities. First stage statistics reported in Table 2 indicate a very strong relationship between the instrument and ILTF branch changes, with F-statistics above 600 across all horizons, way above conventional thresholds.

Table 2 also presents the 2SLS estimates for horizons from one to five years. The coefficients on $\Delta \hat{B}_{i,t}$ are negative and statistically significant at conventional levels for all horizons. At $H = 1$, an additional bank branch is associated with a reduction of about 0.70 km^2 in cumulative deforestation inside Indigenous Lands over the subsequent year. The magnitude of the effect grows with the horizon and peaks around 2.5 at $H = 3$, then remains stable around 2.4 through $H = 5$. This pattern suggests that the impact of local bank presence on deforestation is persistent and continues to accumulate for several years after a branch opening. The lagged deforestation controls show that deforestation inside indigenous lands is somewhat persistent over time, while lagged deforestation in nearby non-protected areas has a very small and statistically insignificant association with current Indigenous Land deforestation, indicating that deforestation dynamics inside Indigenous territories are distinct from those in the surrounding forest.

Overall, the baseline estimates imply that changes in the local stock of bank branches are an economically meaningful determinant of forest loss in Indigenous Lands. To gauge magnitudes, we benchmark the estimates against the baseline deforestation levels. The five-year horizon estimate of roughly 2.4km^2 implies a reduction equivalent to more than three years of average annual deforestation for the average Indigenous land. That indicates that even a single branch opening constitutes a meaningful shift in cumulative forest loss over the medium run. Having established this reduced form relationship, Section 5 turns to the mechanisms that can rationalize it, using the structural framework in Section 5.1 to guide a mediation analysis along the relevant channels.

Dependent Variables:	1 yr	2 yr	3 yr	4 yr	5 yr
Variables					
Δ Branches	-0.6993**	-1.762**	-2.519**	-2.445**	-2.344**
	(0.3463)	(0.7299)	(1.133)	(1.225)	(1.143)
Deforest. Indigenous land (t-1)	0.1796***	0.3073**	0.2025	0.0253	-0.2929
	(0.0469)	(0.1544)	(0.2085)	(0.1644)	(0.3405)
Deforest. non-protected areas (t-1)	-0.0021*	-0.0087*	-0.0131	-0.0145	-0.0172
	(0.0011)	(0.0047)	(0.0085)	(0.0111)	(0.0121)
Fixed-effects					
year	Yes	Yes	Yes	Yes	Yes
ILTF	Yes	Yes	Yes	Yes	Yes
Fit statistics					
Observations	5,715	5,334	4,953	4,572	4,191
R^2	0.40665	0.49331	0.54751	0.59055	0.64759
F-test (1st stage), Δ Branches	786.71	720.76	658.33	713.94	741.20

Clustered (ILTF) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 2: Influence of bank presence on deforestation in indigenous lands

5 Mediation analyses

In this section we elaborate on the baseline results from Section 4 to identify the channels through which banking presence shapes deforestation. Because bank branches are located in surrounding municipalities rather than inside Indigenous lands, their effect on forest loss must operate through indirect mechanisms. We discipline the search for these channels with a structural model in which potential perpetrators weigh the expected returns from illegal deforestation against the payoffs from legitimate activity. The model yields three candidate transmission channels: social capital, local economic conditions, and the availability of physical capital. We find that social capital is the operative channel; we find no evidence that the other two transmit the effect.

Our specifications in this section are related to mediation analysis (e.g., Huber (2020)) with potentially multiple channels.

5.1 Structural model (under revision)

Our structural setting is as follows. The main agents are perpetrators who rationally choose whether to undertake illicit deforestation or a generic legal economic activity (Becker, 1968). Time subscripts and lagged variables are ignored for brevity.

Perpetrators have a technology to illegally clear forests with a Cobb-Douglas function that combines criminal labor available in a given ILTF i, L_i, with the amount of appropriate physical capital (such as heavy machinery) in that location, K_i. This function models the general case of illegal deforestation irrespective of whether the economic driver is timber, cattle pastures, or illegal mining; in any case, it reflects the gross proceeds from illegal deforestation. There are logistical costs ℓ_i reflecting the extensive areas and the different levels of logistical difficulties involved. Perpetrators ponder this net criminal payoff with the disutility of getting caught, J. These two scenarios are weighted by the probability that perpetrators would get caught, $p(E_i)$, explained below. To complete the utility from deforestation, the opportunity cost from engaging in a normal economic activity is deducted. The result is Equation 2:

$$U_i = (1 - p_i)u(L_i^{\alpha} K_i^{1-\alpha} - \ell_i) + p_i u(J) - u(y_i), \tag{2}$$

with α determining the labor share in the deforestation production function.

The probability that perpetrators will get caught depends on the level of enforcement in the region, E_i. This variable summarizes not only the human resources but also other resources available to both FUNAI and the indigenous tribes to monitor and protect ILs. Higher enforcement levels lead to higher probabilities of capturing perpetrators, conditional on them being there. Because it enters the utility function, the level of enforcement factors in the calculation of the expected return to criminal deforestation. The structural equation for the probability of getting caught is set as:

$$p_i = \sigma^p(E_i, V, \epsilon_i^p). \tag{3}$$

Equation 3 says that the probability p of the perpetrators getting caught depends on the level of enforcement in that area E_i, on a common confounder V and on independent shocks; the result lies between 0 and 1. For the purposes of our model, we set the level of enforcement to be exogenous for each ILTF. An active literature represented by Assunção et al. (2023), Merkus (2024), Berger et al. (2024) explores variation in enforcement to identify results, but since this is not a channel we posit as relevant for the *causal* influence of bank presence on deforestation, we do not vary it here. Similarly, the level of punishment is not varied in the model.

Perpetrators have a reservation utility $\underline{U}_i$ that dictates their predisposition to commit crimes. This value changes by location because it depends on the local social capital. In other words, in locations with high levels of social capital, perpetrators would only consider undertaking illegal deforestation if they expected to earn substantially more compared to places with low social capital. This is summarized in Equation 4:

$$\underline{U}_i = f^{\underline{U}}(S_i, \epsilon_i^{\underline{U}}) \tag{4}$$

The level of deforestation in area i, D_i, depends on the positive difference between the utility from crime, already deducted from its opportunity cost, and the reservation utility. This setup is formalized in Equation 5. Note that the utility from deforestation is parameterized as a standard Cobb-Douglas production function because, unlike traditional crimes, deforestation requires substantial capital investment.

$$D_i = f^D(\mathbf{1}[U_i > \underline{U}_i], \epsilon_i^D). \tag{5}$$

The availability of criminal labor depends on the economic conditions C_i and on social capital S_i, as in:

$$L_i = f^E(C_i, S_i, \epsilon_i^E), \tag{6}$$

where the economic conditions are also potentially responsive to the presence of banks:

$$C_i = f^C(B_i, V, \epsilon_i^C). \tag{7}$$

Finally, the stock of capital that can be used to clear forest areas is a function of the availability of bank finance:

$$K_i = f^K(B_i, V, \epsilon_i^K). \tag{8}$$

Banking presence in territorial footprint i is determined by the same unobserved confounder that can shift economic conditions and the availability of capital variables, as well as on the network of banks serving the surrounding region of municipalities $j \neq i$, $j \notin ILTF(i)$:

$$B_i = f^B(B_j, V, \epsilon_i^B). \tag{9}$$

The system has three channels through which exogenous variation in bank presence can affect deforestation. First, social capital S_i raises the reservation utility required before a worker will engage in illegal activity (Equation 4) and reduces the supply of criminal labor (Equation 6): in communities with stronger social ties, participation in illegal deforestation carries higher reputational and social costs. Evidence that social capital in the Amazon responds to local institutional conditions supports this channel: Mayer et al. (2022) document a significant deterioration of social capital in Amazon communities following large-scale hydropower projects. The conceptual motivation and measurement of social capital are discussed in Section 5.2.

Second, economic conditions C_i affect the opportunity cost of crime through labor supply (Equation 6). Bank branch presence raises local economic activity, increasing the returns to legitimate work and thereby reducing the pool of workers willing to engage in illegal deforestation. Fang and Vlaicu (2024) find that branch closures result in a reduction in the number of firms and a decline in formal work hours, consistent with this channel.

A third potential channel relates to the availability of capital K_i to clear forests, for example through credit (Equation 8). This would be consistent with evidence that branch expansion eases access to finance for

local firms: Fonseca and Matray (2024) document that expansion of the branch network in underbanked municipalities reduced informational frictions and increased financial inclusion and firm growth, though they rule out a broader local economic stimulus effect.

5.2 Social capital: concept and measurement

Social capital refers to the features of social structure, such as social bonds and norms, that facilitate collective action (Coleman, 1988). Communities with a higher stock of social capital find cooperation easier, as trust reduces the frictions inherent in most economic transactions (Putnam et al., 1993). For empirical purposes, the precise definition matters little, as different measures of social capital tend to be highly correlated in practice (Guiso et al., 2004b).

In our setting, Indigenous lands are a common-pool resource in the sense of Ostrom (1990): exclusion of illegal actors is costly and incomplete, and collective governance depends on shared norms of reciprocity and trust among community members. Auer et al. (2020) argue that social capital formation is a valuable conservation tool, particularly for indigenous communities, where power asymmetries would otherwise lead to their exclusion from resource governance. Direct evidence from the Brazilian Amazon confirms this: Mertens et al. (2011) show that social capital among local actors predicts the success of collective environmental governance in Amazon municipalities.

Higher social capital is associated with lower crime rates (Buonanno et al., 2009; Akçomak and ter Weel, 2012). This operates through peer sanctioning and community norms: Glaeser et al. (1996) show that criminal behavior responds to local social interactions, and social capital raises the social cost of defection by making deviance visible and punishable within the community. Since illegal deforestation is itself a criminal activity, this mechanism applies directly to our setting. In fact, the role of social capital is particularly pronounced where formal enforcement is weak. Guiso et al. (2004b) show that the effect of social capital on economic outcomes is strongest in regions with less reliable legal institutions, precisely the conditions that characterize the Brazilian Amazon.

Measuring social capital directly is difficult, so the literature relies on observable civic behaviors as proxies (Glaeser et al., 2000). Among the most common in the literature are electoral participation and civil society membership (Putnam et al., 1993; Guiso et al., 2004b; Rupasingha et al., 2006; Buonanno et al., 2009; Akçomak and ter Weel, 2012). Since these indicators capture different facets of the same latent construct and tend to be highly correlated, several papers aggregate them into a single index using principal component analysis (Rupasingha et al., 2006; Akçomak and ter Weel, 2012; Guriev and Melnikov, 2016). We follow this approach, constructing a social capital index (SCI) as the first principal component of valid voteshare and nonprofit association employment at the ILTF level. The construction of the index is described in detail in Section 7.1.

5.3 Econometric approach

The structural model of Section 5.1 lends itself well to represent causal structures, the interest of our analyses. Using g^W to represent a structural function for variable W that represents each variable only in terms of the other variables that *directly* cause it, our system can be simplified as:

$$
\begin{aligned}
D_i &= g^D(S_i, C_i, K_i, \epsilon_{D_i}) \\
S_i &= g^S(B_i, \epsilon_{S_i}) \\
C_i &= g^C(B_i, \epsilon_{C_i}) \\
K_i &= g^K(B_i, \epsilon_{K_i}) \\
B_i &= g^{B_i}(B_j, \epsilon_{B_i}) \\
B_j &= g^{B_j}(\epsilon_{B_j}) \\
\epsilon_{D_i} &\not\perp (\epsilon_{S_i}, \epsilon_{C_i}, \epsilon_{K_i}) \not\perp \epsilon_{B_i},
\end{aligned} \tag{10}
$$

where B_j represents the banks in surrounding municipalities. In other words, bank presence does not cause deforestation directly, but instead causally influences deforestation through three possible mediating channels. We estimate the model above as the following linear system:

$$D_i = \beta_D^S S_i + \beta_D^C C_i + \beta_D^K K_i + \epsilon_{D_i} \tag{11}$$
$$S_i = g^S(B_i, \epsilon_{S_i}) \tag{12}$$
$$C_i = g^C(B_i, \epsilon_{C_i}) \tag{13}$$
$$K_i = g^K(B_i, \epsilon_{K_i}) \tag{14}$$
$$B_i = g^{B_i}(B_j, \epsilon_{B_i}) \tag{15}$$
$$B_j = g^{B_j}(\epsilon_{B_j}) \tag{16}$$

These equations can also be represented in matrix form to facilitate identification of the parameters:

$$
Y_i = \begin{bmatrix} D_i \\ S_i \\ C_i \\ K_i \\ B_i \\ B_j \end{bmatrix}, \Psi = \begin{bmatrix} 0 & \beta_D^S & \beta_D^C & \beta_D^K & 0 & 0 \\ 0 & 0 & 0 & 0 & \beta_S^{B_i} & 0 \\ 0 & 0 & 0 & 0 & \beta_C^{B_i} & 0 \\ 0 & 0 & 0 & 0 & \beta_K^{B_i} & 0 \\ 0 & 0 & 0 & 0 & 0 & \beta_{B_i}^{B_j} \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}, E_i = \begin{bmatrix} \epsilon_{D_i} \\ \epsilon_{S_i} \\ \epsilon_{C_i} \\ \epsilon_{K_i} \\ \epsilon_{B_i} \\ \epsilon_{V_i} \\ \epsilon_{B_j} \end{bmatrix} \tag{17}
$$

in which case, $Y = \Psi Y + E$. Using the second moments of this equality yields $(I - \Psi)\Sigma_Y(I - \Psi)' = \Sigma_E$, with:

$$
\Sigma_Y = \begin{bmatrix} \sigma_{DD} & \sigma_{DS} & \sigma_{DC} & \sigma_{DK} & \sigma_{DB_i} & \sigma_{DB_j} \\ \sigma_{SD} & \sigma_{SS} & \sigma_{SC} & \sigma_{SK} & \sigma_{SB_i} & \sigma_{SB_j} \\ \sigma_{CD} & \sigma_{CS} & \sigma_{CC} & \sigma_{CK} & \sigma_{CB_i} & \sigma_{CB_j} \\ \sigma_{KD} & \sigma_{KS} & \sigma_{KC} & \sigma_{KK} & \sigma_{KB_i} & \sigma_{KB_j} \\ \sigma_{B_iD} & \sigma_{B_iS} & \sigma_{B_iC} & \sigma_{B_iK} & \sigma_{B_iB_i} & \sigma_{B_iB_j} \\ \sigma_{B_jD} & \sigma_{B_jS} & \sigma_{B_jC} & \sigma_{B_jK} & \sigma_{B_jB_i} & \sigma_{B_jB_j} \end{bmatrix}, \Sigma_E = \begin{bmatrix} \sigma^2_{\epsilon_D} & 0 & 0 & 0 & 0 & 0 \\ 0 & \sigma^2_{\epsilon_S} & 0 & 0 & 0 & 0 \\ 0 & 0 & \sigma^2_{\epsilon_C} & \rho_{CK} & \rho_{CB_i} & 0 \\ 0 & 0 & \rho_{CK} & \sigma^2_{\epsilon_K} & \rho_{KB_i} & 0 \\ 0 & 0 & \rho_{CB_i} & \rho_{KB_i} & \sigma^2_{\epsilon_{B_i}} & 0 \\ 0 & 0 & 0 & 0 & 0 & \sigma^2_{\epsilon_{B_j}} \end{bmatrix}.
$$

In terms of notation, in the regressions below we differentiate the direct estimates of the total effects from banking presence on deforestation with the hat notation ($\hat{}$), and the estimates obtained through mediation

analyses of indirect effects with the tilde (~). Our framework builds on the mediation analysis set out in Dippel et al. (2020) (see also Heckman and Pinto (2024)). First we regress each candidate mediator on B_i, using B_j as instrument, and collect $\tilde{\beta}^B_M$. This coefficient is the instrumented variation of bank presence on deforestation in ILs. In such a mediation system, exogenous variations of the mediators through the causal variable - local banking presence - identify the contribution of each mediation channel. Using M to signify a generic mediation channel, its effect would be $\tilde{\beta}^M_D \tilde{\beta}^B_M$. Unlike in Dippel et al. (2020), we don't need to control for bank presence because our estimates are not biased by any direct effect from banks on deforestation.

Equivalently, the total effect is the sum of the indirect effects, $\hat{\beta}^B_D = \sum_{M \in \{S,C,K\}} \tilde{\beta}^M_D \tilde{\beta}^B_M$. We estimate these effects below. It is important to note that because we are interested by definition only on the indirect effect, we judge the relevance of the instrument in the usual way, namely considering F-statistic values of 10 or more to be satisfactory (see for example the simulation exercise in Dippel et al. (2020)).

Our empirical strategy overcomes conceptual and data limitations by exploring signal from multiple variables on each type of mediation. As discussed in Section 5.2, social capital is difficult to measure directly, and economic conditions can be equally elusive. For both channels we therefore use the first principal component of representative variables, following Rupasingha et al. (2006); results for individual variables are presented in Annex B.[3] For economic conditions, the index is constructed from GDP growth, employment growth, and nighttime lights growth. For the stock of capital, we use the density of heavy vehicles per km² and rural credit outlays directly.

To test the different channels, we estimate regressions with ILTF and year fixed effects, which absorb time-invariant territorial characteristics and common annual shocks respectively.

5.4 Social capital: the operative channel

Table 3 reports the mediation estimates with the social capital index (PC1) as mediator. Column (1) is the first-stage regression of social capital on bank presence: an additional bank branch in the ILTF raises the index, and the instrument's first-stage F-statistic is above 10. Columns (2)-(6) project the instrumented mediator onto cumulative deforestation inside the Indigenous land at horizons of one through five years. The point estimates are negative and grow in absolute value with the horizon, mirroring the dynamics of the total effect documented in Table 2. The two stages identify the mediation path: bank presence raises social capital, and exogenous variation in social capital reduces forest loss.

Figure 6 quantifies how much of the headline effect this channel accounts for. The red squares are the total effects of bank presence on cumulative deforestation, with 95% confidence intervals from the baseline IV regression. The blue circles are the indirect effects through social capital, computed as $\tilde{\beta}^{M=S}_D \tilde{\beta}^{\Delta \text{ Banks}}_S$ with bootstrap intervals from 1{,}000 draws of the joint distribution of the two coefficients. The indirect-effect trajectory tracks the total-effect trajectory closely throughout the five-year window and the bootstrap intervals contain the direct point estimates at every horizon, indicating that social capital accounts for the bulk of the deforestation reduction attributable to local banking. This pattern is what the structural model in Section 5.1 suggests: a stronger civic fabric raises the relative payoff to legitimate activity and depresses participation in illegal forest clearing.

5.5 Economic conditions and capital: no evidence of transmission

The two natural alternatives to social capital, local economic conditions and the stock of physical capital, do not transmit the bank-presence effect to deforestation. Table 4 shows the mediation estimates using the first principal component of GDP growth, private-sector employment growth, and nighttime-light growth as a composite proxy for economic activity. Bank presence does shift the index in the first stage, but the

[3]Variables scaled by population (e.g., association employment) use the 2022 IBGE census population for 2022, 2023, and 2024, since municipal-level population data for 2023 and 2024 are not yet available.

Dependent Variables:	PC1	1 yr	2 yr	3 yr	4 yr	5 yr
Variables						
Δ Branches	0.2510***					
	(0.0929)					
Deforest. Indigenous land (t-1)	0.0043	0.1913***	0.3456**	0.2423	0.0617	-0.2742
	(0.0039)	(0.0549)	(0.1738)	(0.2187)	(0.1748)	(0.3400)
PC1		-2.258*	-5.360**	-6.982*	-6.643*	-5.295*
		(1.327)	(2.699)	(3.597)	(3.671)	(2.834)
Lagged deforestation	Yes	Yes	Yes	Yes	Yes	Yes
Fixed-effects						
year	Yes	Yes	Yes	Yes	Yes	Yes
ILTF	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics						
Observations	5,952	5,580	5,208	4,836	4,464	4,092
R^2	0.38713	0.40643	0.49310	0.54730	0.59035	0.64741
F-test (1st stage), Δ Branches	793.13					
F-test (1st stage), PC1		24.467	25.845	29.097	28.532	38.852

Clustered (ILTF) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 3: Mediation effect on indigenous land deforestation through social capital (1st PC)

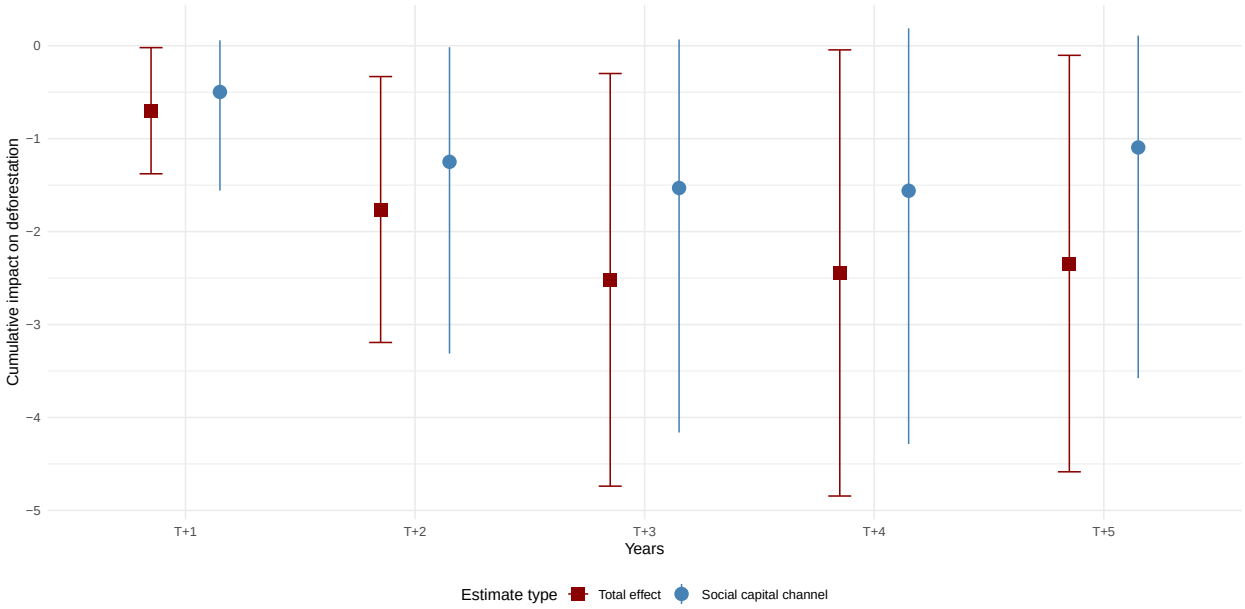


Figure 6: Cumulative deforestation in indigenous land in response to one additional bank branch. Total effects vs. effects mediated through social capital.

instrumented index has no detectable effect on cumulative deforestation at any horizon. The same null result holds when we replace the composite index with each of its components in isolation: GDP growth (Table 23), private-sector employment (Table 24), nighttime-light intensity (Table 25), and foreign-trade growth (Table 26) all confirm that local activity responds to bank presence but does not in turn shape deforestation conditional on that variation.

Dependent Variables:	PC1	1 yr	2 yr	3 yr	4 yr	5 yr
Variables						
Δ Branches	0.2486***					
	(0.0925)					
Deforest. Indigenous land (t-1)	0.0012	0.2673**	0.3697*	0.2132	-0.0321	-0.3385
	(0.0048)	(0.1257)	(0.2167)	(0.2143)	(0.1692)	(0.3746)
PC1		-3.871*	-8.225**	-10.06*	-11.56*	-14.83
		(2.132)	(4.172)	(5.210)	(6.821)	(10.17)
Lagged deforestation	Yes	Yes	Yes	Yes	Yes	Yes
Fixed-effects						
year	Yes	Yes	Yes	Yes	Yes	Yes
ILTF	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics						
Observations	4,893	4,893	4,893	4,893	4,512	4,129
R^2	0.11800	0.43789	0.50715	0.54789	0.59092	0.64805
F-test (1st stage), Δ Branches	646.84					
F-test (1st stage), PC1		8.5022	8.5022	8.5022	5.9780	3.2431

Clustered (ILTF) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 4: Mediation effect on indigenous land deforestation through economic conditions (1st PC)

Capital allocation tells the same story. Heavy-vehicle density, our proxy for the physical capital stock available for forest clearing, responds to bank presence but carries no effect on deforestation (Table 5). Table 6 shows that rural-credit outlays respond positively as well, though the instrument is too weak in the truncated 2016-2022 sample to identify the second stage. Neither channel survives as a plausible mechanism.

In sum, our estimates finds no evidence of standard finance-led development pathways through which bank branches might plausibly reach Indigenous lands: branches raise neither the capital equipment nor the credit available for clearing at magnitudes that matter. What they do raise is the social capital of the small Amazonian municipalities that border Indigenous lands.

Dependent Variables:	Heavy vehicles	1 yr	2 yr	3 yr	4 yr	5 yr
Variables						
Δ Branches	8.793*					
	(5.124)					
Deforest. Indigenous land (t-1)	0.0670	0.1814***	0.3216**	0.2454	0.0887	-0.1578
	(0.0717)	(0.0478)	(0.1592)	(0.2243)	(0.1913)	(0.3188)
Heavy vehicles		-0.1109	-0.2572	-0.2947	-0.3414	-0.3751
		(0.0854)	(0.1801)	(0.2099)	(0.2564)	(0.2832)
Lagged deforestation	Yes	Yes	Yes	Yes	Yes	Yes
Fixed-effects						
year	Yes	Yes	Yes	Yes	Yes	Yes
ILTF	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics						
Observations	6,096	5,715	5,334	4,953	4,572	4,191
R^2	0.89168	0.40665	0.49331	0.54751	0.59055	0.64759
F-test (1st stage), Δ Branches	830.70					
F-test (1st stage), Heavy vehicles		1.6722	2.2113	4.0604	3.5379	3.1854

Clustered (ILTF) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 5: Mediation effect on indigenous land deforestation through capital allocations. Heavy vehicles measured per km².

Dependent Variables:	Rural credit outlays (log)	1 yr	2 yr	3 yr	4 yr	5 yr
Variables						
Δ Branches	0.1064					
	(0.0895)					
Deforest. Indigenous land (t-1)	0.0059***	-0.1143	-0.4010***	-0.8062***	-0.9129***	-0.8279*
	(0.0020)	(0.0996)	(0.1102)	(0.2443)	(0.2156)	(0.4734)
Rural credit outlays (log)		-0.4382	2.226	-9.753	-14.41	4.042
		(4.121)	(9.616)	(11.37)	(15.79)	(6.571)
Lagged deforestation	Yes	Yes	Yes	Yes	Yes	Yes
Fixed-effects						
year	Yes	Yes	Yes	Yes	Yes	Yes
ILTF	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics						
Observations	1,901	1,901	1,901	1,578	1,262	942
R^2	0.95379	0.68697	0.80133	0.92156	0.95974	0.97147
F-test (1st stage), Δ Branches	131.52					
F-test (1st stage), Rural credit outlays (log)		0.95514	0.95514	1.7601	0.96086	5.1446

Clustered (ILTF) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 6: Mediation effect on indigenous land deforestation through capital allocations (outlays of rural credit). Only data between 2016 and 2022.

5.6 How can bank branches foster social capital?

We propose two complementary mechanisms. First, in sparsely populated regions such as the Amazon, a bank branch serves as an attractor to people who live outside the main city center, putting them in contact with other residents locally. Second, local banks more easily finance the small enterprises that make routine social interaction possible: restaurants, bars, entertainment venues, and supermarkets. In either case, the branch is the catalyst for what Putnam et al. (1993) calls the "horizontal" interactions through which trust and norms of cooperation form.

Table 7 tests the second mechanism. Each column reports the instrumented effect of an additional bank branch on the per-capita stock (per 100,000 inhabitants) of one category of business. Restaurants and bars, supermarkets, entertainment venues, and artistic activities all rise with branch entry. Bank branches raise the supply of meeting places, the kind of small business through which a community accumulates social capital.

This is what the social-capital channel looks like up close: not activity in general, but the kind that brings people into contact. The full chain from venue types to the social-capital index to deforestation inside Indigenous lands is documented in Section 7.4.

```
Error in `FUN()`:
! object 'mod_med_social_restaurants_1st' not found
```

Dependent Variables:	Rest. & bars	Hair salons	Entertainment	Artistic activities	Supermarkets	Sport clubs
Variables						
Δ Branches	0.1441***	0.0302	0.0736**	0.0721*	0.0958***	0.0437
	(0.0385)	(0.0517)	(0.0355)	(0.0380)	(0.0244)	(0.0502)
Deforest. Indigenous land (t-1)	0.0043**	0.0039**	0.0125***	-0.0041**	-3.54×10^{-5}	0.0037**
	(0.0019)	(0.0019)	(0.0020)	(0.0017)	(0.0010)	(0.0018)
Lagged deforestation	Yes	Yes	Yes	Yes	Yes	Yes
Fixed-effects						
year	Yes	Yes	Yes	Yes	Yes	Yes
ILTF	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics						
Observations	4,433	2,886	2,394	2,293	4,953	2,603
R^2	0.91987	0.83043	0.79561	0.71070	0.86285	0.77316
F-test (1st stage), Δ Branches	651.37	486.01	470.80	364.70	658.33	453.47

Clustered (ILTF) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 7: Impact of local bank presence on selected activities (each per 100,000 inhabitants).

6 Robustness analysis

We assess the robustness of the baseline result of Section 4 along two dimensions. First, we add state-by-year and mesoregion-by-year fixed effects, which absorb shocks that vary across regions within a year and are not captured by the baseline's year and ILTF fixed effects. Second, we restrict the sample by the indigenous land's legal-protection status, addressing the concern that estimates might be affected by Indigenous Lands whose administrative recognition is still in process.

6.1 Regional fixed-effect saturation

The baseline includes year and ILTF fixed effects, which absorb common time shocks and time-invariant ILTF characteristics. This configuration, however, does not fully absorb shocks that vary across regions within a year: federal credit programmes, commodity-price cycles, or development initiatives that typically operate at the level of states or mesoregions[4]. If such shocks are correlated with both outer-ring branch dynamics and deforestation inside Indigenous lands, the baseline coefficient is biased. To test that, we augment the local projection estimates with state-by-year and mesoregion-by-year fixed effects, identifying the bank effect from within-cell variation only.[5]

Table 8 and Table 9 report the baseline local projection estimates under state-by-year and mesoregion-by-year fixed effects, respectively. Point estimates strengthen monotonically as more regional time variation is absorbed: at the four-year horizon, the coefficient grows from −2.45 in the headline specification (Table 2) to −2.60 under state-by-year, and to −3.77 under mesoregion-by-year, an increase of roughly 50 percent. First-stage F-statistics fall from above 600 in the headline to roughly 300 under mesoregion-by-year fixed effects but remain comfortably above any conventional weak-instrument threshold. The pattern indicates

[4]the IBGE administrative subdivision between municipality and state

[5]When an indigenous land's territory spans more than one state or mesoregion, we assign it to the state and mesoregion containing the largest share of its area.

that regional shocks correlated with both branch dynamics and deforestation bias the baseline coefficient toward zero; absorbing these shocks reveals a larger negative bank effect. The baseline estimates are therefore conservative.

Dependent Variables:	1 yr	2 yr	3 yr	4 yr	5 yr
Variables					
Δ Branches	-0.7743*	-1.875**	-2.635*	-2.601*	-2.734*
	(0.4327)	(0.8859)	(1.401)	(1.533)	(1.482)
Lagged deforestation controls	Yes	Yes	Yes	Yes	Yes
Fixed-effects					
state-year	Yes	Yes	Yes	Yes	Yes
ILTF	Yes	Yes	Yes	Yes	Yes
Fit statistics					
Observations	5,715	5,334	4,953	4,572	4,191
R^2	0.43320	0.51799	0.57038	0.61267	0.66753
F-test (1st stage), Δ Branches	439.33	393.67	354.56	398.34	402.38

Clustered (ILTF) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 8: Baseline local projection estimates under state-by-year fixed effects

Dependent Variables:	1 yr	2 yr	3 yr	4 yr	5 yr
Variables					
Δ Branches	-1.283**	-2.693**	-3.619**	-3.769**	-4.179**
	(0.5921)	(1.088)	(1.563)	(1.744)	(1.816)
Lagged deforestation controls	Yes	Yes	Yes	Yes	Yes
Fixed-effects					
mesoregion-year	Yes	Yes	Yes	Yes	Yes
ILTF	Yes	Yes	Yes	Yes	Yes
Fit statistics					
Observations	5,700	5,320	4,940	4,560	4,180
R^2	0.45825	0.54178	0.59167	0.63147	0.68381
F-test (1st stage), Δ Branches	318.71	295.13	272.61	313.03	319.24

Clustered (ILTF) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 9: Baseline local projection estimates under mesoregion-by-year fixed effects

6.2 Sample restriction by legal-protection status

The baseline sample includes all 381 Indigenous lands in the Brazilian Legal Amazon regardless of administrative phase. Most (87%) are legally protected[6] against outsiders throughout 2008-2024; of the remaining 50, 38 become protected by 2024. A natural concern is that estimates are affected by lands whose administrative recognition is still in process, where the boundary-defense mechanism we propose cannot operate.

To assess this, we drop ILTFs whose Indigenous land was not legally protected throughout 2008-2024, retaining only those continuously protected for the full panel window. Table 10 reports the baseline local projection estimates restricted to the 336 ILTFs whose Indigenous land was continuously legally protected throughout the panel. Estimates are nearly identical to the headline, confirming that the result is not driven by lands whose administrative recognition is still in process. First-stage F-statistics remain comfortably above conventional thresholds.

Dependent Variables:	1 yr	2 yr	3 yr	4 yr	5 yr
Variables					
Δ Branches	-0.6898*	-1.725**	-2.547**	-2.647*	-2.441*
	(0.3634)	(0.7491)	(1.203)	(1.358)	(1.284)
Lagged deforestation controls	Yes	Yes	Yes	Yes	Yes
Fixed-effects					
year	Yes	Yes	Yes	Yes	Yes
ILTF	Yes	Yes	Yes	Yes	Yes
Fit statistics					
Observations	5,040	4,704	4,368	4,032	3,696
R^2	0.45659	0.54158	0.58480	0.61610	0.66555
F-test (1st stage), Δ Branches	691.22	638.34	587.36	630.75	665.06

Clustered (ILTF) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 10: Baseline local projection estimates restricted to ILs continuously legally protected during 2008-2024

7 Conclusion

This paper provides causal evidence that local banking infrastructure shapes deforestation outcomes inside Indigenous lands in the Brazilian Amazon. Using local-projection IV estimates over a 2008-2024 panel, we find that each additional bank branch in an Indigenous Land Territorial Footprint reduces cumulative forest loss inside the protected territory by approximately 2.5 km^2 within three years, an effect that persists through at least five years.

The transmission mechanism is not what prior literature on banking and local development would predict. Bank presence improves local economic conditions and raises the availability of physical capital, but neither of these in turn affects deforestation inside Indigenous lands. The operative channel is social capital: branch entry raises civic engagement (proxied by valid vote shares and employment in civic associations), and exogenous variation in social capital reduces forest loss. Mediation estimates indicate that this pathway accounts for the bulk of the total effect. Two complementary micro-mechanisms are consistent with this

[6] An indigenous land is *legally protected* if it has reached at least the *Declarada* phase by that year, or any of its parallel-track equivalents (*Reserva Indígena*, *Restrição de Uso*, *Dominial Indígena*). See Appendix **[TBD]** for the full classification and the data construction.

finding: branches increase the frequency of face-to-face interactions among residents in otherwise sparsely populated municipalities, and they stimulate small-business creation, both of which strengthen the local civic fabric.

These results carry implications beyond the specific setting. They point to an underlooked facet of local banking infrastructure: beyond financial inclusion, branch presence appears to support community life in ways that bear on environmental outcomes, particularly in regions where formal enforcement is thin. This dimension is worth considering in policy assessments of branch retention in remote Amazonian municipalities.

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Annex A: Understanding ILTF fixed effects

One way to think about the ILTF fixed effects is that they represent characteristics such as the physical features that might influence the decision to clear the forest, as well as enforcement activities. Table 11 shows that replacing ILTF fixed effect with a range of controls yields results that are consistent with our baseline results, albeit with less statistical power.

Dependent Variables:	1 yr	2 yr	3 yr	4 yr	5 yr
Variables					
Δ Branches	-0.6364*	-1.539**	-2.092**	-1.908*	-1.900
	(0.3333)	(0.6635)	(0.9881)	(1.090)	(1.178)
Deforest. Indigenous land (t-1)	0.1790***	0.2984**	0.1766	-0.0348	-0.5332**
	(0.0468)	(0.1512)	(0.1927)	(0.1412)	(0.2503)
Deforest. non-protected areas (t-1)	-0.0020*	-0.0079*	-0.0111	-0.0117	-0.0130
	(0.0011)	(0.0045)	(0.0076)	(0.0098)	(0.0107)
Avg. branches	0.0065	0.0257	0.0339	0.0301	0.0405
	(0.0107)	(0.0260)	(0.0466)	(0.0703)	(0.0943)
Avg. deforest. in protected areas	0.7627***	1.663***	2.867***	4.113***	5.502***
	(0.0587)	(0.1416)	(0.1914)	(0.2111)	(0.2712)
Avg. deforest. in unprotected areas	0.0026**	0.0090**	0.0126*	0.0137	0.0142
	(0.0012)	(0.0045)	(0.0073)	(0.0093)	(0.0099)
Avg. share of valid votes	-0.0005	-0.0192	-0.0385	-0.0468	-0.0524
	(0.0065)	(0.0188)	(0.0354)	(0.0475)	(0.0556)
Avg. empl. assoc. (per 1k)	0.0835	0.2237	0.4875	0.9203	1.130
	(0.0958)	(0.2216)	(0.4006)	(0.6044)	(0.8576)
Avg. no. of credit unions	-0.0017	-0.0019	-0.0033	-0.0060	-0.0039
	(0.0015)	(0.0036)	(0.0067)	(0.0099)	(0.0131)
Avg. CU members (per 1k)	0.0111	0.0111	0.0223	0.0430	0.0342
	(0.0129)	(0.0310)	(0.0569)	(0.0815)	(0.1016)
No indigenous villages	-0.0002	-0.0011	-0.0022	-0.0028	-0.0038
	(0.0005)	(0.0011)	(0.0019)	(0.0027)	(0.0032)
FUNAI branch in ILTF	0.0034	0.0271	0.0561	0.0737	0.1076
	(0.0112)	(0.0261)	(0.0464)	(0.0677)	(0.0887)
Surface (km²)	0.0223	-0.0010	-0.0522	-0.1149	-0.1910
	(0.0260)	(0.0617)	(0.1017)	(0.1471)	(0.1920)
Road across ILTF	-0.0192	-0.1065	-0.1975	-0.2635	-0.3048
	(0.0349)	(0.0865)	(0.1559)	(0.2206)	(0.2646)
Waterways across ILTF	0.0249	0.0707	0.1304	0.1719	0.2403
	(0.0921)	(0.2170)	(0.3696)	(0.5046)	(0.5912)
Port inside ILTF	0.0359	0.0926	0.1547	0.1952	0.1420
	(0.0810)	(0.1950)	(0.3494)	(0.4819)	(0.5318)
Airport inside ILTF	-0.0184	-0.1361	-0.3094	-0.3912	-0.4334
	(0.0403)	(0.1008)	(0.1920)	(0.2654)	(0.3094)
No. of ports in ILTF	0.0097	0.0136	0.0049	-0.0004	0.0513
	(0.0275)	(0.0714)	(0.1282)	(0.1761)	(0.1953)
No. of airports in ILTF	-0.0023	-0.0087	-0.0146	-0.0206	-0.0292
	(0.0030)	(0.0066)	(0.0106)	(0.0150)	(0.0182)
Fixed-effects					
year	Yes	Yes	Yes	Yes	Yes
Fit statistics					
Observations	5,715	5,334	4,953	4,572	4,191
R^2	0.39941	0.48115	0.52975	0.56840	0.62292
F-test (1st stage), Δ Branches	781.95	728.19	672.71	680.45	639.77

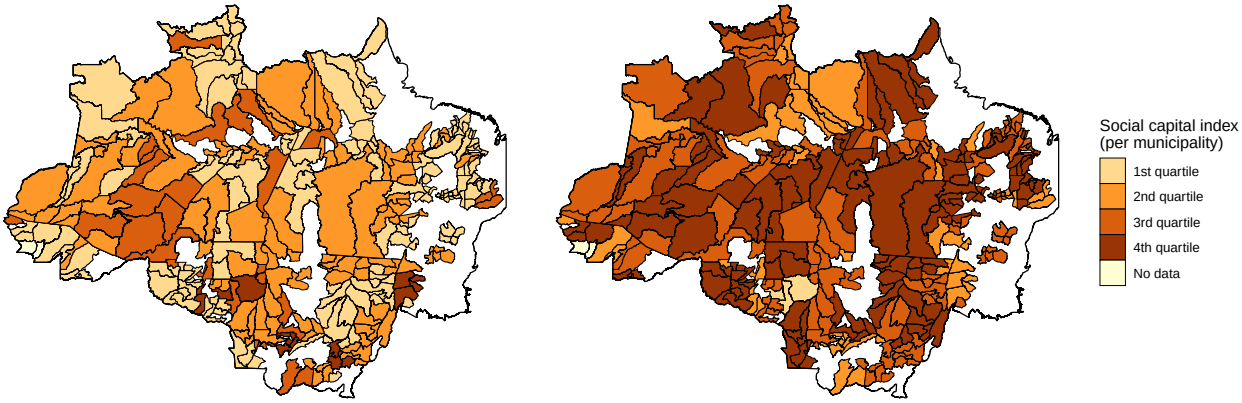
Clustered (ILTF) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 11: Mundlak estimator

Annex B: Social capital measurement

7.1 Social capital index construction

7.2 Social capital distribution



(a) 2008

Figure 7: Social capital index across ILTFs

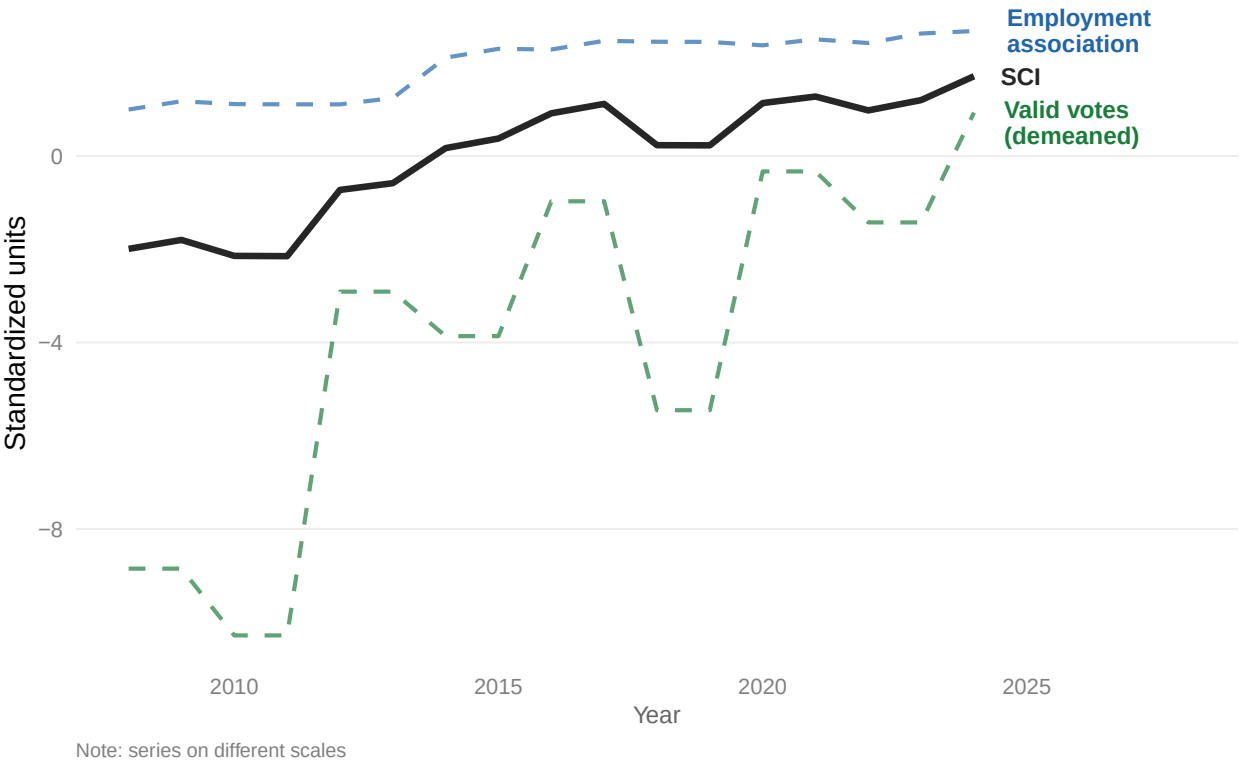
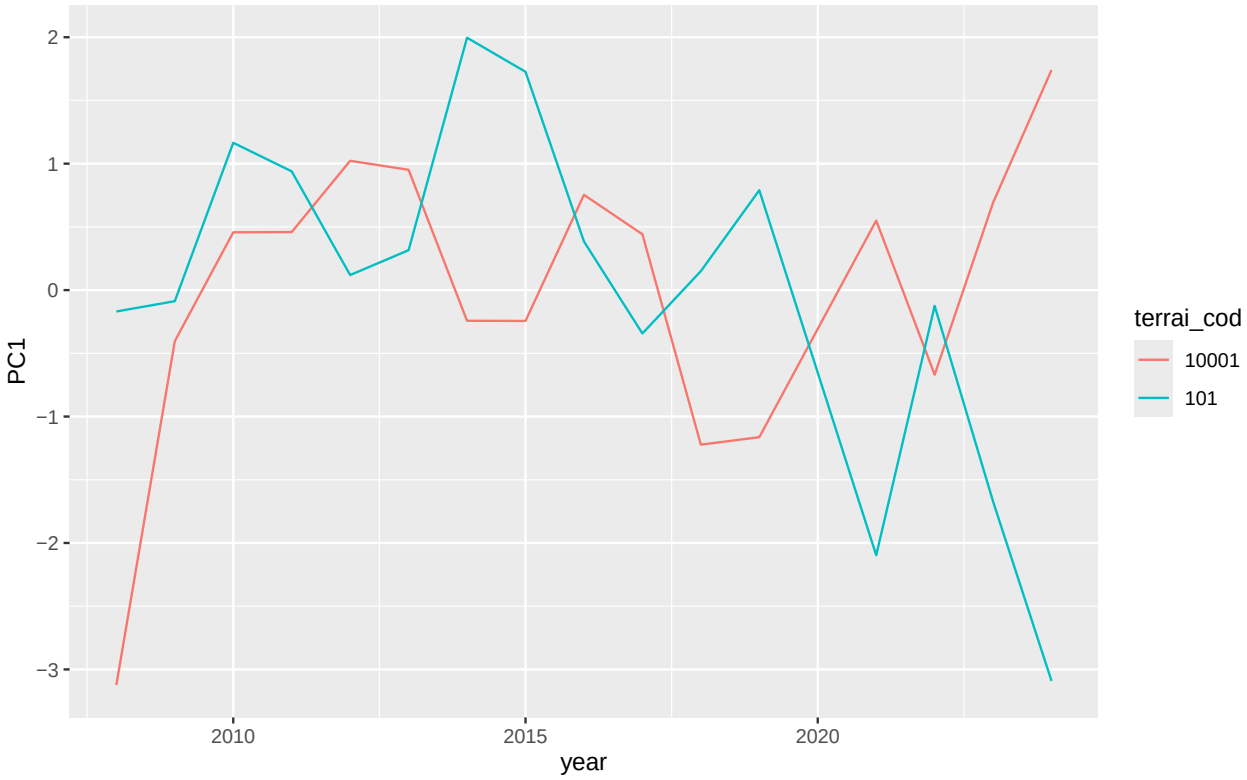


Figure 8: Example of social capital index

7.2.1 Alternative definitions of social capital



7.2.2 Individual social capital metrics

Results for the social capital mediation through the number of employees of associations by 100,000 inhabitants is in Table 12.

Dependent Variables:	Empl. Assoc.	1 yr	2 yr	3 yr	4 yr	5 yr
Variables						
Δ Branches	25.91***					
	(9.502)					
Deforest. Indigenous land (t-1)	1.300**	0.2256***	0.4260**	0.3499	0.1916	-0.1041
	(0.5193)	(0.0640)	(0.1960)	(0.2452)	(0.2226)	(0.3969)
Empl. Assoc.		-0.0324	-0.0850*	-0.1079*	-0.1444	-0.1555
		(0.0215)	(0.0502)	(0.0615)	(0.0969)	(0.1034)
Lagged deforestation	Yes	Yes	Yes	Yes	Yes	Yes
Fixed-effects						
year	Yes	Yes	Yes	Yes	Yes	Yes
ILTF	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics						
Observations	6,096	5,715	5,334	4,953	4,572	4,191
R^2	0.84781	0.40665	0.49331	0.54751	0.59055	0.64759
F-test (1st stage), Δ Branches	830.70					
F-test (1st stage), Empl. Assoc.		6.7209	7.1837	10.599	5.8692	4.8830

Clustered (ILTF) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 12: Mediation effect on indigenous land deforestation through social capital (civil society)

Results for the share of valid votes are in Table 13.

Dependent Variables:	Share of valid votes	1 yr	2 yr	3 yr	4 yr	5 yr
Variables						
Δ Branches	2.200***					
	(0.4571)					
Deforest. Indigenous land (t-1)	0.0578***	-0.0457	-0.2319*	-0.3320	-0.7271	-1.134
	(0.0203)	(0.0740)	(0.1373)	(0.2874)	(0.4800)	(0.8676)
Share of valid votes		-0.2596	-0.6358**	-0.6628**	-0.6620*	-0.6158**
		(0.1630)	(0.3212)	(0.3220)	(0.3628)	(0.2744)
Lagged deforestation	Yes	Yes	Yes	Yes	Yes	Yes
Fixed-effects						
year	Yes	Yes	Yes	Yes	Yes	Yes
ILTF	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics						
Observations	3,048	2,667	2,667	2,286	2,286	1,905
R^2	0.51036	0.36397	0.45222	0.55791	0.60139	0.68317
F-test (1st stage), Δ Branches	705.11					
F-test (1st stage), Share of valid votes		108.87	108.87	136.73	136.73	187.77

Clustered (ILTF) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 13: Mediation effect on indigenous land deforestation through social capital (votes)

Results for the evasion rate of lower school students are reported in Table 14.

Dependent Variables:	Lower school evasion rate	1 yr	2 yr	3 yr	4 yr	5 yr
Variables						
Δ Branches	-0.5216***					
	(0.1718)					
Deforest. Indigenous land (t-1)	0.0397**	0.1409**	0.2719**	0.2244	-0.0663	-0.3301
	(0.0183)	(0.0694)	(0.1168)	(0.1798)	(0.2471)	(0.3444)
Lower school evasion rate		1.325*	8.201*	10.29*	9.129*	10.00*
		(0.7416)	(4.751)	(5.895)	(5.244)	(5.813)
Lagged deforestation	Yes	Yes	Yes	Yes	Yes	Yes
Fixed-effects						
year	Yes	Yes	Yes	Yes	Yes	Yes
ILTF	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics						
Observations	5,334	5,334	4,953	4,572	4,191	4,191
R^2	0.79938	0.38716	0.46523	0.52791	0.57745	0.64759
F-test (1st stage), Δ Branches	775.18					
F-test (1st stage), Lower school evasion rate		7.2924	5.1791	6.2852	6.7679	6.7679

Clustered (ILTF) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 14: Mediation effect on indigenous land deforestation through social capital (evasion rate from lower school)

Results for the rate of suicides by 100,000 inhabitants are in Table **??**.

Results for the number of credit union members for each 100,000 inhabitants are in Table 15, and for the number of long-standing credit union members (those with a tenure of 10 years or more in the same credit union) are in Table 16.

Dependent Variables:	NumCUMembers	1 yr	2 yr	3 yr	4 yr
Variables					
Δ Branches	-1,804.9**				
	(736.2)				
Deforest. Indigenous land (t-1)	-37.83*	-0.1414	-0.0103	-0.6432***	-0.5894***
	(21.84)	(0.1070)	(0.0632)	(0.1602)	(0.0901)
NumCUMembers		-0.0003	-0.0012**	-0.0046	-0.0009
		(0.0004)	(0.0005)	(0.0041)	(0.0010)
Lagged deforestation	Yes	Yes	Yes	Yes	Yes
Fixed-effects					
year	Yes	Yes	Yes	Yes	Yes
ILTF	Yes	Yes	Yes	Yes	Yes
Fit statistics					
Observations	2,286	1,905	1,524	1,143	762
R^2	0.92172	0.64717	0.81404	0.94362	0.98346
F-test (1st stage), Δ Branches	157.69				
F-test (1st stage), NumCUMembers		10.923	37.108	2.9717	4.4923

Clustered (ILTF) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 15: Mediation effect on indigenous land deforestation through social capital (number of credit union members)

Dependent Variables:	NumLongstandingMembers	1 yr	2 yr	3 yr	4 yr
Variables					
Δ Branches	-347.1**				
	(167.4)				
Deforest. Indigenous land (t-1)	1.549	-0.1306	0.0585	-0.5987	-0.5793***
	(4.085)	(0.1263)	(0.0770)	(0.4934)	(0.0906)
NumLongstandingMembers		-0.0018	-0.0079**	-0.0954	-0.0021
		(0.0025)	(0.0039)	(0.3713)	(0.0021)
Lagged deforestation	Yes	Yes	Yes	Yes	Yes
Fixed-effects					
year	Yes	Yes	Yes	Yes	Yes
ILTF	Yes	Yes	Yes	Yes	Yes
Fit statistics					
Observations	2,286	1,905	1,524	1,143	762
R^2	0.92517	0.64717	0.81404	0.94362	0.98346
F-test (1st stage), Δ Branches	157.69				
F-test (1st stage), NumLongstandingMembers		5.1045	12.047	0.08265	12.104

Clustered (ILTF) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 16: Mediation effect on indigenous land deforestation through social capital (number of long-standing credit union members)

There is data between 2019 and 2024 on whether the school offers spaces for community activities. These results are in Table 17.

Dependent Variables:	School shares space with community	1 yr	2 yr	3 yr
Variables				
Δ Branches	0.2455***			
	(0.0861)			
Deforest. Indigenous land (t-1)	0.0034*	0.0673	0.2150	0.3168
	(0.0020)	(1.473)	(0.1385)	(0.3028)
School shares space with community		-252.8	100.2	26.22**
		(3,255.0)	(119.8)	(12.56)
Lagged deforestation	Yes	Yes	Yes	Yes
Fixed-effects				
year	Yes	Yes	Yes	Yes
ILTF	Yes	Yes	Yes	Yes
Fit statistics				
Observations	1,905	1,524	1,143	762
R^2	0.43613	0.63457	0.79622	0.95985
F-test (1st stage), Δ Branches	102.82			
F-test (1st stage), School shares space with community		0.00610	1.1737	28.432

Clustered (ILTF) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 17: Mediation effect on indigenous land deforestation through social capital (number of long-standing credit union members)

Dependent Variables:	School has parent-teacher org.	1 yr	2 yr	3 yr
Variables				
Δ Branches	0.0284***			
	(0.0098)			
Deforest. Indigenous land (t-1)	-0.0002	-0.0843	0.1994*	0.2916
	(0.0002)	(0.2492)	(0.1184)	(0.3722)
School has parent-teacher org.		-284.0	-363.3	-339.0
		(1,146.5)	(334.5)	(303.0)
Lagged deforestation	Yes	Yes	Yes	Yes
Fixed-effects				
year	Yes	Yes	Yes	Yes
ILTF	Yes	Yes	Yes	Yes
Fit statistics				
Observations	1,905	1,524	1,143	762
R^2	0.94571	0.63457	0.79622	0.95985
F-test (1st stage), Δ Branches	102.82			
F-test (1st stage), School has parent-teacher org.		0.04352	0.84796	1.3062

Clustered (ILTF) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 18: Mediation effect on indigenous land deforestation through social capital (schools with parent teacher organisation)

Dependent Variables:	School has student council	1 yr	2 yr	3 yr
Variables				
Δ Branches	0.0043			
	(0.0079)			
Deforest. Indigenous land (t-1)	0.0003***	-0.0241	-2.160	0.5820
	(0.0001)	(0.1391)	(36.05)	(0.5315)
School has student council		-136.4	10,816.8	-1,400.3
		(358.3)	(159,718.9)	(1,684.7)
Lagged deforestation	Yes	Yes	Yes	Yes
Fixed-effects				
year	Yes	Yes	Yes	Yes
ILTF	Yes	Yes	Yes	Yes
Fit statistics				
Observations	1,905	1,524	1,143	762
R^2	0.76750	0.63457	0.79622	0.95985
F-test (1st stage), Δ Branches	102.82			
F-test (1st stage), School has student council		0.41615	0.00379	1.2645

Clustered (ILTF) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 19: Mediation effect on indigenous land deforestation through social capital (schools with student council)

7.3 Summary of variable-level results

7.4 How branches build social capital: supplementary evidence

This subsection completes the chain from bank branches to social capital and ultimately to reduced deforestation inside Indigenous lands. The main text shows in Table 7 that bank branch entry raises the per-capita stock of meeting-place activities. We now show that (i) variation in those activities raises the social-capital index (Table 20 below), and (ii) the same activities mediate the bank-presence effect on deforestation when used directly as the mediator in place of the composite index. Table 21 reports the mediation through restaurants and bars; Table 22 reports the mediation through supermarkets. In both cases the pattern reproduces Table 3: branch entry raises the per-capita stock of these venues, and exogenous variation in the venues lowers cumulative deforestation inside Indigenous lands. The model fits use the same instrument as the headline IV, restrict the sample to 2008-2021 to match the activity-data coverage, and cluster standard errors at the ILTF level.

Dependent Variable:	PC1					
Variables						
Rest. & bars	1.837***					
	(0.6654)					
Deforest. Indigenous land (t-1)	-0.0025	0.0061	-0.0302	-0.0212	0.0209**	-0.0123
	(0.0044)	(0.0044)	(0.0615)	(0.0215)	(0.0091)	(0.0249)
Supermarkets		4.159***				
		(1.454)				
Hair salons			8.798			
			(15.03)			
Entertainment				2.771*		
				(1.632)		
Artistic activities					3.104*	
					(1.628)	
Sport clubs						5.415
						(6.023)
Lagged deforestation	Yes	Yes	Yes	Yes	Yes	Yes
Fixed-effects						
year	Yes	Yes	Yes	Yes	Yes	Yes
ILTF	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics						
Observations	4,395	4,836	2,886	2,394	2,288	2,603
R^2	0.34616	0.31551	0.40714	0.38469	0.41260	0.39910
F-test (1st stage), Rest. & bars	32.617					
F-test (1st stage), Supermarkets		34.093				
F-test (1st stage), Hair salons			0.91212			
F-test (1st stage), Entertainment				7.5711		
F-test (1st stage), Artistic activities					5.2174	
F-test (1st stage), Sport clubs						3.0893

Clustered (ILTF) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 20: Impact of selected activities on social capital (each per 100,000 inhabitants).

Dependent Variables:	Rest. & bars	1 yr	2 yr	3 yr	4 yr	5 yr
Variables						
Δ Branches	0.1441***					
	(0.0385)					
Deforest. Indigenous land (t-1)	0.0043**	0.2915**	0.4214*	0.2776	0.0569	-0.2957
	(0.0019)	(0.1316)	(0.2318)	(0.2280)	(0.1661)	(0.3577)
Rest. & bars		-6.669*	-14.19**	-17.29*	-17.97*	-16.01*
		(3.669)	(7.067)	(8.868)	(10.15)	(8.685)
Lagged deforestation	Yes	Yes	Yes	Yes	Yes	Yes
Fixed-effects						
year	Yes	Yes	Yes	Yes	Yes	Yes
ILTF	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics						
Observations	4,433	4,433	4,433	4,433	4,116	3,802
R^2	0.91987	0.43680	0.50647	0.54720	0.59022	0.64716
F-test (1st stage), Δ Branches	651.37					
F-test (1st stage), Rest. & bars		32.199	32.199	32.199	26.919	30.027

Clustered (ILTF) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 21: Mediation effect on indigenous land deforestation through social capital. Restaurants & bars measured per 100,000 inhabitants.

Dependent Variables:	Supermarkets	1 yr	2 yr	3 yr	4 yr	5 yr
Variables						
Δ Branches	0.0958***					
	(0.0244)					
Deforest. Indigenous land (t-1)	-3.54×10^{-5}	0.2625**	0.3595*	0.2015	-0.0333	-0.3671
	(0.0010)	(0.1200)	(0.2098)	(0.2021)	(0.1439)	(0.3473)
Supermarkets		-10.13*	-21.46**	-26.30**	-35.08*	-43.62*
		(5.379)	(10.43)	(13.09)	(19.90)	(25.61)
Lagged deforestation	Yes	Yes	Yes	Yes	Yes	Yes
Fixed-effects						
year	Yes	Yes	Yes	Yes	Yes	Yes
ILTF	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics						
Observations	4,953	4,953	4,953	4,953	4,572	4,191
R^2	0.86285	0.43723	0.50669	0.54751	0.59055	0.64759
F-test (1st stage), Δ Branches	658.33					
F-test (1st stage), Supermarkets		40.952	40.952	40.952	24.265	15.093

Clustered (ILTF) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 22: Mediation effect on indigenous land deforestation through social capital. Supermarkets measured per 100,000 inhabitants.

Annex C: Robustness analysis

7.5 Alternative baseline specification(s)

7.6 Mediation robustness

7.6.1 Alternative social capital measures

7.6.2 Alternative economic condition measures

Dependent Variables:	GDP growth	1 yr	2 yr	3 yr	4 yr	5 yr
Variables						
Δ Branches	0.0185**					
	(0.0081)					
Deforest. Indigenous land (t-1)	-0.0004*	0.2419**	0.3158	0.1480	-0.1521	-0.3302
	(0.0002)	(0.1121)	(0.1941)	(0.1881)	(0.2045)	(0.3540)
GDP growth		-52.58*	-111.4*	-136.5*	-282.6	-275.0
		(29.86)	(59.56)	(74.75)	(240.5)	(241.3)
Lagged deforestation	Yes	Yes	Yes	Yes	Yes	Yes
Fixed-effects						
year	Yes	Yes	Yes	Yes	Yes	Yes
ILTF	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics						
Observations	4,953	4,953	4,953	4,953	4,572	4,191
R^2	0.25619	0.43723	0.50669	0.54751	0.59055	0.64759
F-test (1st stage), Δ Branches	658.33					
F-test (1st stage), GDP growth		6.6984	6.6984	6.6984	1.4862	1.4233

Clustered (ILTF) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 23: Mediation effect on indigenous land deforestation through economic conditions (GDP growth)

Dependent Variables:	Priv. sector jobs growth	1 yr	2 yr	3 yr	4 yr	5 yr
Variables						
Δ Branches	0.0295					
	(0.0333)					
Deforest. Indigenous land (t-1)	0.0019	0.6201	0.5635	1.088	-3.215	0.0316
	(0.0015)	(5.391)	(0.4176)	(3.428)	(58.12)	(0.6224
Priv. sector jobs growth		-243.1	-100.1	-331.8	1,508.9	-103.0
		(2,991.8)	(148.3)	(1,276.7)	(27,144.3)	(162.8
Lagged deforestation	Yes	Yes	Yes	Yes	Yes	Yes
Fixed-effects						
year	Yes	Yes	Yes	Yes	Yes	Yes
ILTF	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics						
Observations	6,088	5,707	5,326	4,945	4,564	4,183
R^2	0.11962	0.40737	0.49394	0.54803	0.59102	0.6480
F-test (1st stage), Δ Branches	829.41					
F-test (1st stage), Priv. sector jobs growth		0.00937	0.39040	0.06867	0.00338	0.6816

Clustered (ILTF) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 24: Mediation effect on indigenous land deforestation through economic conditions (employment growth)

Dependent Variables:	Nighttime lights growth	1 yr	2 yr	3 yr	4 yr	5 yr
Variables						
Δ Branches	0.0186***					
	(0.0069)					
Deforest. Indigenous land (t-1)	0.0007	0.2065***	0.3728*	0.7410	0.0210	-0.1629
	(0.0006)	(0.0670)	(0.1925)	(1.223)	(0.2748)	(0.4387)
Nighttime lights growth		-38.33*	-175.2	-677.7	-271.1	-244.7
		(23.19)	(134.5)	(1,300.1)	(248.2)	(218.2)
Lagged deforestation	Yes	Yes	Yes	Yes	Yes	Yes
Fixed-effects						
year	Yes	Yes	Yes	Yes	Yes	Yes
ILTF	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics						
Observations	6,060	5,679	5,298	4,917	4,536	4,155
R^2	0.15837	0.40658	0.49325	0.54745	0.59050	0.64754
F-test (1st stage), Δ Branches	821.00					
F-test (1st stage), Nighttime lights growth		3.9924	1.1662	0.15279	0.86169	0.91466

Clustered (ILTF) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 25: Mediation effect on indigenous land deforestation through economic conditions (nighttime light growth)

Dependent Variables:	Exports growth	1 yr	2 yr	3 yr	4 yr	5 yr
Variables						
Δ Branches	-0.0331					
	(0.0559)					
Deforest. Indigenous land (t-1)	0.0045	0.1060	0.2926	0.1266	-0.1174	-0.5612
	(0.0032)	(0.1205)	(0.1971)	(0.2365)	(0.1614)	(0.4062)
Exports growth		14.63	17.34	11.45	7.072	1.050
		(31.22)	(17.60)	(9.244)	(13.38)	(6.742)
Lagged deforestation	Yes	Yes	Yes	Yes	Yes	Yes
Fixed-effects						
year	Yes	Yes	Yes	Yes	Yes	Yes
ILTF	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics						
Observations	2,825	2,621	2,419	2,231	2,044	1,839
R^2	0.12159	0.41829	0.50744	0.56718	0.61522	0.67657
F-test (1st stage), Δ Branches	608.50					
F-test (1st stage), Exports growth		0.19135	0.83486	2.6228	1.2033	5.2515

Clustered (ILTF) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 26: Mediation effect on indigenous land deforestation through economic conditions (exports growth)

7.6.3 Alternative capital stock measures

Annex D: Variable Definitions and Data Sources

Variable	Data source
Population	IBGE
GDP	IBGE
Indigenous land geometries	FUNAI
FUNAI branch locations	FUNAI
Amazon and municipality shapefiles	IBGE
Bank branches	Central Bank of Brazil
Credit unions	Central Bank of Brazil
Indigenous Peoples Census	IBGE
Indigenous peoples ethnicities and languages	Instituto Socioambiental (ISA)
Formal employment establishments (RAIS)	Ministry of Labor and Employment
Mortality records	Ministry of Health (DATASUS)
Vehicle fleet by type	National Traffic Department (DENATRAN)
Election results	Superior Electoral Court (TSE)
School Census	National Institute for Educational Studies and Research Anísio Teixeira (INEP)
Educational indicators	National Institute for Educational Studies and Research (INEP)
Livestock herd size	IBGE
Municipal directories	IBGE
Rural credit operations	Central Bank of Brazil
Municipal imports	Ministry of Development, Industry, Trade and Services
Municipal exports	Ministry of Development, Industry, Trade and Services
Water transport infrastructure (ports and waterways)	Ministry of Transport
Air transport infrastructure (airports and heliports)	Ministry of Transport
Transport infrastructure (ports, airports, waterways)	MapBiomas

Table 27: Data sources

We download the shapefiles with respect to indigenous lands from IBGE, using the status as of 2024 as our baseline measure. Shapefiles on Indigenous tribes ("aldeias"; `aldeias_pontosPoint.shp`) are downloaded from XXXX. The locations of Funai regional centers (`tis_crPoint.shp`) and technical centers (`tis_ctlPoint.shp`) are obtained from XXXX. The Indigenous land census (`il_census.csv`) comes from XXXX. Details about Indigenous peoples' ethniticities and languages (`ti_povos_all.csv`) are obtainable from XXXX. Deforestation data (`yearly_deforestation.shp`) comes from PRODES (specific site).